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KNOWLEDGE IN THE 21<sup>ST</sup> CENTURY»  
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**Частина I. HUMANITIES**

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**PHENOMENON OF MASS MEDIA INFLUENCE ON SHAPING PUBLIC OPINION**

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**Abstract:** Social consciousness is an important part of any culture and this article investigates the extent of manipulating public opinion by mass media. In order to understand the mechanism of media's manipulation, we consider its methods and functions. The arguments revealed in the course of our research allow us to conclude that media is an essential tool for the formation of public opinion in the modern world.

**Keywords:** influence, manipulation, media, public consciousness.

**Introduction:** Today the media plays a big role in a person's life and has a sufficient share of influence on the formation of a personal opinion. Daily millions of newspapers, magazines and TV programs give the world information not in its pure form, but in the light of somebody's profit and the recipient does not have the opportunity to give his/her own assessment of the information. Society has to some extent become dependent on the media, despite the fact that it is not as vital as primary needs. The reason for this is that the present requires a person to be always in the center of events.

At this stage of human development we are hardly ever able to make independent movements and decisions. All of us in one way or another are influenced by the press, radio, television, or Internet. This dependence explains the topicality of the research topic. The main theoretical challenge is the understanding of the relationship between the media and the public through the study of mass communication with its power and influence, professional culture of media professionals, audience of mass communication, the role of the media in political and economic life of society, shaping public opinion and universal reproduction of culture. We have to admit that the media has become one of the powerful structures in modern society, and it is now hardly debatable. In order to be safe from such direct or indirect affection people have to realize the power of the media and understand the processes through which they become puppets.

The **object-matter** of the study is the influence of the media on public opinion in day-to-day life, and **the subject-matter** is methods of the media's influence on the person and his/her priorities.

The **objective** of this article is to examine the place and role of the media in society and its influence on public opinion. The article suggests the following **tasks**:

- 1) to assess the extent of the media influence;
- 2) to investigate the functions of the media;
- 3) to examine the methods of the media influence on public consciousness.

We applied two **methods of research** in the course of this article: description and observation.

**Discussion and results:** The influence of the media on mass audience has been a widely-discussed problem in different countries for about a century. At the beginning of XX century, when mass communication was finally formed, manipulation of society became possible. With the advent of television and radio our world has become more informative. However, the Internet made our society highly dependent on being daily or even hourly informed about all news and events. Nowadays information is not a privilege of minorities, but an

essential necessity for a wide audience. Communication has changed and nowadays it has new means, and the target respectively. Mass communication, or in other words, the media became a translator of the entire information environment for the society [1].

The mass media is one of the means which allows to maintain the functioning of the society as a whole. Among many classifications of the functional characteristics of mass communication, two basic levels are distinguished: the level of society and the level of an individual. The functions of the mass media in society are classified in the following way:

1. information,
2. education,
3. advocacy,
4. socialization,
5. criticism and control,
6. mobilization,
7. innovation,
8. operation,
9. formation of public opinion [2].

The media has developed the most effective training techniques and programs of influence on individuals and groups. It takes into account the specifics of the tasks, goals, and audience which are the target [3]. Such methods and programs include:

- information technique. It is actively used in advertising campaigns and informational announcements. It is aimed at informing the audience about a particular event, person, or phenomenon;
- emotional technique. It brings the emotional component to the forefront when it forms the person's attitudes to a certain phenomenon. It is usually used together with other methods thus enhancing their influence on the audience;
- patriotic technique. Most people are not indifferent to their land, home, and homeland. Using this fact, the media stimulates people's attention and encourages certain actions. This method is actively used for promotional purposes, during political campaigns etc.;
- "awakening the fear" technique. It is based on people's concern for their health, well-being, and welfare and its aim is human emotions. The method is widely used for promotional purposes, during various political actions and campaigns;
- humorous technique. Simple and comprehensible humor captures the audience easily and quickly. Information presented with humor is remembered more easily. The method is actively used during entertainment, political, advertising campaigns. One of the important requirements when using this technique is to ensure that the humor suits culture, age and mentality of the target audience [4].

The abovementioned techniques are in most cases used with positive and friendly purpose. However, we would like to show some examples of the media's negative influence. In this respect it is appropriate to say about subconscious pressure on those people who are easily subjected to such influence because of their complexes, health problems or psychological disorders. Nowadays it is not a secret that the media widely advertises unhealthy food, at the same time urging people to lose weight and maintain a slim figure. Furthermore, a big quantity of entertainment TV programs, series or soaps absorbs a person's leisure and thus leaves no time for physical exercises. As we know, girls of all ages are concerned with their own weight. Many of them keep diets being quite young. One of the reasons for it is that the media often promotes unrealistic appearance of a perfect person. Often a well-built man, whose image is shown on screen or in print, is just a picture composed of different people's parts. This installation is created using computer graphics.

One problem associated with human's health is the promotion of thinness on TV and in the Internet. We can thereupon mention the Russian series "Kuhnya" (eng. Kitchen) (2012). One of the main characters, Dmitriy Nagiiev, the owner of the restaurant, is always eating, but nevertheless stays well built. A lot of people may follow his manner of eating and not doing any workout. As a result, they will gain weight and their health will be undermined. American series "Scream Queens" (2015) can also illustrate this tendency. Its main heroine Chanel Oberlin is worried about her weight too much and she is crazy about diets. Moreover, she constantly pesters other girls who are not so slim. Young and naive viewers believe that if they become the same with this character, their life will be as great as Chanel's. However, being so skinny and healthy at the same time is impossible but many young ladies still harm themselves and follow this role-model. This phenomenon is very common not only with films for adults or teenagers, but with cartoons as well. Nowadays one of the most popular cartoons among children is "Monster High". Its main characters are very skinny with unreal long legs

and thin waists. Their influence is very powerful because little girls are very sensitive at this age as this is the time when they first think about their appearance.

Another example of the media's influence on people is medicine advertising. Nowadays such advertisements are so common that people are mindlessly buying what they see or hear about on TV or in the Internet. Such an irresponsible behavior of people leads to tragic consequences because the right drug for safe treatment may be only prescribed by a doctor. Usually advertised medicine has quite a high price and thus most consumers have no idea about a cheaper analogue.

**Conclusions:** This article considers the basic concepts and types of the media, their role and place in today's society. The media is the main channel of formation and expression of public opinion in the modern world. Print media, radio, TV and the Internet are powerful tools of socialization. Thus, they may implement both the creative and destructive tasks. As the media can influence different target audiences using a great variety of methods and programs, its effect has no limits. It should be noted that through manipulation of values and beliefs, the media can change public attitudes and opinions. We have mentioned that the mass media's influence can be both positive and negative but the latter is coming to the foreground. The best way to be protected from the media's harmful influence is to be aware of its methods of manipulation. Sometimes people allow themselves to be manipulated by dropping responsibility for their actions on the so-called manipulators. However, we have to admit that no one is responsible for our opinions and attitude but we ourselves. We have to read, learn and self-educate as much as possible.

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## PERSONALITY CHARACTERISTICS OF WOMEN WITH DIFFERENT TYPES OF SEX-ROLE IDENTITY

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**Abstract:** The article deals with the particular personality characteristics of women. It considers the components of the personality structure of women with different types of sex-role identity, the components of narcissistic traits associated with the type of gender identity and a number of the individual components associated with the aspects of narcissistic regulation.

**Key words:** narcissism, personality, personality traits, psychoanalysis, sex-role.

#### Introduction

The issues of the sex-role characteristics of an individual are becoming more and more important in modern society. The roles of men and women are undergoing significant changes. The modern world is characterized by modifying the concept of sex and actualization and updating of the concept of gender. An active rethinking of various sex-role stereotypes associated with the departure from the purely biological understanding of gender and the social transition to look at the role of an individual, i.e. gender [Kocharyan A.S., 1996] is going on. As the attitudes towards women and their functions are changing, the preference is more frequently given to the implementation of social achievements rather than to the fulfillment of the tasks due to a greater extent the biological issues as it was before. Social realization is coming to the fore, an individual perceives and implements gender norms, values and cultural attitudes that affect the formation of personality characteristics [Veyninger, O., 1997]. Along with the changes in perception and requirements of gender roles according to the latest trends in modern society, the so-called "narcissistic culture" [Sokolova E.T., Chechel'nitskaya E.P, 2004] is developing. The type of a person characterized by the narcissistic traits is taking shape under the influence of new cultural values. The researchers in the fields of philosophy, sociology and

psychology ascertain "narcissism epidemic" [Pavlova O.N., 2010]. As a personality faces with the need to adapt to the rapid social and economic changes, his/her characteristics that must comply with the competitive individualistic tendencies [Shamshikova O.A., 2009] cannot help being affected, which eventually affects interpersonal relationships. The new systems of interactions which in its turn have an impact on the internal dimension of an individual are emerging.

Thus, it is appropriate to examine the manifestations of the narcissistic personality traits in relation to the type of sex-role identity.

**Object-matter:** sex-role identity.

**Subject-matter:** the personal characteristics of women with different types of sex-role identity.

**Objective:** identify the personal characteristics of women with different types of sex-role identity.

**Tasks:**

1) to conduct the theoretical analysis of psychological concepts of sex-role identity due to personal characteristics;

2) to investigate the personality traits of women with different types of sex-role identity;

3) to analyze the components of personality type of women with different types of sex-identity;

4) to study the structure of narcissism of women with different types of sex-role identity.

**Methods:**

1) Sex-role Structural Scale (Kocharyan A.S., Frolova E.V.);

2) Griger Questionnaire;

3) Self Portrait Personality Test;

4) Narcissism Assessment Test;

5) methods of mathematical statistics – factor analysis, t-Student test.

## **Discussion and Results**

To analyze the structure of the personality of women depending on the type of sex-role identities, a factor analysis of the research methods was carried out (masculine, feminine, androgynous and undefined).

To group the personality types according to the individual factors, a factor analysis of the survey results by Griger questionnaire was made. During the reckoning two factors were revealed.

To group the personality types according to the individual factors, a factor analysis of the research methodology Self Portrait Personality Test was carried out.

In the course of the study of the personality structure of women with different types of sex-role identity such components of personality traits and reactions as "separation" and "fusion" were identified. The component "separation" is associated with the desire for independent behavior, autonomy and freedom, sarcastic attitude to criticism, tendency to accumulate and preserve possessions, great attention to appearance and adornment, getting attention from others, taking pleasure in observing pieces of art and natural phenomena which give aesthetic pleasure, the propensity to innovation and creativity expressed in a handmade manufacture of various objects, the aspiration to social activity, the ability to concentrate even in failure situations and the manifestation of both masculine and feminine traits. This component is more common in androgynous type that can be connected with the adaptation of this type in modern society due to the high levels of both feminine and masculine traits. The component "fusion" is associated with the conformist moods and lack of self control, the increased interest in food, conservatism and inflexibility in responses, the subordination to power and order, the need for attention of the environment, femininity.

In the course of the study of the personality structure of women with different types of sex-role identity such components of personality types as "emotional expressiveness", "vulnerability" and "pedantry" were discovered. The component "emotional expressiveness" is associated with the tendency to express emotions, with the brightness and intensity of emotional component of a personality, the preoccupation with own emotions, bright originality and a shift in the direction of their own subjective experiences and perceptions of the surrounding world in general. As this component is more common in feminine and androgynous types it enables to make assumptions about the largest significance of the constituent factor "emotional expressiveness" of the types of sex-role identities having high rates of femininity. The component "vulnerability" associated with sensitivity, vulnerability, self-doubt and depression is more common in undifferentiated type which can indicate greater significance of the components of the personality structure which are associated with sensitivity, vulnerability, insecurity and depression. The component "pedantry" is connected with liability, productive adaptation, regularity, regard for others and their needs, maintaining a strong link with reality in general. This component is more common in masculine and androgynous types which can be associated with high levels of masculinity.

## Conclusions

In the course of the study of a personality structure of women with different types of sex-role identity such components of narcissistic traits as "narcissistic trauma", which is more common in an androgynous type, "narcissistic grandiosity", which is more common in a masculine type and "narcissistic balance" were revealed. The component "narcissistic trauma" is associated with the destructive aspects of narcissistic abuse regulation, violation of emotional equilibrium, unstable sense of values, loss of self-control and partial loss of touch with reality, including negative perception of their own body that is also connected with the attempt to find a balance due to a strong external object and at the same time willingness to devalue it. "Narcissistic grandiosity" component is associated with the feeling of invincibility, superiority over others, significant achievements and success, lack of attention to possible physical defects, search for an idealized object having a great force, in case of decreasing satisfaction with oneself, need of social approval. "Narcissistic balance" component is associated with the operation of balance of narcissistic regulation, with the perception of oneself as an autonomous person and at the same time as the personality which is capable of fruitful cooperation achieving great results without rushing for perfectionism does not depend on the object and is able to accept outside help.

The prospect of further research is to study the mechanisms of formation of personality characteristics and exposure to the features of family circumstances.

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## ANTI-UTOPIA OF GEORGE ORWELL IN CONTEXT OF PROGRESSIVE ROCK MUSIC

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**Abstract.** The paper deals with the study of influence of postmodern literature on glam and progressive rock music. George Orwell's dystopian novel "1984" is analysed in the context of conceptual albums of British musicians David Bowie and Muse. The connection between lyrics of music and language of postmodern literature is considered. The conclusion is made that postmodern literature and progressive rock music is interrelated in the evolution of their various genres.

**Key words:** anti-utopia, literature of postmodernism, rock music, song writer

**Introduction.** In the middle of the XX century postmodernism was one of the main trends in the world literature. It was developed by the authors who later became symbols of that time. Postmodern literature had its own techniques such as fragmentation, paradox and the unreliable narrator; these techniques were making it so different and influential as a consequence [Felluga 2013: 1].

"1984", written in 1948 by George Orwell, was released in 1949 and caused quite a great stir among contemporaries of its author. The novel, of course, influenced many people of the second part of the XX century; it has its influence even now, at the beginning of the XXI century. Usually musicians are the most influenced people in history — they have got a peculiar sensitivity of the world, they feel those changes in the air because literature and music often keep up with time, sometimes even overtaking it and predicting the future of humanity. Really, "1984" has got a stunning influence in modern culture. Of course, its darkness, sullenness and despair impress sensitive, enquiring and razor-sharp minds of musicians. Nowadays there are two albums, which were inspired by Orwell's "1984": "Diamond Dogs" by David Bowie and "The Resistance" by Muse.

Their albums differ from each other. David Bowie's album is earlier than Muse's one, they belong to different genres of music, but these facts only make the comparison of these albums more interesting. Different times, different views nothing could be more thrilling than that.

**The object-matter** of the paper is postmodern literature and glam- and progressive rock music of the century. **The subject-matter** of the article is the connection between postmodern literature and glam- and progressive music. **The objective** of the research is to consider the influence of literature on music. **The tasks** of the article are to analyse consequences of literature influence on music, to study the connection between music and literature, to compare different reflections of music on postmodern novel. **The materials** of the paper are texts of songs of modern English rock groups. **The methods** of the research are descriptive and comparative.

**Discussion and Results.** In postmodern literature authors use specific language, sentence structure and grammar. Their texts are interspersed with lacunae and everyday language is combined with poetry and biblical references leading up to syntax disruption and distortion of grammar [Ilyin 1996: 201]. Often postmodern authors use substandard vocabulary. George Orwell was not an exception, but his novel was noteworthy because there were many new terms and neologisms in it; the language in the novel "1984" was constructed of them, it was called "Newspeak". It is a language created by totalitarian state Oceania as a means to limit freedom of thought and concepts that pose a threat to the regime such as freedom, self-expression, individuality and peace. The alternative to the IngSoc (the name of a party in "1984") construct form of thought is classified as "thoughtcrime". Use of a different language as a consequence is classified as "thoughtcrime" too [Chernow, Vallaski 1993: 2030]. Orwell was inspired to create Newspeak by the constructed Basic English language, which he promoted from 1942 to 1944 before emphatically rejecting it in his essay "Politics and the English Language" [Orwell 1949].

According to Orwell, the purpose of Newspeak was to make all other modes of thought impossible. "Its vocabulary was so constructed as to give exact and often very subtle expression to every meaning that a Party member could properly wish to express, while excluding all other meaning and also the possibility of arriving at them by indirect methods. This was done partly by the invention of new words, but chiefly by eliminating undesirable words and stripping such words as remained of unorthodox meanings, and so far as possible of all secondary meaning whatever." [Dag 1990: 1]. Many of Newspeak's contracted forms are inspired by the Russian syllabic abbreviation used for concepts relating to the government and society. In Newspeak there are some special suffixes and prefixes. For example, suffix *-ful*: form of words that are used with it instead of known adjectives (for example "*speedful*" instead of *rapid*).

Many of the assumptions from the world of "1984", such as " $2 + 2 = 5$ " or "*War is peace*", appear in songs in conceptual albums which were inspired by Orwell's novel. The vocabulary of songs in these albums cannot be confused with that in other albums. Words have to stress particular importance of albums. Songs that were inspired by "1984" are often pronounced exactly because of their specific vocabulary. And, there is special despair in albums. There are some attempts to find a way to escape from the prevailing situations in Muse's "The Resistance", but they look desperate: at the end lyrical hero dies, freeing himself from the regime, "spreading his soul to the stars" as it was said in one of the songs.

But despite the fact that two albums were inspired by "1984", they are different. Matthew Bellamy chose love story as the main story line for inspiration, while for David Bowie it was just a background, and definitely was not the main line in novel. The title track of "The Resistance" by Muse tells us a story about love of Julia and Winston [Beaumont 2010: 316]; it tells us about their thinking of hiding from Ministry of Truth: Matthew sings: *if our secret is safe tonight and if we are out of sight or if our world comes tumbling down* [Bellamy, Howard, Wolstenholme 2009: Resistance]. In the title track of "Diamond Dogs" David Bowie describes post-apocalyptic world, he does this with shine that is inherent in glam-rock. In "1984" it has been interpreted as representing Winston Smith's imprisonment and interrogation by O'Brien [Carr, Murray 1981: 64]. It is just an influence of time that the authors chose so different story lines. When David Bowie was recording his album, people could only imagine how the world would look like, if it was like in Orwell's novel, and now situation becomes more difficult, so many people think that Orwell's predictions started coming true, and artists appeal to emotional state more often. It is also the influence of genres of music: glam-rock is like baroque in XVII century — it is very important to respect the form, to be bizarre and cutesy, to be rough or imperfect pearl. David even wanted to turn Orwell's "1984" to a musical [Carr, Murray 1981: 64]. Muse's style of album was a mix of progressive rock, glam rock by influence of David Bowie and classic music: the main thing is a sensual side of soul. Emotions of a person are the main things in progressive rock music, it is always stressed in some special way. Matthew based Muse's album on love story from the novel. Bellamy created some kind of modern rock opera.

This difference had an impact on lyrical heroes of albums. Both of them are self-destructive, but in different ways. Bowie's lyrical hero destroys himself with outside funds, such as drugs, alcohol, casual relations, that cause destruction of mental state. For lyrical hero it is just an experiment on his own soul. Muse's lyrical hero is destroying himself from the inside by reflection that disturbs his soul too much. Lyrical hero often has panic attacks. Both of lyrical heroes are asking too many questions and thinking about different important things, such as state of their souls, and surrounding world, etc. But if Bowie's character is apathetic, kind of nihilist; Muse's character gradually goes crazy. He asks who we are, where we are and so on [Bellamy, Howard, Wolstenholme 2009: Exogenesis: Symphony Part 1 (Overture)]. Lyrical hero of Muse is hoping for better future, he asks: *if they will find their hiding place, if this is their last embrace, or if the walls will start caving in* [Bellamy, Howard, Wolstenholme 2009: Resistance]; he keeps fighting. Bowie's lyrical hero on the contrary accepted his fate already, he says: *someday they will get you, you must agree* [Bowie 1974: 1984].

**The conclusion** is that literature and music is connected in the sphere of expressing emotions. They develop, evolve and influence each other, especially during the last 150 years. A musician's conceptual album that was inspired by a certain novel always stands out against the background of other artist's works by a specific vocabulary at least. Two albums ("The Resistance" by Muse and "Diamond Dogs" by David Bowie) by two musicians from different eras inspired by the same book can be absolutely different because in two albums only one story line is outlined by person with his own unique perception. **The perspective** of the work is to develop researching of different genres of literature in the context of pop-music.

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### SOCIO-CULTURAL CAUSES OF EATING DISORDERS

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**Abstract:** The present paper deals with the question of the socio-cultural causes of eating behavior disorders. The results of the study are the following: the contemporary situation in society is favorable for the formation of anorexia nervosa and bulimia; in most cases a decisive role in the formation of pathological desire for losing weight is played by primary group; the families of patients with eating behavior disorders are usually classified as that which are focused on society wanting their children to be successful in life.

**Key words:** anorexia nervosa, bulimia, primary groups, social interaction.

**Introduction.** Anorexia nervosa and bulimia are such eating behavior disorders which belong to severe psychosomatic illnesses. These diseases have spread epidemically among today's youth. Over the past decades the number of people who suffer from anorexia nervosa and bulimia has almost doubled. The statistics is really frightening because the mortality rate among patients with such diseases occupies the first place compared to all other psychological pathologies [Balabonkin 2000: 603-606].

A significant number of women feels extremely unhappy about their figure and consider themselves fat. That leads to the fact that approximately 20% of women regularly keep to a diet, and about 6% of them observe constant diet to keep figure in a good shape. These data suggest about the excessive general social concern about the shape of the physical body. According to statistics, almost 15% of women who kept to diets and tried

to lose weight ended with such an eating disorder as anorexia nervosa. These data indicate an excessive general social concern about how human body is going to look. [Balabonkin 2000: 603-606]

**The object-matter** of the paper is forms of eating behavior disorders such as bulimia and anorexia nervosa.

**The subject-matter** of the research is socio-cultural causes of the eating behavior disorders given.

**The objective** of the present paper is to introduce the problem of eating behavior disorders and identify the connection between the pathologies formation and the forms of social interaction on the individual.

**The tasks** of this paper are:

- to study the issue of eating behavior disorders as a consequence of social communication;
- to investigate the situation concerning the presence of young patients with anorexia nervosa and / or bulimia and social factors of prevalence of these pathologies;
- to determine the prospects of preventing transition of eating behavior disorders into a state of epidemic phenomenon;
- to determine what role body culture plays among the youth in contemporary society;
- to find out what role primary groups play in the eating disorders formation.

**Materials** for the present paper were taken from the next empirical researches:

- The results of the 40 semi-structured interviews with boys and girls aged 15-20 years and 25-30, published in the article "Skinny means normal": body management among urban youth".
- Interviews of patients with anorexia aged 15 to 23 with subjective reasons for losing weight. The study is published in the Myurel Darmons book "The development of anorexia".
- The study which involved 95 women, 65 of them are girls with eating behavior pathologies (35 people diagnosed with anorexia nervosa, 30 - bulimia nervosa) and 30 women without them.

To solve the problems of the research the following methods were used: questionnaire "Scale assessment of eating behavior," projective technique Family System Test (Family-System-Test, FAST) by G. Goering and I. Valera, projective technique "Family georama" by M. Bowen's. "

**Methods** for the study are presented by theoretical and methodological foundations of sociological knowledge in sociology of medicine and by results of empirical sociological research.

Discussion and Results

In today's society there is a tendency to give excessive importance to the image of body, as it provides functionality of communication and serves as a self-presentation tool. As a result of such corporal appearance, certain disciplinary practices appear to transform natural human body in order to conform to certain standards.

Primarily to such practices a specific control of food intake – a diet – is applied. Although the self-control in relation to the individual consumer culture is not dangerous in its essence, a potential threat does exist. When the control of the body appearance is imposed by society, self-regulation of physical state can be under the risk and classified as not healthy.

The result of the imposition of rigorous social standards on physical appearance of the person is that people acquire such eating behavior disorders like anorexia nervosa and bulimia.

Anorexia nervosa is a mental disorder caused by a painful desire to achieve the highest weight loss possible. This disease is almost always in step with bulimia – a disease which is based on neuropsychological disorder that manifests itself in the uncontrolled consumption of food, abnormal focus on food and calories and weight. Patients suffer from irrepressible hunger attacks, take laxatives, causing vomiting. Those ones suffering from anorexia and bulimia demonstrate low self-esteem, feeling of guilt, excessive self-criticism and distorted view about their weight.

The results of the 40 semi-structured interviews with boys and girls aged 15-20 years and 25-30, published in the article "Skinny means normal: body management among urban youth" show the necessity to understand and regulate physical appearance of the body. Analysis of the information obtained through interviews showed that thinness is an essential criterion for assessing the desired dimensions of the body for today's youth:

Q: What do you especially like about yourself?

A: That I'm skinny (per., 20). [Krupec 2014: 532]

It is necessary to mention that the educated urban youth keeps to the following thesis: "skinny means normal" [Krupec 2014: 534].

At the same time a special feature of the self-esteem is that thinness status must be supported by a public assessment of the individual. That means that thinness is closely linked with the social status of a person in a particular social group, and fullness leads to the changes of the body.

The desire to be normal and hence thin at any cost in some cases can lead to anorexia nervosa – a pathology caused psychologically and socially.

In her study Myurel Darmon offers the following sociological analysis: patients with anorexia tend to interpret assessment of any of the forms of their activities in such a way that encourages them to make changes in their own behavior. In other words one of the basic factors of eating behavior pathologies is assessment given by society and its interpretation by a person that later turns into a strategy of action. Darmon says that anorexia is primarily an attempt to make the life controlled by taking control of the body [Darmon 2008; Hachatur'an 2011].

This idea resonates with the theory of self-social behavior personality of V.A. Yadova which is based both on individual self-control in order to achieve a goal and on aspirations of the individual model values, built on the basis of judgments set by society. In most cases a decisive role in the formation of pathological desire for losing weight is played by primary group (family, neighbors, children's groups), as they greatly influence the formation of personality [Cooley 2000: 71].

The most significant effect is usually produced in the family circles, because the family is the leader of social values, norms and rules, and foundation for personal growth [Slepkova 2010: 149].

The research on the basis of a projective technique "Family System Test" (Family-System-Test, FAST) by G. Goering and I. Valera and a projective technique "Family georama" by M. Bowen's has determined that families of patients with eating behavior disorders are usually classified as focused on society. Representatives of such families form socially acceptable norms and values. "Success" in such families acquires the status of the most important value, and encourages the child to a pathological desire to achieve it. In such families, parents act as a mirror for their children's personality formation. It may lead to the formation of the mirror "I" [Cooley 2000: 84] which is characterized by a predisposition to various kinds of pathologies including disorders of eating behavior [Slepkova 2010:148–150].

#### Conclusions

The present research discovered that eating disorders can be formed on the basis of interaction between humans and primary groups. It has also been shown that contemporary situation in society is favorable for the formation of anorexia nervosa and bulimia.

The scientists that analyze mental health of society in the context of eating behavior disorders should focus on the study of individual resistance to verbal and nonverbal criticism.

In order to inform the society about the risks of eating disorders, school and university curricula should include such disciplines as sociology and communication theory. This decision is backed with the following reasons:

1. Understanding rules for proper communication strategy will raise the level of verbal communication to that which denies excessive criticism towards others and bringing each other to a pathological condition caused deliberately by lowering others self.

2. According to the principles of communication and understanding of social processes, the individual will increase his or her resistance to the judgments on his account.

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#### THE IMAGE OF A PSYCHOLOGIST

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**Abstract:** The article deals with the characteristics of the professional image of a psychologist as a factor of a client's confiding. It concerns the students' ideas about the components of a successful image of a professional psychologist. The objective is to study the ideas of students with different university major about the image of a professional psychologist. It can be used in making a program of attracting students of different departments to consult a psychologist.

**Key words:** identity, image, perception, students' idea.

### **Introduction.**

The subject of the given research is psychology of the image. An image is a stereotyped representation of a person, organization or products; the general impression that a person, group, or product presents to the public [Perelygina 2002: 25]. There are four main types of images: an individual image, the image of a product, the image of an organization, the image of a group. The image of a group includes several kinds of images, such as a gender image, a national image, a professional image, etc. So, a professional image is a representation of stereotypes about people of a certain profession. The image of a psychologist is a representation of ideas about a psychologist [Perelygina 2002: 172].

The image of a psychologist is a factor of a client's confiding, so it is important to understand the concepts creating the professional image of a psychologist in the minds of people.

The problem of an image is studied by J.Baumgartner, A.Bodalev, J.Fast, L.Froiland, E.Hall, M.Mark, F.A.Parsons, S.L.Paek, C.S.Pearson, E.Petrova, E.Perelygina, W.I.Thomas, S.M.Heathman.

**The object-matter** is a professional image of a psychologist.

**The subject-matter** is the students' ideas of a professional image of a psychologist.

**The objective** is to study the idea of students with a different university major about the image of a professional psychologist.

**Tasks:** The objective can be reached by carrying out the following tasks:

1. To study the theoretical basis of the subject.
2. To study the features of the ideas of students with a different university major on the image of a professional psychologist.
3. To make up a generalized profile of a professional psychologist based on the students' ideas.

### **Materials:**

The participants (N=129) were the second-year students of V.N.Karazin Kharkiv National University from the department with technical specialization (Physical-technical department, N=29), humanitarian specialization (Historical department, N=47), nature specialization (Biological department, N=33) and Psychology department (N=20).

### **Methods:**

1. Personality Differential (E.Bazhin, O.Etkind)
2. Method "Five Features" (modification of O.Eliseeva)
3. Essay "A Professional Psychologist is..."

### **Discussion and Results**

Studying the scientific works on the image of a psychologist has shown the following results: the image of a psychologist is a factor of a professional identity; the professional image includes three components: internal (personal characteristics), external (manner of clothing and speaking) and procedural (characteristics of professional interaction) [Kuzin 2002: 19-20].

The image of a professional psychologist is considered to be based on three components: cognitive, emotional and behavioral. The cognitive factor includes the idea and predictions of a client about the future interaction. The emotional factor deals with the emotional mark of the interaction. The behavioral factor concerns the attitude for interaction. [Eliseeva 2011: 96]

The results of the research concern the students' ideas of a psychologist's professional image.

There are some features of the ideas of the students with a different university major. The most important professional psychologists' characteristics of the students of technical specialization are candor, openness and sobriety. The students of nature specialization are more interested in such qualities as confidence, strength and kindness. The most attractive characteristics for humanitarian departments are range of vision, high moral standards and strong will. The psychology students are oriented on calmness, kindness, acceptance and deep interaction with a client.

Some generalized factors of a profile of a professional psychologist were found out. These factors are based on the results of the method “Five Features” that was processed by a factorial analysis.

The first three factors refer to features of professional activity. These factors are “Professional Leader” (includes professional qualities, universality, speaking skills, calmness, strong will, enthusiasm, flexibility, authority, range of vision and activity), “Compliance” (involves calmness and flexibility, completed with a low authority and speaking skills) and “Calmness” (comprises one concept - calmness). These factors can be connected with different types of communication strategies which are suitable for different kinds of clients.

The second category deals with the features of professional interaction. There are two factors: “Empathy” including sobriety, responsiveness, fairness, communicability, competence, uncertainty and a pleasant manner of speaking and “Non-attractive” comprising only one concept – non-attractive. The factor “Empathy” refers to the desire of a client to be accepted by a psychologist. The factor “Non-attractive” can be connected with the image of a modern professional which is shown in popular culture.

The third category is individual qualities. There are three factors in the category: “Congruence” (including respect to a client, analytic mind, candor, strong will, communicability, calmness and harmony of a personality), “Activity” (involving bounciness and non-calmness) and “Wingman” (comprising respect to a client and weak will). These factors may refer to the fact that sometimes a psychologist should be active and leading and sometimes a psychologist should follow and support a client. Moreover, psychologists must be honest with themselves and with the clients.

The last category is the features of appearance. There are two factors in the category. The first is “Perfection” (including neatness, charisma, friendly appearance, formal style of clothing, beauty, respectability, tranquility, naturalness). The other is “Snobbery” (comprising formal style of clothing and unfriendly appearance). These factors may be connected with the searching of the role models and ideals in the personality of a psychologist.

### **Conclusion**

The image of a psychologist is a type of a professional image representing generalized predictions, expectations and requirements to people of this profession.

The research of the students’ ideas about the image of a psychologist has shown some features of the students’ expectations. It was discovered that the students of technical specialization concentrate on the characteristics of open interaction (candor, openness and sobriety); the students of nature specialization are focused on the personal qualities which provide the sense of security (confidence, strength and kindness); the students of humanitarian specialization search for a strong personality (range of vision, high moral standards and strong will); psychology students are oriented on deep communication with a client (calmness, kindness, acceptance and deep interaction with a client).

The generalized profile of a professional psychologist includes such factors as “A Professional Leader”, “Compliances” and “Calmness” dealing with professional activity; “Empathy” and “Non-Attractive” concerning professional interaction; “Congruence”, “Activity” and “Wingman” dealing with individual qualities; “Perfection” and “Snobbery” concerning the features of appearance.

There are perspectives of the future studies. The first perspective is to study categories restricted not only by particular university specializations, but by different ages (students, middle-aged people, elderly people). The second perspective is to study the expectations of psychology students and highly-experienced psychologists. And the third perspective is to work out the program of creating a positive image of a professional psychologist, and then to study people's ideas before and after the participation in the program.

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### **FEATURES OF LEGAL REGULATION OF USING DIGITAL SIGNATURE IN UKRAINE**

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**Abstract:** The article examines especially the using of digital signature which is provided by foreign provider in Ukraine. There is an offer to legalize the using of the third-party digital signature according to the current legislature.

**Key words:** Certification Authority, digital signature, document, identification.

**Introduction.** Day by day modern technologies make our lives easier. The relations are also greatly simplified especially with the advent of electronic identifiers, which make deals thorough the Internet become possible. However, what IDs can be used? What is the difference between the using an electronic signature and a digital signature? The article explores these and other related questions.

**Objective.** The purpose of the article is a comprehensive research of the confidence regulation of a digital signature in Ukraine. Also, the article is a development of proposals for amendments to the relevant legal acts for improving the regulation in this area.

**Tasks.** The tasks of the work are to 1) identify options of definitions of the term «electronic signature», "digital signature" which are used in legal acts; 2) explore practical model of using a digital signature 3) make proposals to clarify the established definitions and the mechanism of using an electronic signature on the base of past practices in the IT-field.

**Object-matter.** The object-matter is public relations arising in the regulation of legal relations in using digital signature in Ukraine.

**Subject-matter.** The subject-matter is the legislative regulation of using a digital signature, the relevant regulations and patterns of use which have developed in practice.

**Methods.** The formal-legal method is used in the research to study the general regulation of an electronic signature. The dialectical method is used to identify the relationship between legal phenomena which are the basis for using electronic signatures. The system method is used in the analysis of normative legal acts that govern the using of electronic signatures.

**Discussion and Results.** Nowadays the legislator has entered an electronic signature, a digital signature, the passport of the citizen of Ukraine in the form of a card with a contactless electronic chip (and a digital signature) into the electronic plane. Also BankID has been recognized as the regulator at the legal level by the National Bank of Ukraine recently. The Law of Ukraine "On Electronic Commerce" has entered the concept a "signature by a one-time identifier" and further the Law has an addition defined "an analogue of an own signature" [Law of Ukraine 2015]. The development of another ID - Mobile ID - is in a research operation now. However, it remains unregulated by the law, so the full use of the development is still impossible.

It is known that earlier the category «an analogue of an own signature» was defined and regulated by the Civil Code of Ukraine and the Article 207 established that «using the facsimile reproduction of the signature by means of a mechanical, electronic or other copy, an electronic signature or other analogue of an own signature during a deal is allowed in the cases established by the law, other acts of the civil law or by a written agreement between the parties, which should contain relevant examples of their own signature analogue» [The Civil Code of Ukraine 2003]. At the same time, Article 12 of the Law of Ukraine "On Electronic Commerce" specifies the types of signatures in e-commerce, one of which is "an analogue of an own signature (a facsimile reproduction of the signature by means of mechanical or other copying, another analogue of an own signature) with the written agreement between the parties which should contain relevant examples of own signatures" [Law of Ukraine 2015].

Thus, the Civil Code of Ukraine contains a requirement of reproduction the examples of relevant analogues of an own signature in the written agreement between the parties, while the Law of Ukraine "On Electronic Commerce" [Law of Ukraine 2015] has no such requirement.

Using a digital signature (hereinafter - DS) may only be possible with a participation of a service provider in their service, so there is the Certification Authority (hereinafter - CA) in Ukraine. The accredited CA is responsible for the authenticity of the signature in a document signed by means of DS, which it provides. At the same time, the question of confidence to a particular CA that provides DS-services is resolved as follows: each center has to pass the registration procedure defined by law and to certify its public key in the central certification body (hereinafter - CCB). In this case, the verification of a signatory's public key certificate will help to ensure that CA, which has received a digital signature for signing, certified its public key in the CCB, therefore it is credible, as well as the document was signed by the person specified in the certificate.

However, the third-party suppliers of DS are actively developing, because the service is in demand at creation of electronic documents between persons from different countries. Different standards are used actively, most of them are defined in a separate legal act of Ukraine [1], in order to harmonize their using in our country.

But, for example, the standard "PKCS # 12 (Personal Information Exchange Syntax Standard)", which is actively used by various providers, allows to get a certificate of a DS-key without further verification of whether the information belongs to the person who has undergone the procedure of signing up for the service.

Thus, a digital signature, which was formed by the third-party provider outside of Ukrainian jurisdiction, can not be considered a complete and authentic analogue of an own signature, despite of the fact that it can be generated using the enhanced key certificate, and, in addition, an electronic signature. Using a digital signature on such legal regulation is rather complicated, and, otherwise, it is impossible to form a basis for confidence in the DS.

DS-technology continues to develop actively. Currently there are services that help to establish additional grounds to trust the person who put on their DS in a document. In this case it can be verified by the other parties of the deal by previously known identifiers, according to which they can identify the signature, obtained with a specified person by a set of data, added to the digital signature by a provider.

For example, such verification can take place by phone or e-mail that was indicated in the registration system services of the DS-provider. The duty of the provider is to verify the authenticity of specified additional identifiers and their belonging to the person who created the system account with a special exile activation of a profile or one-time SMS-password.

Then the user opens a document that must be signed, chooses an enhanced electronic certificate, with which they want to sign a document and sends the message on the successful signing to another person. At the same time, the signed document with the graphic reproduction of an own signature (in the presence of such option) or only on the basis of information, generated by the digital signature strengthened certificate and additional data in the form of a timestamp remains on the server. The same procedure takes place during the signing of the document by all subsequent parties.

According to this model, all copies of digital signatures of persons, who have been granted an access to the document, as well as additional identifiers to confirm the authenticity of DS, are kept on a server of the service.

However, when using a digital signature, which seems to be true, those who act on the basis of the Ukrainian legislation, can not define this method of signing as an analogue of an own signature. Therefore, the using of a signature of the third-party DS-provider, which is not registered in the CA of Ukraine, is impossible under the laws of Ukraine.

**Conclusions.** Obviously, the using of the third-party DS is a little complicated in Ukraine from the legal point of view. However, it is possible to use the procedure of agreement for using digital signatures in these relationships. This model facilitates the establishment of relations between the parties, so they can agree in advance on using services of a specified provider in a special agreement, and eventually conduct a document flow by the means of an agreed provider.

Certainly, the risk of a DS-compromise remains nevertheless, though it is difficult to imagine the illegal access to the person's mobile phone and e-mail at the same time, although some services register users in systems of DS-granting only on the basis of a specified e-mail.

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**Abstract:** This paper deals with a question of how informational inequality in the modern world promotes global social inequality. Information is understood as a power-providing resource, as a form of social capital and an access to it, its quality and amount are considered as significant factors of inequality.

**Key words:** Informational inequality, information society, power-knowledge, social inequality.

*“Give the people contests they win by remembering words to more popular songs or the names of the state capitals or how much corn Iowa grew last year. Cram them full of non-combustible data, chock them so damned full of ‘facts’ they feel stuffed, but absolutely ‘brilliant’ with information. Then they’ll feel they’re thinking, they’ll get a sense of motion without moving. And they’ll be happy, because facts of that sort don’t change. Don’t give them any slippery stuff like philosophy or sociology to tie things up with. That way lies melancholy.”*  
**Ray Bradbury «Fahrenheit 451»**

**Introduction:** The modern society is constantly getting more and more informatized and technoficated – not only the role of technologies is growing, but also the range of their extension is getting wider: the information technologies are present in the various fields of human activity and even take over some of them. However, informatization is not an entirely technological phenomenon – in many respects it is a rather social and cultural phenomenon, which influences social life and social organization. In the modern epoch, which is marked by a continuously increasing significance of information and knowledge as socially valuable resources, an access to information, to a large extent, predefines the level of social power that one possesses; and knowledge, gained in the process of informational digestion, is the basis for social power.

This article focuses on the concept of informational inequality as a trigger for global social inequality. Thus, informational inequality is to be considered as **the object-matter** of the paper and the variety of information-related mechanisms, that produce social inequality – as **the subject-matter**. **The objective of the paper** is to study how the development of informational inequality contributes to the extension of global social inequality. To be more precise – what mechanisms modern information society applies in order to maintain itself. **Research methods** of this paper are based on the analysis of the existing **materials:** literature on this topic and some sociological research data, which could help to formulate the problem more globally and actualize it. More precise examination of the problem is needed in further perspective. As the tendencies show [4, 5], the world is moving rather in the direction of information inequality growth, which would certainly trigger quite an extensive growth of social inequality in its various forms.

**Discussion and results:** In the complicatedly organized modern society where the role of information is extremely important, new forms of social power are being formulated – “power-knowledge” [Foucault, 2011] that differ significantly from the traditional understanding of power as a purely political concept. The “power-knowledge” is less obvious and visible, thus, more total, all encompassing and could be found in any aspect of human life. Due to Foucault, it is exactly an access to knowledge production, to formulating a certain type of discourse provides some social groups with the power and deducts it from the others, and therefore, the access to the knowledge is a foundation for social inequality which leads to the division of the society on ruling and being ruled. Thus, social power realises itself in the production of a certain shape of knowledge, formulating suitable for its own reasons dominating discourse which has claims about being totally intrinsic and embedded in history, which creates an overarching world image, which claims to be universally acknowledged and objective.

At the same time, the dominant for mass political and media discourses point of view is that currently the growth of social technification and informatization promotes transformation of the society in the direction of a more just and equal social order, whereas real empirical data<sup>1</sup> demonstrate quite the opposite tendencies: modern capitalistic society, having all material means for fastening social equality, follows interests of the capital, enhancing social inequality [Marcuse, 1964]. For modern people it has become conventional to think

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<sup>1</sup> World Internet Users Stats: <http://www.internetworldstats.com/stats.htm>; «Measuring Informational Society» report: <http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2015.aspx>.

that the modern society is an informational society not only because the role of information is growing, but also because the significant amount of the world population has an access to informational technologies, which consequently means that it is possible to detach certain features of a social activity that characterize informational societies only. In fact, this kind of thinking is strongly misleading. Thus, for instance, due to the research of the Internet World Stats, 86% of the population of Iceland has an access to the Internet, whereas there are only 0.03% Internet users in Liberia; the average for the whole world is that only 49.7% of people have an access to the Internet; and the difference in the availability of the Internet in Africa and Northern America is more than 60% [4]. A significant amount of the world population is not involved in the modern forms of informational exchange. In the world of growing importance of information the limitation of access to personal and public means of communication and sources of information inevitably leads to the limitation of social opportunities.

In order to define global informational inequality Manuel Castells [Castells, 2010] offered to use the term – a “digital gap” which explains that state of society when the opportunities of the new technologies are huge, but an access to them in the global sense is strongly limited and unfairly spaced, which creates a deep gap between those people (or even societies) that have the access and those who do not. This state creates a global social inequality supported by informational inequality. Since the informatization is a necessary condition for competitive development of the modern society and the growth of its welfare, people (or societies, countries or even the whole regions) without an access to the modern informational technologies are being automatically pushed out of the borders of the “modern” world and excluded from the area of attention. Thus, for example, becoming more and more popular big-data sociological research, that is to be able to come up with some global conclusions about the whole society or even the whole world based on the Internet data, do not actually take into account the fact that in the majority of societies an access to the Internet has a non-representative part of population, represented by certain social groups. In this fashion such research make distorted conclusions spreading false results on the whole society.

However, it is not sufficient to provide an equal access to the Internet for everybody in order to achieve informational equality – even in the countries with relatively high Internet coverage there are some other forms of informational inequality. Probably never before there existed such a huge amount of information and probably never before was it under that strict control. There are various examples of informational limitation and the ways of its realization from the harshest to the most transparent ones, all of which lead to the same goal to subordinate masses to the interests of the ruling class, no matter how implicit it is. Therefore, it is possible to explicitly and directly prohibit certain information or create less obvious informational filters (financial, legal, material absence of informational sources, etc.).

Supposedly, no one can doubt that the results of intellectual and creative labor, which are books, movies, pictures, photos, music, etc., are the main instruments of personal development. Adverting to them a person not only enriches himself and his “inner world”, but also gains the knowledge about the world he is living in, creates his image about the world and his place and role in it. Moreover, a person gets an access to various points of view on the same event, that helps to thoughtfully form his own opinion about it. Free informational choice and unlimited access to it make people less perceptive to different forms of manipulation and makes it possible to form the opposition. However, in the modern world market relations and commodification of education turned knowledge into the commodity and the access to the information – into not commonly available good, that drew a line between those who can afford their own development and those who (consciously or not) have to abandon it.

By limiting access to the results of intellectual and creative labor, to information and knowledge, converting them not only into the property, but also into a commodity, a modern state, the world system of international relations and capital create a global system of social inequality, which not only increase a social hierarchy within one society, but also divide the whole world on more or less worthy to get education, to develop themselves, to do what *they* want to do, but not what they have to. The modern copyright law submitting itself to the logic of market develops in the direction of a more severe limitation of the access to information and the state does not contribute to weakening this limitations, that all together creates an endless circle of capital and market needs dictating the rules and science, education, art, politics, public life constrained to obeying them.

**Conclusion:** The above-mentioned states that it is possible to conclude that the concept of information society, whether applied to the western society or to the countries that do not belong to it, is no more than a catchy metaphor, an ideal type that leaves space for huge political manipulations and creates for people who have some kind of access to information a popular illusory image of all encompassing informational space,

which anyone could freely enter if he wants to do so. Not only media and political discourses, but also a scientific one constantly states that information unites people and information society has helped us overcome social inequality. One common example for this which supporters of information society concept use is a popular statement that it is possible to conclude that we have already reached social equality because, for instance, students in Ukraine, workers of some Chinese factory and CEOs of huge corporations watch similar movies, read news from the same source, read the same books, have their own Facebook account, etc. In fact, what we can see here is not a proof of social equality, but smoothing the borders between different social classes, what makes the gap between them less visible, but at the same time, much deeper [Marcuse, 1964]. Basically, what happens here is barely visible substitution of the notion of freedom by imaginary restrictedness of choice. Therefore, till everything stays as it is – non-information society is all we can expect.

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### **DEFENDER AS A COMPLAINANT IN CASES OF OFFENCES AGAINST PUBLIC JUSTICE**

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**Abstract.** While researching the criminal infringement upon the protected social relationships that provide the maintenance at legal proceedings of the constitutional principle of the right for defense, a vitally important problem arises on determination of the range of aggrieved people who have suffered from crimes related to the inference into the defender's activities. This problem is important both for conducting research by the criminal law science and for the correct classification of the nature of the offenses set by Sections 397-400 of the Criminal Code of Ukraine.

**Key words:** complainant, defender, legal representative, object of crime.

**Introduction.** In accordance with Article 1 of the Constitution, Ukraine is a law-governed state. Attributes of a law-governed state are not only the legal fixation of the main rights and freedoms of a person and a citizen in the Constitution, but also their actual enforcement, adherence of the developed legal culture to all citizens and commitment to the supremacy of law principle. The principle of the supremacy of law is implemented specifically through the administration of justice which, in its turn, is available only under favourable conditions for the activities of people who implement it. Targeted at the defense of rights and freedoms of legal subjects mentioned in Chapter XVIII of the Particular Conditions of the Criminal Code of Ukraine, crimes in relation to their immediate targets should be classified into certain categories. One of these categories is crimes that intervene the adherence to the constitutional principle of the right for defense (Sections 397-400 of the Criminal Code of Ukraine).

**Object-matter.** Public relations that ensure compliance of constitutional right of defense while implementation of public justice.

**Subject-matter.** Defender as a complainant in cases of the offenses against public justice.

**Objective.** Clarification of complainant as a constituent of corpus delicti offended by Sections 397-400 of the Criminal Code of Ukraine.

**Task.** Questions concerned with corpus delicti offended by Sections 397-400 of the Criminal Code of Ukraine are important as for theory of criminal law, as for practice.

**Methods.** Theoretical, dialectical, dogmatic.

**Discussion and Results.** Current criminal legislation provides protection to the social relationships that enforce commitment to the constitutional right for defense during the administration of justice and the order of

enforcement of the right for defense for all the categories of persons set by the law or for representation of their legal interests in the form of legitimate activities of a defender or private agent on providing the legal assistance during this activity commitment.

It is universally accepted that the target of crime is always the value which is inflicted by the actual damage, or where there is a threat of inflicting that damage. In criminal law science the dominant view is the one in accordance to which the target of any crime is social relationships protected by law about criminal liability. It is apparent that the target of crimes is not all the social relationships but only those of them which are subject to the protection by the law about criminal liability [Tatsiy, Borysov, Tiutiugin 2015: 110].

V.O. Navrotskyi argues that a crime as a human activity is directed, firstly, onto something external for the person who commits the attempt, – some value or benefit that exist intrinsically beyond the will and conscience of a person; secondly, onto something that had existed before the starting point of the offense; thirdly, onto something that presents a certain social advantage, some value that is in itself subject to the criminal and legal protection. That way the offense causes damage to and the way is subject to protection are agreed to be called a target of crime [Navrotskyi 2013:155].

While analyzing the concept of ‘a target of crime’, it is necessary to focus on the fact that a characteristic feature of many crimes is targeting at certain material things or particular individuals. Thus, the corpus delicti, apart from the target, is defined by means of such features as ‘object of crime’ and ‘the aggrieved from the crime’. Here it is important to consent with Muzyka A.A. who mentions that, apart from the social relationships protected by criminal legislation, an object of intervention is characterized by such a feature as an aggrieved person [Muzyka, Lashchuk 2011:63].

It is essential to point out that there is an idea in the theory of criminal law about the fact that not only a private individual, but also other social subjects of law (state, society, legal entities ) can be considered aggrieved from the crime. Such researchers as Dziuba V.T., Senatorov M.V., Mel’nyk M.I., Khavroniuk M.I. express this view. However, there are some opposite views. For example, in the view of Navrotskyi V.O, the aggrieved person is an individual – a human – only.

It is evident from the analysis of the current criminal procedural legislation that an aggrieved person in the criminal proceedings can be an individual who suffered emotional, physical or property damage as well as a legal entity that suffered property damage from the offense (Part 1, Section 55 of the Criminal Procedural Code of Ukraine).

Thus, the identification of the range of persons who are called aggrieved is necessary for the correct classification of the nature of offense set by Sections 397-400 of the Criminal Code of Ukraine.

First of all, it is necessary to identify the range of these complainants by means of the research in the concept of ‘defender’.

V.M. Tertyshnyk states that a defender is a participant in the litigation process who is liable for the function of defense, and as a result of that, he/she is obliged to utilize all the means and ways mentioned in the law legislative in order to investigate the circumstances that could legitimate a defendant or attenuate one’s liability, and to provide the defended individual with the judicial assistance [Tertyshnyk 2016:99]. A.M. Tytov provides an explanation of a ‘defender’ as an independent and self-sustained participant of the criminal proceedings who, possessing all the professional expertise, in accordance with the procedure established by law, commits such an important social function as defense of rights and legal interests of a suspected offender, alleged offender, a person on trial and an acquitted by court as well as provides them with the required aid and advice on legal matters [Tytov 2002:87]

S.A. Gizatova provides a definition of a defender as of an independent and self-sustained participant of criminal proceedings who possesses all the required professional expertise, is endowed with rights indicated by legislation, authorized with certain liabilities for the commitment of defense of rights and legitimate interests of a suspected offender, alleged offender (a person on trial, a convicted and sentenced prisoner and a person acquitted by court) as well as for providing them with the required aid and advice on legal matters [Gizatova 2010:188].

It is stated in the current criminal procedural legislation of Ukraine that a defender is a lawyer who commits defense of a suspected offender, an alleged offender, a convicted and sentenced prisoner, a person acquitted by court, a person who is accounted for the use of medical or disciplinary measures of constraint, or towards whom the issue of such measures application has been regarded, as well as of a person in whose respect the examination of an issue about rendition to a foreign power (extradition) is envisaged (Section 45 of the Criminal Procedural Code of Ukraine).

In our opinion, it is in place here to mention that the Convention on Defense of Rights and Fundamental Freedoms of an Individual ratified by the Supreme Rada of Ukraine on 17.07.1997 and 'Basic Principles on the Role of Lawyers' adopted by the Eighth Congress of the UNO on the issues of crime prevention and attitudes toward offenders from 27.08-07.09.1990 contemplate the right for each person to apply to any lawyer for assistance for defense and assertion of rights and their protection at all stages of criminal proceedings; no law-court or administrative body of power that indicates the right for a lawyer cannot refuse to acknowledge the right of a lawyer to advocate the interests of one's client apart from the cases when a lawyer was denied the right to do his/her professional duty in accordance with the national law and practice and these principles.

Thus, the mentioned-above international law acts actually equated the term 'defender' with the concept of 'lawyer'. However, it is not acceptable to agree to this approach since the term 'lawyer' is a generalized term which involves all the types of professional activities (notary officer, judge, attorney, investigation officer, solicitor and others).

While analyzing the concept of 'defender', it is important to emphasize the attention on the fact that, in accordance with the provisions of Part 2, Article 59 of the Constitution of Ukraine, advocacy accomplishes the right for defense from the prosecution and providing the juridical assistance during the court trials and hearings in other official bodies of power in Ukraine. Section 6 of the Law of Ukraine 'On Advocacy and Practice of Law' gives the following definition to the concept of 'advocator': an advocator is considered to be an individual who has a complete higher juridical degree, mastery in the official language, experience in the sphere of legislation of not less than two years, has passed the qualification test and undertaken an internship (apart from the cases set by this law), has taken the oath of office for the advocator of Ukraine and received the Certificate of the Right to accomplish the practice of law.

It should be noted that Part 2, Section 45 of the Criminal Procedural Code of Ukraine enshrines the reasons why an advocator cannot accomplish the functions of a defender in the criminal proceedings. They are namely: 1) when the his/her data are not put on the Unified register of Advocators of Ukraine; 2) if there are data about the suspension or termination of the right for practicing law in the Unified Register of Advocators of Ukraine.

In reference to such a complainant as a legal representative and for the explanation of the concept of 'legal representative', it is worth considering Section 44 of the Criminal Procedural Code of Ukraine which indicates that in case a suspected offender or alleged offender is a minor person or a person who has been declared legally incapable or partially incapacitated, his/her legal representative is involved into the proceedings together with him/her. The proceedings can involve parents (adoptive parents), and if they are not available, guardians or trustees of a person, other majority-age close relatives or members of their families as well as representatives of guardianship and custodianship agencies, offices and organizations under whose guardianship or patronage the minor, legally incapable or partially incapacitated is placed.

Here, Section 58 of the Criminal Procedural Code of Ukraine also deserves attention. The concept 'representative of a complainant' has been documented in it. It is stated in the first part of the mentioned Section that a complainant in the criminal proceedings can be represented by a representative – a person who has a right to be a defender in the criminal proceedings. On the other hand, the second part of this Section states that a representative of a legal entity that is a complainant can be its supervisor, another person empowered by law or authorized by corporate governance documents, an employee for the legal entity according to the letter of attorney as well as a person who has the right to be a defender in the criminal proceedings. Apart from that, it is worth mentioning that there is a concept of a 'legal representative of a complainant' in Part 1, Section 59 of the Criminal procedural Code of Ukraine which defines that, if a complainant is a minor person, legally incapable or partially incapacitated person, his/her legal representative is involved into the procedural action together with this person. The issue of a legal representative of a complainant participating in the criminal proceedings is regulated in accordance with the guidelines of Section 44 of this Code.

The current Criminal Procedural Code of Ukraine, apart from everything mentioned above, sets such concepts as 'representative of civil plaintiff, civil defendant' and 'legal representative of a civil plaintiff'. Thus, it is mentioned in Part 1, Section 63 of the Criminal Procedural Code of Ukraine that a representative of a civil plaintiff or civil defendant in the criminal proceedings can be: 1) a person who has a right to be a defender in the criminal proceedings; 2) a supervisor or any other person empowered by law or authorized by corporate governance documents, representatives of a legal entity according to the letter of attorney – in case when a civil plaintiff or a civil defendant is a juridical person. Part 1, Section 64 of the Criminal Procedural Code of Ukraine indicates that, if a civil plaintiff is a minor person or a legally incapable, partially incapacitated person, their

legal representative enjoys their procedural rights. The issue of the participation of a legal representative of a civil plaintiff in criminal proceedings is regulated in accordance with the guidelines of Section 44 of this Code.

From the set forth above, it is seen that the current Criminal Procedural Code of Ukraine does not use the generic concept of 'defender'. However, the analysis of the scientific research papers and regulatory enactments has shown that the term 'representative of a person' is a generic concept which combines the following representatives of a person: 1) legal representative of a suspected or alleged offender; 2) a legal representative of a complainant; 3) a representative of a civil plaintiff or civil defendant; 4) legal representative of a civil plaintiff.

While researching the issue of identification of a complainant, in the context of criminal juridical protection of legitimate activities of a defender or representative of a person related to providing juridical assistance, it is not sufficient to limit the research to the activities of a defender or representative of a person connected to providing juridical assistance exclusively in the criminal proceedings. Here, it is worth agreeing with the opinion of I.P. Mishchuk that in connection with criminal and juridical life protection of a defender or representative of a person when the complainant is being indicated, it is not right to limit the procedure to his/her activities related to providing the juridical assistance in the criminal proceedings [Mishchuk 2013: 74]. However, we can hardly accept her view that the concepts 'defender' and 'representative of a person' have received their reflection in administrative, civil and commercial law. That is because such a concept as 'defender' is enshrined in the law only in the Criminal Procedural Code of Ukraine. Meanwhile, the Civil Procedural Code of Ukraine enshrines such concepts as representatives of parts and third persons, and Administrative Procedure Rules Code of Ukraine contains the concepts of representatives and legal representatives.

**Conclusions.** On the basis of the research conducted it is possible to make conclusions that a complainant as a structural target of offenses against law, and namely offenses that infringe on the right of maintaining the constitutional principle of the right for defense (Sections 397-400 of the Criminal Code of Ukraine) can be defenders of representatives of a person. This being said, the representative of a person related to a complainant is a generic concept which involves the following list of persons: a representative of a complainant, a representative of a civil plaintiff or civil defendant, a legal representative of a suspected or alleged offender, a legal representative of an aggrieved person, a legal representative of a civil plaintiff.

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## MAIN APPROACHES TO THE DEFINITION OF MILITARY SERVICEMAN IN UKRAINE

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**Abstract.** As reform and development of the Armed Forces of Ukraine is going on, they grow in size and strength. Under such conditions, there is an exceptional importance to define status of those who serve the homeland in military ranks. Ultimate and inclusive definition of military serviceman might help to ease drafting, interpretation and implementation of military law in Ukraine. Such starting point being clearly defined for those who draft and implement law might lead to resolution of the various disputes between the state and its citizens and do not let arguments between these two parties being referred to court.

**Key words:** military servicemen, officer, enlisted, conscript, definition, legislature, implementation.

**Introduction.** The value of definition of military serviceman is particularly sound when we strive to meet legislative, financial (material), administrative demands of military service. Also, such definition is needed for legal academics to proceed in their research. The definition is of great importance for legal scientists who research and study contemporary military law, mainly in its administrative segment, bearing in mind further utilization of the product of research in legislation and implementation.

**Object-matter.** Public relations in the sphere of state service, particularly military service in Ukraine.

**Subject-matter.** Military serviceman while maintaining its status both in time of active service and being on stage of induction into military service.

**Objective.** Definition of military serviceman from prospective of contemporary legislature and scholarly papers.

**Task.** Obtain unified and inclusive definition of military serviceman for further insertion into legislature and following implementation.

**Methods.** Theoretical, dialectical, dogmatic.

**Discussion and Results.** Some aspects of this problem have being defined in monographs of scholars in the fields of constitutional and administrative law. For instance: V.M. Aleksandrov, I.N. Archibasov, Z.A. Bahishaiv, D.N. Bahrah, U.P. Bityak, U.V. Bilousov, A.P.Gornii, E.I. Grigorenko, V.A. Dzuba, G.M. Dolgopyatov, V.N. Dubrovin, O.O. Zaphin, T.E. Kaganovska, I.F. Korzh, S.S. Korolyov, O.V. Kudashkin, M.I. Kuznetsov, V.M. Manichin, V.I. Pashinskii, A.P. Petrochenkov, M.A. Petuhov, I.F. Pobezimov, O.S. Polyakova, S.U. Polyakov, M.M. Prohorenko, U.O. Prudov, O.U. Synyavska, M.S. Studenikina, M.M. Tyshenko., and others.

However, recent changes to the legislation on administrative definition of the status of military serviceman to great extent modernized this status and influenced various aspect of military service. Unfortunately, majority of these amendments have been made promptly and mainly unjustifiably. This is the reason for further academic research in this field in order to find out new options to improve legislation and its following implementation.

Yet, before we begin analyzing administrative status of military serviceman, it is vital to define object of this status – military serviceman. In this substance it is very important to understand what enduring legislature says about this matter and scholarly papers contain on this subject.

Thus, laws of Ukraine “On military compulsion and military service”, “On social and legal protection of military servicemen and their dependants”, and Regulation on responsibility of military servicemen for damage to the state property, approved by the Parliament of Ukraine on 25<sup>th</sup> June 1995, contain a list of those who hold the status of military serviceman.

At the same time, legal scientific literature proclaim that analysis of existing legislature on the subject matter allows to come to conclusion that it is pivotal to have universal meaning of “military serviceman” to avoid misreading and collision in course of implementation. It is worth to mention here that it is absolutely wrong approach to give definition to military serviceman by simply listing those who potentially meet this definition. Here we should say that it is greatly important to mark common features which shape special legal status of military serviceman.

Unfortunately, other legal acts in Ukraine do not enclose inclusive definition of military serviceman. For instance, paragraph 4, article 1 of the Law of Ukraine “On military compulsion and military service” says that military servicemen are people who maintain military duties. At the same time, paragraph 1, article 5 of the Law of Ukraine “On social and legal protection of military servicemen and their dependants” has very specific explanation for military serviceman. It says that military servicemen are citizens of Ukraine who maintain their duties on the territory of Ukraine, take part in Ukrainian state referendum and indigenous referendums, have a

right to vote and to be elected to local councils and other state institutions with elective positions, in accordance with the Constitution of Ukraine. They are subject to the Law of Ukraine “On election of the President of Ukraine”.

We should mention here that such a definition and its legal form are quite outdated and do not meet current requirements of other legal acts in Ukraine. Additionally, this definition is based on old-fashioned methods and techniques of drafting the legislature.

In our view definition “military serviceman” must reflect specific legal status of persons who maintain military duties in light of special state service. In first instance we have to bear in mind administrative legal status which dominates over others, such as constitutional, criminal and procedural, e. t. c., and holds great potential to be improved.

To prove this statement we have to mention here that above mentioned laws: “On military compulsion and military service”, “On social and legal protection of military servicemen and their dependants”, as well as various regulations and procedures over military service and military duties, adopted by presidential decrees, primarily focused on administrative issues of military service. To make the mentioned above assumption sounder it is worth to quote here very prominent academic, who is specialized on administrative law – D.M. Bahrah. He said that state service is an interlocker amongst different spheres of law. However, it contains essential features of administrative law, inclined towards constitutional law, and interlined with financial and criminal law.

As we previously mentioned, military service is sort of state service. That is why Bahrah’s statement is in place here and can be used to define either military service or legal status of military serviceman. Concerning the military service another author, U.P. Bytyak stressed that it is state service of specific character and fulfillment of military compulsory service is an honorable duty for every citizen.

Therefore, we should bear in mind that definition “military serviceman” must accumulate essential features of legal administrative status of military serviceman. At the same time it is important to remember that correctly crafted definition “military serviceman” will inevitably affect understanding and perception of legal administrative status of military serviceman in Ukraine.

Speaking of doctrinal approaches to the definition of military serviceman, we can find diverse meanings to it.

Thus, V.I. Pashinskii states that military serviceman is a citizen of Ukraine who maintains military duties, which are state duties of special character, while he or she is a member of state military institution established for maintenance of state defense in accordance with the law of Ukraine.

In its turn, Great Legal Encyclopedia Dictionary, editor – U.S. Shemshuchenko, defines military servicemen as people who maintain military duties under provisions of the Law of Ukraine “On military compulsion and military duties”. Let us assume this definition is based upon uncovered and unclear meanings of military serviceman given by contemporary Ukrainian legislature. Moreover, the only reference to the Law of Ukraine “On military compulsion and military duties” is narrowing the definition despite the numerous legal acts, starting with the Constitution of Ukraine, which govern military service in Ukraine per se.

Additionally, definition “military serviceman” is given by scientist E.I. Grigorenko, who writes that military serviceman is a citizen of Ukraine who maintains his or her professional duties in accordance with Constitution and laws of Ukraine with a specific focus on military features of such service within the Armed Forces of Ukraine or other state military institutions.

At the same time, another author – V.M. Aleksandrov draw our attention to the notion under which military service might hold essential features of state service in Ukraine after the full transition of the Armed Forces of Ukraine to contract (enlisted) military service without compulsory service.

We can assume here that professionalism of military service in general should be inclusive. It means that citizens of Ukraine who maintain compulsory military duties fall under the paradigm of professionalism.

To prove this we can quote contemporary military law. For instance, in the Law of Ukraine “On military compulsion and military service” there is a Chapter II “Induction into military service”. Paragraph 1, article 8 of this law says that induction of the citizens of Ukraine into military service includes patriotic education, professional education of conscripts, training of conscripts for military positions, education and training for military orchestra, military lyceum, military school and college, military education for cadets, military education for reserved officers, physical training, medical training and education, learning of state official language.

As we can notice, amongst the various types of military training and education, as part of induction into military service, there is professional education of conscripts. In its turn, according to article 10 of the Law of Ukraine “On military compulsion and military service” professional education of conscripts includes education

of conscripts in schools, lyceums and colleges where they can obtain professional knowledge and skills for future military service. Under the same article of the law conscripts might obtain military profession while doing their job for employer. Persons who reached 17 years, physically and mentally fit are allowed for such kind of education and training with following on recruiting to compulsory military service.

Based on analysis of above mentioned notion we can conclude that military service is professional in its nature regardless of what kind of military serve in focus: compulsory military service, military service of reserved officers, military service of cadets in military schools, colleges and universities, or military service of different types of uniformed personnel (enlisted, none commissioned officers or officers).

There is one more aspect of military service in Ukraine under contemporary law. In October 6, 2015 the Law of Ukraine "On military compulsion and military service" was amended. In accordance with this adjustment the military service in Ukraine is not an exclusive job for Ukrainian citizens any longer. Instead foreign citizens as well as those without citizenship may join military ranks in Ukraine. This means that definition of "military serviceman" fits into much broader spectrum of potential uniformed personnel compare to citizens.

**Conclusions.** Based on the above mentioned analysis we can come to conclusion that "military serviceman" is a person who holds Ukrainian citizenship, citizenship of another state or does not possess citizenship of any state, maintains his or her professional duties in accordance with Ukrainian law, and is a member of Ukrainian Armed Forces or other military formations under Ukrainian law.

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### **THE NOTION AND TYPES OF MILITARY PROPERTY ACCORDING TO THE LEGISLATION OF UKRAINE (SOME PROBLEM ASPECTS)**

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**Abstract:** The article examines the definition of military property employed in the legislative acts, characterizes the legal technique used by legislators to formulate the notion of military property. Conveying the concept of the articles of war, the author represents the researchers' views on the correlation between military property and the property of the Armed Forces of Ukraine, exposes the problem aspects in the legal regulation concerning certain types of military property, including more general issues of civil law associated with this topic.

**Key words:** goods designated for military purposes, military stations, the notion of military property, the property of the Armed Forces of Ukraine, the types of military property.

**Introduction.** Although in our country there is a principal act of civil legislation, which is the Civil Code of Ukraine, some issues do not fall under its control, such as the legal regulation concerning military property. Of course, this is not a classic example of absence of such regulations in the Civil Code of Ukraine; on the contrary, the fact that the adjective "military" is used with the noun "property" immediately points out the sphere where public interests (the national safety and defense) take up a leading position. At the same time, the core of the problem is not so much the lack of certain legislative rules in the Civil Code of Ukraine or their imperfections, but contradictions in such legal regulation, which is carried out on the level of specific legislation by both laws and subordinate acts different from the Civil Code of Ukraine.

First of all, it should be mentioned that, from the point of view of tasks and functions assigned to a state and its armed forces, a military sector is of national importance, where the public interests dominate; thus, the majority of matters are subjects of legal regulation of a public law. However, the civil law relations also occur in this sector, including those concerning military property. So before researching military property matters either in their statics or dynamics (real or obligation relationships respectively), we have to define the notion of military property. Of course, certain issues of this topic were investigated by such scholars as S.O. Ivanov, E.H. Boichenko, P.M. Kondyk, V.Y. Kisel, V.S. Shcherbyna, but these studies have not fully contributed to the solution of the problem aspects of military property, particularly because the authors concentrated on different issues: "Military Units as Subjects of Civil Law," 2007 (Kisel V.Y.), "The Participation of the Public Law Legal Entities in the Civil Relations (on the Example of the Ministry of Defense of Ukraine)," 2009 (Ivanov S.O.), "The Legal Regulation of Economic Activity in the Military Units of the Armed Forces of Ukraine", 2015 (Boichenko E.H.).

**The object-matter** of the research in this article is legal relations concerning military property and its types; **the subject-matter** is the specific rules of law expressed in the articles (paragraphs) of the laws of Ukraine and subordinate acts that specifically regulate the matters of military property.

**The objective** of the research is to clarify characteristics of legal regulation concerning military property, while also defining its peculiarity and types.

**The tasks** of the research are closely connected with its objective, and are aimed at formulating possible ways of eliminating the defects detected in the legal regulation concerning military property.

**The materials** of the research are existing laws and subordinate acts, the decisions of the Constitutional Court of Ukraine, thesis abstracts and scientific articles.

**The methods** used for the research are various scientific methods including analysis, synthesis, classification, analogy.

**Discussion and Results.** The notion of "military property" is legally stated in the Law of Ukraine dated September 21, 1999 No1075-XIV "On the Legal Regime of Property in the Armed Forces of Ukraine" (as amended) [Zakon Ukrayiny 2016] (hereinafter referred to as Law No1075-XIV), Article 1 of which states the following: "Military property is the state property assigned to the military units, establishments, institutions and organizations of the Armed Forces of Ukraine (hereinafter referred to as military units). Military property includes buildings, facilities, transmitter units, all kinds of weapons, war and other materiel, ammunition, fuel and greasing substances, rations; technical, aircraft, naval stores, military uniforms and gear; cultural and educational, medical, veterinary, household, chemical, engineering equipment, communication gear etc." Characterizing the legal technique used to formulate Article 1 of Law No1075-XIV, we should pay attention to the following two points. Firstly, the law contains the definition of military property, and secondly, it includes the list of the examples of military property. At the same time, this list is not exhaustive, which is evident from the use of such language means as the word "etcetera."

Research literature draws our attention to the fact, that from a comparative analysis of the title of Law No1075-XIV and the before-mentioned definition of military property, the diametrically opposite conclusions can be made: 1) legislators equate the notion of property in the Armed Forces of Ukraine with military property; 2) in addition to the articles of war, the property of the Armed Forces of Ukraine includes other types of property. According to professor V.S. Shcherbyna, the first conclusion should be considered correct, since the content of the subsequent articles of law does not give grounds to identify "non-military property" in the property of the Armed Forces of Ukraine [Shherby`na 2012]. E.H. Boichenko holds a different opinion and states, that the notion of "the property of the Armed Forces of Ukraine" is more comprehensive and includes, in addition to military property, physical resources and financial means; he also thinks there are sufficient reasons for a legislative differentiation between the notions of "military property" and "the property of the Armed Forces of Ukraine" [Bojchenko 2010]. Without denying the importance of the correlation between these concepts, we want to raise a slightly different question.

Regardless of legislative consolidation and definition of the articles of war, there is still a question whether military property is a separate notion or a collective term. It is quite relevant here to cite Ye. Sukhanov's views regarding the term "property" in general. According to him, lawmakers position the term "property" as a collective concept under a common rule, but property cannot be a unified matter because of a real-right principle of specialization. It cannot fall under a sole absolute (real) right, meaning that property as such cannot be an object of possession [Venediktova, Berveno, 2010]. Of course, if we take into account a positivistic approach and a separate legitimate definition of military property with the peculiarities of its legal regulation, the answer suggests itself – military property is a separate type. However, when we begin to

consider the list of equipment that makes up military property and its civil legal characteristics, the unambiguousness disappears. Thus, we must firstly address Article 1 of the Law of Ukraine dated February 20, 2003 №549-IV "On the State Control of International Transfers of the Goods Designated for Military Purposes and Dual-Use Goods" (as amended) [Zakon Ukrayiny 2016] (hereinafter referred to as Law №549-IV), which states the following: "Goods designated for military purposes are weapons, ammunition, war materiel and special-purpose machinery, special components for their production, explosives, materials and equipment specifically designed for the development, production or use of these goods." Thus, there occurs a certain conflict, when we start employing both terms "military property" and "property designated for military purposes," or more precisely "goods designated for military purposes," which include the objects that are limited in or withdrawn from public circulation. Therefore, when describing articles of war, we can distinguish between military property proper (goods designated for military purposes) and other property, considered military only because it is assigned to military units. The fact, that property is not restricted in public circulation, but is military because it belongs to military units, does not give us enough reasons to talk about its dual nature or dual legal regime. This situation reminds the author of the famous debate about the complex areas of law, the arguments on self-sufficiency of which are rather doubtful. So we believe that military property is different from other types of property because of a specific character of its legal regulation; but according to the list of equipment that makes up (may form) the military property, we can single out military property proper (goods designated for military purposes) and other kinds of property allotted to military units, hence, making it military. Comparing the definition of military property and the notion of goods designated for military purposes used in the above-mentioned laws, we see an overlap of these concepts. At the same time, the identical articles of war, stated in both the list of military property and the list of goods designated for military purposes, possess different names. Therefore, the terminology employed by legislators requires a certain unification.

As for the types of military property, there are such phrases as "the types of military property," "the list of military property," "the category of military property" used in the legislative acts.

As is known, a traditional method of reviewing the objects of civil rights is a consideration of their types. There is also a common approach in civil law: when making a classification of property, it is divided into certain kinds. All this brings us to the need to sort out the types of military property as well. The exact phrase "the types of military property" is used in Part 3 of Article 1 of the Law of Ukraine dated September 21, 1999 №1076-XIV "On Economic Activity of the Armed Forces of Ukraine" (as amended) [Zakon Ukrayiny 2016]; in the name of a separate section (section VI "The Peculiarities of Disposal of Certain Types of Military Property") of The Procedure for Disposal of Military Property of the Armed Forces of Ukraine, approved by the order of the Ministry of Defense of Ukraine dated January 12, 2015 №17 [Nakaz Ministerstva oborony` Ukrayiny` 2016]; and in the first sub-paragraph of paragraph 7 of the Regulations on Inventory of Military Property in the Armed Forces, approved by the resolution of the Cabinet of Ministers of Ukraine dated May 3, 2000 №748 (as amended) [Postanova Kabinetu Ministriv Ukrayiny` 2016]. Moreover, in order to distinguish between certain types of military property, the Constitutional Court of Ukraine also employed the phrase "the types of military property", mentioning it in the decision dated December 10, 2009 №31-rp/2009 in the case of tenant's preemptive right to purchase military property [Cy`vil`ny` kodeks Ukrayiny` 2009].

In the second sub-paragraph of paragraph 3.2 of the statement of reasons for the above-mentioned decision of the Constitutional Court of Ukraine it is stated that, "According to the laws of Ukraine "On the Legal Regime of Property in the Armed Forces of Ukraine" (Part 2 of Article 6)," "On Economic Activity of the Armed Forces of Ukraine" (Part 1 of Article 1, Part 3 of Article 7), there are the following types of military property: removed from a public circulation - weapons, ammunition, war materiel and special-purpose machinery; free in a public circulation - property that is suitable for further use but is not applied in the daily activities of forces; excess property; integral property complexes; other real estate."

Thus, we can assert that in the legal documents of different legal force and from the various aspects of the legal regulation of the articles of war, the phrase "the types of military property" has become widespread. Moreover, if we move beyond the definition of military property cited above in Law №1075-XIV and "come down" to the level of subordinate acts, we will find even more comprehensive list of the articles of war including military stations and facilities (integral property complexes) in particular. The definition of military stations is given with the help of the notion of property complexes, though in civil law there is no clear concept of what they are (a complicated thing; the legal regime of property, that is a constituent element of a complex (V.A. Bielov); a set of things (I.V. Spasybo-Fatieieva); is not a thing, there is a need to recognize its independent place in the system of the civil rights objects (O.P. Pechenyi), etc.).

Considering everything mentioned above, the following question emerges, "What type of military property does a military station belong to?". As for the term "an integral property complex," the Economic Code of Ukraine uses it to denote enterprises, while the Civil Code of Ukraine employs the term "a unified property complex."

#### **Conclusions:**

The military property as a legal term is used in the existing legislation on the level of laws. Military property is (1) the state property, meaning that it is owned by the state, that (2) is assigned to the military units, establishments, institutions and organizations of the Armed Forces of Ukraine. In the current legislation the concepts of "military property" and "goods designated for military purposes" overlap; at the same time, when defining them, we find a contradiction in terms for denoting essentially the same military property. All this does not contribute to the efficiency of the legal regulation; hence, there appears a need in the legislative agreement on terminology. In the legislative acts the term "the types of military property" is widely used on the level of both the laws and subordinate documents. It was established, that when considering such military property as military stations, we will certainly encounter more general controversial issues of civil law, as military stations are defined through the notion of a property complex, the concept of which remains disputable in civil law. Thus, the consideration of the military property notion should be made in close connection with such categories and institutes of civil law as the civil rights objects and their types, property, an article, a property complex, in order to be able to detect the common and different features, the peculiarities, the place in civil law; to identify the defects (contradictions) in the legal regulation; and to suggest the recommendations on how to address them for the most effective legal control of relations concerning military property. Therefore, eliminating a terminological controversy by applying the relevant changes to the legislation should be one of the first steps on the way to achieve the before-mentioned efficiency.

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## THE SPECIFICS OF FAMILY RELATIONSHIPS IN ANCIENT GREECE

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**Summary:** This article is devoted to specifics of family relationships in Ancient Greece. The research shows that the Greek family was the most durable establishment of Greek civilization, as it was the basic unit of economic output. Greeks had different rules and duties for men and separately for women. Children also had special education and behavior conditions. The knowledge obtained in this research is an important element of awareness of society in Ancient Greece.

**Key words:** family relationships, Ancient Greece, family, marriage, children, women, the Greek society.

The issues of the Greek family and responsibilities, structure and relationships are studied in this article. It is very important to understand the structure of the single unit of Greek society to have a full picture of the Greek society in all, as it was not only the basis for the government, but also was the basis for economic and cultural development. The differences of male and female responsibilities and duties in Greek family and Greek society are aligned and give us the complete pack of knowledge of Greek civilization.

**Object-matter** is to analyze Ancient Greek civilization through the prism of family unit, paying attention on the difference between female and male education and social position

**Subject-matter** of the research is socio-cultural aspects of Greek family

**Objective** of the present paper is to introduce the problem of difference in people's behavior in ancient Greek family and to identify the connection between the family formation and the forms of social interaction.

**Tasks** of this paper are:

- to study the issue of Greek family as a part of Greek civilization;
- to determine the principles and matters of Greek marriage and divorce;
- to align the differences between the male and female roles in the Greek family;
- to determine the role of children-citizen in a Greek family and the difference between them and abandoned children;
- to study the family Greek traditions and their influence on the Greek civilization.

**Research methods** of this paper are based on the analysis of the existing **materials:** literature on this topic and some historical research data, which could help to formulate the problem more globally and actualize it.

The Greek family was based on the Indo-European pattern and consisted of father, mother, unmarried daughters, sons, servants and their wives, children and slaves. Until the end, it remained the strangest part of the Greek civilization, for both agriculture and industry, it was a unit and a tool of economic production.

Greek's marriage was considered to be an agreement between two chaimen of families for the majority of Greeks in order to prolong generation. The state was interested in recruiting troops, so bachelors in some cities had to paid fines and were deprived of honors. They often treated to the marriage as to a duty.

There were many differences between the various Greek city-states, especially in the sphere of family life of their inhabitants [Vinnychuk L, 1988:69] . For example, in Sparta where the men of the ruling class during their lifetime were dedicated to themselves and mainly fulfilled their military and civilian responsibilities, while family life played the secondary role [Yeger, Paydeya 1997: 232] . Young people in Sparta had to choose their wives from poor families, in that way they prevented the concentration of wealth in one family [Vinnychuk L. 1988:69]. In Attica marriage was considered to be legal only if both the husband and the wife had full civil rights [Nikituk 2005:99]. Consanguinity was not an impediment to get marriage. The law forbade marriage only for those people who had a common mother. But there were something in common for the all people of Greece, — the compulsory monogamy and institutionalized patriarchy almost everywhere [Vinnychuk L, 1988:70] .

There was a special place for Romantic love among the Greeks, but it was seldom the reason of marriage. Romantic relationships in classical Greece leded to extramarital affairs, but not to the marriage [Durant 1997:110]. In primitive Greece, it was believed that marriage existeds only to ensure the continued existence of

family and continuity of hereditary victims [Giro, 1995:33]. The age for marriage was not specified in the Athenian law, but, as a rule, girls got married under the age of 15 years, young people got married after 20 years old. The head of the family enjoyed enormous power. It was typically, that power was in the his father's hands. And if the father died, power passed to his eldest son [Nikituk, 2005:101].

The Athenians used two words for the determination of the divorce: *ἀποπομπή* (reference) — divorce by the husband's will, and *ἀπόλειψις* (abandonment), divorce for wife's wish [Giro 1995:50]. Divorce for men was simple; he could release the wife from himself at any time without explanation of the reasons. Conversely it was need able a sufficient reason for divorce from his wife, because the sterility purpose of marriage was to born and to bring up children [Durant 1997:312]. If a divorce sought by wife, she had to expound the reasons why she wanted to get divorce from her husband in a letter to the archon name. Sometimes the couple parted peacefully by mutual agreement [Vinnychuk L. 1988:72]. But in Athens V-IV centuries divorces were rare [Nikituk 2005:102].

It was believed that every Athenian citizen should have children, and all the forces of religion, property and the state aimed at condemnation of childlessness [Durant 1997:295].

Neither before the birth nor during childbirth women were not under the supervision of a doctor. The Greeks believed into quite sufficient presence of midwives or even just experienced slaves in such matters would be enough [Vinnychuk L. 1988:74]. In the first days after birth the father had a right to refuse it [Giro 1995:76]. Father has the right to give up the newborn to the mercy of fate if he doubted that was his child or if one was frail or crippled. The parental right to give up a child allowed ruthless eugenics together with severe natural selection by means of difficulties and natural competition were greatly conducive to the Greeks to transform them into the strong and healthy people [Giro 1995:295]. However, it also happened that someone found an abandoned baby, started to take care of him and educated him. People who found abandoned babies and saved their lives, also did not do that out of compassion, but from selfish calculation: they raised their faithful slave or a slave, who in the future could earn a lot of money [Vinnychuk L. 1988:77].

The birth of the child was for a family an solemn event and was completely independent even of how the father treated to the child [Vinnychuk L. 1988:76]. At the girl's birth in a free family free a woolen bandage hung up on a door, in case of the boy born — an olive branch was means a symbol of civil valor [Blavatskiy 1973:112].

For the fifth day cleaning ceremonies and an *amfidromiya* were made [6, page 105]. The Woman, holding the child on her hands, quickly faced him it around the center and acquainted him with a house custom. After that relatives and friends of the family gathered for a meal [Giro 1995:52]. For the seventh or tenth day noted an *onomatesiya* (a name giving ceremony) — a sacrifice was made to gods and the feast was arranged, the child was given toys by guests, and a mother was given painted vases [Nikituk 2005:105].

Girls were educated at home until marriage [Nikituk 2005:106]. The system of education for girls did not exist. Under the supervision of her mother, she was engaged in reading, writing, music, needlework, and learned to weaving, and housekeeping. Accompanied by older she had a right to go outside and take part in religious processions [Blavatskiy 1973:112]. Boys were raised at home until 6 years. In 7 years the boy started to visit art school, where he was taught reading, writing, speaking, playing a musical instrument. From the age of 10 the boys began attending a gymnastics school in private *Palestro*. From the age of 16 young men attended the state [*gimnasii*]. At school they were accompanied by their slave-teachers, who served and stayed with him to adulthood (18 years) [Nikituk 2005:107].

Like all other civilisations the Greek civilization also reached its splendid without the assistance and influence of women [Blavatskiy 1973:103].

The woman didn't take part in the men's affairs and in public life. A woman was treated like a daughter, sister, wife or mother of a citizen who was under the protection of the laws, but always subject which belongs to the man — father, brother, husband, son [Blavatskiy 1973:110]. In classic Greece the freedom of women, especially of Athens, had been subjected to considerable restrictions. It was widespread in ancient society even free-born woman had no civil rights [Vinnychuk L. 1988:78]. The situation with the Athenians sometimes can be compared with the situation of women in modern East, exaggerating the severity of the ancient customs, according to which they allegedly had been kept and still have been kept in the *gynoecium*, like in prison. In short the rules were very strict for girls as compared to a married woman

In ancient Athens the woman didn't receive spiritual and physical education [Yeger, Paydeya 1997:235]. She was allowed to participate in religious celebrations: this has been confirmed by literary monuments, sculptures and painting on vases [Vinnychuk L. 1988:80]. In an appropriate dress (dress covering their full body)

women could visit relatives. In the most part of their time they used to spend their time in their room (Female Room) which was generally in the backyard of the house where the guests' entry was prohibited.

She did not take even greater part in the upbringing of their children. First of all, the children were entrusted to nurses [Giro 1995:42].

The Athenian woman who was brought up in gineky and was taught weaving sewing and a household often didn't satisfy her husband's spiritual needs of. Considering that fact men were less interested in family and tended more to women. Heteras were foreigners or released slaves in Ancient Greece. Some of them were familiar with literature, art, philosophy, attracted the youth with their education and even could write epigrams. Of the famous heteras painted portrait, they were erected statues, devoted dramas and moreover participated they in the symposium. The Greeks considered: "wives are necessary to us for the birth of children, and for entertainment we have heteras". The aged hetera sacrificed her mirror to Aphrodite and often finished life in poverty [Blavatskiy 1973:110].

Poor rural women, wives of artisans had more freedom, they couldn't be the prisoners of the gynoeceum, because they worked along with their husband [Blavatskiy 1973:111].

### Conclusions

We have specified the family relations in ancient Greek, in general research shows attitudes towards children and women in the Greek society. Their traditions and customs have faded into the background, nevertheless, bases of family life, family law have come to modern society from the antique states.

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## THE BODILY AS A MARKER OF PERSON'S IDENTITY: SOCIOCULTURAL DIMENSION

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**Abstract:** In the article, an issue of expressing identity through the bodily practices is discussed. The correlation between the bodily practices, personal self-determination and social practices, and reactions are under spotlight. The analysis reveals the connection between a personal identity and its bodily expression, on the one hand and culture of society, on the other. The main issue is studied from the perspective of a constructivism paradigm.

**Key words:** bodily, identity, politics of identity, sociocultural triad

**Introduction.** There is a strong tradition in social sciences to discuss human being as a person, individual, actor, which focuses our attention on internal, personal characteristics. For instance, from the sociological perspective we are interested in an issue how common shared norms and values are accepted by an individual and how they influence social behavior and social practices. Usually, researches in this perspective focus on ideal essences, something hidden that rules practices from the inside. Nevertheless, the bodily is one of the modes of perception of an individual, their identification and following social practices towards them.

The **object-matter** of this article are politics of identity which influence an individual's social position are discussed. The **subject-matter** of the article is the bodily in sociocultural studies of identity. The **method** is theoretical overlook, used for acknowledgement with the theme of the bodily in sociological dimension. According to that, the **task** of the article is to actualize theme of the bodily in terms of constructivism paradigm.

**Discussion and results.** The basis for studying the issue of the bodily is P. Sorokin's construct of sociocultural triad "individual – culture – society". According to this construct an individual becomes a member of a society when they accept its culture, in other words, when they take part in the (re)production of culture [Sorokin 1947]. From this perspective the culture is taken as meanings, values and norms, an individual is guided by [Ionin 2000]. Here we can see a connection between micro- and macrolevel of society: to be

understood and accepted an individual should share common, prevalent in this society meanings, values and norms. According to C. Geertz's definition, the culture is determined as a set of generalized admonition for communication and an interpretation [Geertz 2004]. In the context of a person's connection with the society through the culture, body is taken as a product of influence of cultural factors. The latter means that body is no more just a physical shape but a semiotic system, an instrument in a symbolic struggle and a way for self-representation.

The bodily as a mode of body existence, representation of a body in a cultural context is a particular semiotic practice. According to M. Weber, a social action is aimed at understanding and, in our view, the bodily is another way to gain it [Davydov 2002: 344-398]. Using the bodily practices an individual signifies their self by presenting others the meanings which they recognize as the most valuable and reflecting their position and their understanding of themselves.

In the contemporary world, a cultural monopoly no longer exists and an individual has an opportunity to choose between a variety of semiotic and symbolic systems which propose different understanding of the world. In this situation, an individual's identity becomes problematic: the more flexible the society is, the more opportunities for an individual it brings. In the case when a society is closed it has strictly scheduled rules and frames and stepping out of them may lead to marginalization of an individual and raising social distances towards them [Fillipova, Soroka 2009]. Whereas the above mentioned samples make an identity unproblematic. The availability of a set of alternatives question, the individual choice to choose not only belonging to some group but also to script specific interactions with the others.

Studying the issue of the bodily practices as an identity marker in situation face-to-face, we use the definition proposed by Rycroft: "Identity is a sense of the self unity and continuity as an essentiality which differs from any other" [Rycroft 1995]. This definition gives an opportunity to distinguish an individual's self and the Other, which is based on the usage of different symbols and meanings. As M. Bahtin says, an individual becomes himself only with reference to the Other, in situation of a dialog, that is in situation of exchange of meaning [Bahtin 1979].

Identity is an answer to the question "Who am I?" There are many possible answers to this question and they will include a list of significant for an individual social roles and statuses that they possess. Historical and cultural contexts influence the self-definition, the definition that an individual estimates as the most appropriate to a social situation, the most important. For instance, a period of notional social transformation like the war or revolution will be a motive for the "forced identification" and defining themselves as a part of some group.

Roy Baumeister studies identity as a composite definition of a self: the Self is based on having a physical body, experiencing reflexive consciousness, having interpersonal connections and belonging to small groups, and exercising the executive functions of decision-making and self-regulation" [Baumeister 1996]. Identity is composed by many factors which take shape in the bodily.

The bodily is an illustration of our mind. Using the bodily practices an individual constructs themselves, their image on the basis of values and ideals common for society. The bodily is an object and product of social influences, record of norms and values [Faucoult 1998]. Being under pressure of social expectations provokes "normative discontent" that you're your body [Rodin 1985: 267-308]. The bodily as a composite of two aspects: external and internal, seeing and not seeing, physical, material and ideal essentials [Tishenko 2001]. While knowledge about social life is being constructed by the discourse, the influence on the aspect of ideal essences originates from society and is disclosed in social practices [Berger, Lukmann 1967]. In this matter understanding of popular, common, encouraged bodily practices provides a basis for understanding the culture of a society and an individual's identity in it.

Growing informational field proposes individual new narratives, descriptions and excuses which legitimate new identities. Manipulating existing information an individual actualizes particular texts. Articulated in a discourse identities become available for discussion, revising, acceptance or denying [Filliss, Jorginsen 2008]. The knowledge, adopted by an individual in communication process defines their opinions, prejudices, mindsets, also including thoughts about the bodily practices.

Visual characteristics as the most obvious and accessible are the first motive for rendering an individual's identity. According to the politics of identity, an individual may choose how exactly he will be rendering. Operating with symbols, an individual realizes the bodily practices which correspond to their social position. The level of commonality of a set of characteristics of different actors defines distance between them in the social space [Bourdieu 1994]. Between those individuals who take social positions near each other, communication and social connections are more likely to be established. Communications and connections create a social network which, in its turn, influences interests and estimations. Being a part of some social

network or group means that an individual becomes an actor in the struggle for different types of power and resources. The bodily practices of an individual mark their expectations, aspirations and possible actions.

Identification as a process of formulation and acceptance of an individual's identity has two main effects. On the one hand, it provides an individual with already existing sets of behavior which correspond to particular values. On the other side, it makes an individual a significant actor, accentuates him as a particular group representative in a social and political space. By operating on behalf of the group, an individual takes into account notions about this group and expected background features towards this group.

An individual expresses his identity through the symbols which he addresses to others. The bodily as a practice of the body existence actualizes by the sight and reading. In this respect, the identity may be understood as a social action – an action that is oriented at understanding [Davydov 2002: 344-398]. While defying themselves and coding their identity an individual uses signs which others will use in communication with them. These signs show how others should treat an individual and what to expect from them. Similarly, an individual should accept enforcements of the group to be a part of it. Using knowledge that was socially constructed earlier an individual interprets and accepts symbols which will mean some particular identity and the model of behavior. By doing so, an individual is taking part in (re)production of this knowledge and this understanding of the world. In this case an identity serves as a habitus, which means as an incorporated social game that becomes a character.

In the matter of a visual identity expression, the bodily itself serves as a sign. While implementing the particular bodily practices, an individual transforms themselves with the aim of signing to be read correctly, which means “as it is expected”. In other words, an individual realizes some politics of identity by influencing opinions of others about themselves [Goffman 1990]. Talking about visual coding of their identity, an individual may implement the compensation technique (by deforming an opinion about themselves), de-identification technique (by changing features of an identity) or avoiding technic. According to F. de Saussure's concept of duality of a sign, it has two aspects: form (significant) and content (signified) and correspondence between them is randomly [de Saussure 2011]. This means that, firstly, the form has no concrete meaning while it appears as a result of social negotiations. There is no certain logic in naming some object in this way. These negotiations appear in the communication process between generations. This thesis also holds for a definition of the body as a symbol.

Signs of an identity which we can register visually is a part of an individual's self-representation as an intentional way for expression of his Self. Obviously, among visual ways to code an identity are the following: clothes, physical shape, hairstyles, tattoo, gestures, facial expression, body proximity. All of the list may be understood through semiotic interpretation of visual images, proposed by Sztompka. Using C. Pearce typology we can articulate symbol icons (they mean what they refer to), symbols indicators (they connect the image and reality; for example, luxury features refer to the wealth), sign symbols (their meaning is conventional) [Sztompka 2010]. In the analysis of sign symbols we need to distinguish denotation (that provides us with the answer for “what is it?”) and connotation (our feelings, interpretations and associations). Consequently, any bodily practice includes denotation and connotation and to understand it we need to refer to social knowledge concerning each particular sign. Difficult meanings are transmitted with codes, i.e. systems of signs. Furthermore, the image as a visual code is interpreted as a cultural code with the purpose of understanding an identity.

**Conclusion.** The study of the bodily practices through the respective of visual methods can provide understanding of significant symbols and their meanings. This leads us to the question of different groups and their social position. Nevertheless, social knowledge about visual markers of identity are based on simplified pictures and stereotypes, the interest is about how an individual manipulates this knowledge in their politics of identity.

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## PROTECTING THE LEGITIMATE INTERESTS OF THE JOINT STOCK COMPANIES' SHAREHOLDERS IN CASE OF THE LIQUIDATION THEREOF

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**Abstract:** The article analyzes the applicable legislation regarding the exercising rights and protecting legitimate interests of the joint stock companies' shareholders in case of the liquidation thereof. The article defines the term of protection of the liquidation process shareholders' interests and based on such definition provides analysis of protection of the joint stock companies' shareholders interests in case of joint stock company liquidation. Particular attention is paid to the property interests of shareholders, and accordingly the definition and classification of property, which is the object of property interests of the joint stock companies' shareholders, are provided. The article also highlights the problem of protecting the minority shareholders interests and suggests mechanisms to improve their protection. This article may be of interest to the students, scholars and corporate law experts.

**Key words:** legitimate interests, liquidation of the company, property interests.

**Introduction.** Institute of elimination is one of the important elements of a market economy, which applies to entities that have no ability or intention to pursue economic activities.

As economic organizations created to participate in property turnover, the most important task is to complete the process of elimination of property relations with their participation. Efficiency of the elimination procedure depends on proper regulation of relations associated with 1) the accumulation of property of the organization, 2) meeting the requirements of its creditors and 3) transferring of property to the remaining shareholders of this organization. This issue combined interests of all categories of participants in the elimination of the enterprises: owners (shareholders) and contracting businesses, consumers, government and society in general.

Legislation on elimination, despite the relatively short period of development, has a significant impact on economic relations, eliminating from the market economic organizations that are inefficient or those whose activities are not consistent with the public interest. The **object** of this article is interests of the shareholders in liquidation process in Joint Stock company. The **subject** of the article is a problem of the definition of the interest concept in commercial law particularly in the Joint Stock company. The **method** is theoretical overlook. According to that, the **task** of the article is to determinate the interests of all members of Joint Stock company regardless of their share and coast of legislation.

Disadvantages of law which was formed at the beginning of transition to a market economy led to massive violations of the procedure of elimination of commercial organizations. In the absence of control over the implementation of elimination proceedings, the legal consequences of dodging the owners and the elimination commission of the elimination of enterprises suffered property interests of creditors and shareholders of liquidated companies, the stability of economic exchange as a whole.

**Discussion and Results.** The issue of protection of interests of the liquidation process was investigated by L. Azarov, Alexander Vinnik, W. Juneau, A. Efimenko, Alexander Zeldin, A. Kibenko, Boris Polyakov, S. Tenkov, O.V. Titov and others. But the authors touched only certain problems of protection of property interests of stakeholders' liquidation.

The main goal of this study is analyzing the existing regulations of realization and protection of legal interests of the shareholders' of the joint-stock company in the liquidation of the company.

During last time the problem of interest gained great practical significance due to the emergence of new types of interests. The core process of elimination is the accumulation and distribution of assets, that's why property interests are the most important to stakeholders in the procedure of liquidation.

We acknowledge the definition of protection the interests of stakeholders in the procedure liquidation, provided by Titov O.V. It is proposed to understand it as the introduction of the system of legal measures to prevent, mitigate and eliminate adverse consequences for such interests [Titov 2006: 7].

In liquidation procedure can be found the interests of creditors and shareholders of the company, employees, the state, the interests of the company being liquidated. In some cases, the process of liquidation also affects property interests of territorial community (liquidation of mining companies, etc.). Each participant of the relations in elimination has his (her) own property interests, and their observance and implementation require implementation of appropriate legal mechanisms. The starting point for the implementation of such mechanisms should balance the interests of the liquidation process and further the interests of the most vulnerable participants in the process of liquidation.

In our work, we will pay attention to the realization and protection of the joint-stock companies shareholders' interests.

According to Art. 3 of the Law of Ukraine "On Joint Stock Companies" joint-stock company is a business entity whose charter capital is divided into a certain number of shares of the same face value, and whose corporate rights are certified by the stocks [The Law of Ukraine "On Joint Stock Companies" 2008].

According to the art. 3 of the Law "On Joint Stock Companies" shareholders can be physical and legal entities and the state represented by the body authorized to manage state property or local community represented by the body authorized to manage municipal property owning shares [The Law of Ukraine "On Joint Stock Companies" 2008].

Liquidation of the company may be voluntary or on the grounds specified by law. Voluntary liquidation of the company is initiated by a decision of the general meeting, including the expiry of the period for which the company has been created or after achieving the purpose for which it was created (Art. 88 of the Law "On Joint Stock Companies") [The Law of Ukraine "On Joint Stock Companies" 2008].

According to the Law "On Restoring Debtor's Solvency or Declaring it Bankrupt" liquidation means the termination of a business entity, recognized by the economic court of bankruptcy, to take measures to meet the order of the Law of creditors by selling its assets [The Law of Ukraine "On Restoring Debtor's Solvency or Declaring in Bankrupt" 1992].

If at the time of making the decision the corporation has no obligations to creditors then its assets should be distributed among the shareholders in accordance with Article 89 of the Law "On Joint Stock Companies" [The Law of Ukraine "On Joint Stock Companies" 2008].

During the liquidation process the key to protect the property interests of its shareholders is to establish a special legal regime of company's property being liquidated, and order of satisfying the interests of its creditors.

According to Art. 139 of the Commercial Code property is recognized as a set of goods and other assets (including intangible assets) that are worthwhile determining produced or used by business entities and reflected in their balance or captured in other statutory forms of assets of these entities [Commercial Code of Ukraine 2003]

It is noted that it is important the division of property in the beginning of the process of liquidation. More precisely property is divided on: the basic and working capital; tangible assets and intangible assets; movable and immovable property; property that uses the property that is not used in production activities; property withdrawn from circulation, limited in circulation and that can freely move and alienated from one person to another.

Also during the liquidation there is a specific division of the property, which is a typical thing for liquidation proceedings. For example, credit indebtedness is divided into 1) declared in due time; 2) declared after the deadline; 3) one that has not been declared. In turn, the declared debt can be divided into 1) recognized by the liquidation commission and 2) not recognized by the liquidation commission. One of the responsibilities of the liquidation committee in the bankruptcy estate consolidation is debt collection. As part of the liquidation procedure plays out the division of receivables to current and long-term receivables. It matters allocation in its composition doubtful and uncollectible receivables [Cursive 2010: 8].

It is important to extract credit and debtor obligations in the property of the company. It takes place usually in the period between the beginning of the liquidation process and drafting the interim liquidation balance. Liabilities are grouped not according to the urgency of maturity, but depending on the order of their maturity set by the law [Cursive 2010; 9].

It should be noted that the current legislation does not define the interim liquidation balance sheet and liquidation balance sheet.

In order to protect the interests of shareholders law establishes certain restrictions on their property liability. In particular, shareholders are not liable for the company's obligations and bear the risk of losses associated with the activities of the company, only to the extent of their shares. Shareholders may not apply any sanctions that restrict their rights in case of illegal actions of the company or other shareholders. If the shareholders do not fully paid shares, in cases stipulated by the charter company, they are responsible for the company's obligations within the unpaid part of the value of their shares [The Law of Ukraine "On Joint Stock Companies 2008].

We admit the need to establish in the legislation arrangements for compulsory liquidation only by a decision of the courts. It will protect the interests of the shareholders' of the company in the liquidation process and prevent violations of such interest.

We consider useful the proposal of Titov O.V., who proposes to exclude from the current legislation such liquidation basis as the decision of the public authority [Titov 2006; 11].

There is also a need to introduce mechanisms to ensure additional protection for the interests of the minority of shareholders in the process of liquidation, giving them the right to influence the appointment and revocation of liquidators (liquidation commission members) as well as additional features control of the process of liquidation. We propose to give to shareholders owning in the aggregate not less than 5% of the capital, the right to appoint an additional liquidator. We assume that it will ensure the rights of the minority shareholders to exercise control over the liquidation procedure.

**Conclusions.** Protecting the interests of the shareholders of the joint-stock company in the procedures of liquidation should be considered as a system of legal measures to prevent, mitigate and eliminate adverse consequences for such interests.

We consider that there is a need for consolidation in the legislation the liability of owners (participants) of the companies that evade the procedure of liquidation. We believe that it will help to protect the property interests as creditors of companies and public interests in general and also will reduce the appearance of shadow economic activity.

The interests of the minority of shareholders are the least protected during the liquidation of the company. That is why we consider the need to introduce mechanisms to ensure additional protection for the interests of the minority of shareholders in the process of liquidation of joint stock companies, giving them the right to influence the appointment and revocation of liquidators (liquidation commission members) and the possibility to control the process of liquidation.

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#### **PERSONAL NON-PROPERTY HUMAN RIGHTS IN UKRAINE**

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**Abstract:** This article deals with value of personal non-property human rights in Ukraine. It substantiates the importance of the institute of human rights, explains their appearance and development in the legal system of Ukraine. The classification of personal non-property rights and methods of their protection is carried out.

**Key words:** individual, non-wealth benefits, personal non-property rights, privacy.

### **Introduction**

Topicality of this issue is of great importance for such kind of human rights as personal non-property rights. On the background of social changes, building of civil society, the institution of human rights gained a great interest in Ukraine. As a legislator notes that non-property human rights are more important than property rights (which include inheritance and contractual law), they have the highest social value, and can be prerequisite for relations of material nature which are expressed through freedom, legal equality, rationality and equity of individual's actions in civil law on entering into property relations. Their significance and priority are represented in the article 3 of the Constitution of Ukraine, which says that human's life and health, honour and dignity, inviolability and security are recognized in Ukraine as the highest social value.

Basic Law represented and declared human rights including substantive provisions of international documents, that declared main non-property rights of individuals, being guided by the principles of the rule of law and humanity. This gave a significant impulse to develop the civil law in Ukraine, and to define non-property human rights as the most important.

**Object-matter:** civil non-property relationships of an individual.

**Subject-matter:** non-property rights of human.

**Materials:** scientific views, ideas, Constitution of Ukraine, books of local authors and Internet resources.

**Tasks:** to show importance of the non-property rights in Ukraine, to perform their classification, to describe the most important ones and to define the protection of non-property rights and to identify ways to protect them.

**Objective:** to review the definition of non-property rights, their features and benefits as objects of civil law, to determine ways of protection non-property rights.

**Methods:** system method, method of analysis, comparative method, method of synthesis and abstraction.

### **Discussion and Results**

For the first time, rules of law that regulate issue on implementation of human rights and freedoms were internationally enshrined and enumerated in the Universal Declaration of Human Rights in 1948, then in the European Convention on Human Rights and Fundamental Freedoms in 1950, in the International Covenants on Civil and Political Rights in 1966 and others.

In the legal area of independent Ukraine they were taken over by means of constitution adoption in 1996. According to the Constitution, one of the central roles is devoted to personal human rights, namely Section 2 "Rights, freedoms and duties of individual and citizen". A list of these rights and freedoms is quite large, but they are not comprehensive (Art. 22), and they are not disposed (p. 21). State guarantees equal rights and freedoms regardless of race, color, political, religious and other beliefs, sex, ethnic or social origin, property status, place of residence, language or other characteristics (p. 24) [2].

"Securing of these rights in the Constitution of Ukraine accelerated the development in the area of civil law regulations, that's why the 1990s of the 20th century were extremely favourable period for the Ukrainian civil law, to the sublime, and even romantic legal perception and law-making. It became a basis for the development of a new Civil Code of Ukraine by leading Ukrainian scientists and the second Book which is devoted to the non-property rights became victory of the old aspirations of mankind on the implementation of the right concepts of morality, justice, the idea of self-worth of each individual throughout centuries", - affirms professor O. Kohanovska [1 p. 8].

The great achievement of the consolidation of non-property rights is that the legislator has devoted a separate book in the Civil Code, as non-property rights assemble foundation of society, which is the prerequisite for all other rights and freedoms. Thus, the provisions of Book Two of the Civil Code of Ukraine contribute to the humanization of human relations, understanding of man's place as the largest value in society, increase the level of relations between people of Ukraine to European standards of human rights [1 p. 8].

Personal non-property right is an individual human's right arising on non-wealth benefits, devoid of economic substance, closely linked to person and aimed at the identification and the development of his personality, gives a person an opportunity to determine their behaviour on their own in the area of privacy without the intervention of others [3 p. 251].

These rights originate from the intangible benefits, and they have their own characteristics, such as:

- They are inseparable from the person, so they are called "personal". This close connection helps to individualize person to preserve and protect its uniqueness;
- They are absolute, because person's rights are opposed to a large, indeterminate number of persons who have responsibilities not to violate the personal rights. In case of failure of these duties, the relations with defined circle of persons occur, that is the offender singled out;
- They are deprived of material content.

Personal non-property rights can be divided into two types:

- The rights that provide natural existence of human (right to life, right to health care, the right to liberty, the right to a family, etc.);
- The rights that provide social-being of human (right to a name, the right to personality, the right to respect for their dignity, honor and business reputation, the right to privacy correspondence, right to information, etc.).

*Honor* is an assessment of the individual by public opinion.

*Dignity* is a special moral relationship of man to himself.

*Business reputation* is a set of confirmed information about the person, his managerial and professional skills.

Actions are defined as violating non-property rights of a person honor and dignity if they humiliate evaluation and social status of person in society on the side of moral principles and norms, customs and law. The spread of information that insults or humiliates person's honor and dignity, means that this information was known to some unspecified person or group of people. These actions directly violate the Constitution of Ukraine, which affirmed the human right to privacy. Secrets can be divided on personal and professional.

It is worth mentioning that the list of personal rights is opened according to the Constitution of Ukraine, and it makes possible to convince of the choice of legislator in legal direction of state's building where people's rights continue to expand.

The most important element of the existence of non-property rights in Ukraine is a civil guard. Guard means that the state is enshrined of measures in a law system and ways in which a person can freely dispose of their rights and can be protected by the State.

Analysing provisions of Civil Code of Ukraine about protection of personal non-property rights, we defined following types of protection:

- stopping (admission of the right; stopping of actions, which violate the right; modification of legal relations; stopping of legal relations; admission of unlawful decisions, etc.);
- recovery (recovery of state, that existed before the violation of law, denial, admission of transaction);
- compensation (non-pecuniary damage, etc) [4].

If the rules of human rights are not enshrined in the laws of the state, these rights will be only "words" that the legislator has written in the regulatory legal act. People can protect their property rights due to these rights. We can not expect that people will only follow the rules of morality and will not violate non-property rights of other person. It will lead to lawlessness and legal nihilism in society.

Rights exist if they are protected. The International Covenant on Civil and Political Rights obliges the state to provide an effective way of remedy for violations of human rights and freedoms.

### **Conclusion**

Personal non-property right is an important legal institution, which includes different branches of law. The basis of the legal regulation of these rights consists of the rules of constitutional law that reinforce the whole system of personal rights. The legal guarantee implementation, safety and protection of personal non-property rights are provided by civil law of Ukraine.

Personal non-property right is not a "declaration" due to effective protection defined by the Constitution of Ukraine. According to Art. 15 of Civil Code of Ukraine every person has a right to protect their civil rights and interests, which are not contrary to the principles of civil law, the requirements of justice, equity and rationality [4].

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## PRAYER CROWNS AS A GENRE OF LITERATURE UKRAINIAN BAROQUE

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**Abstract:** The article deals with the creative activity of Dymytrii Tuptalo and Varlaam Yasinsky. "Prayer crowns" are considered from the point of view of their conceptual significance in baroque literature. Symbols are analyzed on the basis of the comparison of their original interpretations with the well known understanding of biblical symbols.

**Key words:** prayer crown, symbol, poetry with Biblical motifs.

### Introduction

Poetic creation of Dymytrii Tuptalo and Varlaam Yasinsky in the context of literature of baroque deserves the special attention. Until now it was not conducted the detailed comparative analysis of poetic creation of two authors – Varlaam Yasinsky and Dymytrii Tuptalo. In addition, there were no attempts to analyze «crowns» for purposing the selection of specific lines, which would allow select them as a separate genre.

The **relevance** of our research determined spreading in the literature of the seventeenth century. The genre of prayer crowns and a reflection of this genre characteristic tendencies of the literary process, developed in the coming century. Nevertheless, it has not been in detail-analyzed poetry of works of individual characters that make up the structure of works and poems, which make up the complex theme. The **object-matter** of our study is Dymytrii Tuptalo`s and Varlaam Yasinsky`s poetry, which can be determined as prayer crowns.

The **matter of a subject** of the research is the genre of prayer crowns.

Our **objective** is to study the prayer crowns as a separate genre based on Dymytrii Tuptalo`s and Varlaam Yasinsky`s creativity, identify specific features of the genre and their cataloging and research overall structure works based on the analysis of their parts.

Tasks determined the following: analyze the study of Dymytrii Tuptalo`s and Varlaam Yasinsky`s selected poetry; explore their poetry; identify their role and perception of the then reader; find out the causes of the genre, drawing attention to historical context.

**Materials** of our research — poetry of Dymytrii Tuptalo and Varlaam Yasinsky, entitled "Prayer crowns".

Until now many works are not subjected to semiotic analysis (the **method** we choose the main for the study). Separately, we note that the researchers resorted only to descriptive method, and to biographical (partly). But these works require a comparative analysis to determine the general and specific features of prayer crowns.

### Discussion and Results

It has been known for a long time that the image of Mother of God ascensions to heaven in glory as Queen. This image is embodied in these lines of Scripture: "Kings' daughters were among thy honorable women: upon thy right hand did stand the queen in gold of Ophir" (Psalms 45:9), "And there appeared a great wonder in heaven; a woman clothed with the sun, and the moon under her feet, and upon her head a crown of twelve stars..." (Revelation 12:1) [Holy Bible 1982: 87; 448]

The establishment of the Uniate Church, which combines the features of Eastern and Western Churches (after the Union of Brest in 1596) contributed to the penetration of Ukrainian tradition of borrowing from the Latin rites and the rite of coronation of the icons of the Mother of God.

There was a combination of the tradition in Ukraine. Thus, according to the tradition of Byzantine icons, silver or gold garments were created and made precious frame, while according to tradition of Rome, creating crown and images, which were crowned by them, thus honoring the Virgin and Jesus Christ [Povch 2010].

For our work the most comprehensive and appropriate is the study of semiotics, the science, which postulates are formulated in the nineteenth century by Charles Pierce. His successors, Roman Jakobson, Roland Barthes, Claude Levi-Strauss, Umberto Eco, have developed a theory about the three types of signs: iconic signs

(signs, images) index signs (signs, indices), signs-symbols. The latter differs from the previous two groups, because correspondence between the sign and what it represents is based on «preliminary agreement» or arise spontaneously, and the relationship between them is arbitrary. There are special kinds of signs such as the content, which can be displayed in a symbol and which is very diverse. Symbol as a communication unit in such case can act at the same time marking several concepts. It produces a reading versions of symbol [Stepanov 1990: 440-442].

The main features of the symbol (including symbolic symbol) is informing and perceptualization. The first feature means that the symbol must contain some information, which means that we can call «a sign» only something interpreted by the availability of any content in it. On the other hand, perceptualization provides an availability of such content to be accepted by the addressee information.

In semiotics the process of sign functioning is nominated “semiozys”. It consists of four essential components: the actual symbol (designation); signified his information; the interpreter, by whom rationality or their own feelings interpret the information embedded in the symbol, and “interpret”, the reaction that occurs when one perceives information.

For a Literary Criticism, the main importance is not only studying the symbols, but also the sphere of their operation. For literary work, which is remoted in time, is the study of language and cultural understanding of the situation and the person interpreter of a text in order to be able to understand the purpose of the character is especially important. It is also connected with the degree of interpretation capacity of audience, for which the work is intended; distinguishing a particular type of character, whether it is occasional, conditional or universal like.

The most important feature of the symbol as the transmitter of information is its two-way nature. On the one hand, it is the material (the expression); on the other hand, it is the bearer of an intangible sense (of the content). The symbol, which has a value and is portable Tropez, creates metaphor and makes art characterization of the hero, as a symbol of things design is ideological imagery. A very important thing is the difference between a symbol and a metaphor. Unlike a metaphor, a symbol can have its relatively constant value, which contained in a particular coordinate system in the context of a phenomenon or era. The symbol is more straightforward, the metaphor is broader polysemantic, based on associative row.

V.I. Krekoten notes that Dymytrii Tuptalo`s and Varlaam Yasinsky`s «crowns» are counted among the best examples of epigrammatic poetry [Krekoten 1992].

An epigram (as a poetic microform) is the component of a macroform of Baroque poetry, such as declamations, poetical cycles, poems etc. This applies to most panegyric compositions, particularly macrogenre form as «crowns» – collections, related content and the addressee of prayer epigrams, turned to Jesus Christ, the Virgin Mary, the angelic forces, saints, kings and their heavenly patrons. The most prominent spiritual master of epigrams of the XVII century is Dymytrii Tuptalo. His poems are marked poetic grace.

First, there is a symbolic name of each verse, which contains the nomination «crown». Crown is a sign of the prophet chosen to head, which shows the highest expression of God's mercy. Homonyms extremely enrich facets of comprehension: the crown — the wreath, the crown — the end (of life), the crown — the poetic cycle more.

Among other genres an important role belongs to the crowns genre, which fit in the genre and style peculiarities Baroque and demonstrates the inextricable European tradition. This tradition was present in the Ukrainian literature of the seventeenth century as closely related to the historical and cultural surroundings. It is represented in the Ukrainian Baroque works of Dymytrii Tuptalo`s and Varlaam Yasinsky`s poetry.

The appearance of genre was preceded by innovations in the literary field, establishment of rice as a constant appeal to the character, increasing the frequency of use of metaphorical means "conspetyzm" theatricality. The last one was involved in the creation of text reader, saturation codes. In such circumstances, a symbol of the crown was one of the key concepts of the Baroque.

Symbols (fire, cross, thorns, sun, vine branches, etc.) and imagery (Jesus, Virgin, Heaven forces, St Nicholas and others), which we have studied are close to the Scriptures. They can be interpreted only through him. So one of the most frequent stylistic figures in poetry is allusion and available reminiscences.

Prayer crowns are mostly built on binary oppositions. Prayer resemblance to the «crown» is achieved by comparison of God and man, the general and the particular, universal and personal. In poetry, the author creates a kind of evangelical interpretation of events in the fate of the individual, these works inherent nature of prayer.

## **Conclusions**

The analysis of Varlaam Yasinsky`s and Dymytrii Tuptalo`s poetic crowns allows us to conclude that these lyrical works differ in structure, themes and also in extensive use of the concept crown. These features allow us to allocate them in a genre, which is on the verge of emblematic and hagiographical poetry.

The structure works are similar: they all consist of 12 verses, but Dymytrii Tuptalo, unlike Varlaam Yasinsky, uses «final» or «wedding» additional stanza without violating the symbolic number 12. This pattern allows not only unite poems in cycles but also isolate them as a separate genre. One verse combines two, four or six (rarely) lines.

Not only impersonal, but also generalized image of man is represented in the poetry. The character does not favor either, but each specific person, a Christian. The works were designed for the interpreter [reader] personal experience and provided special subjectivity under which the author needed to dissolve his own "I" in the book.

All works are syllabic verse with 13 components (preferably less — 14 elements) lines. Some of them are mostly female, full, rhyming — adjacent.

In the works of this genre, we found the combination of an oxymoron that helps identify God's special presence in the hagiography of the saint, which is dedicated to the crown. They are also available antithetic expressive means, but it should be noted that often in crowns matching words or phrases, opposite in content, leads to awareness of their similarities by reader.

In some writings, which contained anaphora, it is built as a reference to Jesus, which emphasizes pleading nature of monologue speech character. Crowns peculiar inversion in order to strengthen of gravity of those or other words in a sentence. The phenomena of the nature are personified and authors often use comparisons. The motif is abundant loading of works: the motif of purity, burial grounds and so contribute to a holistic perception of individual poems or cycles.

In the works of hagiographical themes linear composition is available as gradually and chronologically disclosed holy life events. They have distinct «inside story», which enhances the dynamism, generally uncharacteristic of poetry.

One of the distinct features is a play on words (e.g. — «Варваром [рожденная]» — «Варваро»).

According to the thematic diversity poetry can be roughly divided into three distinct currents, one of which is a hagiographic theme, which addressing the lives of the saints, projecting them on the character. The second, called a passion theme, is like the construction of "Rosary" described the suffering of Christ. The third is Evangelical theme facing the key episodes from the Scriptures.

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#### MOTIVES OF PROSTITUTION AMONG YOUNG PEOPLE

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**Abstract:** The article reveals the motives of prostitution among young people, the most important of which are: situation in the family, early sexual debut, parents' attitude towards sexual life of their children. Prostitution as a social phenomenon is considered as part of the average level of the theory – sociology of deviant behavior. We also analyze empirical data concerning prostitution as possible profession in the consciousness of youth.

**Key words:** deviant behavior, motives of prostitution, prostitution, young people.

**Introduction:** The phenomenon of prostitution among young people of Ukrainian society is a very acute and complex issue: to prove how serious it is, we present data from a survey of teenagers from Kharkiv

and Kharkiv region of 2016: 4,2% of respondents consider prostitution as the most attractive occupation [Deyneko 2016: 74]. Moreover, in 2006 Ukraine took the second place among the countries, which provide migrant sex workers from Europe [Brussa 2009: 20]. Unfortunately, the fact that prostitution exists and that it is common among young people in Ukraine is usually held back or ignored.

It is important to admit the fact that though the majority tends to speak about prostitution in a negative way, the thesis that this occupation guarantees good money is rooted in our consciousness since very early age. In this regard, we risk to receive such youth for whom morals and principles will not be as important as high salary at any cost.

It is also impossible to ignore the fact that prostitution is one of the main ways of transfer of venereal diseases and various viruses (including HIV, herpes, hepatitis B etc.). The investigation reveals the fact that sex workers usually have no corresponding medical examination and they seldom use well-tried contraception and thus put their clients at risk.

Taking into account the abovementioned facts which prove the topicality of the issue of prostitution, we may suggest that the latter confirms the relevance of our article.

As prostitution is a primary deviation from the established standards and moral principles within society and it is also a crime, youth prostitution can be considered as issue of both youth sociology and crime sociology. However, in our opinion, the best way of studying this phenomenon is consideration of prostitution within sociology of deviant behavior.

**Object-matter** is prostitution as form of deviant behavior, a **subject-matter** is interaction of prostitution and factors influencing it in the modern world.

Many people have a certain idea of what prostitution is, but the **objective** of our work is profound and stage-by-stage research of the phenomenon of prostitution among youth as well as clarification of factors which make the youth consider prostitution as a possible profession.

This article considers the following **tasks**:

1. to give the main characteristics of the phenomenon of prostitution in modern society (risks inherent in sex workers and motives of choosing prostitution as occupation);
2. to generalize historical prerequisites of emergence and development of sociology of deviant behavior;
3. to define factors in connection with which the youth decide to be engaged in prostitution;
4. to reveal the main problems and offer solutions;

**Research methods:** Theoretical analysis and generalization of scientific literature and periodicals devoted to the factors which influence the youth and provoke their wish to be engaged in prostitution.

**Material:** Empirical basis relies on research of youth prostitution by Goroshkov M. and Sheregi F., manuscript by Deyneko A., and also the collective monograph named "Teenager in a big city: factors and mechanisms of socialization" [Arbenina, Voljans'ka, Zinchina, Kurjacha, Nikolievskaja, Sokurianska. and Shmachko 2010].

**Discussion and results:** The main issue which this article brings up is connected first of all with the reasons why young people are ready to provide services at sexual labor market. It is especially odd in our modern world which is developing very promptly, the world which gives equality to all people in all respects, and the youth receive more and more conditions for development. Such social phenomenon is not fictional; it is present all around the world and in Ukrainian society in particular.

In general, every young person can think of his/her future occupation and of the position s/he will hold as soon as s/he starts thinking about free money. Therefore social and professional plans are quite a usual and expected subject of conversations among youth. The results of the poll show that teenagers often discuss their plans after school leaving with friends and acquaintances: teenagers from the rural area (51,2%), teenagers from urban area (44,5%). Thus, we may suggest that at this age teenagers are not very far-sighted about their future job.

It should be noted that the modern youth, being in conditions of primary socialization, cannot be guided in the choice of future career by real professional self-determination yet. More often teenagers choose their professional way according to the picture which was created in their imagination, which sometimes is very far from reality.

Today the position of "sex worker" is on the list of professions chosen by teenagers. 4,2% of teenagers choose prostitution as their future profession because of a high salary proposed by this occupation [Deyneko 2016: 74]. Therefore, we can draw a conclusion that a modern teenager considers sexual services first of all as source of livelihood, and as a result, honest employment is less attractive to him/her (only about 3% of respondents plan to become a worker, farmer or scientist) [Deyneko 2016: 74]. We can see that professions

important today are in a smaller demand among younger generation as they first of all choose high remuneration for the work as the main criterion. Such notions as fulfilment, personal growth and development yield to the desire to get much money and ensure stable existence at any cost.

At present we can already give unfavorable data on the age of young people who are regularly engaged in prostitution in percentage terms: up to twenty years old (21,7%), from twenty to twenty-four years old (26,1%), from twenty-five to thirty-four years old (43,5%) [Goroshkov, Sheregi 2010: 218].

We can observe such a tendency: with increase in age the number of young people who are engaged in prostitution grows. Those people who are already mature (the youth from 25 to 34 years old) resort to prostitution more often. We suppose, it can be connected with the fact that adults can have more complex problems in life and they try to find new ways for their solution while the youth up to 24 years old (teenagers, students) can shift their problems on others. Young people can pay less attention to them and be in general less responsible for their problems in comparison with adults.

Young people do not take a decision to become a sex worker in one day. This decision is influenced by many factors that we consider in this article. The first circumstance which can push the youth to commercial sex is a problem situation in the family. It is an important factor because most of representatives of the younger generation, despite complaints of adults, still try to improve economic situation in their family. However, if a youngster doesn't feel love and care in the family, he/she then most likely tries to change his/her life at any cost (for example, girls tend to leave the house where they are exposed to domestic violence). According to results of the research, the main reason why the youth decide to be engaged in prostitution is drug abuse by family members (13,9%) [Goroshkov, Sheregi 2010: 222].

Another important factor which influences the youth's decision to consider prostitution as future profession is illusions concerning the guaranteed stable income. Unfortunately, the youth most often do not know dangers and risks of prostitution. As poll results show most sex workers lead a poor life, they note that they have enough money for food, but they can hardly buy any clothes. A share of the poor regularly engaged in prostitution exceeds a share of the poor not engaged in prostitution by 1,5 times [Goroshkov, Sheregi 2010: 220]. A delusion "prostitution will help me to make easy money for existence" pushes the youth to opt for the most ancient profession.

We also suppose that early sexual debut among teenagers is another powerful reason. Distribution of the received answers looks like this: some teenagers (their number is not considerable) named the age from 10 to 13 as acceptable, but most often the first sexual intercourse falls on the age from 14-16, with the "peak" at the age of 15 [Arbenina, Voljanska, Kurjacha 2000]. In our opinion, early sexual debut can be a prerequisite for prostitution. As physical development usually advances mental one, teenagers are rarely able to analyze situations or take their decisions. Parents' attention and care are of great importance at this age. Today the majority of Ukrainian parents do not know anything about their child's sexual relations. In our opinion, parents have to give the maximum quantity of their attention to teenagers during the period from 14 to 17 where the personality is formed.

The last but not the least factor which we would mention is feature films which show life of a sex worker romantically and this is why the youth have the wrong idea of prostitution and in the future they plan to be engaged in it. After watching the American comedy "Escort" (2015) many girls supposed that the life of a prostitute is filled with different adventures, events, money. Girls might think that working in sex industry is easy to get the lucky ticket and to find true love. However, we have already proved that it is an illusion

**Conclusions:** The youth's opinion of prostitution as profession or as way of additional income is confusing and every modern individual should not be indifferent to this fact. We believe that all people have to understand that prostitution is such a phenomenon that can never be obscured and must be fought against by society for the sake of the youth: their personality, health and life. Prostitution has not evolved much – its forms of manifestation are the same. However, with development of technologies it became much easier for a sex worker to provide his/her services and for the client to use them.

This article provides empirical data on factors which influence the decision of the youth to consider prostitution as a profession in the future. We found out that the youth usually argue on the future profession and often coordinate their choice with schoolmates and peers rather than adults. The main priority for them is to take up a profession which would guarantee a sufficient salary. Most often the first choice of profession falls on teenage age when the youth still cannot consciously estimate their abilities and inclinations.

The decision to become a sex worker is not spontaneous. It is usually influenced by a set of factors, the main of which are the following: an economic incentive, a situation in a family, an early sexual debut, low

knowledge of risks and dangers of prostitution, and the influence of feature films which show the life of a prostitute in a romantic way.

The abovementioned results and conclusions of our research reveal the need of holding special events and campaigns for secondary schools. They have to acquaint pupils with features of modern labor market in order to liquidate stereotypes of “prestigious” and “not prestigious” professions. Another aim of such events is to explain to modern youth that everyone has equal chances for self-realization and s/he should never engage in any activity which humiliates his/her personal honor.

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УДК 316:32:35

## WORLD AGRICULTURE COMPLEX UNDER GLOBAL CHALLENGES: STATE AND TRENDS OF DEVELOPMENT

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**Abstract.** The article investigates development and specificity of world agriculture in the context of the global issues. The paper considers global issues in the context of international economic relations, in particular food issues. The authors suggest the possible ways in further development of world agriculture.

**Keywords:** globalization, global issues, food issues, agriculture.

**Problem statement.** The modern stage of development in world agriculture is characterized by permanent transformation of national economic policies, still there are failed attempts to carry out a supranational regulation within the world agriculture by spreading economic and political interrelationship among the world countries. World economics considers agricultural growth as the factor providing social economic progress of society, development of agriculture acts as an engine that provides growth of the other economic branches, poverty reduction, guarantees food supply security and food sovereignty.

**The latest research and publications analysis.** In the context of the theoretical foundation much attention has been paid to appearance, existence and solution of the key global development problems for the recent decades in the research of a number of the foreign and domestic scientists: Bilorus O., Golikov A., Dovgal O., Zagladin V., Zadorozhnyi G., Klymko G., Lukyanenko D., Maksymova M., Meadows D., Rokocha V., Rumyantsev A., etc.

**The objective of the research.** The objective of the research is analysis of the modern agricultural complex and study the ways of its further evolution.

**Discussion.** In the 70s of the 20th century after the first report ‘The Limits to Growth’ to the Club of Rome (1972) the global issues concept was found to be a standard notion. The book was prepared by a group of scientists directed by the American scientist Dennis L. Meadows who used the catalogue of ideas suggested by his teacher, professor of cybernetics Jay Forrester a year before in his book ‘World Dynamics’. The latter predicted the imminence of universal catastrophes such as depletion of natural resources, environmental pollution and also population growth in the developing countries at the beginning of the 21st century [Nadvychnyi 2014: 69-75].

With the birth of the civilization people faced with the food supply problem. During the period of human development the food shortages issue for a variety of reasons at different times repeatedly emerged in some regions and countries, but it was not of any global nature. Death from starvation of about 100 million people in China in the 19th, 20 million people in India in the last 30 years of the 19th led to some actions of the

world community in food aid in the suffering countries. It can be accounted for by the fact that the human of that time was not knowledgeable about the global nature of the problem [Saprykin].

The global food issue consists of the food shortages problem (it is especially critical in the developing countries the number of starving people in the world in 2012 was 870 million people [Saprykina 2013: 125-129]); the unbalanced nutritional problem (the consumption of the most important types of food per head is beyond the medical standard of good nutrition); the problem of the world agricultural production [Piterz 2008].

For the all-round understanding of the term 'food problem' let us look at the definition of the basic categories which relate to this term.

The definition of the food supply security is rather diversified. The Food and Agriculture Organization of the United Nations gives the following interpretation of the term food supply security: 'there is a situation when all the people at any time have a physical, social and economic opportunity to have access to the safe and nourishing food which meets their demands for active and healthy life' [Saprykin]. This definition consists of accessibility, stability and usage of the food supplies.

The National Institute for Strategic Studies in Ukraine gives the following definition of food supply: 'this is such a level of the food supply for the population which guarantees social and political stability within society, survival and growth of a nation, a person and a family, economic growth' [Piterz 2008].

The objective law of the modern world economy is internationalization production and integration in the international economic structure that promotes activation of export and import operations on the external market.

The market of agricultural production occupies a special position among the markets of traditional products. First, there is no country that does not take part in the process of international turnover of agricultural products as an exporter, an importer or a humanitarian and food aid receiver. Second, agricultural production is the oldest human occupation. For this reason, in fact, in any world country there is an agricultural sector that produces some goods. Third, the oldest products in the history of the world market growth are food supply and agricultural raw materials [Hozin 1982].

The market of agricultural products is the system of economic relationships and it is formed with the help of different institutions, provides and regulates agricultural output production in economics and goods movement towards a consumer in interchange [Europe in figures 2015].

Studies of the agricultural market content and its mechanism prove that the first signs of market relationships in agriculture existed in the Ancient times when there was exchange of the work results as an excess of producers over their demands between agricultural and cattle-breeding tribes. In such a way the interest was provided fairly and to the extent of the capacity of both participants of the exchange. It was the simplest exchange and the most primitive form of market relationships when the output was sent primary from the source to a customer.

In the evolution, there happened to be expansion of social division of labor which induced development of commodity production and caused necessity of regular excess production on the market instead of accidental occasions.

The food product market has had a long way beginning from some primitive fairs to the modern-organized markets with the constant updates and product quality increase, stock list replenishment, demand response of the customers despite strong competition.

Approximately 12% of the world agricultural production enters the world market. The output level is estimated by the general rate of economic growth of countries. By the 1980s, most of the world labor forces had been engaged in agriculture, and only in the middle of the 1980s the number of the people working in that field decreased. It coincided with the general tendency of employment reduction in agriculture. It concerned both highly-developed countries and developing countries. Besides, if in the former case the rate of employment is between 3-10%, then in the later case it is from 50 to 90% [Hozin 1982]. This high disagreement in the index of employment is due to the degree of mechanization, chemicalization, and power infrastructure in agriculture in the countries with different social and economic growth standards, and also due to the structure and effective functioning of their agricultural complex. Highly-developed countries with the intensive type of agriculture and a small percentage of employees provide of a considerable volume of agricultural production. In the US agriculture less than 4 million people provide not only the US citizens (more than 316 million people) with necessary agricultural products but also a considerable amount of the production is exported (about 25%). The same situation can be observed in France, Canada, Denmark, the Netherlands, Australia and other highly-developed countries. The situation is different in underdeveloped countries where the majority are employed in

agriculture; besides, chronicle lack of food supply is observed there [Derzhavna sluzhba statystyky Ukrainy 2015: 379].

All the world countries are involved in the process of food trade, trade of agricultural raw materials and also goods necessary for their production and processing. The big part of the world food trade is in regions to avoid the expenses for transportation. First of all, it concerns Europe. Asia and Africa are still the areas with the biggest deficit in supplying their citizens with food, especially with small grain crops and meat. It is necessary to mention that the importance of the European continent as a supplier of the main food types to the world market is rapidly increasing, while Europe used to be a food importer till the middle of the 20th century. At the same time, the role of North and South America and also of Australia that used to dominate but has declined. Mostly these changes took places because of the success achieved in the Common Agricultural Policy of EU [Saprykina 2013: 125-129].

The biggest food exporters are the USA, France, the Netherlands, FRG, Canada, Spain, Brazil, Italy, Australia, China and for the recent 5 years they have been the leaders holding different positions [Pavlov 2014]. According to this, the biggest importers are the USA, FRG, China, the United Kingdom, Japan, France, the Netherlands, Italy, Canada, Spain.

More than half of the world food export and import is accounted for 10 biggest exporter- and importer-countries. It proves there is a high level of the diversification of their stock list which is common for developing countries [Derzhavna sluzhba statystyky Ukrainy 2015: 379].

Another relevant issue in the world food trade nowadays is its further liberalization that includes exclusion of different tariff and non-tariff restrictions. The Agreement on Agriculture developed under GATT (came into force in 1995), provided trade liberalization and sponsoring reduction and export and also delivery facilitation from developing counties to the market of developed countries. However, this agreement is constantly being violated [Saprykina 2013: 125-129].

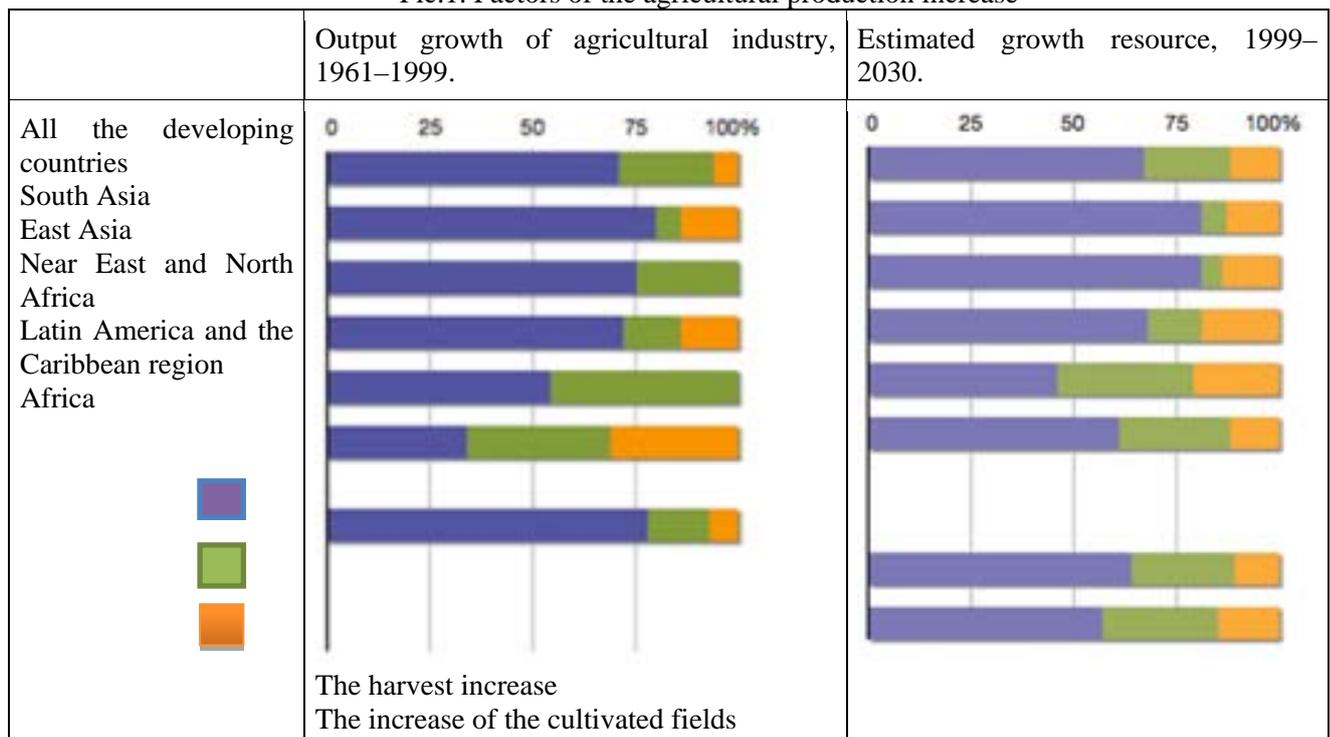
Maintaining the position on the external markets and the further export expansion demand solution of the external markets excess, removal of constraints of export in developing countries and elimination of threat of their usage in the future. This task becomes more and more meaningful, because it bears a potential of paying profit on the world market [Survey of Energy Resources 2014].

Three main factors that influence the recent increase of the world harvest are:

- 1) Expansion of croplands and rangelands of a region (15% of the input in 1961 — 1999);
- 2) Harvest increase per unit area (78% of the input);
- 3) High intensity of agriculture (7% of the input).

The tendencies mentioned above are represented in pic. 1.

Pic.1. Factors of the agricultural production increase



	The load increase on the land	
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Pic. 1. Factors of the agricultural production increase [Survey of Energy Resources 2014]

**Conclusions.** The below-stated tasks have to be solved to form an adequate reaction to the global challenges [Nadvychnyi 2014: 69-75]:

- to reequip and update agriculture, reorient it towards an innovative and investment model of development;
- to train efficient and highly-skilled staff, capable of effective work within the frames of the innovative and investment model of development;
- to optimize the agrochemical interference and increase the amount of organic and green fertilizers;
- to create modern social infrastructure in rural areas.

All these will provide an opportunity to react to modern global challenges, to speed up economic growth, to guarantee economic and food security in a country, to take the leading position on the world agricultural market, to become a knowledge-based and a hi-tech sector in the national economy. Development of the biotechnologies as a result of innovative progress in agriculture will let solve the problem of food supply in the world and especially in Ukraine.

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## EVOLUTION OF SPATIAL DEVELOPMENT THEORIES AS THE BASIS FOR MODERN MANAGEMENT OF REGIONS

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**Abstract.** The article investigates and systematizes basic theories of spatial development. Basic and modern theories are referred to as two classification blocks of spatial development theories. The study has been undertaken of the theories evolution and relationship in terms of their usage in management of regions. The applied nature of theories of regional growth as well as incompleteness of their formation have been emphasized.

**Keywords:** placement factors, regional management, resources of growth, spatial development.

**Introduction.** The acceleration of the development pace of individual regions, as well as the strengthening of the inter-regional competition and integration, using the domestic resources of growth, require a need for the model to manage spatial development of regions. Theories of spatial development make up the basis for the development of conceptual approaches to, techniques and tools of such management. The activities of the authorities must rely on the scientific grounds. In other words, without proper knowledge of spatial development theories, one cannot intuitively identify and formulate effective patterns and mechanisms of economy growth.

The relevance of the given research can be proved by the fact that the European Commission adopted the program „ESPON” (The European Observation Network for Territorial Development and Cohesion) on 7 November 2007. The program’s budget amounts to EUR 20 billion, with a part of the funds being aimed at research on theoretical aspects of spatial development. Besides, every three years on the initiative of the Council of Europe, the Europe Conference of Ministers responsible for Spatial Planning (CEMAT) is held to discuss the conceptual foundations for the selected issues.

Scientific and theoretical aspects of spatial development find their reflection in the fundamental works by outstanding foreign researchers. Thus, Nobel prize winner in Economics Paul Krugman is convinced that there is an acute necessity for taking into account spatial factors in economic research because of a specific place occupied by economy on the map [Krugman 2012].

Regarding the most important Ukrainian researchers interested in the theory of spatial development, it is worth referring to A. Belous, V. Geyets, Z. Gerasimchuk, N. Dolishniyy, D. Lukyanenko, V. Chuzhikov and others.

According to academician of the National Academy of Sciences of Ukraine V. Geyets, the development of the economic space of Ukraine is accompanied by structural changes in all spheres of economic activities, which requires the search for, development and introduction of new progressive forms of management at the regional level together with the invention and use of adequate methods of spatial development management [Geyets 2004: 3-27].

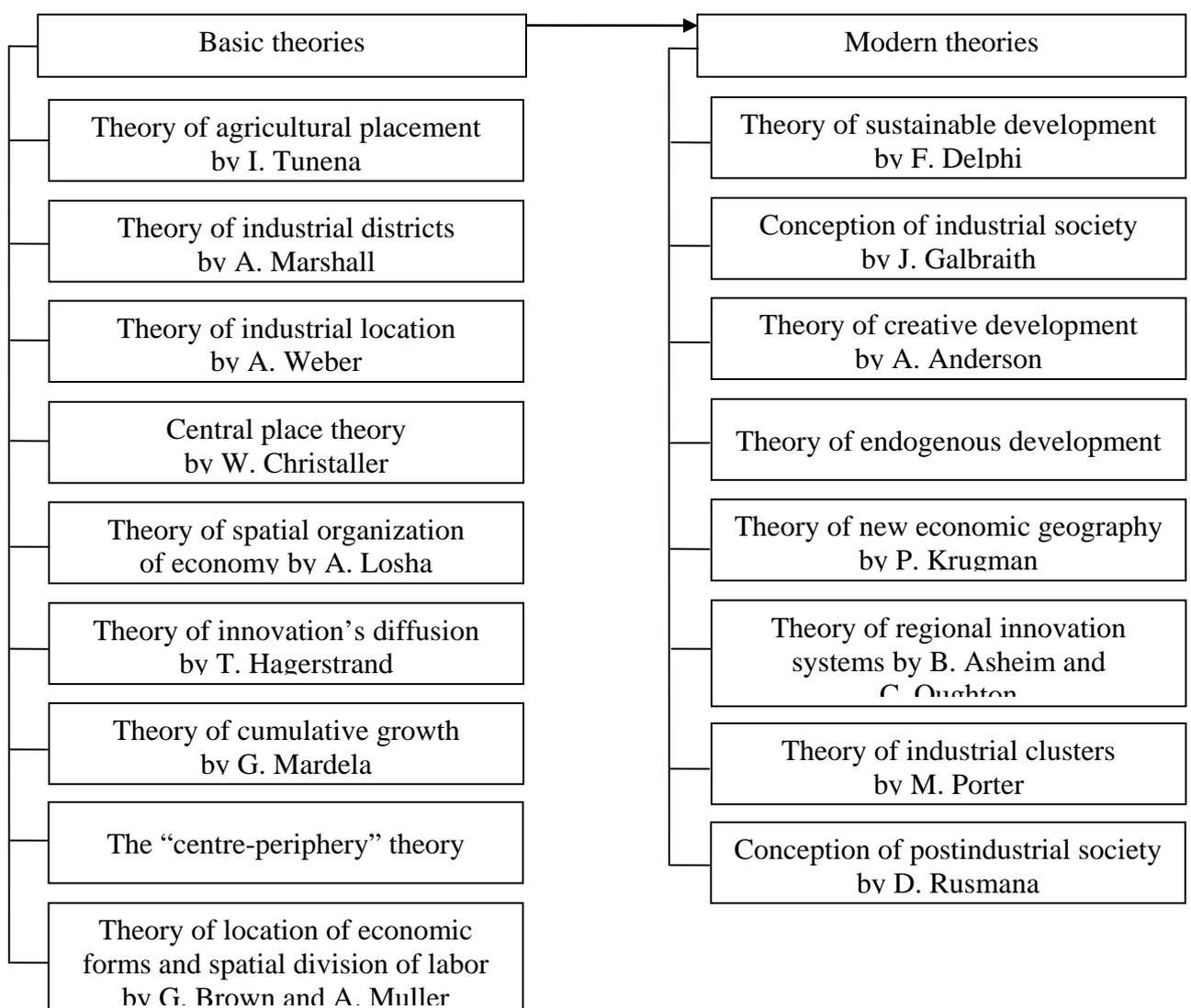
The **object-matter** of the study is the management of the regional space, and the **subject-matter** is spatial development theories as the basis for modern management of regions.

The **objective** of this article is to systematize and justify the main theories of spatial development in economic science and their practical value to regional management. The article suggests the following **tasks**:

- to summarize the theoretical aspects of spatial development management;
- to develop a classification of theories of regions' spatial development.

The study used the following **methods of research**: structural and logical, scientific analysis, graphic.

**Discussion and Results.** The contradictions between countries and their regions has led to the emergence of a number of theories of spatial development, which continue to evolve in the context of the new modern factors. The theories, which became the basis for subsequent theories of spatial development, originated in the 19th century. Their appearance is due to economic problems in relation to the development of new territories and the need for a balanced distribution of productive forces. To streamline the existing diversity of theories of spatial economics is virtually impossible. However, we have attempted to highlight the most famous centers for scientific thought in terms of the theory of spatial development, which have proved their effectiveness in practice. To this end, two blocks of their classification have been identified: the basic theory and the modern one (Fig). Let us consider some of them.



## Figure – The evolution of spatial development theories

According to the basic theories of spatial development, the benefit from economic activity is acquired depending on the placement factors. For example, in his research “The isolated state in its relation to agriculture and national economy” (1826) I. Tunen explained the basics of the agricultural placement theory. The main focus of I. Tunen’s theory was two factors of spatial development – land rent and transport costs affecting the formation of prices of agricultural products. What is more, I. Tunen was the first to formulate the concept of economic space and note the importance of geographical location.

Marshall’s theory of industrial districts involves increase in competitive advantages of SMEs as opposed to large ones by the location of the former on a particular territory and availability of resources. In Marshall’s view, highly skilled workforce, local business partners, the possibility of the division of labor between enterprises that collectively contribute to the development of innovative activities constitute the main factors in successful development of individual regions.

The theory of economy spatial organization by A. Losha is based on the idea that the main factor in rational allocation of production, market sales and settlements is the ability to maximize profits. The researcher stressed the dependence of the number of sales on distance of the transportation.

Mardela’s theory of cumulative growth is based on the assertion that economic growth is concentrated in large cities. Thanks to the concentration of large enterprises in cities and specialization, one can gradually reduce production costs and continuously enhance competitive advantages. The development of large cities is due to the backward areas. Over time disparities in development grow: the leading cities and towns will increase their competitive position, while backward areas will get deep in crisis.

According to the “centre-periphery” theory, centre dominates at the expense of continuous innovation, investments and the agglomeration effect. Periphery serves as the opposite to the centre. The peripheries located closer to the center gradually accept innovation, whereas remote peripheries are less developed and continue to maintain conservative approaches. Supporters of this theory can see the existence of the “center-periphery” system through the innovation generation and adoption.

The authors of the theory of location of economic forms and spatial division of labor – G. Brown and A. Muller – justify the leading role of capital in spatial development.

Since the end of the 20th century (1980-1990) under the influence of scientific-technical progress and the development of information technologies there have appeared modern theories of spatial development that are characterized by the increasing role of regions in the national economy, the expansion of local authorities’ power, overcoming the territorial imbalances and strengthening the competitive position of regions.

The main idea of Delphi’s theory of sustainable development is the following: economic growth is due to the intensive use of natural resources in the region. However, further destructive use of resources, as the deepening of existing environmental problems may lead to a global ecological crisis. The main goal of sustainable development is to meet the needs of modern society without compromising the ability of future generations to meet their own needs.

The author of the industrial society conception J. Galbraith believes that the basis for the spatial development is new energy sources and the possibility of their use in production and distribution.

According to A. Anderson, the development of creative economy requires people and their potential (talents, creativity), favorable conditions for the development and realization of a creative personality, intellectual legal protection for creative products, introducing new technologies,

encouraging small and medium businesses engaged in creative projects, the preservation of the region culture and identity. In the framework of creative economy, key competitive advantages are represented by high technology, know-how and highly qualified employees capable of generating a new competitive model of sustainable development.

Theory of endogenous development launched in Europe in the 1970s suggests that the natural potential of backward regions can contribute to the equalization of territorial disparities between the regions. In fact, the disadvantages of the territory might be converted into its advantages: peripheral, geographically isolated areas can be tourist centers, which will house the health resorts and the enterprises of tourist service.

Krugman's theory of new economic geography investigates the sequence of creation of regional agglomerations, which results from the access to markets, rather than from distance or cluster of enterprises. As the author puts it, the main factor in economic growth is the regional concentration of industrial enterprises, which are placed geographically unevenly. The reason for the uneven development of regions is agglomeration of production activity areas.

The Porter's theory of industrial clusters comes from the diamond of competitive advantage (production, demand, major and related industry, strategy): favorable conditions for formation of competitive advantages of the region evolve when enterprises belonging to one industry are related or geographically concentrated. For M. Porter, cluster is a group of adjacent, geographically concentrated and interconnected companies which operate in the same area and have established business relationships [Porter 2011].

Thus, the main criteria for basic theories are the placement factors, innovations, and formation of growth poles. The modern theories are based on the concept of sustainable development, which provides the harmonious development and efficient use of resources, innovative growth, attraction of local capacity and its optimal use for self-development. Each of the theories of spatial development was formed at the time characterized by specific features. The basic theory of spatial development became widespread in the periods of formation and decline of traditional industries, with the formation of modern theories being affected by scientific-technical progress and creative potential of the territories. The formation of modern theories of spatial development is not completed. Nowadays economic conditions and information-innovative development are creating preconditions for fundamentally new approaches to spatial development to come into being.

Conclusions. Increased attention to balancing regional development led to the emergence of a number of theoretical studies of spatial economy factors and building a model for their effective management. Being fundamentally different, the theories of spatial development involve distinct methods to improve the region on the basis of internal and external environmental factors. Almost each of the theories can be used in the region at a certain stage of its development. Most modern researchers believe that it is appropriate to apply the "integrated" theory, which would contain basic methodological elements of the above conceptions. That is, given the applied nature of concepts, attempts are made to unite the different branches of theories of economic development, which might determine the subject of the further research in this area.

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**Summary:** the Article is devoted to music culture of Ancient Greece. The study is the musical culture of Greece as the background of the European musical culture; the basis of modern musical instruments was built on ancient Greek instruments and music theory. Music is also described as the basis of the Greek educational process.

**Keywords:** music culture, ancient Greece, musical instruments, art, music.

The role of music in Ancient Greece is studied in this article. It is very important to understand the principles of music as moral and aesthetic element of education in Greek society. The link between ancient and modern music is aligned.

**Object-matter** is to analyze Ancient Greek education through the prism of music, paying attention on its aesthetic and educational components.

**Subject-matter** music in Ancient Greece

**Objective** of the present paper is to introduce the role of musical education in Ancient Greek and to identify its importance in social interaction of that time.

**Tasks** of this paper are:

- to study the issue of Greek music as a part of Greek culture;
- to find out what musical instruments were created in Ancient Greece;
- to align the importance of musical education for children in the Greek family;
- to study the link between Greek music and European music and analyze its importance.

**Research methods** of this paper are based on the analysis of the existing **materials:** literature on this topic and some historical research data, which could help to formulate the problem more globally and actualize it.

The musical culture of Ancient Greece formed the first historical step in the development of musical culture in Europe. It is the ultimate expression of the culture of the ancient world and moreover had definite links with the more ancient cultures of the Middle East - Egypt, Syria, and Palestine [Livanova 1983:3].

The words "music" comes from the Greek "art music". Today, scientists, based on new information of archaeological and ethnographic researches, have found that in a primitive society music formation was quite a long process. According to materials extracted during archaeological excavations on the territory of ancient Greece there was a rather developed musical culture in the Mycenaean period. There is not a lot of specific data about it left. However, such instruments as sistrom, horns, lyre in the hands of musicians, allow us to think about the considerable experience of creating music [Livanova 1983:6].

We can talk about music of ancient Greece primarily on the basis of the written monuments of literature (artistic and scientific), and the samples of visual arts. Only a few fragments of the actual musical monuments have survived. The development of ancient Greek music covers about 20 centuries.

Thanks to the testimony of ancient music writers, we can imagine its specific features, its place and meaning in the common system of ancient culture. It is widely known that ancient Greek music was closely associated with the performing arts, dance, rhythm, gesture [Shestakov 1975:61]. In Athens in the era of Cimon and Pericles, the Greek music could take partly advantage of ancient legacy cultures: Egyptian, Syrian, Hittite, perhaps, Indian - and later separate parts of the Greek culture were established. Musical notation of Greek folk songs is missing. In the early period of its development, the Greek music was closely connected to poetry. Music played an important role in public and private life of the Greeks. For free citizens in the Greek cities of Athens, Sparta, Thebes and others were taught musical art, musical theory, aesthetics, techniques of execution and others. It was an obligatory component of civic education. However, musical art and life could not have been severely regulated by the state [Zaykov 1995:52]. The songs had special names indicating their variety genres. The folk song originally developed into such frets - Dorian, Phrygian, Lydian, - which later formed the basis of compositional techniques of that time. One of the most frequent forms of choral poetry - dithyramb is a song presented in honor of the god Dionysus. Other songs like prosody, a paean are a song performed of thanksgiving to Apollo, Artemis, or other gods; giporhema anthem is a song cooperated with the dance. There was also epinikia a song presented in honor of the winners in different competitions [Kymanetskiy 1994: p.68].

The earliest known music artists and performers were both poets, composers and singers accompanied themselves on any stringed instrument. Personalities and artistic activities of the ancient artists were depicted in various myths and epics. Archaic period (7-6 century B.C) in ancient Greece music is associated with the names Terpander, Archilochus, Arion, Tirteya, Alcman, Stesichorus, Sappho, Alcaeus, Anacreon, Mimnermus, Ilica, Pindar, Vakhilida and other. At that time there was the formation and development of many musical genres. The

dawn of Greek tragedy and Comedy reached its point in the classical period (V - 1st half of IV century BC), where music performed important dramatic function. Music of VI - V centuries BC was based on the strict canons, dimensions and simple modulations. Since the IV century a tricky rhythm, unexpected effects and contrasts penetrated into the music [Shestakov1975:72].

There were a string, wind and percussion instruments in Ancient Greece. The Greeks did not know stringed instruments. String instruments were often called by the general name – Lyra, prevailing from ancient times to the present day. Greek mythology places Hermes and Orpheus among the inventors of the lyre. Homer in his Hymn to Hermes describes the construction of the first lyre from Hermes, who lived on the mountain Kellini. For the construction of the instrument Hermes used a large tortoise shell (kheilos) for the body and bull intestine for the strings. In other descriptions, the lyre is found to be used, most commonly, by the aristocratic society and was connected with the worship of the god Apollo, making it a highly respected instrument. Apollo is the divinity that according to mythology improved the lyre developing the kithara [Lavdas1987:89]. In addition to the lira, cittern and barbitone and others it was widely known. [Baluh2001:200] The kithara was a seven-stringed lyre with a bigger size and plane wooden body. It produced richer and deeper sounds than the simpler lyre and it could be played in the open air. Strings of gut or sinew were stretched from a holder at the base of the instrument over a bridge to the crossbar that joined the two sidepieces. The kithara with its large sound box was more appropriate for virtuoso display. Kithara was played by professional musicians called “kitharodes”, thus, it was considered a more masculine instrument [Nef1945:121]. Lyra which had 4 strings was used only for accompaniment, echoing the voices of the singers. The number of strings was increasing gradually in the VII century BC there was a seven-stringed lyre. Further improvements of the Lira have led to the appearance of the cithara or cittern. The cittern was played only by men. The cittern had a flat heavy wooden body with straight or curved shape; strings were fastened with the body [Kymanetskiy1994:66].

The musical theory and musical aesthetics also developed in Ancient Greece. The doctrine of Pythagoras was fundamental to European music theory; it was attributed to Pythagoras with establishing of the mathematical relationships between the frequencies of the individual sounds and the invention of Pythagorean system. He was not a musician, but he discovered the diatonic scale. Having received basic information about the divine theory of music from the priests of the various Mysteries, Pythagoras spent several years in thinking over the laws of consonance and dissonance. Musical and mathematical harmony of the Pythagoreans masterpieces was the first and basic division of their aesthetics [Losev2000:89].

The extensive treatise "Against the mathematicians" belongs to Sextus – Empiricist. The sixth Chapter of the second book of this treatise was dedicated to music and was called "Against musicians". In fact, Sextus – Empiricist was not against the music as art, but opposed to music theory [Shestakov1975:52].

There also were many theoretical schools of musical art in Ancient Greece. Harmonic was believed to be the main criterion for music and beauty was the listening perception ("good harmony"). The canonists understood proceed from the abstract and mathematical understanding of music. They argued that "in music is the nature and power of numbers". The palm in their dispute belonged to the harmonics.

One of the main achievements of ancient musical theory and aesthetics was the doctrine of ethos. This doctrine explained the essence and nature of music, its influence on feeling and behavior. The doctrine of ethos was the dominant aesthetic doctrine throughout the antiquity [Shestakov1975:68].

The oldest information about the educational value of music among the Greeks goes to Sparta. Through music here achieved a spiritual education that can ignite in the soul courage and love of country, and protect against any corruption. Boys and young men in Sparta trained to play on the cithara and to sing in chorus or alone. Chorales in the Doric style had to sow in the hearts of the young Spartan courage and discipline, noble pride, true humility, contempt of all slave and poor, the pursuit of virtue [Zaykov1995:26].

The Athenians, unlike the Spartans dominated individual style in the education. Even from birth, children heard the music. To make child asleep, it was rocked with the cradle songs. Music was also used in games with children. Girls' education was limited to the scope of family education in the female part of the house. There girls received basic knowledge of reading, writing, and playing musical instruments. The education of boys was different. Choosing sciences depended on father, but son must had to train gymnastics and music. Full musical course boys received from citharist where they learned to wield a lyre and cithara. Like the Spartans, the Athenians preferred the Doric style which expressed the importance of calm and had a character of strength and courage [Koroleva2010:31].

## **Conclusions**

Music played an important role in the ancient education as a means of moral and aesthetic education of harmoniously developed personality. Music in Ancient Greece appeared as an element of moral education. In Greece, special instruments were developed and became the basis for the creation of new modern types of instruments. Learning music became a child-educating system, singing and playing instruments became a part of the gymnastic and artistic events. Ancient Greek music had a great influence on the development of European professional musical culture and musical science.

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### FEATURES OF THE EMOTIONAL SPHERE OF VOLUNTEERS HELPING INTERNALLY DISPLACED PERSONS FROM ANTI-TERRORIST OPERATION AREA

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**Abstract:** the article deals with certain characteristics of the emotional sphere of the volunteers helping the internally displaced persons from anti-terrorist operation areas. The article considers the features providing successful professional activity of volunteers and the influence of stress at work on the development of the volunteers' professional burnout.

**Key words:** emotional intelligence, empathy, professional burnout, sociology professions, volunteers.

#### Introduction

The relevance of the study is conditioned by the situation which formed in Ukraine in 2014-2015 and caused an increase in demand for workers providing assistance. This situation has caused deep social upheaval and, therefore, the need to feel support of other people. That is why the Institute of Volunteering began to develop in the country quite rapidly, since social work today can be considered as one of the institutions of modern civil society [Pevnaia 2012]. Today volunteering in Ukraine is a fairly large-scale process. In 2014, the movement of selfless help in the country reached its peak since the time when Ukraine got independence. According to UN data, 23% of respondents are involved in voluntary activity in Ukraine. [Podubnyak]. Volunteering has a positive effect on the process of socialization, on the formation of the spiritual world, on the definition of moral values [Kryvokon 2012].

The depth and quickness of socio-economic changes taking place in the society, its democratization and humanization, an accelerated pace of life, a high level of stressogenic conditions and the problems of an individual's adaptation in the society have required an increase in the number of workers providing help of the so-called sociology professions (doctors, psychologists, social workers, teachers). The activity of these professionals is very diverse, but all of them have close contacts with people, which are often so difficult to maintain for a long time, from an emotional point of view [Maslach 1978].

Since the personality of a specialist is a tool of professional activity in the areas of social practice, much attention should be paid to the peculiarities of a professional activity process, the conditions influencing an individual, the consequences of labour activity having an impact on an individual. It should be noted that due to a difficult geopolitical situation in the country the employers, who join the ranks of volunteers, usually do not have the appropriate education, and it often leads to certain difficulties in their professional activities.

The competent expression of emotions, the ability to understand themselves and others, to govern their own behavior and influence the behavior of the environment are rather important for sociology professions. Emotional intelligence greatly influences the person's ability to feel happy. It is believed that the individuals with more developed emotional intelligence adapt in a society better, are more effective in various types of activities, are able to resolve conflicts more constructively, which is considered to be an important professional feature for a social worker.

The increased interest in stress associated with work has been lately observed. An occupational or professional stress may impair the working capacity of an organization, leading to the loss of human resources. The development of stress reactions has complex multifactorial conditionality: from structural and organizational characteristics, organizational culture, the nature of the work itself up to the personal characteristics of employers, and the nature of their interpersonal interactions. Adversely affecting certain people both their physical and mental state, and internal environment of an organization, stress at work has an influence on the workers' productivity and can lead to the syndrome of emotional burnout [Vodopiyanova, Starchenkova 2008].

**Object-matter:** the emotional sphere.

**Subject-matter:** the features of emotional sphere of volunteers helping internally displaced persons from anti-terrorist operation area.

**Objective:** to study the features of emotional sphere of volunteers helping internally displaced persons from anti-terrorist operation area.

**Tasks:**

1) to study the theoretical concepts of emotional intelligence, emotional burnout and the concept of volunteering;

2) to study the features of emotional intelligence, emotional burnout, personal self-conception, self-control and empathy of volunteers;

3) to identify the types of burnout among volunteers.

To perform this study, the following **methods** have been used:

1) Emotional Intelligence Test of Liusin D.V.;

2) Professional Burnout Questionnaire of Maslach K., Jackson S.;

3) Methodology of Studying Personal Self-conception of Panteleev S.R.;

4) Methodology of Establishing Empathy Level of Yusupov I.M.;

5) Questionnaire "The Style of Behavior of Self-regulation".

**Materials:**

Sample characteristics: 20 women from 20 to 27 years old, working on a voluntary basis in the volunteer organizations of Kharkiv. Work experience is from 2 months to 5 years. The control group is made up of 20 women from 20 to 27 years old, working in the field of "person-person", namely on paid positions related to education, servicing, training people and communication with them. Work experience is from 5 months to 5 years. The size of the total sample is 40 people. All the people under investigation have higher education or were studying at the time of research.

**Discussion and Results**

It has been found out that the emotional exhaustion of people working in the field of "person-person" has the greater intensity than in the group of volunteers. It can be connected with the labour conditions, the regime of work and rest, and the ability to counteract the sense of exhaustion and fatigue. Emotional exhaustion of volunteers remains within the normal range, but despite this, volunteers are in the risk group of professional burnout.

It has been found out that such feature of the field of emotional intelligence, professional burnout, self-regulation and personal self-conception of volunteers as emotional intelligence is associated with the self-regulation of behavior providing a successful professional activity. A professional burnout occurs due to the employers' lack of understanding of their own emotions and, therefore, due to the lack of emotional intelligence development. The positive personal self-conception helps to avoid internal conflict and emotional burnout.

The three main types of professional burnout among volunteers helping the internally displaced persons from anti-terrorist operation area have been highlighted: 1) emotional exhaustion caused by a high level of empathy to others coupled with full self-absorption, and also a high level of independency and a low level of understanding of own emotions; 2) professional reduction caused by disappointment because of volunteer activities at a general positive background of self-regulation of behavior and emotional intelligence; 3) lack of emotional exhaustion coupled with the complete absence of empathy, involvement in the professional activities,

understanding and managing emotions. Volunteering is a way of self-assertion and self-realization for such a person.

### Conclusions

Due to the geopolitical situations and the increased level of stressogenic conditions in the world in general and in Ukraine in particular, there is a demand for workers providing help. The increased demand for workers providing assistance in Ukraine is explained by the unreadiness of the population to military operations and the need to feel support of others due to the deep social upheaval. Because of the demand for sociology professions, there arises a question of competent expression of emotions, the ability to understand themselves and others, self-control of own and others' behavior, allowing to be effective in own professional activity.

The issue related to the syndrome of professional burnout is important for sociology professions, because through constant interaction with people, they often suffer from the described syndrome. The occupational or professional stress can impair the working capacity of the organization, leading to the loss of human resources.

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## INFLUENCE OF ANCIENT RECEPTION ON MODERN CINEMA

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**Abstract:** The paper deals with the influence of ancient reception on modern cinema. The concept *reception* of antiquity is considered from the point of view of historiography as a means of intercultural communication. The basis of ancient reception in modern foreign films is analyzed. The paper concerns the interaction between antiquity and modernity. The conclusion is made that ancient images are source of studying contemporary science and art.

**Key words:** antiquity, mythology, reception, retrospection.

**Introduction.** In modern information society, the concept *reception* is inherent in almost every field of Humanities, where it is based on the study of the problem of society perception of ancient influence on history, art, cultural studies and other related sciences in the 21-st century. The work is aimed at analysis of the term *reception* and the study of the influence of antiquity on the development of modern cinema.

The relevance of the study is due to the fact that in the recent decades reception of classical antiquity has become quite popular in the world classics. At this stage there are various studies on the subject, starting from reception of antiquity in literature to that in music and so on. Reception of antiquity in the cinema is not studied deeply in modern domestic historiography. At present, there are quite a lot of works on reception of antiquity. A historiographical review of the concept of reception determined by A. Ashaeva and E. Chiglinev is presented in some of their works [Ashaeva, Chiglinev 2012: 162]. They present theoretical and methodological foundations of the current research on reception. The research of M. Morcillo provides the materials by which we can compare the visualization and reconstruction of the Greek cities in modern movies [Morcillo, 2015: 135].

**The object-matter** of the research is ancient reception. **The subject-matter** is the influence of ancient reception on modern foreign films. **The objective** of the work is to study the variability of display of reception

of antiquity in modern foreign films. **The tasks** are to investigate the importance of the concept of *reception*, to study the influence of antiquity on the cinema, to trace the patterns of ancient images. **The materials** are the films *Agora* (Spain, 2009) and *300 Spartans* (The USA, 2007). **The methods** of the research are comparative-historical method (comparing different historical epochs) and psycho-historical reconstruction (the study of mental realities of the epoch).

**Discussion and Results.** In European culture there is a tradition of interpretation of the term *reception* as a unique contribution to the cultural traditions and modern civilization. A special attitude to ancient history is manifested in the combination of anthropological and cultural approaches popular at the turn of XX–XXI centuries. The culturological meaning of reception is revealed through the concept of interaction, dialogue, cultural-historic systems of antiquity and modernity. The synthesis of these approaches, that are at the beginning of the XXI century changes the study of reception (*Reception Study*) in cultural studies (*Cultural Studies*) and determines aesthetic reception functions.

The main problem of methodological reception of antiquity reveals a completely new view on the relationship of antiquity and modernity. H Martindale, Professor of the University of Bristol, says that this approach may change the positivist theory of traditional classical Sciences [Martindale, 2006: 1-13]. The English researchers propose to examine the reception of antiquity as a vertical communication that occurs not only beyond the boundaries of societies and cultural regions, but also through the boundaries of time. In this regard, there is the interdependence of the concepts *reception* and *dialogue of cultures*. The most significant approach for this study is a "historical-cultural" approach. Y. M. Lotman, starting from the ideas of intercultural communication opposes to the synchrony and diachrony in it and suggests two trends in the development of dialogue of cultures [Lotman, 1993: 87]

Reception of antiquity is a kind of social engineering, which is reflected in contemporary art, literature and history. Reception of antiquity can also act as a design of flashbacks of the past on contemporary events. Reception of antiquity in the cinema can serve as a striking sample of this phenomenon, where the combination of reconstruction and visualization is the image of travelling through the centuries. The appeal to the antiquity in the cinema concerns military subject, which is presented in all films of the recent years. But we focus on the study of reception of antiquity on the material of the film *Agora* as a historical drama directed by Alejandro Amenabar (2009, Spain). The film takes place on the territory collapsing into two parts of the Roman Empire in Alexandria (Egypt) at the end of IV century – beginning of V century AD. One of the central lines of the film is life of Hypatia. Hypatia of Alexandria was a scientist of the Greek origin, philosopher, mathematician, astronomer. She taught in Alexandria. She was a scholar of the Alexandrian school of Neoplatonism. Hypatia is believed to have invented or improved several scientific instruments: the distiller (a device for obtaining distilled water), the hydrometer (a device for measuring fluid density), the astrolabe (an instrument for astronomical measurements, improving astrolabe Claudius Ptolemy) and the planisphere (flat planisphere of the sky). Many of the works attributed to Hypatia are believed to have been written in collaboration with her father Theon. Most famous works are: the comments on the 13th book *Arithmetic* of Diophantus; reviews of Theon to the *Almagest* of Ptolemy; reviews of Theon to the *Beginnings*. But it should be noted that along with the artistic flow of the film there is a disagreement in the assessment of historical and factual accuracy of the picture. Alexandria since the IV century has been recreated as far as it was possible. There are serious inaccuracies in the film. In fact, there is no single written work of Hypatia, but it was shown that she was the inventor of law of gravitation before Newton, and that she suggested the ellipticity of the orbits of the planets to Kepler. There is no historical evidence that the books were destroyed in Serapeum. Hypatia died not because she was a gentile, or a scientist, or a woman, she died as a result of the involvement in politics. In addition, the director depicts Hypatia as an atheist, while she professed religious philosophy, especially neoplatonism and she was a deeply religious woman [Kvasha, 2010: 2-3].

The appeal to antiquity in the cinema is expressed by military subject: *Three* directed by Piterson, *The Gladiator* by Ridley Scott, *The Spartacus* by Robert Dornhelm, and others battle scenes make these films particularly attractive to the mass audience. Most of them like *300 Spartans* by Zack Snajders. Although critics accused Snajders of the aestheticization of violence and too repulsive image of Persians. [Teperik, 2010: 29-33].

**Conclusions.** The conclusion is that the main echo of antiquity was the ancient image. Through the prism of writers, composers, directors antiquity shows the problems of modern era. Antiquity in itself expresses every range of human activity, so it needs to be important part of learning in our lives. **The perspectives** of the work are to develop the idea that the antiquity influences of cultural life nowadays and to study the influence of ancient reception on cultural self-development of humanity.

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## OVERCOMING THE BURDEN OF “VOLYN TRAGEDY” AS AN OPPORTUNITY OF FURTHER DIALOGUE OF COEXISTENCE

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**Abstract.** In the present paper the author analyzes dynamics of research and debate as for the issue of “Volyn tragedy”, political reasons for non-decision of the conflict. The concepts of Ukrainian and Polish historiography of “Volyn events” are viewed. Policy of reconciliation is researched as one of the forms of overcoming conflicts in modern times.

**Key words:** collective memory, historic memory, historiography, policy of reconciliation, “Volyn tragedy”.

**Introduction.** Historic memory is a powerful tool for the formation of national idea, civil society and state as a whole. Very often it influences the identity of every nation – its historical development, traditions, customs, culture and origin. So, no wonder that now historical memory, which presents the **object-matter** of our research, is used for manipulation, updating past, broadcasting some ideas, turning them into mainstream currents of modernity.

A striking example of this "policy" is an update of events related to World War II, especially in Central and Eastern Europe. Such an event presenting the **subject-matter** of our research, is "Volyn tragedy" – an event that is really controversial, "painful" for both sides (Poland / Ukraine), and for a long period of time anyhow used by both parties to achieve their goals. Therefore, this issue is urgent and requires thorough research and analysis through the prism of Ukrainian and Polish historiography practices to overcome such conflicts in Europe and Asia, which is the **objective** of the given research.

**Methodological bases of research.** Both in Polish and Ukrainian historiography there formed the main research approaches towards "Volyn tragedy," among which we should note traditionalist (V. Filiar, G. Mazur, J. Turovsky) revisionist (D. Motyka T. Olshansky), Polish historians of Ukrainian origin (R. Drozd, M. Syvitskyy) - Polish historiography, and the public (I. Ilyushin), cultural and anthropological (J. Hrycak, A. Portnov) - Ukrainian historiography.

The article is aimed at the analysis of the dynamics of research and debate on the phenomenon of "Volyn tragedy", practices of "policies of reconciliation", making possible recommendations for continued dialogue to resolve the conflict both in Ukrainian and in the Polish community.

**Presenting main material. Dynamics and actualization.** "Volyn tragedy" is the events that occurred in 1943 during the Second World War in Volyn. Historians note that this event is bilateral ethnic cleansing on the part of the Ukrainian Insurgent Army (UPA), and from the Kraiov Army, and was due to long-term confrontation between Ukrainians and the Polish in Western Ukraine (Volyn, Galychyna, Kholmshchina, Pidliashia, Lemkivschyna) . The Volyn events of 1943 remain the subject of heated Polish-Ukrainian discussions, which are held by professional historians, politicians, public figures [Volyn Tragedy].

Well, to begin with, it will be interesting to trace the dynamics of research and discussion of the phenomenon of "Volyn tragedy", i.e. the analysis of studying, omission, updating events both in Ukrainian and the Polish community for a long time. After the war Ukraine continued to exist in the USSR ("internal colony"),

while in Poland there established pro-Soviet regime ("outer colony") and began the integration of the "socialist camp". So, at the state level the theme of "Volyn" was not relevant, but it was present in public discourse.

One of the first discussions of "Volyn tragedy" occurs in underground Ukrainian magazine "Idea and work", which referred to defending the Ukrainian population as a reaction to the policy pursued by the Polish political elite in ethnic Ukrainian lands [2, p. 461]. Another underground newspaper "Surma" (1943) characterized the event in Volyn as a way of Ukrainian defense from "Polish anti-Ukrainian terror" [2, p. 461].

During the 1940-50's the topic of "Volyn" was not used for the analysis of the events and those responsible but for establishing by Soviet authorities the image "national enemies", under the stamp of which fall UPA and Kraiov Army supporters, that is all so-called collaborators and "traitors" of the Soviet ideology. So there was no important research of this topic in the historiography of that time, as Volyn events were not discussed in the community at all.

It is not surprising that a return to studies of "Volyn tragedy" was already in the 1990s when both countries became independent and began to establish bilateral relations, including cultural ones. Poland was the first to recognize the independence of Ukraine, contributed to the establishment of economic, political and cultural relations, lobbied the interests of Ukraine on "European scene".

In 1990 the Ukrainian historians began to explore the issues of "Volyn." The first trips to the blast site, meetings with Polish historians, witnesses of those events took place. The formation of a huge layer of information, analysis of the events began [Volyn Tragedy: 13].

In 1996 a new wave of mainstreaming the question "Volyn" begins when the discussion began, research and analysis of issues from both the Ukrainian and the Polish side. And during the 1996-2001 10 scientific seminars were held, which involved 15-20 historians from each side [In Search of Truth: 1]. The main objective of the seminar was to seek common approaches to the evaluation of the past, in determining the issues on which the positions of Ukrainian and Polish specialists coincide, and where there are noticeable differences that need further research [Volyn Tragedy: 8].

Political aspect of unresolved issues. The special event, as it was noted by historians, was the mutual actions and deeds of Ukrainian and Polish sides during the historical development of both countries. This is the official Polish-Ukrainian reconciliation at the national level, July 11, 2003 with the participation of the presidents of both countries – Leonid Kuchma and Alexander Kwasniewski. This event was dedicated to 60-th anniversary of "Volyn tragedy," where presidents issued a joint statement, opened a monument "Memory - Grief - Unity" in the village of Pavlovka, Volyn region. The conclusion of the mutual recognition was presented in the following thesis "Volyn tragedy was a natural consequence of historical and political mistakes made in 1917-1945 by the previous occupation regimes in Volyn. It was the kind of tip of the iceberg, the main basis of which remained under water" [Myshchak 2008: 9].

Certainly, signing a joint official reconciliation was the result of long-term cooperation during the nineties. However, it has become more formal and demonstrative action, though at the international level. From the political point of view we can outline the following terms for "failure" of the policy of reconciliation:

- 1) The change of leadership in both countries. In 2005 in Ukraine and Poland new presidents were elected (Yushchenko, Kaczynski respectively), which changed vectors of policies which were developed by the Presidential Administrations, and changed priorities at both national and regional levels;

- 2) Lack of action plan. The process of reconciliation was not shown in the "reconciliation policy", so there was no strategy for further action to study events of "Volyn", interactions between scientific and political circles of both countries, formation of common vectors.

- 3) Destructuralization of historical memory. If the events of "Volyn" in Poland are regarded as an important criterion for the collective memory, among Ukrainian society this issue is relevant at least for the western regions. The problem of "Volyn" is still unknown to most Ukrainian. In 2003, according to opinion polls 48.9% of Ukrainians knew nothing about "Volyn tragedy" [Berdychovska 2003: 69].

- 4) Continuation of the policy of different vectors. In 2009, during the 65th anniversary of "Volyn" Polish Sejm unanimously adopts a resolution according to which the OUN and UPA committed "anti-Polish campaign - the mass murder that had the character of ethnic cleansing and had signs of genocide" [Uchwala]. President Viktor Yushchenko in 2010 gives the status of Hero of Ukraine to S. Bandera and continues the policy of the OUN and UPA popularization of Ukrainian society. Such heterogeneity and diversity of actions and deeds of power in Poland and Ukraine can thus be noticed.

Since 2013 significant dynamics in updating "Volyn tragedy" has continued and this historical fact has been used for political purposes. In particular, there was an appeal of the Ukrainian MPs to the Polish Sejm in 2013 to recognize "Volyn tragedy" as genocide of the Polish people. The group of initiators were deputies

representatives of the Party of Regions and the Communist Party. However, Polish Foreign Minister R. Sikorski made a request not to aggravate this subject, and Sejm rejected the project.

The politicization of "Volyn" events is the process of populism, in our opinion, because Polish society has formed a strong collective memory of these events and the political elite uses an episode from history to preserve the unity of the national idea. Therefore, the use of historical episodes appealing to these events once again consolidates society, taking it from the important and pressing issues of economic, social or political character. In 2007-2009 Poland's economic growth began to decline, moreover the global crisis manifested itself, foreign exchange reserves decreased, unemployment rose, emigration of Poles to European countries (Germany, France, Italy, Spain, UK) increased [Iliushyn 2003, Morozova 2013]. Therefore, updating the historical events that are important for Poles is a good political move to shift the focus of public attention from the economic vector to historical and cultural ones.

In 2014 the president of Ukraine P. Poroshenko during a visit to Poland apologized to Polish people for "Volyn" events in his speech in the Polish Sejm. Also, at the beginning of June 2016 a group of prominent Ukrainian, including President Viktor Yushchenko and Leonid Kravchuk addressed the open letter to Poland, in which they apologized for the historic event and at the same time forgave Poles for the same historical events. This document caused the positive trends and Polish elite reacted to it also with an open letter in which forgave Ukrainians and apologized to them for their historical mistakes.

However, the apogee of the "new" mainstreaming "Volyn issues" were the events of 2016, when a conservative political party "Law and Justice" led by A. Duda came to office in Poland. A new wave of updating "Volyn" issue began, however, it had a rather negative side. The result was the decision of Sejm to regard July 11 as the "National Day of Remembrance for the victims of the genocide committed by Ukrainian nationalists against the citizens of the Second Polish Republic."

**Polish and Ukrainian historiography.** During the long-term development of the subject both in Ukrainian and Polish historiography there were some currents that differently assessed "Volyn" events, interpreted their meaning, explored both certain aspects, and in general conducted comprehensive studies. As for Polish historiography it is important to say that there are three main areas [Iliushyn 2003]

1) traditionalist (V. Filiar, G. Mazur, J. Turovsky). Representatives of this trend define "Volyn tragedy" as the ethnic cleansing of Poles by Ukrainian nationalists. They try to interpret these events as a crime of Ukrainians against the Polish and require condemnation [Morozova 2013: 461].

2) revisionist (D. Motyka, T. Olshansky). Representatives of traditionalists oppose this direction and try more thoroughly, objectively and critically analyze materials and explore topics, using declassified archives, to observe, to use qualitative methods of analysis [Morozova: 457].

3) Polish historians of Ukrainian origin (R. Drozd, M. Syvitsky) insist that "Volyn tragedy" was a reaction of Ukrainians to policies and actions that were carried out by Polish elite on ethnic Ukrainian lands which were in the Polish-Lithuanian Commonwealth [Hud 2011: 109].

In any case, most Polish historians tend to interpret "Volyn" events as a deliberate policy of Ukrainian nationalist groups regarding the Polish population. However, it should be said that Polish scholars came to study this issue thoroughly and fairly informatively. Indeed, all the necessary resources have been arranged: information space, archives of special services and the government, cooperation with international researchers, foundations, creation of research centers, analytical centers devoted to the "Volyn" events.

As for the Ukrainian historiography, it also consists of several scientific approaches:

1) state (I. Ilyushin). Scientists of this approach are not interested in-depth study of the nature and course of Ukrainian-Polish conflict because of their "hanging" fear of being accused of "lack of patriotism" [Uhach 2010: 11-17];

2) cultural and anthropological history (J. Hrytsak, A. Portnov). Representatives of this approach determined not only political, but also ethnosocial character that was formed for centuries and had an impact on the events that occurred during World War II [Uhach 2010: 229].

However, we should say that regardless of the approach, most Ukrainian historians come to the idea that "Volyn" is the culmination of a gradual chronological events during the 20-30s of the XX century by the Polish authorities on Ukrainian territory. That is, at a time when there is a war and the two countries were divided into three camps (Soviet, German, nationalist), literally defending of ethnic lands took place, so the event of "Volyn" is just one of the pieces of this period of time, which was transformed into a huge focus and turned into a means of populism among the political elites of both countries.

**Practices of the policy of reconciliation.** In this context, the urgency is given to the "politics of reconciliation", which is repeatedly used in many countries to overcome injuries and to establish the dialogue of

cooperation. Policy of reconciliation is a process of looking for consensus, creating conditions for the consolidation of society, the use of collective memory to overcome injuries, contradictions, conflicts, searching for joint positive traits, characteristics, values that are necessary to create a single "field of understanding."

For example, the practice of reconciliation in Spain teaches us that "one goal - and different ways to it" but that does not mean that people should be responsible for their ideological persuasion or their own choice. According to the researchers, after the Spanish Civil War in 1939, the new head of state General Franco continued the policy of persecution of Republicans and those who opposed him and his political beliefs. However, already 20 years later Franco understood the importance of honoring the memory of those who gave their lives for the country, therefore, the memorial was built, where Republicans and Franco proponents, who died in the war were buried near one another, which symbolized the unity of the country [Shapoval 2014].

Another example of a policy of reconciliation is Poland. In 1989, the official authorities (NDP) and the opposition trade union movement "Solidarity" began talks, round tables, regular meetings and discussions, which helped stabilize the political space, begin destructuralization of the old system, economic reforms, establishment of the Polish national idea of unity and European movement.

**Conclusions.** "Volyn tragedy" is a clear example of inter-ethnic conflict that reflected the two countries in modern times and became politically special. However, "Volyn" is also a historical memory of society, those events that should not be overlooked in order to prevent this in future, so we should continue to explore the issues of the topic, analyze the sources and materials, try to move away from political influences. So, this topic requires further analysis and research. Overcoming the trauma and looking for a common dialogue and equal coexistence is the main goal of both Ukrainian and Polish societies. It should always be understood that the events created in the past can be realized, accepted and forgiven in the future. F. Bacon once said: "One should be fair and respectful to the memory of any predecessor; otherwise this debt will probably be given to him but not you". So, let us fairly and respectfully treat the events of the past, however fairly and honestly coexist in the present.

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## Частина II. NATURAL SCIENCES

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INTEGRATION DER BEHINDERTEN MENSCHEN IN DIE GESELLSCHAFT

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**Abstract:** Menschen mit Behinderungen haben immer noch Schwierigkeiten in unserer Gesellschaft. Mit dieser Arbeit möchte ich auf die Umstände der Behinderten eingehen, die mit einer Situation konfrontiert werden, dass sie keinen eigenen Platz in der Gesellschaft haben. Dabei stelle ich die Frage: "Wie kann man solchen Menschen helfen und was soll sich eigentlich ändern, um die Integration zu erreichen?". Um darauf eine Antwort zu finden, werden im ersten Teil meiner Arbeit der Begriff und die Typen der Behinderung betrachtet, da ein umfassendes Verständnis der Situation der behinderten Personen ein solches Vorwissen voraussetzt. Im zweiten Teil werden die existierten Modelle der Integration und ihre Konzeptionen beleuchtet. Weiter wird die aktuelle Situation der Behinderten in unserer modernen Gesellschaft dargestellt. Abschließend erläutere ich die Möglichkeiten der Hilfe und Unterstützung, die die Gesellschaft endlich einführen soll.

**Schlagwörter:** Behinderte; Behinderung; Gesellschaft; Integration; Menschenrechte.

### **Einleitung**

Das Problem der Behinderten und ihre Anpassung an die gesellschaftlichen Konventionen, des Zusammenwirkens und des Verhaltens der Gesellschaft zu ihrer sogenannten Minderheit ist heutzutage aktuell und relevant. Als **Objekt (object-matter)** dieser Arbeit wurden nämlich Behinderte und als **Gegenstand (subject-matter)** ihre beschränkte Rechte und zwar Diskrimination ausgewählt.

Obwohl etwas schon erreicht wurde, bleibt noch ein unlösbares Hauptproblem übrig: Das ist die geistige Entwicklung solcher Menschen und dabei Mängel an moralischer Unterstützung von der Seite der Gesellschaft. Man soll nie über ihre verletzten Schicksale und unerfüllten Träume vergessen. Die Sache ist die, dass man solche Menschen lange für Last und Zwischenschicht hielt, weil sie angeblich keinen Nutzen bringen. Darum konnten die Behinderten nur ihr Dasein fristen und als Außenseiter sterben. Deswegen bestehen **die Ziele (objective)** der Arbeit darin, die richtige Lage der Behinderten in der Gesellschaft zu zeigen und die Wege ihrer Anpassung an das Milieu zu erklären. **Die Aufgaben (tasks)** bestehen im Folgenden: Um die Integration zu erreichen, soll man entsprechende Maßnahmen treffen und neue Perspektiven suchen, um solche Bedingungen zu schaffen, bei denen jeder Mensch sich vollwertig und gefragt in seiner Umgebung fühlt.

Sehen wir beispielsweise das Leben der Invaliden des Zweiten Weltkrieges. Ja, für sie gibt es Invalidenheime, wo sie wohnen und ärztliche Hilfe bekommen können. Sie sind von Subsidien und Zuschüssen versorgt und haben Vergünstigungen. Trotzdem sind sie doch die Menschen, die nicht nur gut materiell versorgt werden, sondern auch Wärme für ihre Seele und menschliche Rücksicht haben wollen. Aber wie kann man das endlich ins Leben hineinragen? Warum ist der Begriff „Außenseiter“ noch im Bewusstsein einiger Menschen und sogar in der Gesellschaft erhalten geblieben? Wie kann man die Seele der Behinderten heilen? Auf alle oben gestellten Fragen gebe ich die Antwort im Laufe meines Vortrages.

Als **Materialien (materials)** wurden wissenschaftliche Studien, etliche Regierungsdokumente und Arbeiten aus dem Literaturarchiv benutzt. In verschiedenen Stadien der Forschung wurde ein breites Spektrum von **Methoden (methods)** zur Erfassung des Tatsachenmaterials und dessen Verarbeitung verwendet. Im Rahmen des theoretischen Teils kann man der Übergang vom Abstrakten zum Konkreten, die Einheit der logischen und praktischen Analyse, Klassifizierung, Strukturierung und Verallgemeinerung beobachten. Die Zuverlässigkeit der Ergebnisse und der Schlussfolgerungen der Forschung ist von den repräsentativen Stichproben gewährleistet.

### **Diskussion und Ergebnisse**

Zuerst möchte ich den Begriff „Behinderung“ entschlüsseln und präzisieren, wann der Mensch eigentlich behindert ist.

Gesetzlich zählt man einen Mensch zum Behinderten nur dann, wenn er physische oder psychische Störungen hat, beziehungsweise seelisch krank ist. Dementsprechend wirkt das alles negativ auf sein soziales Leben in der Gesellschaft. Behinderung ist also ein ernsthafter und beständiger gesundheitlicher Schaden, aber keinesfalls „Krankheit“. Dieser Begriff wird auch als Umschreibung gebraucht für eine dauerhafte und gravierende Beeinträchtigung der gesellschaftlichen und wirtschaftlichen Teilhabe beziehungsweise Teilnahme einer Person, verursacht durch das Zusammenspiel ungünstiger Umwelt-, sozialer oder anderer Faktoren (Barrieren) und solcher Eigenschaften der behinderten Person, welche die Überwindung dieser Barrieren erschweren oder unmöglich machen [Schwager 2016: 7-8].

Es gibt verschiedene Typen der Behinderung. Das sind: körperliche und psychische Behinderung, Sinnes-, Sprach-, Lern- und geistige Behinderung. Und außerdem teilt man die Behinderungen auf erworbene

und angeborene. Die ersten kann man durch perinatale (während der Geburt) entstandene Schäden, durch Krankheiten, durch körperliche Schädigungen (sowie Gewalteinwirkung, Unfall oder Kriegsverletzung) und durch Alterungsprozesse bekommen. Und die zweiten erscheinen wegen Vererbung beziehungsweise chromosomal bedingt und wegen pränataler (vor der Geburt entstandener) Schädigungen.

Aber die Behinderung ist nicht nur die Eigenschaft eines Menschen, sondern auch Barriere, auf die er in der Gesellschaft stößt. Für die Integration der Behinderten bedarf man der zweckgebundenen Beseitigung dieser Barriere. Dafür wurden verschiedene Modelle ausgearbeitet, unter denen die medizinischen und sozialen Modelle die verbreitetsten sind.

Das medizinische Modell stellt die Ursachen von Schwierigkeiten der Behinderten wegen ihrer beschränkten Möglichkeiten fest. Die Hauptidee dieses Modells besteht darin, dass die Behinderten nicht imstande sind, das zu machen, was dem anderen Menschen üblich ist. Darum sind sie gezwungen, selbst die Schwierigkeiten mit der Integration in die Gesellschaft zu überwinden. Laut dieses Modells muss man den Behinderten helfen, dafür ist es nötig, für sie spezielle Institutionen zu schaffen (beispielsweise Abteilungen für Sehbehinderten und Vereine für Blinde), wo sie die zugängliche Arbeit machen, mit den Kollegen verkehren und verschiedene Privilegien dabei haben könnten. Auf solche Weise tritt dieses Modell für die Isolation der Behinderten von der Gesellschaft auf und trägt nur zur Unterstützung ihrer materiellen Lage bei. Das medizinische Modell überwog sehr lange in den Meinungen der Menschen und des Staates, sowohl in der Ukraine, als auch in den anderen Ländern, darum waren die Behinderten meistens isoliert und diskriminiert.

Das soziale Modell vermutet, dass die Schwierigkeiten, die die Teilhabe der Menschen mit verschiedenen Behinderungen an der gemeinsamen Tätigkeit nicht voraussetzt, von der Gesellschaft geschaffen werden. Solch ein Modell ruft die Behinderten zur Integration in die soziale Umgebung auf und trägt zu ihrer Anpassung an die Lebensbedingungen in der Gesellschaft bei. Das berücksichtigt das Schaffen des für die Menschen mit Behinderungen aufgeschlossenen Milieus, und auch die Unterstützung von Maßnahmen bei der Arbeitsplatzvermittlung in die gewöhnlichen Institutionen. Und deswegen muss man auch der Gesellschaft die Fähigkeit des Umgangs mit den Behinderten beibringen. Laut dieses Modells verlangt die Behinderung eine politische Einmischung, weil dieses Problem wegen keinerlei Adaptation der Umgebung beziehungsweise wegen des Verhaltens und anderen Eigenschaften des sozialen Milieus verursacht ist. Das soziale Modell ist in den entwickelten Ländern sehr populär und allmählich gewinnt ihre Position in der Ukraine.

Diese beiden Modelle sind doch nur teilweise begründet. Die Behinderung ist doch ein kompliziertes Phänomen: Das ist ein Problem sowie auf dem Niveau des Menschenorganismus, als auch auf dem sozialen Niveau. Die Invalidität ist immer ein Zusammenwirken zwischen den Eigenschaften eines Menschen und seines Umfeldes, in dem dieser Mensch lebt, obgleich sind die einen Aspekte der Behinderung nur seine inneren, die anderen sind umgekehrt nur die äußeren. Anders gesagt können beide Konzeptionen, das heißt medizinische und soziale, die mit der Invalidität verbundenen Probleme entscheiden und man soll nicht auf beide verzichten. Also, das beste Modell der Integration von Behinderten wird so aussehen: Es wird eine Vereinigung der vervollkommensten Seiten von medizinischen und sozialen Modellen sein. Dabei soll man nicht ihre Fehler bei der Unterschätzung der komplexen Einsicht der Invalidität zulassen.

Jetzt will ich einige statistische Angaben anführen. Weltweit gibt es ungefähr eine Milliarde Menschen mit verschiedenen Behinderungen. Dies entspricht 15% der Weltbevölkerung. Was besonders wichtig ist, dass rund 80 Prozent aller Behinderten in Entwicklungsländern leben. Zirka 360 Millionen Menschen weltweit haben eine mäßige bis schwere Hörschädigung, davon brauchen ungefähr 20 Prozent ein Hörgerät, das heißt fast 72 Millionen. Leider werden jährlich weniger als zehn Prozent der weltweit benötigten Hörgeräte produziert: In Entwicklungsländern erhalten nebenbei weniger als drei Prozent der hörgeschädigten Menschen solches Hörgerät. Außerdem sind weltweit 39 Millionen Menschen blind und 246 Millionen Menschen sehbehindert. Fast 90 Prozent aller Menschen mit Sehbehinderungen leben in Entwicklungsländern. Und rund 80 Prozent aller Sehbehinderungen könnten vermieden oder geheilt werden.

Etliche der genannten Zahlen gehen aus dem Weltbehindertenreport hervor, der 2011 von der Weltgesundheitsorganisation und der Weltbank herausgegeben wurde [Weltgesundheitsorganisation 2011: 1-4]. Betrachten wir jetzt die aktuelle Situation der Behinderten in unserer modernen Gesellschaft. Was macht eigentlich die Gesellschaft für alle diesen Menschen mit Behinderungen?

Für die Erleichterung der Lebensbedingungen der Menschen mit beschränkten körperlichen Möglichkeiten werden spezielle Rollstuhlrampen und Aufzüge geschaffen. Für Blinde werden verschiedene Blindenschriften (zum Beispiel Brailleschrift) und für Schwerhörige Vervielfältigung von Audioinformationen in Gebärdensprache synchronisiert.

Es gibt auch viele Begünstigungen in der Arbeitssphäre: Das Recht auf Arbeit der Invaliden, ungeachtet der beschränkten Arbeitsfähigkeit, ist unentbehrlich. Rechtliche Prinzipien der Arbeitsplatzvermittlung von Behinderten sind in den gesetzgebenden Akten gesichert. Deswegen sollen die Arbeitgeber spezielle Arbeitsplätze für Behinderte schaffen und ihrer Arbeitsfähigkeit unter Berücksichtigung der beschränkten physischen Möglichkeiten beitragen.

Und wie sieht die Situation mit der Integration der Kinder mit Behinderungen in den Schulen? In der Realität ist es häufig so, dass Kinder mit Behinderungen keinen Platz in regulären Schulen finden – in Baden-Württemberg (Deutschland) beispielsweise praktisch nie [Evers-Meyer 2011]. Daher müssen Kinder mit Behinderung oft in gesonderte Schulen gehen, das betrifft vor allem weiterführende Schulen. Als Grund für die Ablehnung von Kindern mit Behinderung wird von entsprechenden Einrichtungen oft angeführt, die Umgebung sei ungeeignet. Das hat häufig zur Folge, dass Kinder vom Elternhaus getrennt werden, da entsprechende Schulen oft weit vom Wohnort gelegen sind und somit nur eine Internatslösung in Frage kommt. Das wiederum kann leicht zu einer weiteren Hürde im Integrationsprozess für die Betroffenen werden und kann auch zu großen Problemen im persönlichen Umfeld führen.

Wie man bemerken kann, ist aber in letzter Zeit die Senkung der Verantwortung des Staates für dieses Problem zu sehen: Vielleicht ist das auch nicht genug aktive Arbeit von der Seite der Behinderten selbst daran schuld. Auf solche Weise sollen Maßnahmen zur Beseitigung der Unmöglichkeit der Integration von Behinderten in die Gesellschaft ergriffen werden, um die volle Adaptation eines behinderten Menschen an das gesellschaftliche und wirtschaftliche Leben zu erreichen.

Wenn man sich in jedem Staat auf die Menschenrechte basiert [Vereinte Nationen 1948], den Wert jedes Menschen nicht unterschätzt und dabei berücksichtigt die Würde und freie Entwicklung jeder Person, inklusive Menschen mit beschränkten Möglichkeiten, dann muss man entsprechende Maßnahmen treffen und neue Perspektiven suchen, um solche Bedingungen zu schaffen, bei denen jeder Mensch sich vollwertig und gefragt in seiner Umgebung fühlt.

Man muss beispielsweise Vorlesungen für Behinderte von Psychotherapeuten oder Psychologen durchführen. Außerdem ist es wichtig, Beratungszentren für die Sozialarbeiter zu schaffen, wo ihnen die Fachleute qualifizierte Hilfe beim Umgang mit behinderten Menschen anbieten könnten. Bei den Sportzentren muss man jeweilige Sportgeräte ausnutzen und gut eingerichtete Hallenbäder bauen, damit die Menschen mit verschiedenen Behinderungen sportlich motiviert sein könnten. Selbstverständlich soll man zudem in Massenmedien die Aufklärungsarbeit über die Lage der Behinderten im Land veranstalten. Die gesellschaftlichen Organisationen von Behinderten verlangen auch korrekte Sprache beim Umgang mit ihnen: Man soll solche Worte sowie „schwachsinnig“, „Polio-Opfer“, oder „an Rollstuhl gefesselt“ vermeiden. Einerseits verletzen diese Worte die Menschenwürde, andererseits teilen sie die Menschen in „Gesunde“ und „Kranke“, was jedenfalls unzulässig ist.

**Schlussfolgerungen.** Aus oben angeführten Tatsachen kann man zusammenfassen, dass die Situation mit behinderten Menschen in der Gesellschaft nach wie vor stagniert. Um ihre Probleme zu lösen, soll es immer Kooperation zwischen den gesunden Menschen und Behinderten gepflegt. Und nur wenn man alle Vorurteile über Behinderte vermeidet, dann können sich solche Menschen in der Gesellschaft wohl fühlen. Je früher das alles man versteht, desto mehr Menschen mit Behinderungen gespeichert werden können. Sie erhalten doch Chancen für ein würdiges Leben.

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УДК 544.354:544.6

## **INTERIONIC INTERACTIONS IN AQUEOUS SOLUTIONS OF SOME IONIC LIQUIDS**

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**Abstract.** In the present paper the results of conductometric investigation of aqueous solutions of room temperature ionic liquids (RTILs) is presented. Experimental data processing was performed by using the Lee–Wheaton equation within two approaches, with and without ion association concept. It was established that RTILs under investigation are weak electrolytes in aqua media.

**Key words:** aqueous solutions, conductivity, ionic liquid, water.

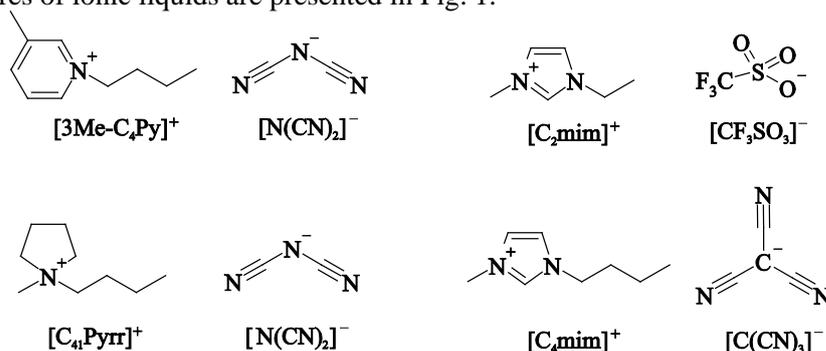
## Introduction

Recently a new class of chemical compounds with unique properties — ionic liquids (ILs) — has grabbed much attention. ILs as a rest of ionic substances consist entirely of ions, they are mainly, but not exclusively, organic in nature, the cations in particular. Some of ILs which have melting points below 100°C are referred to as room temperature ionic liquids (RTILs). The unique properties of RTILs are negligible vapor pressure and thus low flammability, no-toxicity, wide electrochemical window, stability at temperature up to 300°C and more. These properties along with electric and thermal conductivity, and viscosity are tunable by altering anion.

By now a number of papers on ILs investigation has been growing extremely. ILs have found their application in many distinct fields from analytical analysis (such as heavy metal extraction [Leyma *et al.* 2016: 164-171] and extractive desulfurization [Dharaskar *et al.* 2016: 578-587]) to ionic liquid membranes (ILMs) and separation technologies (for gases, sulfur compounds, metals, organic compounds) [Wang *et al.* 2016], to organic synthesis (in catalysis [Rezaee Nezhad *et al.* 2015, Waseem *et al.* 2015] and as a reaction medium [Rezaee Nezhad *et al.* 2015]) and, finally, to modern technologies, also ILs show their promising properties for being used as electrolyte for capacitors and batteries [MacFarlane *et al.* 2016: 9-12].

In the present paper investigation of aqueous solutions of RTILs is presented. The necessity of their further investigation is stipulated by their unique properties which make RTILs widely applicable in a range of water-based energy devices [Kim *et al.* 2012: 239-246]. Their properties are highly determined by a state of IL in a solvent. For this reason a high-accuracy conductometric method has been used for quantitative describing of RTILs performance in water solutions.

Electrical conductivities of aqueous solutions of 3-methyl-N-butylpyridinium dicyanamide [3Me-C<sub>4</sub>Py][N(CN)<sub>2</sub>], 1-butyl-1-methylpyrrolidinium dicyanamide [C<sub>4</sub>1Pyr][N(CN)<sub>2</sub>], 1-ethyl-3-methylimidazolium trifluoromethanesulfonate [C<sub>2</sub>mim][CF<sub>3</sub>SO<sub>3</sub>], 1-butyl-3-methylimidazolium tricyanomethanide [C<sub>4</sub>mim][C(CN)<sub>3</sub>] ionic liquids in concentration range (of *approx.* 1·10<sup>-4</sup>÷5·10<sup>-3</sup> mol/dm<sup>3</sup>) have been investigated. Structures of ionic liquids are presented in Fig. 1.



**Fig. 1.** Structures of ionic liquids used in this study

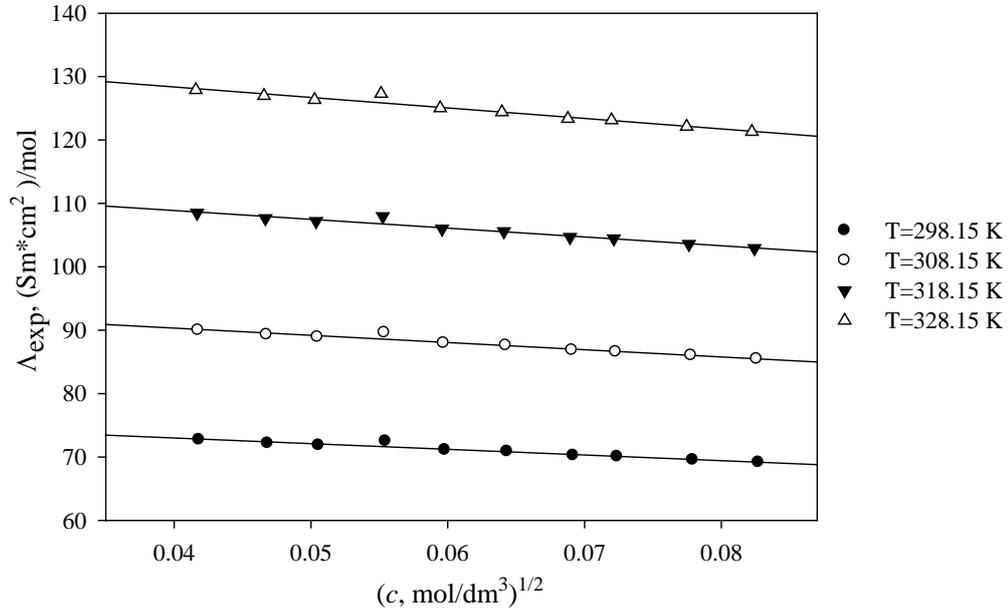
## Experimental

To avoid water contamination of the neat RTILs all the operations with them were carried out in low-water-level air conditions using a glove box. Double distilled water for solutions preparing was used throughout.

For measurements in concentration range mentioned above the sets of 12 – 15 water solutions for each RTIL were prepared by dilution of concentrated solution. The correction on weighting in vacuum was taken into account. Measurements were performed in conventional molybdenum glass cells with two platinized platinum electrodes. Preliminarily the cells were calibrated by KCl aqueous solutions by the standard procedure [Barthel, Feuerlein 1980: 214-215]. The temperature was controlled with an accuracy of 0.01°C by means of water thermostats.

Electrical resistances of solutions were measured using GW Instek LCR-821 meter at 1 kHz frequency with an accuracy of *ca.* 0.1% in temperature range 25÷55°C with 10°C step.

As an example stoichiometric concentration dependence of molar electrical conductivity of aqueous solutions of  $[C_4mim][C(CN)_3]$  in temperature range mentioned above are presented in Fig. 2.



**Fig 2.** Concentration dependence of molar electrical conductivity of aqueous solutions of  $[C_4mim][C(CN)_3]$  in temperature range from 278.15 K to 328.15 K with 10 K step.

Concentrations of solutions were performed in units of moles per kilogram of solution  $\tilde{m}$ ,  $\text{mol}\cdot\text{kg}^{-1}$ . For further calculation convenience all concentrations were converted into molarities  $c$ ,  $\text{mol}\cdot\text{dm}^{-3}$ , using the following equation (1):

$$\tilde{n} = d \cdot \tilde{m} \quad (1)$$

Densities  $d$  for each system at all temperatures were calculated by means of equation:

$$d = d_0 + B \cdot \tilde{m} \quad (2)$$

where  $d$  and  $d_0$  are density of solution with concentration  $\tilde{m}$  and density of solvent at corresponding temperature respectively. Previously using LSM method coefficients  $B$  were obtained from experimental concentration dependence of density for several solutions (for each RTIL-water system). Densities were measured on Mettler Toledo DM50 LiquiPhysics densimeter. This coefficient  $B$  is considered to be independent on temperature [Barthel, Feuerlein 1980, Kalugin *et al.* 2013].

#### Experimental data processing

As a theoretical model for the concentration dependence of conductivity the Lee–Wheaton equation was used. According to this equation, the molar conductivity is expressed through the following formula (3) [Lee, Wheaton 1978: 1478]:

$$\Lambda^{theor} = A_0 [1 + C_1(y)\epsilon\kappa + C_2(y)(\epsilon\kappa)^2 + C_3(y)(\epsilon\kappa)^3] - \frac{\rho\kappa}{(1+y)} [1 + C_4(y)\epsilon\kappa + C_5(y)(\epsilon\kappa)^2] \quad (3)$$

According to the stoichiometry of RTILs (1:1) the possibility of one-step ion association in solution was presumed:



It is worth emphasizing that conductivity depends on ion concentration  $c^\pm$  rather than stoichiometric one  $c^{st}$ . Relations between  $c^{st}$  and  $c^\pm$  are determined by the equations of material balance, mass action law and activity coefficients. Within the framework of unassocation model concentrations  $c^{st}$  equals to  $c^\pm$ . Thus, overall concentration dependence of conductance can be expressed as follows:

$$A_i = f^*(c_i^\pm, A) \quad (5)$$

Summing up, in calculations two sets of adjustable parameters for each model are used respectively:

$$A = \{A_0, \log K_a, R\} \quad (6)$$

$$A = \{A_0, R\} \quad (7)$$

In the current study the parameter of the closest approach  $R$  was fixed. According to Kalugin [Kalugin *et al.* 2013: 190] parameter  $R$  is the least sensitive parameter, so for each RTIL parameter  $R$  was set as a sum of cation and anion radii:  $R=R^++R^-$ . Some ion radii were taken from Kalugin [Kalugin *et al.* 2013: 190], others were calculated.

Finally limiting molar conductivities  $A_0$ , logarithms of association constants  $\log K_a$  and parameters of the closest approach  $R$  were determined by minimization of squared deviations sum [Kalugin *et al.* 2013: 189]:

$$Q = \sum_{k=1}^K [A_k^{\text{exp}} - A_k^{\text{theor}}(c_k^{\text{st}}, A)]^2 \Rightarrow \min \quad (8)$$

The simplex method proposed by Nelder and Mead [Nelder, Mead 1965: 308-313] was implemented for minimization of  $Q$  as part of our own program.

### Results and discussion

The limiting molar conductivities  $A_0$  and association constants  $\log K_a$  for water solutions of RTILs obtained at 298.15, 308.15, 318.15, and 328.15 K are listed in Table 1. Each of two data lines for each RTIL corresponds to association and unassociation approach respectively.

All association constant values obtained do not go beyond the unity but they are still close to it. Furthermore, dispersion of approximation does not depend significantly on calculation variant so  $\sigma_\Lambda$  values are similar for both association and unassociation approach. Limiting molar conductivities calculated within two approaches do not distinguish noticeably. It allows one to make a conclusion that all ionic liquids are weakly associated in aqueous solutions in low concentration range.

### Conclusions

Electrical conductivities of [3Me-C<sub>4</sub>Py][N(CN)<sub>2</sub>], [C<sub>41</sub>Pyrr][N(CN)<sub>2</sub>], [C<sub>2</sub>mim][CF<sub>3</sub>SO<sub>3</sub>], [C<sub>4</sub>mim][C(CN)<sub>3</sub>] ionic liquids in aqueous solutions at 298.15, 308.15, 318.15, 328.15 K within concentration range of *approx.*  $1 \cdot 10^{-4} \div 5 \cdot 10^{-3}$  mol/dm<sup>3</sup> were obtained. For this concentration range limiting molar conductivities and association constants were calculated. It was established that RTILs are weak electrolytes in aqua media.

**Table 1.** Limiting molar conductivities,  $A_0$  (S·cm<sup>2</sup>·mol<sup>-1</sup>), logarithms of association constants,  $\log K_a$ , parameters of closest approach,  $R$  (pm), dispersion of approximation,  $\sigma_\Lambda$  (S·cm<sup>2</sup>·mol<sup>-1</sup>), for water solutions of [3Me-C<sub>4</sub>Py][N(CN)<sub>2</sub>], [C<sub>41</sub>Pyrr][N(CN)<sub>2</sub>] [C<sub>2</sub>mim][CF<sub>3</sub>SO<sub>3</sub>], [C<sub>4</sub>mim][C(CN)<sub>3</sub>] at 298.15, 308.15, 318.15, 328.15 K obtained within two approaches (association and unassociation respectively).

RTIL	$A_0$	$\log K_a$	R	$\sigma_\Lambda$
298.15 K				
[3Me-C <sub>4</sub> Py][N(CN) <sub>2</sub> ]	84.7±0.9	0.2±1.2	736	1.5
	84.5±0.5	-	736	1.4
[C <sub>41</sub> Pyrr][N(CN) <sub>2</sub> ]	85.3±0.8	0.6±0.4	693	1.1
	84.5±0.4	-	693	1.1
[C <sub>2</sub> mim][CF <sub>3</sub> SO <sub>3</sub> ]	80.8±0.7	0.7±0.2	696	0.6
	79.4±0.3	-	696	0.7
[C <sub>4</sub> mim][C(CN) <sub>3</sub> ]	77.5±0.5	0.9±0.1	715	0.9
	75.6±0.3	-	715	1.2
308.15 K				
[3Me-C <sub>4</sub> Py][N(CN) <sub>2</sub> ]	104.1±1.1	0.3±0.9	736	1.8
	103.6±0.6	-	736	1.7
[C <sub>41</sub> Pyrr][N(CN) <sub>2</sub> ]	102.3±1.0	-	693	3
	102.3±0.9	-	693	3
[C <sub>2</sub> mim][CF <sub>3</sub> SO <sub>3</sub> ]	99.0±0.8	0.7±0.2	696	0.7
	97.4±0.3	-	696	0.8
[C <sub>4</sub> mim][C(CN) <sub>3</sub> ]	95.9±0.6	0.9±0.1	715	1.0

	93.5±0.4	-	715	1.5
318.15 K				
[3Me-C <sub>4</sub> Py][N(CN) <sub>2</sub> ]	124.7±1.3	0.5±0.7	736	2
	124.0±0.7	-	736	2
[C <sub>41</sub> Pyrr][N(CN) <sub>2</sub> ]	125.1±1.1	0.6±0.4	693	1.4
	124.0±0.5	-	693	1.5
[C <sub>2</sub> MIM][CF <sub>3</sub> SO <sub>3</sub> ]	118.5±0.9	0.7±0.2	696	0.8
	116.7±0.3	-	696	0.9
[C <sub>4</sub> mim][C(CN) <sub>3</sub> ]	115.6±0.7	0.9±0.1	715	1.1
	112.7±0.5	-	715	2
328.15 K				
[3Me-C <sub>4</sub> Py][N(CN) <sub>2</sub> ]	146.3±1.5	0.6±0.6	736	2
	145.3±0.8	-	736	2
[C <sub>41</sub> Pyrr][N(CN) <sub>2</sub> ]	146.5±1.3	0.6±0.4	693	1.7
	145.1±0.6	-	693	2
[C <sub>2</sub> MIM][CF <sub>3</sub> SO <sub>3</sub> ]	139.0±1.0	0.7±0.2	696	0.9
	136.9±0.4	-	696	1.0
[C <sub>4</sub> mim][C(CN) <sub>3</sub> ]	136.2±0.8	0.9±0.1	715	1.2
	132.9±0.5	-	715	2

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## MAGNETIC PROPERTIES OF IRON (III) OXIDE NANOPARTICLES AND THEIR BIOAPPLICATION

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**Abstract:** The paper presents a review of the progress and recent achievements in exploring the synthesis and applications of iron oxide nanoparticles (NPs). A role of the surface functionalization and the optimal magnetic properties of NPs for their use in biological applications are discussed. The capability of iron oxide NPs for chemisorption and binding with organic ligands, polymers, and biomolecules is considered. The attention was also drawn to review the promising practical tools and the potential use of iron oxide NPs in biomedical applications with a focus on the anticancer treatment.

**Key words:** iron oxide nanoparticles (NPs), synthesis, molecules, anticancer treatment.

### **Introduction**

**The object – matter** is to study iron oxide nanoparticles magnetic properties and their bioapplication.

**The subject – matter** is to review literature reports of iron oxide nanoparticles exploration.

**The objective** is to describe the functionalization of iron oxide nanoparticles with biomolecules and their potential use in the anticancer treatment.

**Materials:** books, articles and scientific magazines.

**Methods:** theoretical analysis.

The aim of the article is to analyze the recent advances in synthesis and in studying magnetic properties of iron oxide nanoparticles. The novelty is the exploration of way the iron oxide nanoparticles can be used in anticancer treatment.

It is widely known that iron (III) oxide is used in different fields, such as: magnetic storage, jewellery and cosmetic industry.

The typical iron oxide nanoparticles (NPs) have different sizes ranging from 22 to 56 nm.

On the basis of the iron nature, iron oxide NPs have many unique magnetic properties. Magnetic NPs are of a great interest for researchers from a wide range of disciplines, including magnetic fluids, data storage, catalysis, and bioapplications. Especially, magnetic iron oxide NPs became the strong candidates for in vitro diagnostics, and their application here has been practiced for nearly half a century [<sup>i</sup>. Zboril, Mashlan, Petridis 2002: 152].

### **The way of magnetic iron oxide synthesis**

Magnetic iron oxide (Fe<sub>2</sub>O<sub>3</sub>) NPs have a large surface-to-volume ratio and, therefore, they possess high surface energies. Consequently, to minimize the surface energies, they tend to self-aggregate. Moreover, the bare iron oxide NPs have a high chemical activity, and are easily oxidized in air (especially magnetite), i.e. generally resulting in loss of magnetism and dispersibility.

Actually, it appears to be a real technological challenge to control size, shape, stability, and dispersibility of NPs in desired solvents. Therefore, providing proper surface coating and developing some effective protection strategies to keep the stability of magnetic iron oxide NPs is very important. These strategies comprise grafting of coating with organic molecules, including small organic molecules or surfactants, polymers, and biomolecules, or coating with an inorganic layer, such as silica, metal or a nonmetal elementary substance, metal oxide or metal sulfide. Practically, in many cases the protecting shells not only stabilize the magnetic iron oxide NPs, but can also be used for further chemical functionalization.

Taking into account all of the above, Vijayakumar et al. described the sonochemical method of synthesis of iron oxide NPs to generate novel nano-materials with unusual physico-chemical properties [<sup>ii</sup>. Vijayakumar, Koltypin, Felner, Gedanken 2000: 101].

The chemical effects of ultrasound arise from the acoustic cavitation, i.e. the formation, growth, and implosive collapse of bubbles in liquid. The acoustic cavitation phenomenon happens when a bubble which was created in the liquid grows and then collapses. The bubble grows because the solute and/or the solvent vapors diffuse into the volume of the bubble, and it collapses when it gets to its maximum size. During the implosion, the molecules shell collapses into the bubble center and, thereby, creates a nanoparticle that contains many small aggregates. This implosive collapse of the bubble generates a localized hotspot through adiabatic compression or shock wave formation within the gas phase of the collapsing bubble. The conditions formed in these hotspots have been experimentally determined, with transient temperatures of 5000 K, pressures of 1800 atm, and cooling rates in excess of 1010 K/s. These extreme conditions were beneficial to form the new phase, and have a shear effect for agglomeration, which is prone to prepare the highly monodisperse NPs (Fig.1).

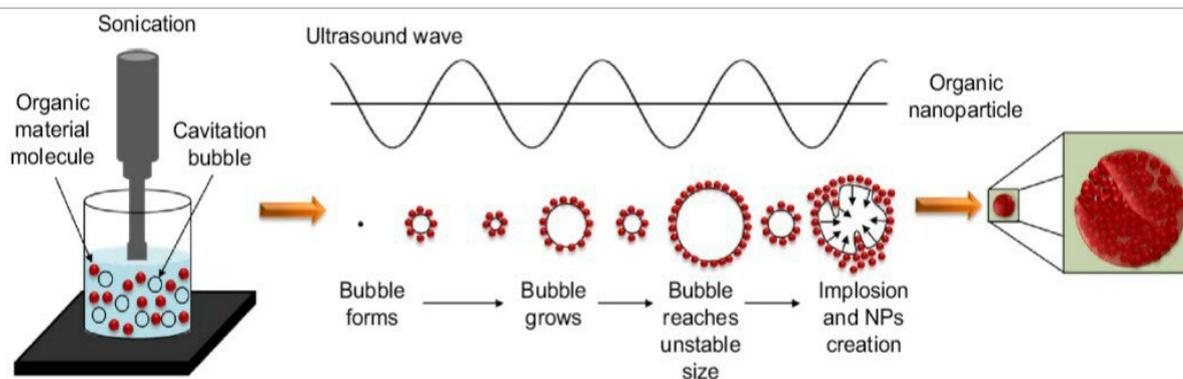


Fig.1. The acoustic cavitation phenomenon that occurs under ultrasonic radiation and the nanoparticle formation [iii. Bang, Suslick 2007: 2242-2243].

This method has been applied for the synthesis of various nanocomposites, and its versatility has been successfully demonstrated in iron oxide NPs preparation. As follows, magnetite NPs can be simply synthesized by sonication of iron (II) acetate in water under an argon atmosphere. The prepared  $\text{Fe}_3\text{O}_4$  NPs by Vijayakumar et al. are superparamagnetic and their magnetization at room temperature is very low ( $<1.25 \text{ emu g}^{-1}$ ).

Recently Pinkas et al. developed a sonochemical method synthesis for preparing the amorphous nanoscopic iron oxide by sonolysis of tris (acetylacetonato) iron (III) under argon with a small amount of added water [iv. Pinkas, Reichlova, Zboril, Moravec 2008: 257]. The organic content and the surface area of the  $\text{Fe}_2\text{O}_3$  NPs can be controlled with an amount of water in the reaction mixture, and it increases from  $48 \text{ m}^2 \text{ g}^{-1}$  for a dry solvent up to  $260 \text{ m}^2 \text{ g}^{-1}$  when wet argon is employed. Such a surface modified ultrasmall (1–2 nm) NPs exhibit an unrecorded low magnetic transition temperature of about 25 K, below this temperature they behave as speromagnetic, highly magnetically disordered systems with a high contribution of the surface anisotropy, and this speromagnetic behavior can be observed by Mössbauer spectra [3. Bang, Suslick 2007: 2242-2243].

In general, there are other different ways of the NP synthesis, such as co-precipitation, thermal decomposition, microemulsion, and hydrothermal synthesis etc., each of which has certain advantages and disadvantages for preparing iron oxide NPs. In terms of size and morphology control of the iron oxide NPs, thermal decomposition and hydrothermal synthetic route seem to be the optimal methods. To obtain the water-soluble and biocompatible iron oxide NPs, co-precipitation often was often employed, but this method presents a low control of the particle shape, broad distributions of sizes and aggregation of particles. As a time-competitive alternative, sonochemical route can also be used to synthesize iron oxide NPs with unusual magnetic properties. In addition, it should be mentioned that some green chemical synthesis routes and biological synthesis routes have been reported for the environmental protection purposes. For example, recently Bharde et al. [v. Bharde, Parikh, Baidakova, Jouen, Hannoyer, Enoki 2008: 5787] reported the bacterium *Actinobacter* sp. is capable of synthesizing maghemite under aerobic conditions when reacted with the ferric chloride precursors. Moreover, maghemite NPs show superparamagnetic characteristics as expected. Therefore, as the environmental protection and eco friendliness-competitive alternative, green chemistry and biological methods such as bacterially induced synthesis are important advances [vi. Wei Wu, Quanguo, Changzhong 2008: 397].

#### **Functionalization of the surface of iron oxide nanoparticles with biological molecules**

The various biomolecules, including enzymes, antibodies, proteins, biotin, bovine/human serum albumin, avidin and polypeptides have been bound onto the surface of iron oxide NPs. Iron oxide NPs functionalized by biological molecules will greatly improve the particles' biocompatibility. Such magnetic NPs can be very useful to assist an effective separation of proteins, DNA, cells, biochemical products, etc.

The major strategy for surface functionalization by biological molecules includes two steps, first synthesizing the small molecules or polymers functionalized by NPs, and then coupled to the biomolecules by chemical bond or physical adsorption [vii. Lao, Li, Wang, Ge, Yue, Li 2012: 2747].

For example, Magro et al. reported on the surface characterization, functionalization, and application of stable water suspensions of novel surface active maghemite NPs by avidin [viii. Magro, Faralli, Baratella 2012: 15392]. Bound avidin was determined by measuring the disappearance of free avidin absorbance at 280 nm, as a function of increasing nanoparticle concentration, showing the presence of  $10 \pm 3$  avidin molecules per

nanoparticle. Fe<sub>2</sub>O<sub>3</sub>-avidin was applied for the large scale purification of recombinant biotinylated human sarco/endoplasmic reticulum Ca<sup>2+</sup>-ATPase (hSERCA-2a), expressed by *Saccharomyces cerevisiae*.

The protein was magnetically purified, and about 500 µg of a 70% pure hSERCA-2a were recovered from 4 L of yeast culture, with a purification yield of 64%. As shown in Figure 2, Bhattacharya et al. demonstrated a rapid, sensitive, specific and efficient method for the detection of *Staphylococcus aureus* (*S. aureus*) as the model analyte at ultra-low concentrations using antibody labeled multifunctional Au-Fe<sub>3</sub>O<sub>4</sub> nanocomposites. Fluorescence/confocal as well as optical microscopy could detect a total count of *S. aureus* within concentrations of 10<sup>2</sup>–10<sup>7</sup> CFU mL<sup>-1</sup> in 30 min and the detection limit is 10<sup>2</sup> CFU mL<sup>-1</sup>. These antibodies targeted by NPs are a potent probe for a broad application in detecting specific bacteria, *S. aureus*, in various biodetection systems [9. Bhattacharya 2011: 17273]. The biological molecule functionalized by iron oxide NPs will greatly improve the particles' biocompatibility. Such magnetic iron oxide NPs can be very useful to assist an effective separation of proteins, DNA, cells, biochemical products, etc.

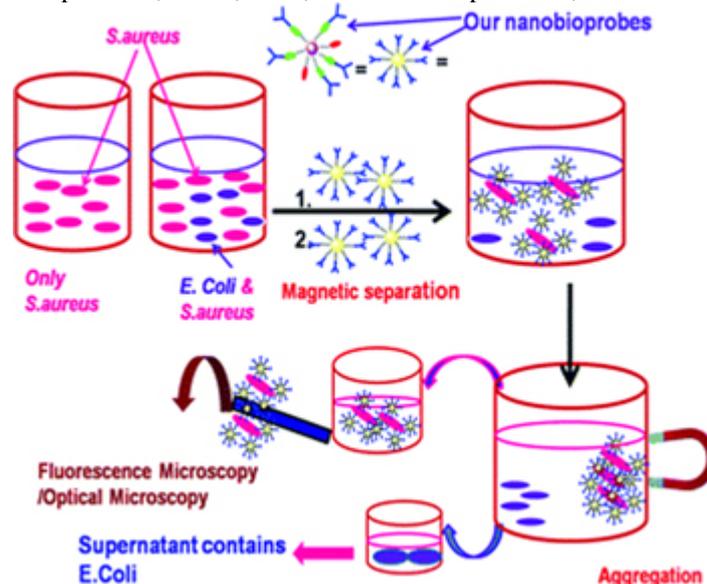


Fig.2. Schematic demonstration of pathogen detection by antibody-modified-fluorescent-MPA–Au–Fe<sub>3</sub>O<sub>4</sub> nanocomposites [ix. Bhattacharya 2011: 17273].

### Bioapplications of magnetic iron oxide nanoparticles

Nowadays, the most frequent human diseases are related to cancer and tumor pathologies. This is why many scientists around the world are paying their attention to try solving these health problems and developing novel anticancer treatment strategies.

The researchers at the Stanford University School of Medicine suggested that iron nanoparticles can activate the immune system to attack cancer cells. "It was really surprising to us that the nanoparticles activated macrophages so that they started to attack cancer cells in mice," said Heike Daldrup-Link, MD, who is the study's senior author and an associate professor of radiology at the School of Medicine. "We think this concept should hold in human patients, too" [x. Zanganeh, Hutter, Spitler, Lenkov, Mahmoudi, Shaw, Pajarinen, Nejadnik, Goodman, Moseley, Coussens, Daldrup-Link 2016: 986].

The researchers conducted a series of follow-up tests to characterize what was happening. Having the experiments with cells in a dish, they showed that immune cells called tumor-associated macrophages were required for the nanoparticles' anticancer activity; in cell cultures without macrophages, the iron nanoparticles had no effect against cancer cells (Fig.3).

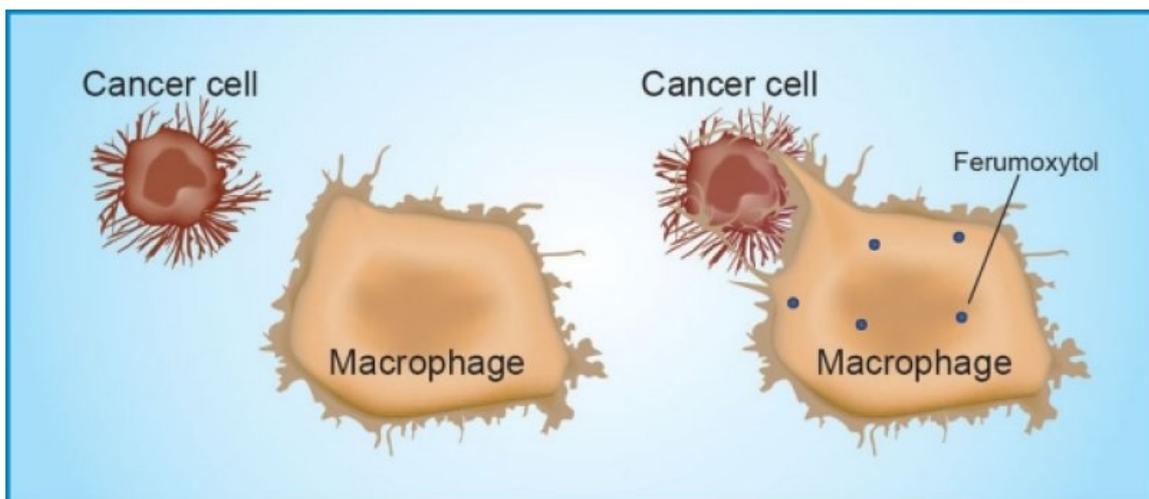


Fig. 3. A mouse study found that ferumoxytol prompts immune cells called tumor-associated macrophages to destroy tumor cells.

Before this study was carried out, it had already been known that in healthy people, tumor-associated macrophages detect and eat individual tumor cells. However, large tumors can hijack the tumor-associated macrophages, causing them to stop attacking and instead begin secreting factors that promote the cancer's growth. The study showed that the iron oxide nanoparticles switch the macrophages back to their cancer-attacking state, as evidenced by tracking the products of the macrophages' metabolism and examining their patterns of the gene expression. Furthermore, it was shown that the anticancer effect of a single dose of nanoparticles declined over about three weeks. The scientists also tested whether the nanoparticles could stop cancer from spreading. In a mouse model of small-cell lung cancer, the nanoparticles reduced a tumor formation in the liver, a common site of metastasis in both mice and humans. In a separate model of liver metastasis, pretreatment with nanoparticles before tumor cells were introduced greatly reduced the volume of liver tumors [10. Zanganeh, Hutter, Spitler, Lenkov, Mahmoudi, Shaw, Pajarinen, Nejadnik, Goodman, Moseley, Coussens, Daldrup-Link 2016: 986].

### Conclusions

Iron oxide nanoparticles (NPs) possess unique physicochemical properties, which are different from a lot of metal materials on a large scale. These features open up the opportunity to use them in many chemical and biomedical applications. The paper presents overviews of the progress and the recent achievements in synthesis and chemical functionalization of nano-sized iron oxide ( $\text{Fe}_2\text{O}_3$ ) materials. A broad range of biological and medical applications of iron oxide nanoparticles (NPs) is summarized with focusing on the new achievements that will help researchers in the field of anti-cancer treatments conduct the evaluations of nanoparticle-drug combinations.

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## QUANTITATIVE DETERMINATION OF ETHACYSINE IN TABLETS BY SPECTROFLUOROMETRY AS ITS SULFONE

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**Abstract:** The new method was elaborated for a quantitative determination of ethacysine hydrochloride (the diethylamino analog of ethmozine) (ET) in the form of corresponding sulfonic derivative obtained with the use of potassium hydrogenperoxomonosulphate by means of the spectrofluorometry ( $\lambda_{\text{ex}} = 264 \text{ nm}$ / $\lambda_{\text{em}} = 380 \text{ nm}$ ). Linear concentration dependence was preserved in the concentrations interval  $(1-8) \cdot 10^{-6} \text{ mol/l ET}$ ,  $\lg I = 97047c - 0.003$  ( $r=0,999$ ).  $\text{LOQ} = 1.1 \cdot 10^{-6} \text{ mol/l}$ . It was shown that in the determination of ET in the tablets 50 mg (Olainfarm, Latvia) using the developed method,  $\text{RSD} = 1.7\%$  (accuracy,  $\delta = -0.2\%$ ).

**Keywords:** kinetic, potassium hydrogenperoxomonosulfate, ethacysine, spectrofluorometry, quantitative determination.

### Introduction

**The object matter** is to study the spectrofluorometric properties of the form of a corresponding sulfonic derivative of ethacysine.

**The subject matter** is to review literature reports of spectrofluorometric properties of ethacysines analogs.

**The objective** is a quantitative determination of ethacysine in tablets by spectrofluorometry as its sulfone.

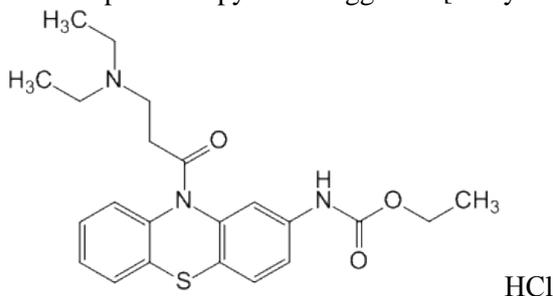
**Materials:** books, articles and scientific journals.

**Method:** spectrofluorometry.

Ethacysine (*sin.* Aethacizin; Etacizin; Ethacizin; Ethacyzin; EZ-55; NIK-244) – ethyl N-[10-[3-(diethylamino)propanoyl]phenothiazin-2-yl]carbamate hydrochloride (ET) – belongs to 10-acyl derivatives of phenothiazine (the diethylamino analog of ethmozine) and is used in medicine as the antiarrhythmic agent [Kovalenko 2014: 2448] (Fig. 1). It is produced in the form of 2.5% solution for injections in 2 ml ampoules, and also 0.05 g tablets (manufactured by Olainfarm, Latvia).

Despite the wide application of ET in medical practice, the analytical method of the quantitative determination of this pharmaceutical preparation has not been considerably investigated.

For the quantitative determination of ET in medical preparations and biological fluids the UP method was suggested [Prokof'eva, Chernov, Kashtanova, Shavratskii, Gneushev 1990: 306, Beloborodov, Zalesskaya, Tyukavkina 2000: 41] of direct ultraviolet spectrophotometry [Kubrak, Popova 1992: 79], photoelectrocolorimetry in the form of an oxydative-hydrolitic decomposition product in the sulfuric acid environment [Kubrak, Byeikin 1989: 69]. For the purpose of detecting the falsified medicines (the identity clarification) the methods TLC, UV, and IR-spectroscopy were suggested [Kuvyrchenkova 2006: 18].



**Fig. 1. Ethacysine hydrochloride structure**

Besides, in the literature a number of original articles describing the highly-sensitive spectrofluorometric methods of identification and quantitative determination of the phenothiazine derivatives in different medicines were found [Mohamed 1995: 2491, Yang, Qu, Shen, Qu, Wang, Zhu, Hu 2007: 119, Shlyusar, Blazheyevs'kyy, Aleksandrova 2012: 39].

However, the ET fluorescent characteristics have not been studied before, and there appeared to be no methods.

The aim of this article is to provide a detailed investigation of the kinetics of ET oxidation with the potassium hydrogenperoxomonosulfate, and fluorescence spectrums of ET and its oxidation products for the development of the unified highly-sensitive and selective method of quantitative ET determination in the pharmaceutical preparations.

### Experimental section

#### *Instruments, materials, reagents and methods.*

Ethacysine hydrochloride, a substance-powder, is manufactured by FSUC State Research Center of Organic Products and Colorants (NIOPIK, Russia) complying with the ND 42-8072-97.

Ethacysine 0.05 g tablets are produced by AS Olainfarm, Latvia (Ser. 280615). Film-coated tablets: tablet core: active substance: Ethacysine hydrochloride (ethyl N- [10- [3- (diethylamino) propanoyl] phenothiazin-2-yl] carbamate hydrochloride) 50 mg of additive agents: potato starch – 9.57 mg; sucrose – 19.3 mg; microcrystalline methylcellulose – 0.33 mg; calcium stearate – 0.8 mg shell: sucrose – 37.695 mg; povidone – 0.753 mg; quinoline yellow dye ( E104 ) – 0.025 mg; dye "sunset" yellow FCF (E110) – 0.003 mg; calcium carbonate – 6.308 mg; magnesium hydroxycarbonate main – 3.678 mg; titanium dioxide ( E171 ) – 0.665 mg; silica dioxide – 0.827 mg; wax Carnuba Wax – 0.046 mg.

Oxone®, monoperoxosulfate ( $2\text{KHSO}_5 \cdot \text{KHSO}_4 \cdot \text{K}_2\text{SO}_4$ ) (SIGMA-ALDRICH), CAS: 70693-62-8 (further as *oxone*), Active oxygen (AO) 4.5 % w/w.

For preparation of  $4 \cdot 10^{-2}$  mol/l of the initial solution of *potassium* hydrogenperoxomonosulfate ( $\text{KHSO}_5$ ) the sample weight 0.615 g oxone was diluted in 50 ml double-distilled water. The solutions were kept for a week at the room temperature. The solution with the concentration of  $2.2 \cdot 10^{-3}$  mol/l was received through the corresponding dilution of double-distilled water.

The standard ET solutions were prepared at the exact sample weights of preparation substance on the double-distilled water. The working standard solutions of ET were prepared from of the initial solutions through the corresponding dilution with double-distilled water. All the solutions were kept at the room temperature in the dark cool place.

The absorption and fluorescence spectrums were recorded at the temperature of 20°C on the fluorescent spectrophotometer MPF-4 «Hitachi», equipped with the specialized MPF computer (612-0655). The gauge and recording of the fluorescence spectrums of the researched ET oxidized derivatives were conducted at least 5 times, averaged and deducted the averaged specter of base solution (without the determined derivative: potassium hydrogenperoxosulphate taking into account the oxidation stoichiometry).

*Oxone solution standardization procedure.* The composition of an active oxygen in the oxone samples and concentration of potassium hydrogenperoxosulphate solutions were determined using the iodometric titration method: a precisely weighted amount of oxone is diluted in 10-15 ml of double-distilled water, acidified with 1-2 ml 0.1 M dipping acid solution, added 1 ml potassium iodide solution 5% and free iodine was titrated with 0.02 M of standard sodium thiosulphate solution using 10 ml microburette. The amount of the standard test reagent was measured with the accuracy of  $\pm 0.01$  ml.

Standard sodium thiosulphate solution was prepared of the standard titre fixanal ampoule on the double-distilled water. Titrated 0.02 M thiosulphate solution was prepared through the corresponding dilution of the initial solution in the newly boiled double-distilled water with the addition of chemically pure sodium carbonate [Suslennikova, Kiseleva 1978: 184].

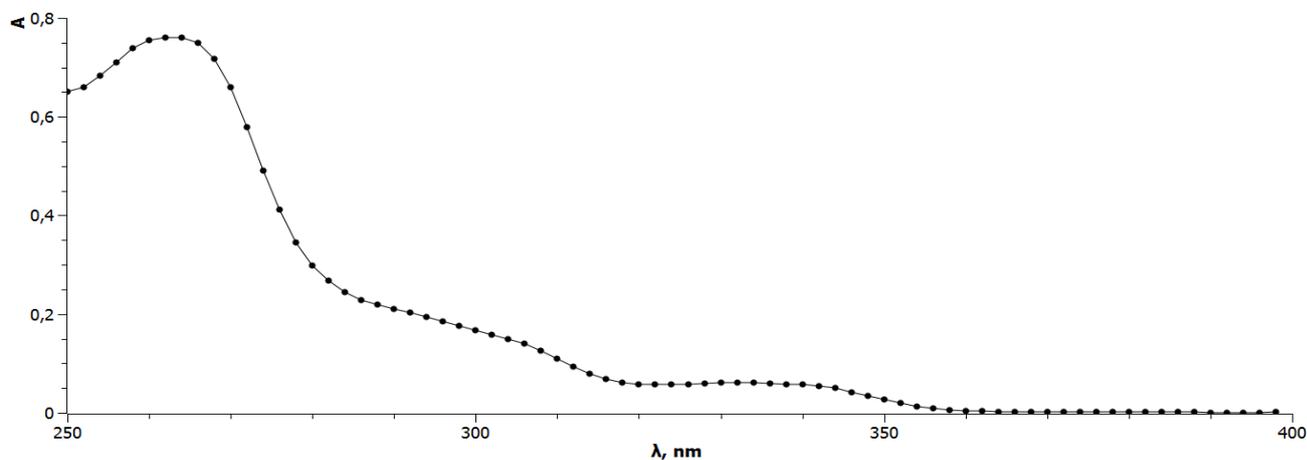
The solutions pH were prepared using the electrometric compensation method on the laboratory ion-meter И-130 with the glass electrode ЭСЛ-43-07 together with "SSCE" (sat. Silver/Silver Chloride Electrode).

The necessary environment acidity was maintained using the buffer solutions prepared on  $\text{KH}_2\text{PO}_4$  and  $\text{K}_2\text{HPO}_4$  according to Green [Lazarev, Kharlamov, Yakovlev, Yakovlev 1976: 184]. The S-oxidation kinetics of phenothiazine derivatives was studied using the methods of the samples selection according to the discharge of potassium hydrogenperoxosulphate (iodometric titration of an oxidant residue).

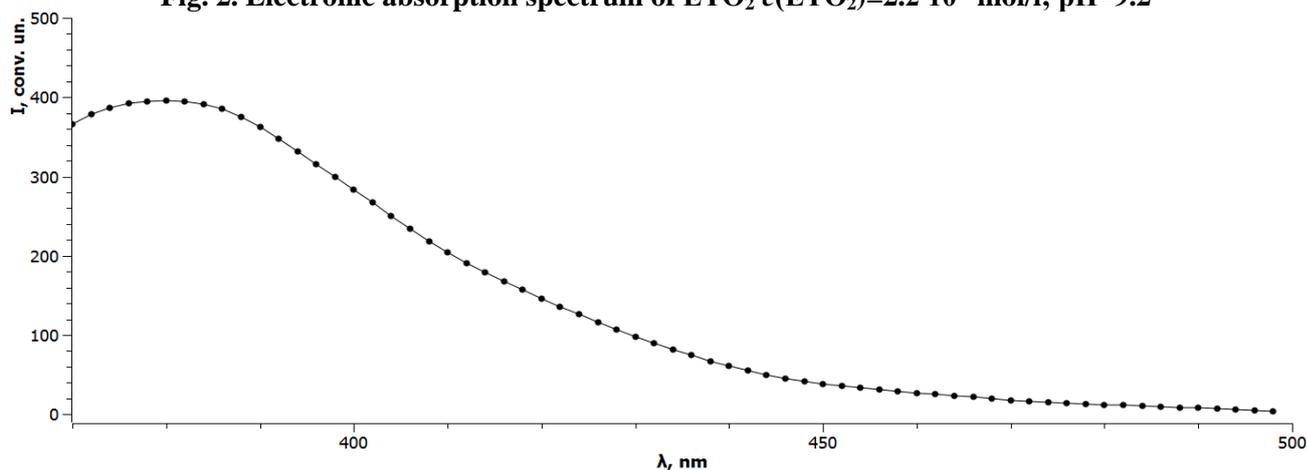
*Methodology of the reaction kinetics studying was using the iodometric titration method.* Into 100 ml measuring flask 20-30 ml buffer solution, 20.0 ml  $1 \cdot 10^{-2}$  mol/l potassium hydrogen peroxomonosulphate and 5.0 ml  $1 \cdot 10^{-2}$  mol/l ET solution were sequentially poured (the stopwatch started), shaking the solution in the flask the volume was immediately brought to the mark, corked and thoroughly mixed turning the flask. Then, after some time using the 10 ml pipette the reaction mixture was selected and while mixing it was poured into

the conic flask with 1 ml 5% potassium iodide and 5 ml 0.1 mol/l dipping acid solution. The released iodine was titrated with 0.02 mol/l solution of sodium thiosulphate measuring the volume with an accuracy of  $\pm 0,01$  ml.

Spectrums of fluorescence of ET solutions of concentration (solution pH) for the maximum excitation band ( $\lambda_{ex}$ ) position of maximum emission band ( $\lambda_{em}$ ) for different forms of ET: ETO (ET sulfoxide)  $c=1 \cdot 10^{-5}$  mol/l (pH 5.6; 0.02 mol/l  $KH_2PO_4$  and  $K_2HPO_4$ ) ( $\lambda_{ex}=264$ ) ( $\lambda_{em}=392$ ).  $ETO_2$  (ET sulfone)  $1 \cdot 10^{-5}$  M (9.2, 0.02 mol/l  $K_2HPO_4$ ) ( $\lambda_{ex}=264$ ) ( $\lambda_{em}=380$ ) (Fig. 2 and 3).



**Fig. 2. Electronic absorption spectrum of  $ETO_2$   $c(ETO_2)=2.2 \cdot 10^{-5}$  mol/l; pH=9.2**

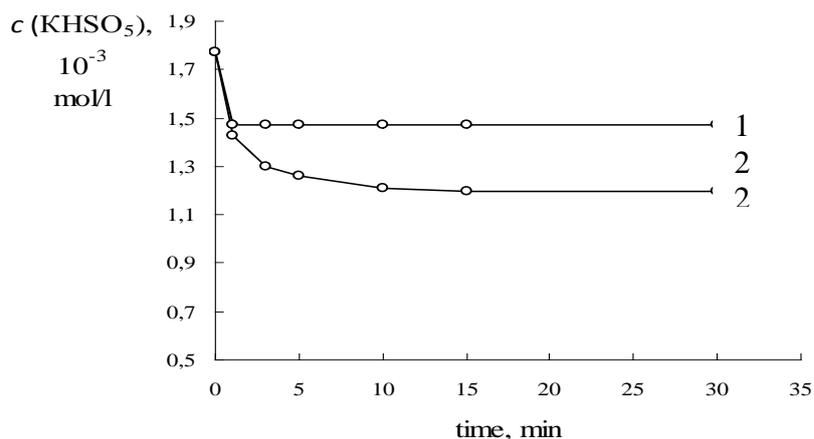


**Fig. 3. Fluorescence spectrum of  $ETO_2$   $c(ETO_2)=2.2 \cdot 10^{-5}$  mol/l; pH=9.2**

Kinetics of ETO oxidation reaction was also studied spectrofluorimetrically according to the formed oxidation product ( $ETO_2$ ) at 380 nm, the cell thickness  $l = 1$  cm, for the solutions mixing the Budarin's reactor was used [Yatsimirskiy 1967: 200], the time was recorded using the stopwatch from the moment of solutions mixing. Before draining the solutions were thermostated in the thermostat UTU-2 (Zeamit, Horizont Krakow-Poland) at  $20 \pm 0.5^\circ$  C. The reactions constants ( $k_{ef}$ ) were found by the slope ratio of the initial sections of kinetic time curves  $\ln I_{\eta}$ .

### Results and discussion

The kinetics studying results showed that at  $c(KHSO_5)=1.77 \cdot 10^{-3}$  mol/l;  $c(ET)=3.1 \cdot 10^{-4}$  mol/l ET oxidation takes place quantitatively and stoichiometrically with the formation of the corresponding sulfoxide of ET (ETO) and sulfone of ET ( $ETO_2$ ) etacisin derivative: in acid medium (pH 5.6-6.5) per 1 mol ET 1 mol  $KHSO_5$  (formation of ETO) is spent, and in the alkaline medium (pH 8.5-9.2) – 2 mol  $KHSO_5$  ( $ETO_2$  formation). Stoichiometric ETO formation is achieved practically immediately (the observation period – 1 min);  $ETO_2$  is quantitatively formed during the period not exceeding 15 min (Fig. 4).



**Fig. 4. Kinetic curves of ET oxidation using potassium hydrogenperoxomonosulphate**  $c(\text{KHSO}_5)=1.77 \cdot 10^{-3} \text{ mol/l}$ ;  $c(\text{ET})=3.1 \cdot 10^{-4} \text{ mol/l}$ ; pH: 1 – 5.6; 2 – 8.5-9.2.

Fig. 5 provides the general scheme of reaction of ET S-oxidation using potassium hydrogenperoxomonosulphate.



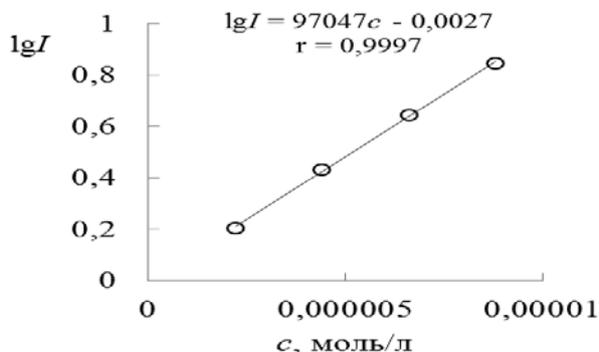
**Fig. 5. Scheme of ET oxidation using potassium hydrogenperoxomonosulphate**

It was determined that the reaction of ETO oxidation into ETO<sub>2</sub> is bimolecular, first-order with two reagents. Under the conditions of the pseudo-first reaction behavior order (KHSO<sub>5</sub> surplus) the  $k_{\text{ef}}$  were calculated. The ET oxidation reaction equation was derived, it looks as follows:

$$-d[\text{ET}]/dt = k_1[\text{ETO}], \quad d[\text{ETO}]/dt = k_1[\text{ET}] - k_2[\text{ETO}], \quad d[\text{ETO}_2]/dt = -k_2[\text{ETO}], \quad k_1 \gg k_2.$$

The quantitative sulfone of ET formation was achieved for 15 min in the presence of oxidant surplus at  $\text{pH} \geq 8,5$ . Under the comparative conditions the fluorescence of ET sulfonic derivative is far stronger than that of unoxidized ET or partially oxidized derivative (ET sulfoxide). The highest fluorescence was observed in the alkali water solution with pH 9.2. Taking into consideration the received results the relatively simple and quite sensitive method of spectrofluorimetric ET determination in the coated 0.05 g tablets (manufactured by «Olainfarm», Latvia) was developed. The method was based on the formation of intensely fluorescent S-oxidation product and formed at the interaction of ET with potassium hydrogenperoxomonosulfate in the alkali medium (pH 9.2).

Into the measuring 25 ml flask through the paper filter (blue bond) analyzed pills solution (or working standard sample) ET was poured, the oxone (surplus) solution was added as well to the buffer mixture solution, and, thus the volume was brought up to the mark with double-distilled water and thoroughly mixed. After 15 min of storage the fluorescence of the received oxidation product was measured ( $\lambda_{\text{ex}} = 264 \text{ nm}$ /  $\lambda_{\text{em}} = 380 \text{ nm}$ ). The preparation composition was determined using the standard method, taking into account the dilution.



**Fig. 6. lg I<sub>n</sub> dependence from concentration of ETO<sub>2</sub> (pH 9.2)**

c, mol/l

Linear concentration dependence was preserved within the concentrations range  $(1-8) \cdot 10^{-6}$  mol/l ET,  $\lg I = (97.0 \pm 7.9) \cdot 10^3 c$ , where  $c$  in mol/l ( $r=0.999$ ) (Fig. 6). Using the method of «introduced ( $\mu$ )- found ( $\bar{x}$ )» the correctness of the analysis results was verified,  $\delta < \text{RSD}$ , where  $\delta = \frac{(x-\mu)100}{\mu}$ . ( $n=5$ ,  $P=0.95$ ). It was shown that when determining the ET in the tablets 50 mg manufactured by Olainfarm using the researched method  $\text{RSD} = 1.7\%$  ( $\delta = -0.2\%$ , as compared with the certificate data).  $\text{LOQ} = 1.1 \cdot 10^{-6}$  mol/l. The content of the active pharmaceutical ingredient (API) was 50.3 mg (at admission 47.5-52.5 mg) to one tablet.

### Conclusions

1. The kinetics of the reaction of ethacysine S-oxidation using the potassium hydrogenperoxomonosulphate in the acid and alkali medium under the conditions of oxidant surplus was studied. The oxidation products identification was conducted.
2. The study was conducted by means of the simple, selective and sensitive method of the quantitative ethacysine determination in the form of the corresponding sulfonic derivative (ethacysine sulfone) using the spectrofluorometry method in the tablets 0.05 g.

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УДК 574.64:504.064

### ECOLOGICAL AND TOXICOLOGICAL ASSESSMENT OF SMALL RIVERS IN KHARKIV CITY

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**Abstract:** The author has studied the quality of surface water in Kharkiv small rivers (the Kharkiv and the Nemyshlia rivers) with the purpose of ecological-toxicological evaluation of their conditions. It has been found out that 86 % (12 of 14 samples) of general quantity of selected water samples revealed the available toxic properties. Their quality does not correspond to the set standards of toxicological indicators. The level of water toxicity ranges from 2.0 units of chronic toxicity (the second quality class, slightly polluted water) to 4.0 units one (the third quality class, moderately polluted water).

The results of the researches indicate the need in toxicological expertise of surface water quality to determine the ecological state of water objects quality.

**Keywords:** small rivers, test-object, chronic toxicity, ecological-toxicological evaluation, surface waters.

**Introduction.** Small rivers of Ukraine make the bulk of the fresh water reserves and play an important role in the economic life of the population. According to the experts, they form 60% of total water resources of Ukraine. Polissia and forest-steppe contain about 60% of the water resources of the rivers, the Carpathians - about 25%, the desert - about 12%.

Kharkiv region is one of the largest regions of Ukraine on territory and population. However, the security area of water resources is very low – 3 times lower than the average for Ukraine, excluding transit flow - almost 8 times, and contains an average of only 1.8% of the total water resources of Ukraine, in dry years this figure falls to 0.99% [1].

Small rivers form much of the hydrological network in Kharkiv region, but have the lowest, compared with larger watercourses, ability to cleanse itself and buffer capacity of ecosystems. Within the small drainage basins of small rivers laws of formation conditions of water do not fit into zonal ones - they are unique for each river. As a small river is the initial link in the river network, any changes in their mode of water quality affect the whole hydrographic network. Due to a small basin, the degree of small rivers' ecosystem sustainability to anthropogenic pressure is much less compared to medium and large rivers.

Most small rivers are exposed to sewage pollution by industry, agriculture, utilities. Many rivers are silted because transportation on them decreases the capacity of water flow. Water regime of small rivers is very sensitive to unilateral lowering of groundwater that occurs during the land reclamation and groundwater intake.

Methodology of environmental assessment of surface water quality [2] recommends to use a set of indicators, namely, indicators of salt content and saprobity water trophy to evaluate the quality of surface water. They also characterize conventional ingredients inherent to water ecosystems, specific indicators of toxic chemicals content in the water as well as radiation exposure. Among the list of indicators that reflect the properties of water, an important role plays an integrated water toxicity indicator, determined by biotesting.

**Formulation of the problem.** According to statistical 2TP-water industry, about 4443 m<sup>3</sup> of contaminated wastewater is discharged annually into small rivers of Kharkiv region, including 700 m<sup>3</sup> of untreated and 3743 m<sup>3</sup> of insufficiently treated water [1].

To prevent further contamination of water bodies a series of water conservation measures are held, among which an important place takes the monitoring system, which aims to monitor the ecological state of the environment in the area, including surface water.

Analysis of the developed countries' experience indicates that one of the effective measures to prevent the flow of environmentally hazardous chemicals into the water is to complement the monitoring system by toxicological information. In particular, the countries of near and far abroad (Russia, France, Germany, Sweden, Norway, Ireland, England, Canada, USA, Japan) have conducted toxicological monitoring of wastewater, the results of which are taken into account when issuing permits for water use. Environmental authorities of Canada developed a ranking system for wastewater criterion of their toxicity to aquatic organisms. The analysis for organisms' toxicity using various test indices calculated toxicity of wastewater. Since the early 1980s in the United States methods of biological testing, along with chemical-analytical methods of toxic waste water properties testing have been used to assess wastewater quality and restrictions on its discharge into water bodies [3-7].

In recent years Ukraine has also adopted a number of legislative acts, implementation of which creates conditions for environmentally sound wastewater treatment. These documents include CMU from 11/09/96 y. Number 1100 "On the order of development and approval of standards for maximum allowable discharge of pollutants." According to the abovementioned list A resolution indicator "level of toxicity" (based on biological test) normalized in all cases the dumping of sewage into the water, CMU from 20/07/96 y. Number 815 "On approval of the state water monitoring" in which it indicates that the index level of toxicity of wastewater listed as mandatory for observations of the sources of negative impact on the ecological state of water bodies. In the regulations [10] biological testing method expanded the scope to the observations of the surface, groundwater, marine water and sediment.

Urgency of eco-toxicological methods used in conducting water conservation measures is confirmed by the Framework Directive 2000/60 / EC, which first introduced the term "priority substances" and "priority hazardous substances". According to Article 16 of the abovementioned Directive the priority substances are determined by the risk assessment based solely on water ecological toxicity and on human toxicity via the aquatic environment.

In this regard, **the purpose of this study**, performed in 2015, was to determine the toxic properties of water taken in small cross-sections of the rivers Kharkiv and Nemshlyha that are in the areas of various sources of

pollution. In water samples we determined lethal acute and chronic toxicity by biological tests using as test objects the most sensitive to toxic substances representatives of crustaceans - *Ceriodaphnia affinis* [8].

**Research Methodology.** Method of determining the acute lethal toxicity based on establishing the difference between the number of dead *Ceriodaphnia* in the water analyzed (research) and in water that contains toxic substances (control). The criterion of acute lethal toxicity of death is 50 percent or more in *Ceriodaphnia* experiment compared to the control biotesting in 48 hours.

Method of determining the chronic toxicity based on establishing the difference between survival and (or) fertility of *Ceriodaphnia* water analyzed (research) and water that contains *Ceriodaphnia* (control). The criterion for chronic toxicity is the statistically significant decrease in survival rate and (or) *Ceriodaphnia* fertility experiment in comparison with control over biological testing [8].

Water quality assessment was carried out on the basis of biological testing for classification scale [8].

**Research results.** The study was conducted in 2015, the objects of study were chosen small rivers of Kharkiv: r. Kharkiv (5 alignment) and r. Nemyshlya (2 Design). The Kharkiv and both rivers create the district. The Nemyshlya is in the area of heavy traffic. The Kharkiv river is in operation within a number of industries.

A total of 14 water samples were selected in different seasons. Analysis of the research showed that 86% (12 of 14 samples) of water samples had chronic toxic effects on test sites in terms of their survival and fertility, including four water samples in the vicinity of a number of industrial enterprises (p alignment. Kharkiv), and eight water samples in the affected area of motor vehicles (alignment in years. Kharkiv - 4 samples and Nemyshlya - 4 samples). The level of water toxicity ranged from 2.0 units of chronic toxicity (second class quality, water slightly polluted) to 4.0 units chronic toxicity (third class quality, moderately polluted water). The results of environmental and toxicological assessment of water in the rivers Kharkiv and Nemyshlya are confirmed by the presence of specific substances with toxic action in water, including heavy metals (mercury, cadmium, copper, lead, chromium, etc.), organo chlorine pesticides (HCH, DDT and its metabolites), anionic surfactants, petroleum and others. [1].

It should be emphasized that according to the requirements for water quality by groundwater standards the maximum acceptable level of toxicity which prevents disruption of aquatic organisms' life, is the lack of chronic toxicity [8].

So, based on the research results it can be concluded that the environmental state of water bodies, along with the physical and chemical characteristics of water should also use the index of water toxic properties in integral form considering joint action of toxic chemicals present in water [9].

In the future it is planned to conduct research to identify the sources of water pollution in the Kharkiv and Nemyshlya rivers. Toxic substances will be ranked in terms of danger to river water ecosystem in order to prepare proposals for water conservation measures to convert pools of small rivers into sustainable landscapes, which hold environmental specifications provided by Water Code of Ukraine and the Water Framework Directive of the European Union [11-12].

**Conclusions.** One of the most pressing problems of Kharkiv region is storm water pollution and sewage by dumping from sewage treatment plants into surface waters, polluted wastewater categories "no treatment" and "not treated" due to unsatisfactory technical condition of wastewater treatment plants, violations of technological regulations of cleaning and disinfection of wastewater.

Small rivers form much of the hydrological network in Kharkiv region, they form the resources of hydrochemical regime and water quality of major medium rivers and create large areas of natural landscapes.

The studies indicate the need for toxicological indicator of surface water quality as required when assessing the ecological conditions of water bodies.

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УДК 316.7

## WHAT WENT WRONG WITH THE ELECTION POLLS IN THE US?

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**Abstract.** Polls remain to be a reliable source of information about election results. Yet, 2016 Elections in the USA have made the public feel doubt about their inerrancy. There are several reasons causing manipulations with poll results linked to polls techniques and respondents' responses. It is suggested that Trump supporters may have been a hard-to-reach kind of respondents.

**Keywords:** election polls, polls problems, the US election.

**Introduction.** The President Election Day in the US this year seems to be a failure of polls. Most of the polls had predicted the victory of the Democratic candidate, but they actually got wrong this time. Common people and scientists both were used to expect polls to be highly accurate and unmistakable. Therefore, pollsters were aware of the challenges faced after this occasion. Consequently, there is a reason to find out why the results of polls did not represent the real way of election process in the US in 2016. This article will identify several possible explanations of such an upshot that we can be summarized as follows: problems connected with polling techniques and problems that have their roots from respondents.

The **object-matter** of this article is the US election polls in 2016, the **subject-matter** comprises the reasons that caused the unexpected results. The **objective** is to build the hypothesis about why polls got wrong during pre-election surveys. The main **tasks** are to get acquainted with the literature connected with this theme using survey results, scientific research, news article, to systematize the information, to propose several hypotheses, to make a conclusion. During the research we use such **materials** as polls results, scientific articles, news articles, election maps, exit poll results. The main methods include the analysis of the polls data and methodology.

**Discussion and Results.** Most of election polls in the US used the technique of On-line Polls, Live Telephone Polls, and Interactive Voice Response Polls (I.V.R.) in which respondents would talk with an automated, recorded voice [Latest Election Polls 2016]. Face-to-face techniques which are highly spread in Ukraine, have decreased in popularity and are no more used because of their costs and complexity. There are several bottlenecks connected with the techniques that were used in the polls.

Firstly, the access to the Internet is not yet evenly distributed across some groups of American society [Latest Election Polls 2016]. We can divide several factors which make a limited access to the Internet holy probable: low income, absence of the college degree, living in rural territories. This fact is, undoubtedly, important especially after revising the Republican electorate. According to Edison research exit poll, most of Donald Trump's supporters (51%) showed that they are white people without a college degree. Moreover, many of them live in suburban (49%) or rural areas (61%) [Edison Research 2016]. Therefore, some of them may have had a limited access to the Internet. Exit poll results show that the majority of people with the income under 50,000 \$ are Clinton's supporters (53%), and 41% of them are Trump's electorate [Edison Research 2016]. Nevertheless, we can suppose, based on some observations in the articles [Arnade, C. 2016] and the maps of the previous elections results [Newman, M. 2016] that people with a low income, without a college degree, who lived in rural areas, are more inclined to be Republican supporters. Thus, those people that missed On-line polls are quite probable to become Trump's supporters.

Moreover, most of modern telephone polls use cell phone numbers, not landline's. Caller ID provided for cell phones have made it easier for people who would full reluctant to answer the calls from unknown sources to avoid calls from strangers, including pollsters [Keeter, S. 2010].

Besides the polls technique problems there is a large complex issue directly connected with respondents or possible respondents.

On the one hand, the amount of refusals is rising up. For example, at Pew Research Centre, the response rate of a typical telephone survey was 36% in 1997 and is just 9% today [Pew Research Center 2012]. This process can be caused on non-response bias. It is widely known that those people who participate in surveys tend to be significantly more engaged in civic activities than those who do not participate. Yet, it is probable that many Donald Trump supporters refused to take part in the polls, because they considered them as a part of the same media-political establishment that they and Donald Trump stay against [Cassidy, J. 2016]. So, those who did respond to pollsters may not have been representative of a wider group.

On the other hand, we cannot disregard the fact that political views and participation in election is a sensitive question for respondents. We call the questions sensitive if they make a respondent feel uncomfortable, shy because the theme of the question is private and people do not want to share with their answer with the stranger. Roger Tourangeau said that questions about the drug use, sexual behaviors, voting, and income are usually considered sensitive; they tend to produce comparatively higher nonresponse rates or a larger measurement error in responses than questions on other topics [Newman, M. 2016]. We suppose that Donald Trump voters felt shy to express their true preference not without media influence that mostly support Democrats. This hypothesis may be confirmed by the following fact: James Lee of Susquehanna Polling & Research Inc. said his firm combined live-interview and automated-dialer calls, and Trump did better when voters were sharing their voting intention with a recorded voice rather than a live one [Bialik, C 2016].

It is also possible that the amount of undecided voters had swung to Republicans just before the elections. Whereas Democrat supporters did not take part in the elections. Actually, pollsters do not know in advance how many members of each politically relevant demographic group will actually turn out to vote. Therefore, another complication arises.

**Conclusions.** In conclusion, there are two main groups of hypotheses concerning the election results failed to forecast objectively. These are polls technique problems and problems connected with respondents. Republican supporters may have been a hard-to-reach group of respondents because they had a limited access to the Internet, they refused to take part in the polls more often than others did. Moreover, they may have felt shy to say their true choice because questions about voting and political views were admitted to be sensitive. The polls were designed to measure opinion at a particular point in time during which interviews were conducted. They are the best available estimates, but they are still estimates – approximations, not certainties. Still, pollsters were aware of the challenges facing them in the 2016.

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## NEW FINDINGS OF THE FAMILY EUCNEMIDAE (COLEOPTERA) IN UKRAINE

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**Abstract:** The article deals with the biotopical distribution of the family Eucnemidae in Ukraine. The family is described. The results of the research made at the biological station of V.N.Karazin Kharkiv National University are presented. The results are following: three biotopes have been tested, two species from the family Eucnemidae have been found, namely, *Dromaeolus barnabita* and *Hylis olexai*.

**Key words:** beetles, Eucnemidae, biotopical distribution, Coleoptera, glue traps

### Introduction

Insects are the most numerous and diverse animal class in the world. Their biodiversity is of great interest but not all insect groups have been thoroughly studied yet. The family Eucnemidae is such a group.

The Eucnemidae belongs to the order Coleoptera, class Insecta. For the first time this family was described by Johann Friedrich Eschscholtz in 1829.

There is the family Elateridae of the same order which is much better studied. It has some similarities in appearance with the Eucnemidae therefore they are easy to confuse. But the Eucnemidae have a more prominent body of a wedge-shaped or cylindrical form and their labrum is invisible. Most species of the Eucnemidae click well although not as readily as the Elateridae. Most species have sexually dimorphic antennae with several different types of antennomeres [Muona 2010: 62]. The adult body length varies from 1,7 mm to 30 mm. The indumentum is usually dense with thin hairs. For the majority of these species dull brown or black color is typical. The head is usually short, wide and declined. The majority of the Eucnemidae has elongated elytra. The wings are well-developed and completely covered with elytra.

The Eucnemidae are widespread in the world but the most abundant and diverse in the tropics. Nowadays slightly less than 200 genera and about 1500 species are included in the family [Muona 2010: 61]

As a rule, adult Eucnemidae are rarely encountered in nature although they can be regionally abundant. Most species develop in rotten woods and the adults usually can be found running on trunks and stumps, especially on their rough and broken surfaces. Many species are nocturnal and are easily attracted by light-traps. Most of them are excellent fliers and often caught in Malaise traps. Adult Eucnemidae are short-lived and it is still unclear whether they feed at all, because some studied specimens of genus *Hylis* are considered to have no functional intestines.

Most Eucnemidae require forests with a good supply of dead wood so in heavily populated regions, where a lot of forests are being destroyed, many of them are endangered.

Most foreign researchers present the information about this family distribution in Ukraine without mentioning the exact places where the species have been found. In Kharkiv region only eight species have been found: *Otho spondyloides*, *Dirragofarsus attenuatus*, *Clypeorhagus clypeatus*, *Rhacopus sahlbergi*, *Melasis buprestoides*, *Eucnemis capucina*, *Dromaeolus barnabita*, *Isoriphis melasoides* [Kovalev 2014: 163-200]. The list of other species found in Ukraine is following: *Hylis procerculus*, *Microrhagus pygmaeus*, *Dirrhagus attenuatus*, *Nematodes filum*, *Drapetes mordelloides*, *Xilophilus leseigneuri*, *Microrhagus emyi*, *Melasis spondyloides*, *Hylis olexai*, *Phlegon konigi* [Kovalev 2014: 163-200; Muona 2007: 81-87]. So it is quite obvious that in our country the Eucnemidae have not been studied thoroughly.

Our research was made in summer 2016 at the biological station of Karazin Kharkiv National University, which is located near Gaidary village, Kharkiv region. The **aim** of this work is to analyze the results of using the glue traps in order to find specimens of the family Eucnemidae. The **tasks** are to analyze the taxonomic structure of the collected insects and to identify the presence of the Eucnemidae specimens. The **object-matter** of the research is the beetles from the family Eucnemidae and the **subject-matter** is the methodology for identification of the Eucnemidae specimens and their biotopical distribution.

### Materials and methods

Insect collecting has been carried out by the method of glue traps. For six days (28<sup>th</sup> June 2016 – 3<sup>rd</sup> July 2016) the glue traps were placed in three biotopes (an upland oak forest, a high-water bed and an aspen forest), four traps in each biotope, two of them were rolled, two others were unrolled. The biostation and the examined biotopes are situated on the right bank of the river Seversky Donets, in the forest-steppe zone, specifically on the hill. So one of two unrolled traps in each biotope was opened with its glued surface to the slope and another one

was opened to the high-water bed. The traps in the high-water bed were placed at the forest border (upland oak forest).

The collected insects were washed clean with chloroform. Some insects were fumed with ethyl acetate if needed. They were kept temporarily on entomological cotton mattresses. Then they were mounted on entomological pins with special glue so that they could be handled and examined with the greatest convenience and with the least possible damage. Most of the insects were identified down to the family and the Eucnemidae specimens were identified down to the species. The insects from the family Cicadellidae were counted directly on the traps.

### Results

1521 insects which belong to 28 families of 7 orders (namely Coleoptera, Homoptera, Hemiptera, Dermaptera, Diptera, Hymenoptera and Mecoptera) have been collected. Quantitatively 81% of the collected materials belong to the family Cicadellidae of the order Homoptera and only 9% and 8% belong to the orders Coleoptera and Diptera respectively.

Two specimens from the family Eucnemidae, order Coleoptera, *Dromaeolus barnabita*, A.Villa et G.B.Villa, 1838 and *Hylis olexai* Palm, 1955 are of the greatest interest. Both beetles were caught in the aspen forest with a rolled trap (49°37'33.1"N 36°19'28.2"E). It should be noted that we could not find these species in the studied biotopes using other methods such as collecting with entomological sweeping net or handpicking.

### Conclusion

By the method of glue traps 1521 insects from 28 families of 7 orders have been collected. Two species from the family Eucnemidae have been found among them. These species are *Dromaeolus barnabita* and *Hylis olexai*. Two photos of each specimen taken by our group at the biological station of Karazin Kharkiv National University last summer are presented below.



Fig.1. *Dromaeolus barnabita*, A.Villa et G.B.Villa, 1838



Fig.2. *Hylis olexai* Palm, 1955

*Dromaeolus barnabita* has been found in 14 other countries. In Ukraine this species was found in Kharkiv and Odessa regions in 1999 [Kovalev 2014: 194] and Crimea in 2007 [Mertlik, Jenis, Zbuzek 2007: 92]. As for *Hylis olexai*, it can be found in 19 other countries. The only previous reported finding on the territory of Ukraine was made in Gorgany in 2008 [Mertlik, Jenis, Zbuzek 2009: 2]. Owing to our research *Hylis olexai* has been discovered in the Left-bank Ukraine for the first time.

The obtained results will be used to continue studying the distribution of Eucnemidae in the Left-bank Ukraine as well as to analyze the efficiency of different types of traps for their collecting.

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## IST IN DER UKRAINE DIE KRANKENVERSICHERUNG NOTWENDIG?

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**Abstract:** Heute reformiert die ukrainische Regierung alle wichtigen Lebenssphären, und das Thema der Modernisierung im Gesundheitssystem ist ein brennender Tagesordnungspunkt. Die Bevölkerung hofft immer gesund zu bleiben, und eine entwickelte und effiziente Gesundheitsversorgung ist unentbehrlich. In der Ukraine sollen die Menschen ihre Behandlung bezahlen und dazu brauchen sie große Geldsummen. In den meisten europäischen Ländern dient Programm der Krankenversicherung. Die Versicherten fühlen sich geschützt und wissen, dass sie eine qualifizierte und rechtzeitige Hilfe im Notfall bekommen können. Es handelt sich um den Begriff „Krankenversicherung“, es werden verschiedene Arten der Krankenkassen, ihre gesetzliche Regelung in Deutschland und in der Ukraine verglichen, bzw. Pro und Contra Auffassungen erörtert.

**Stichwörter:** Betreuung, Gesundheitswesen, Krankenversicherung, Medizin.

### Einleitung

Die Gesundheit ist der größte Wert, den jeder Mensch hat. Leider kann nicht jeder lebenslang gesund bleiben. Die Bevölkerung leidet an verschiedenen Krankheiten: einige von denen, zum Beispiel Onkologie und Krebs haben schwierige Folgen, andererseits Erkältung bemerkt man doch fast nicht. Der Patient interessiert sich in erster Linie für die Kosten der Behandlung. Medizinische Betreuung kostet heute nicht billig und nicht jeder Ukrainer kann sich teure und wirksame Behandlung leisten. Obwohl ärztliche Versorgung in der Ukraine gesetzlich kostenlos ist, brauchen viele Patienten Arznei zu besorgen und Therapie häufig selbst zu bezahlen. Das Problem existiert aber in vielen Ländern der Europäischen Union nicht, weil die Bürger durch Krankenkassen krankenversichert sind. In diesem Zusammenhang dient Gesundheitsversorgung in der Ukraine zum **Objekt (object-matter)** der Untersuchung. Die Notwendigkeit für die Voraussetzungen zur nationalen Krankenversicherung gilt als **Gegenstand (subject-matter)** der Forschung.

**Das Ziel (objective)** ist den Zustand im ukrainischen und im deutschen Krankenversicherungssystem kennen zu lernen und zu vergleichen.

**Die Aufgaben (tasks)** bestehen in der Analyse der Grundsätze der Krankenversicherung in europäischen Ländern, um den Weg der der Modernisierung für die Ukrainische Medizin zu bahnen.

**Materialien** und Informationsquelle (**materials**): In der Abhandlung werden gesetzliche Regierungsdokumente, wissenschaftliche Studien und Vorträge nach dem Thema eingesetzt und durch **Verfahren (methods)** der statistischen, vergleichenden (komparativen), kritischen Untersuchung, bzw. Content-Analyse durchgearbeitet und synthetisiert.

### Diskussion und Ausblick

Die Krankenversicherung ist eine Art der Versicherung, die die Ausgaben der versicherten Person teilweise beziehungsweise voll und ganz deckt. In Deutschland regelt das Gesetz „Gesetzliche Krankenversicherung“ die Funktionen der Krankenkassen, die gesetzliche Träger der Krankenversicherung sind (Allgemeine Ortskassen für Beschäftigte in Gewerbe und Hauswirtschaft, Betriebskassen für gewerbliche Betriebe, Landkassen für Landwirtschaft, Knappschaftsversicherung für Beschäftigte im Bergbau, Ersatzkassen, daneben private Krankenversicherungen).

Das Prinzip der staatlichen medizinischen Versicherung besteht darin, dass die Einzahlungen der Versicherten nur vom Einkommen abhängen und nicht vom individuellen Risiko. Die Dienstleistungen von Versicherten werden im vollen vorgesehenen Umfang gewährt, unabhängig von den Einzahlungen zur Krankenkasse. Außerdem sind mit dem Hauptzahler alle seine Familienangehörigen automatisch versichert. Auf solche Weise sind die Chancen eines jeden Patienten auf die Gewährung der entsprechenden medizinischen Hilfe gleich [Nod'; Sozialgesetzbuch. Fünftes Buch.; Verband der Privaten Krankenversicherung].

Eine qualitativ hochwertige, effiziente und effektive medizinische Versorgung erfordert eine patientenzentrierte Kommunikation verschiedener Gesundheitsdienstleister (GDA). Schon heute werden bei verschiedenen GDAs gesundheitsbezogene Daten elektronisch erfasst und gespeichert. Das Ziel von eHealth ist die elektronische Dokumentation, Kommunikation sowie die Verarbeitung von patientenbezogenen Gesundheitsdaten, um eine bestmögliche Kooperation aller GDAs zum Wohle des Patienten zu erreichen. Nutzen und Risiken vernetzter Kommunikation zwischen dem Gesundheitswesen und dem ukrainischen Volk lassen sich in der Zukunft testen [Pfeiffer K. P., 2007].

Wie sieht die Situation in der Ukraine aus? Zurzeit wurde nur ein Gesetz der Werchowna Rada „Pro strakhuvannya“ vom 07. März 1996 erlassen. Laut dieses Gesetzes werden nur die Ärzte und Pharmazeuten, die in den Privatbehörden arbeiten, Feuerwehrleute und Leistungssportler gesetzlich versichert. Auf die Mehrheit der ukrainischen Bevölkerung verbreitet sich dieses Gesetz nicht [Die Verfassung der Ukraine, 2016; Gesetzfassung der Werchowna Rada №85/96, 2015].

Das System der Krankenversicherung enthält und bietet unbestreitbare Vorteile an, und nämlich:

- Gewährleistung der sicheren medizinischen Hilfe bei dem
- Versicherungsfall eines Bürgers;
- Versorgung des Finanzbudgets für die Entwicklung des Gesundheitswesenssystems;
- Verbesserung der materiell-technischen Basis der Gesundheitsbehörden;
- Schaffung der Bedingungen für die Heranziehung der Investitionen für Entwicklung der medizinischen Wissenschaft und Technologien.

Die Krankenversicherung hat praktisch kaum Nachteile, mit Ausnahme davon, dass die Erzeuger der medizinischen Einrichtungen oder die Dienstleistungsgesellschaft die Preise stark erhöhen, unter der Voraussetzung, dass für die Dienstleistungen nicht die Patienten, sondern die Versicherungsgesellschaft zahlt. Deshalb es zu teuer ist, selbständig, ohne Krankenversicherung die Leistungen zu tragen [Henrich A., 30.05.2011].

Es gibt zwei Arten der Krankenversicherung: eine private (PKV) und eine gesetzliche (GKV). Bei der gesetzlichen Versicherung bestimmt der Staat für die versicherte Person die Summe, die die Versicherung deckt, Ärzte und Heilpraktiker. Im Fall der freiwilligen Versicherung stellt der Kunde selbst die gegebenen Beschränkungen fest und wählt das Personal. Statistische Ämter des Bundes und der Länder hat eine Erforschung gemacht, die zeigt, dass im Jahr 2010 fast 70 Millionen Bürger Deutschlands die Police der gesetzlichen Krankenversicherung hatten, 9 Millionen Bürger gaben der privaten Krankenversicherung den Vorzug, und etwa 3 Millionen besitzen andere Versicherungspolice.

In der Ukraine gibt es praktisch keine gesetzliche Krankenversicherung. Das Projekt des Gesetzes über die GKV in unserem Land hat offensichtlich einige Nachteile:

- Der regressive Charakter der Fondsbildung (arme Leute bezahlen relativ mehr als reiche);
- Verschiedene Versicherungsprogramme, die von der Versicherungssumme abhängig sind;
- Kompliziertes Leistungsmodell vom Standpunkt der Verwirklichung.

#### **Fazit**

Zum Schluss lässt sich folgende Tatsache betonen: während die Bürger der Bundesrepublik abhängig vom Wohlstand zwischen P- und GKV wählen können, steht im Mittelpunkt des Systems der Bürger. Die Patienten der Krankenanstalten in der Ukraine haben die Ausgaben für Medizin privat zu tragen, weil das Gesundheitswesen in unserem Land von den westeuropäischen Modellen noch weit entfernt ist. Weder gesetzliche noch freiwillige Krankenversicherungen stehen den Menschen zur Verfügung. Darüber hinaus

kommt es oft vor, dass kostspielige Operationen aus Geldmangel unterbleiben; deswegen liegen die Lebenserwartung und Geburtsraten niedriger als in Europa [Verband der Privaten Krankenversicherung].

Man könnte markante Beispiele der Gesundheitservice für die Bürger und kostengünstige eHealth-Anwendungen hinzufügen. Möglicherweise erweckt diese Darstellung aber auch Gedanken an den gläsernen Patienten. Entscheidend wird aber sein, wie wir mit diesen Daten und Informationen umgehen, dass der Bürger die Autonomie über seine Gesundheitsdaten behält und dass nur von einer Person berichtigte Personen entsprechend ihren definierten Rollen Zugang zu diesen Daten haben. Die aktive Teilnahme des Patienten an seiner Gesundheitsversorgung könnte durch verschiedene Homemonitoring-Projekte unterstützt werden. An Stelle von papierbasierten Diabetikertagebüchern oder Aufzeichnungen des Blutdrucks könnten in Zukunft Messgeräte die Daten automatisch an ein Telefon weiterleiten. Von dort werden die Daten an eine Datenbank weitergeleitet, wo sie analysiert werden. Bei Auffälligkeiten informiert das System automatisch den zuständigen DGA.

Unsere medizinische Versorgung entspricht leider dem westeuropäischen Standard nicht und eine dringende Einführung der GKV ist in der Ukraine zweifelsohne notwendig. Die Frage über die GKV für alle Bürger der Ukraine ist jetzt sehr aktuell, darüber wird grundsätzlich diskutiert, aber man muss sich damit ohne Zögern sachkundig und wissenschaftlich auseinandersetzen.

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УДК 616.441-006.6-085

### **BIOLOGICAL AND CLINICAL PERSPECTIVES OF THYROID CANCER TREATMENT**

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**Abstract:** The clinical aspects of thyroid cancer are considered in the paper. The principles and methods of cancer detection are analyzed. Basic principles of thyroid cancer diagnosis are identified. The paper studies the kinds of thyroid cancer and the criteria of determining different stages of disease. It is found in the paper that the knowledge of genetic and biological characteristics of thyroid cancer result in improving the diagnosis and treatment of the patients.

**Key words:** diagnosis, genetic characteristics, therapy, thyroid cancer kinds.

**Introduction.** As evidenced by statistics, thyroid cancer, although does not in the lead in the number of cases, but in recent years the incidence rate has been steadily increasing. As shown by clinical studies, during which no one studied the history of the disease, thyroid cancer is often asymptomatic in the initial stage. Note that in some cases, malignancy arises against existing long benign tumor.

**Objective** of the paper is to investigate the current approach to the diagnosis and treatment of thyroid cancer patients. **Subject-matter** involves thyroid cancer causes, diagnosis and methods of treatment. **Object-matter** of the research is classifying thyroid cancer types. **The tasks** are to clarify the causes of cancer and analyze the dynamics of cancer changes in time. **Materials** used are scientific articles from e-resources and medicine journals, investigating subject-matter. **Methods** of research are ultrasonography and ionizing therapy.

**Discussion.** It can be stated that the causes and nature of thyroid cancer are well researched. The transmutation of endodermal-derived thyroid follicular cells or neural crest-derived thyroid C cells leads to

distinct types of cancer. Follicular cells give rise to two main forms of differentiated thyroid cancer: papillary thyroid carcinoma and follicular thyroid carcinoma. Poorly differentiated and anaplastic thyroid carcinomas are comparatively rare tumors that also arise from follicular cells and are associated with aggressive disease. Medullary thyroid carcinoma has distinct biologic features. Papillary thyroid carcinoma accounts for approximately 85% of thyroid cancers. Most papillary thyroid carcinomas are indolent clinically, consistent with their simple genome, which has few copy-number alterations. Papillary thyroid carcinoma has one of the lowest mutation densities of cancers that have been studied by means of whole-exome sequencing. Although formerly thought to be a single entity, papillary thyroid carcinoma encompasses several tumor types that have mutually exclusive mutations of genes encoding effectors that signal through the mitogen-activated protein kinase pathway [Fagin and Wells 2016].

We can assume that the different driver mutations are associated with different histological variants of papillary thyroid carcinoma and confer distinct patterns of gene expression, signaling, and clinical characteristics.

Tall-cell-variant papillary thyroid carcinomas have a high frequency of lymph-node metastases and recurrence after thyroidectomy; these carcinomas also have a poor response to radioiodine therapy. Their refractoriness to radioiodine appears to be due to the high pathway output that is driven by the oncoprotein, which suppresses the expression of genes required for iodide incorporation. Mutated papillary thyroid carcinomas are associated with the follicular variant of papillary thyroid carcinoma. Follicular-variant papillary carcinomas with vascular invasion spread infrequently to regional lymph nodes, retain the expression of iodine-metabolism genes [Norman 2016].

According to experts, encapsulated noninvasive follicular variants of papillary thyroid carcinoma have recently been reclassified as a benign entity and renamed as “noninvasive follicular thyroid neoplasms with papillary-like nuclear features,” thereby substantially reducing the number of patients who are considered to have thyroid cancer. Follicular thyroid carcinomas represent 2 to 5% of thyroid cancers. The prognosis of patients with these cancers depends on the size of the tumor, the age of the patient, and the degree of angioinvasiveness, which predicts the risk of distant metastases [Shapira 2015].

Exposure to ionizing radiation is a risk factor for the development of papillary thyroid carcinoma. After the nuclear-reactor accident in Chernobyl in 1986, there was a sharp increase in the incidence of papillary thyroid carcinomas, primarily affecting very young children in iodide-deficient regions. Similar age-dependent trends were seen after the atomic-bomb explosions in Hiroshima and Nagasaki in 1945 and in persons receiving external radiotherapy for benign or malignant conditions of the head and neck.

The research reveals the fact that ultrasonography identifies high risk for cancer and is the best imaging method for the assessment of thyroid nodules. Papillary thyroid carcinomas that are less than 1 cm in the greatest dimension (papillary microcarcinomas) occur in up to 30% of adults in the general population, yet they rarely become clinically significant. Therefore, papillary microcarcinomas need not be biopsied unless there is extrathyroidal invasion, nodal metastases, or arguably, previous exposure to radiation or a family history of thyroid cancer.

Although cytopathological testing can discriminate between benign and malignant tumors, it is inconclusive in 20 to 30% of cases. Two molecular diagnostic methods can sharpen the differential diagnosis. Afirma, a proprietary gene-expression classifier with a high negative predictive value, is designed to identify benign nodules among those with inconclusive results on cytopathological testing. Alternatively, next-generation sequencing of a panel of oncogenes and tumor-suppressor genes identifies nodules with mutations that have been associated with thyroid cancer, with high positive and negative predictive values. These two tests appear to reduce the incidence of unnecessary surgery, although their reliability in various clinical-practice settings remains to be established [Norman 2016].

The research proves that radioiodine therapy uses the property of thyroid follicular cells to transport and incorporate iodide into thyroglobulin, a feature that is retained in a subgroup of differentiated thyroid carcinomas. Until recently, most patients with differentiated thyroid carcinoma received postoperative radioiodine therapy despite a lack of data from prospective clinical trials to support the practice. Radioiodine therapy is no longer recommended in patients with low-risk thyroid cancers, because the recurrence rate and mortality are low and large retrospective series have not shown improved outcomes. The data regarding radioiodine therapy in patients with intermediate-risk disease are not compelling [Fagin, Wells 2016].

As it has been investigated, most patients with differentiated thyroid carcinoma are treated with high doses of thyroid hormone, which are sufficient to suppress the secretion of thyrotropin. The intensity and duration of suppressive therapy can be affected by disease status. It is unclear whether this therapy benefits

patients with mutated papillary thyroid carcinoma, because most such tumors express low levels of the thyrotropin receptor.

Patients with low-risk or intermediate-risk disease are followed by means of neck ultrasonography and measurements of serum thyroglobulin levels. Antithyroglobulin antibodies, which are present in patients with autoimmune thyroiditis, can interfere with the accuracy of thyroglobulin immunoassays; however, persistent or rising levels of antithyroglobulin antibody also indicate disease activity. Diagnostic radioiodine scans have low sensitivity and are unhelpful in routine surveillance unless there is structural or biochemical evidence of disease. Clinically apparent persistent or recurrent cervical nodal disease is found in approximately 10% of patients with thyroid cancer. Selected cases can be managed expectantly or by means of surgical resection, thermal destruction, or alcohol ablation.

Thyroid cancers are often slow progressing, even when they have metastasized to distant sites. Most physicians reserve systemic therapy for patients who have metastatic disease that is progressing, symptomatic, or in a location that threatens vital structures and is not amenable to localized therapies. Palliative radiotherapy, either alone or concomitant with low-dose chemotherapy, or local therapies may control disease in patients with unresectable regional or metastatic disease. Treatment with bisphosphonates or anti-receptor activator of nuclear factor ligand antibody may benefit patients who have bone metastases, although the efficacy of the compounds has not been tested in prospective trials [Shapira 2015].

The Food and Drug Administration approved two multikinase inhibitors, sorafenib and lenvatinib, for the treatment of patients with radioiodine-refractory metastatic thyroid cancer on the basis of phase 3, prospective, double-blind, randomized, placebo-controlled trials that showed longer progression-free survival. Adverse effects of the two drugs make the maintenance of full-dose therapy a challenge. The effects of the drugs on quality of life and the long-term cumulative toxic effects remain to be fully explored.

**Results.** Considering the above-mentioned facts, we can assume that poorly differentiated thyroid carcinomas are aggressive and are defined histologically by a combination of architectural and high-grade features (high mitotic rate and presence of necrosis). Poorly differentiated thyroid carcinomas represent approximately 6% of thyroid cancers and are associated with a mean survival of 3.2 years. Radioiodine therapy is of limited benefit. Most patients require systemic therapies that are similar to those described for differentiated thyroid carcinomas.

It has been found that anaplastic thyroid carcinomas account for approximately 1% of thyroid cancers and are associated with a mean survival of 6 months. They are refractory to radioiodine, and traditional chemotherapy and radiotherapy are of limited benefit. Anaplastic thyroid carcinomas probably arise from preexisting differentiated or poorly differentiated thyroid carcinomas and have a high mutation burden.

Further discussions with patients and families about the extent and intensity of medical interventions and the option of home or institutional hospice care are important aspects of treatment.

**Conclusions.** It can be concluded that recent discoveries in molecular medicine, coupled with advances in biotechnology and medicinal chemistry, have led to enormous progress in the diagnosis and treatment of patients with thyroid cancer. We have no doubt that this progress will continue with the development of more effective methods of therapies that are based on new compounds with greater specificity for oncogenic targets and combinatorial regimens that overcome resistance to single agents.

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## ACCURATE CLASSIFICATION OF CURRENT SITUATION IN KHARKIV FOREST MASSIVES

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**Abstract:** The paper deals with the usage of Maximum Likelihood classification and NDVI from ArcGis software package for the purpose of creation vegetation and arboreal-species images of Kharkov. New

data about the arboreal massive limits, the species composition and abiotic objects have been obtained during the classification.

**Key words:** arboreal-species images, Maximum Likelihood Classification, NDVI, remote sensing, ArcGIS.

**Object-matter** is woodlands of Kharkiv

**Subject-matter** is vegetation and tree species composition.

**Objective** is to study and map the woodlands of Kharkiv

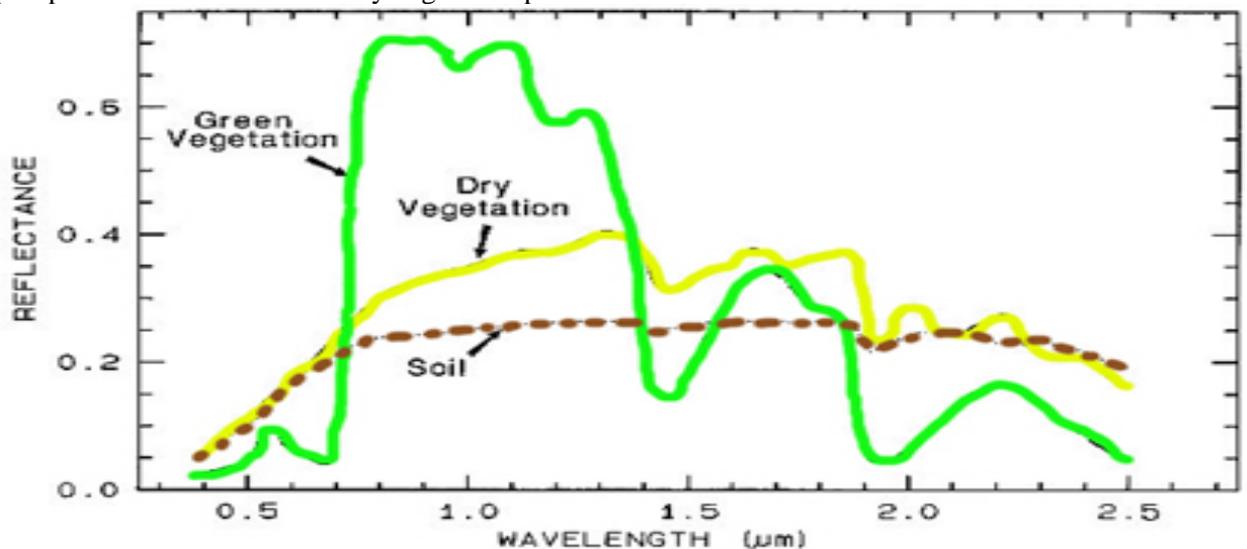
In this article we have the following **tasks** such as:

- 1) Study the quantity of vegetation of Kharkiv
- 2) Study the tree species composition of vegetation of Kharkiv
- 3) Consider the differences interactively.

**Materials** are remote sensing images.

The article was provided by following **methods**: modelling, graph-analytical, deduction, statistical, mathematical.

Modern possibilities of remote sensing allow to get more quality spectral information from multispectral images. One of the main ways in this kind of research is the study of vegetation. Mostly such studies are based on unique spectral characteristics of any vegetation presented below.



Pic.1. Spectral characteristics of vegetation [4]

It is clearly seen that the graphs for healthy and dry vegetation differ. Reflectance decreases in healthy vegetation in red spectral zone and increases in near infrared one. Reflectance increases in dry vegetation in the red spectral zone comparing with the healthy one, and in the near infrared zone it becomes less. Dead vegetation even more strongly reflects in the red zone that is why red and black colors are typical for dead plants. Knowing difference in spectral information it is easy to identify a picture of each type of vegetation, as well as the density of the vegetation cover [3]. In this study multispectral images with a resolution of 1 meter were used. NDVI index was used to visualize this method [5].

The next step is to study of Kharkiv vegetation and species composition of the trees. In this case, these species of trees were selected: lime, oak, ash, maple. The classification has been conducted by Maximum Likelihood Classification [4]. This classification works in such a way: each object in the image (a tree, a house, a road) has a spectral profile, and it is different from the others. Thus, the classification takes into account only the spectral characteristics but not the forms of objects [2].

The basis of this classification is the creation of “samples” - signatures. User specifies certain objects in the image and asks the program to find similarities in the other part of the image. During the first several classifications typical errors were identified. If the classification uses only samples of tree species, the final image will be incorrect

According to the fact that the study is carried out only in the city there is a high probability of detection of large number of different objects. If this classification does not specify buildings, roads, water and grass (which does not belong to the primary arboreal classification), the final classification will not be correct. Index images appeared during the classification showing the specific structure of Kharkiv trees. The next step was to

smooth out the minimum error and remove single pixels [1]. Further, the pictures were cut only according to the forms of woodlands using cadastral maps. For each woodland was the total number of pixels [5]. The number of pixels of each tree species is presented below. Thus, the proportion of the number of trees have been counted percentage-wise.

For a greater accuracy of the study, abiotic elements were also taken into account, i.e. roads, buildings and water. Grass was differentiated into a separate class.

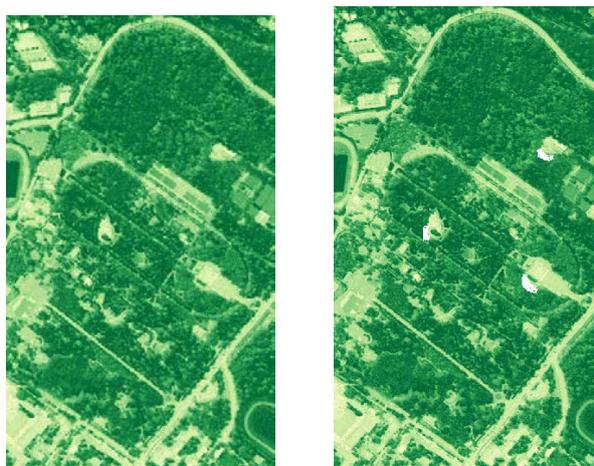
A pivot table has been made by the results of the calculations, a fragment of which is shown below.

table 1

District	Objekt	Lime-tree, %	Maple, %	Ash-tree, %	Oak, %	Grass, %	Roads, buildings %
Shewchenkowskiy	Alekseewski woodland	35,9	7,7	53,7	0,8	0,4	1,4
Shewchenkowskiy	Botanical garden	20,9	21,6	18,0	10,7	7,0	21,8
Shewchenkowskiy	Shewchenko park	2,6	20,4	8,9	41,5	7,4	19,3
Shewchenkowskiy	Alekseewskiy park (1 part)	38,0	24,2	24,2	8,8	3,6	1,1
Kiewskiy	Molod'orzniy park	12,8	34,5	11,0	31,6	3,4	6,8
Kiewskiy	Cemetery № 2	14,8	35,0	9,5	25,5	4,0	11,2
Kiewskiy	Woodland № 1	35,0	4,9	58,5	0,4	0,5	0,7
Cholodnogorskiy	Alekseewskiy park (2 part)	23,0	27,6	22,7	9,6	12,3	4,8
Cholodnogorskiy	Cemetery № 8	34,6	14,0	42,1	4,4	4,9	0,0

The biggest woodlands were detected in Moscovskiy and Shevchenkowskiy districts, and the smallest woodlands – in Kiewskiy district. The smallest changes of area and species composition were noted at the cemeteries, and the highest ones - in the parks and gardens. Comparing the number of trees and the number of factories in each district it was found out that in most of districts (except for Moscovskiy and Shevchenkowskiy) the number of trees is not enough to clean the air efficiently.

Taking into account the most important woodlands of Kharkiv as well as their different location in the city, three representative woodlands have been picked out: Shevchenko Park, Gorky Park and Alekseevskiy Park.



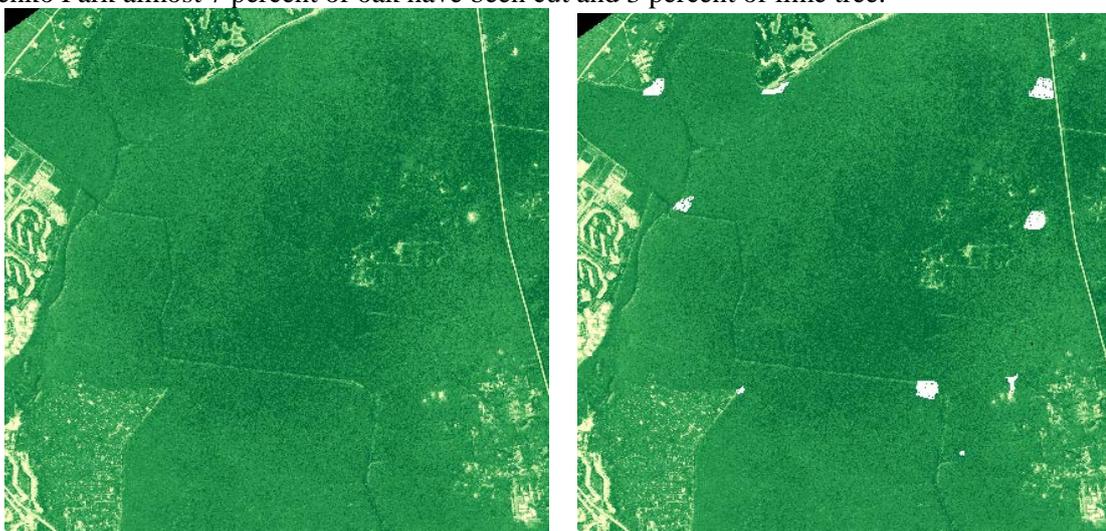
Pic.2 Difference in vegetation of Gorky Park in 2011 and 2016

There are more buildings in 2016 than it was in 2011 in Gorky Park. On the city outskirts problems are even bigger: not only trees were cut but woodlands have less territory than they should have according to cadastral maps. In Gorky Park 1 percent of oak has been cut and 2 percent of ashes.



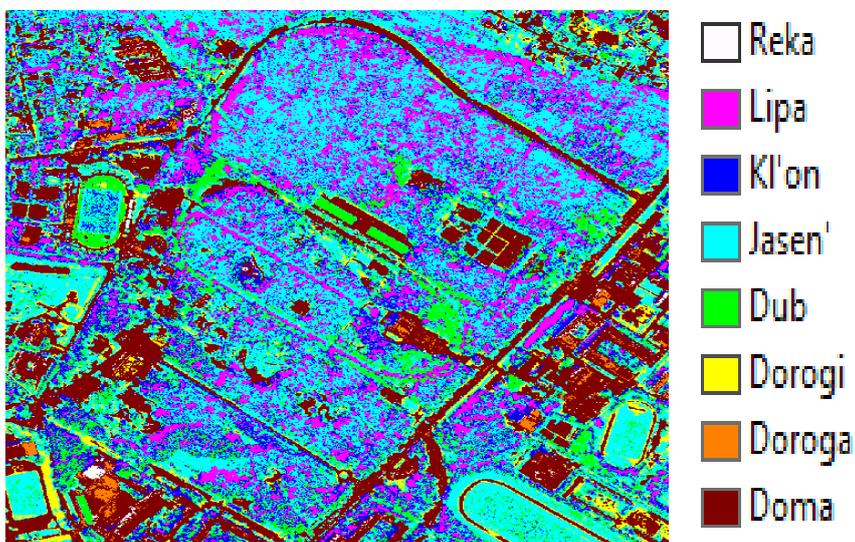
Pic.3 Difference in vegetation of Shevchenko Park in 2011 and 2016

In Shevchenko Park there are 5 % more territory covered by buildings and roads than it was in 2011 and considering about the construction processes within the park it can be made a conclusion about bigger percentage of cafes, hotels and road as well. According to such a bad statistical information, it is shown that in Shevchenko Park almost 7 percent of oak have been cut and 3 percent of lime tree.

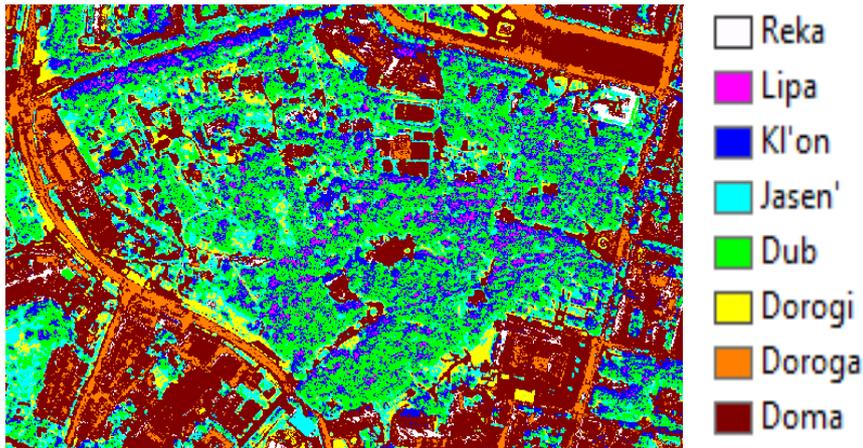


Pic.4 Difference in vegetation in Alekseevskiy lugopark in 2011 and 2016

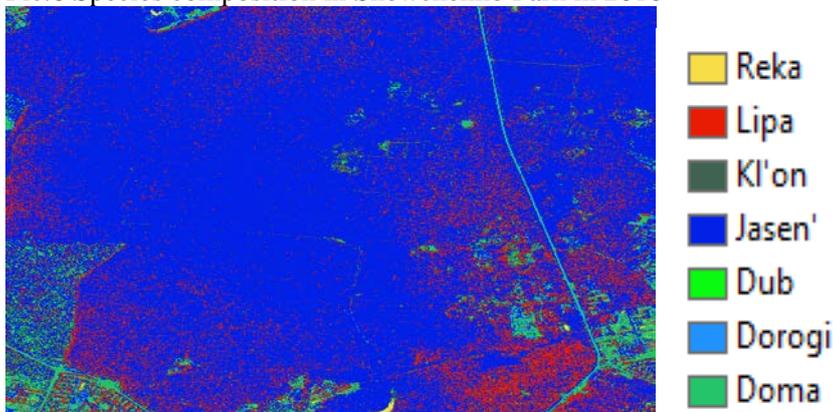
Square of Alekseevskiy Lugopark decreased by 2 percent in 5 years and there are more buildings in a scale of 7 percent. In addition, the worst situation in Alekseevskiy Lugopark, where 15 percent of oaks has been cut and 7 percent of lime tree and 3 percent of ashes as well.



Pic.5 Species composition in Gorky Park in 2016



Pic.6 Species composition in Shewchenko Park in 2016



Pic.7 Species composition in Alekseevskiy Park in 2016

It is clear, that Maximum Likelihood classification depicts not only arboreal species information but the decreasing of square of woodland as well. Parks and semi-park places, which are situated in central parts of the city, stay in right borders, but there are a lot of roads, buildings, which appeared in 5 years period. It is shown that many trees were cut out because of this. Such a bad dynamics caused by following problems: badly framed system of land and trees protection, misunderstanding of tree's influence on nature and existence of unprotectable important territories. If the process of cutting of arboreal fund doesn't stop in Kharkiv, the city will have these problems obviously:

1. Surface erosion by destroying tree root system.
2. Erasing quantity of  $CO_2$  in lower atmosphere horizons.
3. Pooring and destroying modern and attractive park by trees cut.

The creation of a consistently updated database that could be based on the multispectral data is an important aspect of future work. The final task is to show relevant information about the vegetation of Kharkov. This project is planned to start within this year.

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## EFFECTS OF SLEEP DEPRIVATION ON STUDENTS' GENERAL STATE

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**Abstract.** The article considers the factors influencing the quality of sleep and effects of sleep deprivation on students' health. It describes the survey of sleeping habits of Kharkiv students, the influence of circadian rhythm sleep disorders on the quality of their life and gives effective methods of sleep deprivation prevention for students.

**Key words:** sleep deprivation, circadian rhythm sleep disorders, delayed sleep phase disorder (DSPD), hypersomnia.

**Introduction.** Sleep is an integral part of human life. It is one of the most important factors of health. Getting enough quality sleep at right times can help protect physical and mental health, quality of life, and safety. The way person feels while he is awake depends in part on what happens while a person is sleeping. During sleep the body is working to support healthy brain function and maintain physical health. In children and teens, sleep also helps support growth and development. Regular and restful sleep is essential for good health. Sleep helps people feel less stressed and even maintain a healthy diet. University students often lead very busy and stressful lives. Everyday activities such as attending classes, working out at a gym, working on a computer, learning until late at night can strain mind and body. Sleep deprivation can affect important aspects of mind and body such as mood, energy, ability to learn, memory, good judgment, reaction time and efficiency.

There are a lot of studies showing that regular lack of sleep can result in sleep disorders, which, in turn, provide a lot of pathological changes in the body and finally lead to such complications as anxiety and depressive symptoms, weakened immune system, increased risk of myocardial infarction, stroke, heart attack, heart failure and diabetes [Sigurdson, Ayas 2007: 179-183]. The studies also show that sleep loss and poor-quality sleep can lead to accidents and injuries. About 35% of people in the world are suffering from sleep disorders.

According to the National Institute of Health college students are one of the most sleep-deprived populations. The research carried out at Brown University found that only 11% of students reported good sleep, while 73% reported sleep problems. 18% of college men and 30% of college women reported having suffered from insomnia. Sleep deprivation in students can certainly be linked to lower GPAs (Grade Point Average) because it affects concentration, memory and ability to learn. However, the National Sleep Foundation's [2014 Sleep in America Poll](#) reports that less than a half of American children get at least nine hours of sleep each night, and 58 percent of 15–17-year-olds regularly sleep fewer than seven hours each night [National Sleep Foundation 2014: 9]. The National Sleep Foundation recommends 7-9 hours of sleep for young adults (18-25 years old) [Hirshkowitz, Whiton 2015: 40-43].

Sleep disorders are broadly classified into dyssomnias, parasomnias, circadian rhythm sleep disorders involving the timing of sleep, and other disorders including those caused by medical or psychological conditions and sleeping sickness. Circadian rhythm sleep disorders a family of sleep disorders, affect (among other bodily processes) the timing of sleep, 4 types of CRSD were identified: advanced sleep phase disorder (characterized by difficulty staying awake in the evening and difficulty staying asleep in the morning), delayed sleep phase disorder (DSPD) (characterized by a much later than normal timing of sleep onset and offset and a period of peak alertness in the middle of the night), irregular sleep-wake rhythm, non-24-hour sleep-wake disorder. Some common sleep disorders include sleep apnea (stops in breathing during sleep), narcolepsy and hypersomnia (excessive sleepiness at inappropriate times), cataplexy (sudden and transient loss of muscle tone while awake), and sleeping sickness (disruption of sleep cycle due to infection). Other disorders include sleepwalking, night terrors and bed wetting. Management of sleep disturbances that are secondary to mental, medical, or substance abuse disorders should focus on the underlying conditions.

**Object-matter:** sleep disorders, circadian rhythm sleep disorders, hypersomnia.

**Subject-matter:** students of 15 Kharkiv universities.

**Objective:** to identify sleep disorders among student population and factors influencing the development of these disorders, to formulate recommendations for students about sleep.

**Tasks:** to study sleeping habits of students and contributing factors of sleep deprivation, to consider effective preventive methods of sleep deprivation to use by students.

**Materials:** 302 students of 15 universities (such as Kharkiv Karazin National University, Kharkiv National Medical University, Kharkiv National Economical University, and others) were interviewed, average age of students was 20 years (17-25 years), women – 70, 5%, men – 29, 5%.

**Methods:** The interview was conducted in the form of an online survey by Google forms. Statistical analysis of the research materials was performed using Microsoft Excel 2010 software.

**Discussion and Results.** How many hours do students sleep at night? The research has shown that 2.7% of respondents sleep less than 4 hours, 6.3% – 5 hours, 16.6% – 6 hours, 27.8% of the students sleep 7 hours, 40.8% of respondents sleep on average 8-9 hours and 9% – more than 10 hours.

The results concerning the dependence between the general state of the students and time of their going to bed and waking up is given in the diagrams below.

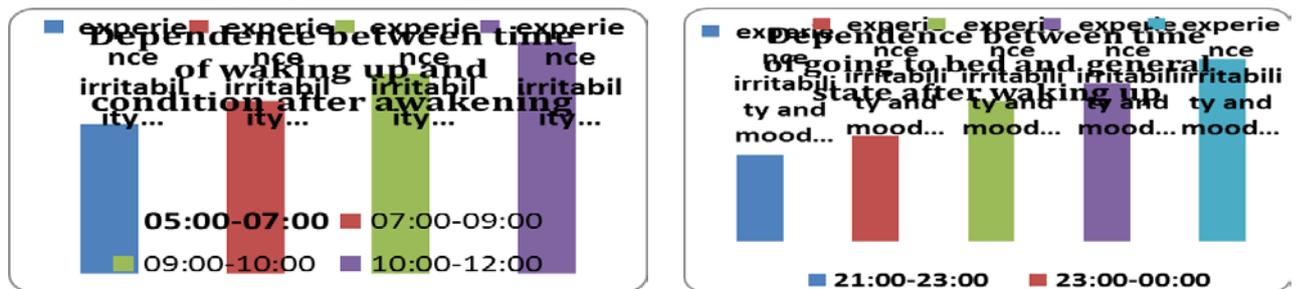


Diagram №1 "Dependence between time of waking up and condition after awakening"

Diagram №2 "Dependence between time of going to bed and general state after waking up"

Delayed [sleep](#) phase syndrome is one of many circadian rhythm sleeping disorders, and is the most prevalent of all such disorders. People with delayed sleep phase have a natural inclination to go to bed later and wake up later than what is typically considered normal. People with delayed sleep phase generally go to bed in the early morning hours, from 1 am to 4 am, and wake up later in the morning, from 8 am to 11 am. Socially active people, and those considered 'night owls', who feel more awake or sharper during the evenings, are at a high rate of having or getting this disorder. The study showed that delayed sleep phase disorder affects 18.5% of respondents.

Students whose sleeping area complies with sleep hygiene standards (no loud noises, bright lights, ventilated room, comfortable pillow and mattress), in 51.5% of cases feel sleepy and frustrated after waking up. Respondents whose sleeping area does not comply with sleep hygiene standards, in 68.2% cases.

The dependence between the time of the last meal and the state after awakening was identified. Students who eat 2-3 hours before bedtime in 47% of cases feel sleepy and frustrated after waking up, while those who had supper just before bedtime (1 hour, 30 minutes) – in 67.6% of cases.

The relationship between using digital gadgets (smartphone, TV-set, computer, tablet) and speed of falling asleep was established. The pollees, who regularly use digital gadgets before going to bed (94%), in 40.7% of cases, have difficulty falling asleep. Students, who do not use digital gadgets before bedtime (6%) – only in 16.6% of cases.

**Conclusion.** The survey findings show that students adhere poor sleep habits even though they are aware of the damaging effects of sleep loss on their health. Students are more likely to get less than 7 hours of sleep per night if they take part in all-nighter studies. In average 25.6% of students sleep insufficient number of hours. Students are also less likely to sleep if they use products such as cellphones, smartphones, tablets, TV-sets and computers. It was found that 28% of respondents have difficulty falling asleep. The study showed that delayed sleep phase disorder affects 18.5% of respondents. There are many long-term health effects of DSPD. These can include depression, lowered immune response, anxiety disorders, weight gain, fibromyalgia, diabetes, and cancer.

Factors affecting the condition after waking up, falling asleep speed, the quality of sleep were established: the time between the last meal and going to bed, conformity of the sleeping area to the norms of sleeping hygiene, using digital gadgets and exposure to various emotional ups before going to bed.

Recommendations for students to protect their sleep and prevent the risk of development of lots of pathological changes were formulated. First of all, they were recommended to stop using any technology 30 minutes before going to bed: no smartphone, laptop, or TV. The light blocks melatonin production which can help fall asleep. A 30-minute wind down with relaxation and reading (a paper book) can make it easier to fall asleep. The second recommendation was not to drink coffee and other caffeinated drinks after 3 PM. Finally,

they were advised to sleep only an hour longer during the weekend than the latest weekday wake-up time in order to prevent the effects of hypersomnia.

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УДК: 504.61:630

### ANALYSIS OF AREAS AFFECTED BY FIRES IN VASYSCHIVSKY FORESTRY IN 2001-2012

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**Abstract:** The article deals with the problem of forest fires and ways of their solution, factors affecting the forests fire conditions, especially the increase in the incidence of forest fires during the summer recreational activities of people. The facts of negligent use of forest resources for the purpose of waste disposal have been analysed, and the peculiarities of forest fires have been studied. Their temporal and spatial analysis for 2001-2012 has been conducted on the example of Vasyschivsky Forestry territory.

**Key words:** recreation, dumps, forest fires, fire conditions, anthropogenic factor, forest protection.

#### Introduction

Today, forests in suburban areas are used as a recreational resource. It is especially true in summer, when people adversely affect on the ecological conditions of the forest ecosystem that ensures the biodiversity conservation in the area. The fact that people stay in the forest leads to forest fires, littering of areas, destruction of the forest stand, etc.

In recent years the problem of forest fires has attracted a particular attention because at our time they are a spontaneous, uncontrollable spread of fire on forest areas. These fires are divided into grassroots, upper and, underground. The intensity of wildfires can be weak, medium and strong.

Analysis of many scientific sources has showed that such scholars as I.M. Malinovska [3], A.V. Skvortsova, V.P. Voron, E.E Melnyk, S.G. Sydorenko [1 ] have been studying the forest fires for a long time. O.A. Borsuk [2] studied the tendencies of fires and developed measures to protect forests from them.

#### The purpose and objectives of the study.

The purpose of the work is to assess the ecological conditions of Vasyschivsky forestry by means of landscape and environmental planning .

The aim is achieved by studying the after fire areas limits based on the analysis of cartographic works.

**Methods:** a field survey of the Vasyschivsky forestry territory, soil sampling by the envelop method on key points according to the experiment plan, analysis of samples on pH and carbonate content.

#### Discussion and Results:

Among the causes of forest fires the main is considered an anthropogenic factor (according to statistics, 96-98% of forest fires occur because of the population negligence). Therefore, forests located near major

industrial centers, medical and health facilities, roads, electrical lines require special attention. Natural and climatic conditions (high temperature, low rainfall, etc.) often only increase the probability of ignition and affect the rate of fire spread.

In order to identify and call to account violators of fire safety the teams of state fire protection have been created to patrol the forest areas on weekends and holidays. This practice gave positive results. In 2001 more than 18 thousand raids were held, 4,100 violators were discovered and fined. Total fines amounted to 83.8 thousand hryvnas.

Under such conditions, it is impossible to ensure reliable protection of forests from fires without an adequate material and technical base, which would include high-performance detection and extinguishing of fires. To some extent these requirements are met by forest fire stations (fire stations), which are subject to the State Committee of Forestry, Ukraine. Now Ukraine has 226 such fire stations. Their equipment is: 437 fire engines, 17 fire units HPV-149 and 1 - TLP-55, 9 excavators GT-3 and 73 ALF-10, 8 car forest fire trains ALU-15, 5 strip layers, 38 removable tanks (DSP), 1700 different types of fire extinguishers, 599 pumps and nearly 50,000 meters of fire hoses, 3036 radio stations. For early detection of forest fires there have been erected 402 towers and masts, of which 30 are equipped with a television sets STP-59 [4].

Each year the fire department prepares to fire dangerous period, together with local councils develops and approves operational and mobilization plans in case of major forest fires, state forestry bodies lay fire breaks and mineralized bands, perform care stripes and gaps that have been laid before [4].

To improve the interaction of fire protection departments in the event of a large and complex forest fire "Instruction on the interaction between departments of Minforest of Ukraine and the State Fire Service of Ukraine during the extinguishing of forest fires" has been developed.

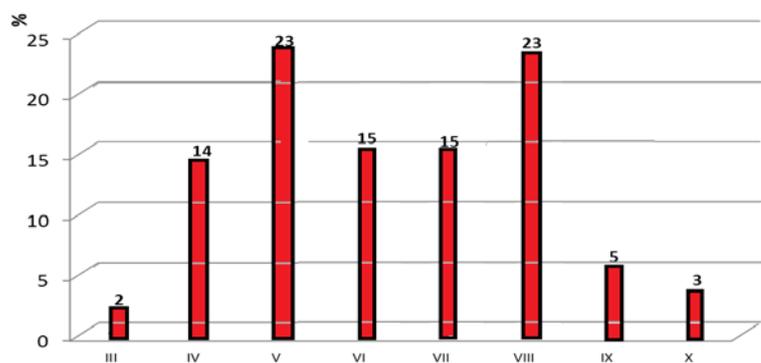
Efficiency of extinguishing forest fires, as well as coordination of air and ground services should be provided by special control service. Its objective is to collect and transfer the information on forest fires that comes from the forestry to the committee [4].

Improvement of the finance industry, organization of fire stations on newly established forests areas, replacement of obsolete equipment - these are measures that will help protect our green friend from fire [4].

Vasyschivske forestry is within the forestry of Zhovtneve forestry which includes, except Vasyschivsky, such forestries as Babayivske, Merefyanske, Rakytyanske, Dergachivsky, Vodolazkyy, Zolochivske, Lyubotynske, Valkivske.

Major figures from the area are also characteristic of Vasyschivsky (111.6 hectares). Between 2001 and 2012, in Vasyschivsky forestry 670 cases of fires were noted. This is an average of 50 cases per year.

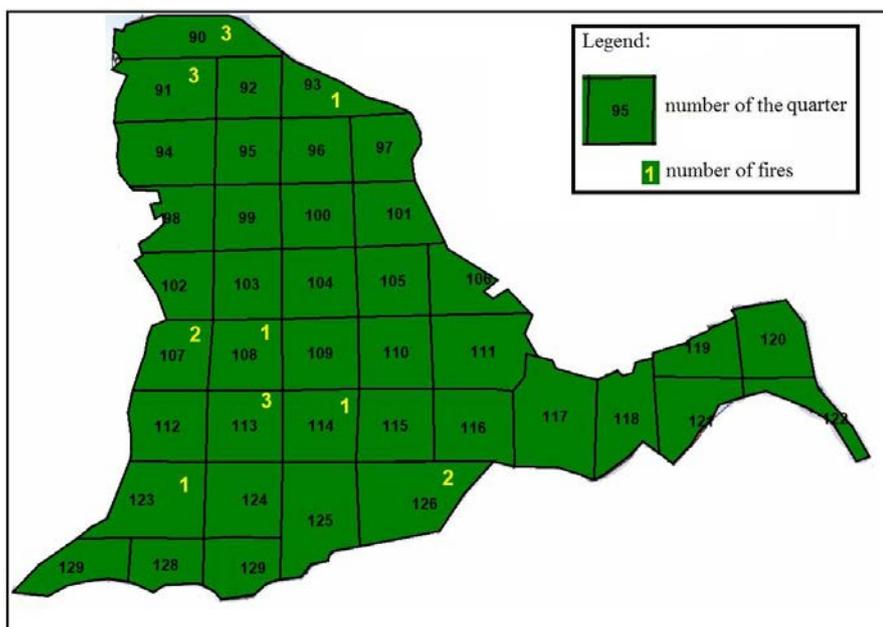
The largest number of fires in Vasyschivsk forestry in 2001-2012 (Fig. 1) was observed in May and August, 23% is due to recreational activity in these months, when a large number of people have a rest in the forest.



**Fig.1** distribution of forest fires by month

Of great importance are the weather conditions, particularly in August when the weather is warm, and there has been no precipitation for relatively long periods of time. This may explain the fairly large value in other summer months. One of the highest rates in May can be explained by quite a common phenomenon in the spring, such as burning of dry grass that frequently leads to forest fires.

The major sites of fires are neighborhoods 94, 101, 102, 106, 107, 112, 113, 119, 124 (Figure 2). The reason for this distribution is the human impact. In quarter 90 there are waste dumps, and a gas pipeline runs through neighborhoods 91 - 128.



**Fig.2** number of the quarter

The total area of fires in these quarters is 6.6 hectares, the average size of a fire is – 0.1 ha, respectively, showing ineffective fight against fires.

#### **Conclusions.**

Therefore, to improve fire conditions in the territory of Vasyschivsky Forestry, a number of fire protection measures should be carried out, such as: improvement of technical equipment, thoroughly instructed local residents to avoid the accumulation of waste in the forest, reduction of the number of tourists by continuous monitoring of the area.

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УДК 616.33-008.6-057.87:613.24

### **EVALUATION OF RISK OF DEVELOPMENT OF GASTROESOPHAGEAL REFLUX DISEASE CAUSED BY WRONG DIET IN STUDENTS.**

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**Abstract.** The article deals with gastroesophageal reflux disease (GERD), its definition, contributing factors of its development, diagnosis and treatment. It also describes the research of risk of GERD development in students as a result of wrong diet, basing on the evaluation of eating habits of students from Kharkiv universities.

**Key words:** Gastroesophageal reflux disease (GERD), contributing factors, questionnaire, eating habits.

**Introduction.** Gastroesophageal reflux disease (GERD) is one of the most frequent pathologies among the various diseases of the chest [Hershcovici 2011: 258 - 264]. According to epidemiological studies, 7-10% population of the USA every day suffer the main symptom of the GERD – the heartburn, 12% – once a week, 40-50% – once a month. Recent publications testify about the steady trend of the GERD to the extension. The spread of this disease constitutes 40-60% in Ukraine, 45-80% of them have esophagitis [Kasasbeh 2007: 47-58].

Gastroesophageal reflux disease (GERD) is a long term condition where stomach contents come back up into the esophagus resulting in either symptoms or complications [Zajac 2013: 79 - 85]. The symptoms include taste of acid in the back of the mouth, heartburn, bad breath, chest pain, vomiting, breathing problems, and wearing away of the teeth. The possible complications are esophagitis, esophageal strictures, and Barrett's esophagus.

This is considered to be a normal physiological phenomenon, if it occurs rarely after ingestion and without unpleasant feelings [Smits 2011: 925 - 35]. But if the blowout is great and is accompanied by inflammation and damage of mucosal tissue, this is considered to be a disease [Hershcovici 2011: 258 - 264].

Stressful lifestyle, work related to the inclined position of the body, obesity, pregnancy, smoking and, of course, nutrition influence the development of GERD [Kahrilas 2008: 1392–1413]. There are a lot of factors that can contribute to development of GERD including obesity (in a large series of 2,000 patients with symptomatic reflux disease, it has been shown that 13% of changes in esophageal acid exposure is attributable to changes in body mass index), increased gastric acidity due to gastrin production, the use of medicines, and others [Smits 2011: 925 – 35]. GERD has also been linked to a variety of respiratory and laryngeal complaints such as laryngitis, chronic cough, pulmonary fibrosis, earache, and asthma, even when not clinically apparent [Kahrilas 2008: 1392–1413]. These atypical manifestations of GERD are commonly referred to as laryngopharyngeal reflux (LPR) or as extraesophageal reflux disease (EERD). Factors that have been linked with GERD, but not conclusively are obstructive sleep apnea and gallstones, which can impede the flow of bile into the duodenum, which can affect the ability to neutralize gastric acid [Zajac 2013: 79 - 85].

Gastroesophageal reflux and heartburn caused by them may be aggravated by intake of certain foods. The most common cause for concern chocolate, onions, fried foods, fatty foods, peppermint, alcohol, caffeine, carbonated drinks and acidic foods. Spicy foods, citrus foods can exacerbate heartburn. A large number of fatty foods, slows gastric emptying, eaten late at night can contribute to the nocturnal heartburn. Alcohol can relax the lower esophageal sphincter and thereby strengthen reflux.

The GERD appears with the heartburn, acid eructation, which usually occurs after eating, when the body is tilted forward. Also the patient can feel the chest pain that spreads into the interscapular region, neck, lower jaw [Fedorak 2010: 431–4]. Outesophageal manifestations of the disease include pulmonary symptoms (cough, shortness of breath, often resulting in a prone position) otolaryngological symptoms (hoarseness, dry throat) and gastric symptoms (early satiety, bloating, nausea, vomiting) [Smits 2011: 925 - 35].

The diagnosis of GERD is usually made when typical symptoms are present. Reflux can be present in people without symptoms and the diagnosis requires both symptoms or complications and reflux of stomach content [Kasasbeh 2007: 47-58].

The current gold standard for diagnosis of GERD is esophageal pH monitoring. It is the most objective test to diagnose the reflux disease and allows monitoring GERD patients in their response to medical or surgical treatment [Kahrilas 2008: 1392–1413]. One practice for diagnosis of GERD is a short-term treatment with proton-pump inhibitors, with improvement in symptoms suggesting a positive diagnosis. Short-term treatment with [proton-pump inhibitors](#) may help predict abnormal 24-hr pH monitoring results among patients with symptoms suggestive of GERD [Kasasbeh 2007: 47-58].

The investigations may include [esophagogastroduodenoscopy](#) (EGD). [Barium swallow X-rays](#) should not be used for diagnosis. [Esophageal manometry](#) is not recommended for use in diagnosis, being recommended only prior to surgery [Kahrilas 2008: 1392–1413]. Ambulatory [esophageal pH monitoring](#) may be useful in those who do not improve after PPIs and is not needed in those in whom Barrett's esophagus is seen. Investigation for *H. pylori* is not usually needed [Smits 2011: 925 - 35].

The treatments for GERD include lifestyle modifications, medications, and in more severe case surgery is possible. Initial treatment is frequently with a [proton-pump inhibitor](#) such as [omeprazole](#) [Piesman 2007: 2128–34].

**Object-matter:** gastroesophageal reflux disease.

**Subject-matter:** prevalence of the GERD.

**Objective:** to estimate the risk of development of gastroesophageal reflux disease as a result of wrong nutrition in students of some Kharkiv universities.

**Tasks:** 1) to study the definition, symptoms, contributing factors, diagnosis and treatment of GERD; 2) to conduct a survey of Kharkiv students in order to estimate the risk of development of gastroesophageal reflux disease caused by wrong nutrition; 3) to estimate the results of the survey.

**Materials and methods.** The research was conducted at the Department of General Practice – Family Medicine of Kharkiv Karazin National University in the form of a questionnaire. 175 students from various Kharkiv universities took part in this research.

Discussion and Results.

**The questionnaire used for evaluation of risk of development of GERD resulting from a wrong diet in students included the following questions:**

- 1) How often do you have breakfast?
- 2) How many times a day do you eat?
- 3) What food products do you prefer?
- 4) How much liquid do you drink a day?
- 5) What drinks do you prefer?
- 6) Would you like to change your regimen and diet?

The analysis of answers shows that nutrition of 1-2 year students of different Kharkov universities is quite rational, healthy and can hardly promote the development of GERD. According to the survey, more than half of students have breakfast regularly. 80,3% of students eat more 3 times a day while only 4% don't eat in the morning. 64,5% of students eat 3 times a day. Only 33.5% of students prefer vegetables to animal food. More than half of the students want to change their diet, meanwhile, 12,6% would like to do it, but cannot do it for objective reasons. 42,5% of students drink above 1.5 liters per day. About 40% drink 1,5 liter per a day. Most students prefer to drink water instead of energy-drinks, beer, juice, wine and other beverages of chemical composition, which is also a good tendency among adolescents. From this it should be noted that young people realize that nutrition is very important to maintain good health and they are aware of risks of developing stomach problems including GERD, so they try to follow healthy eating habits.

Conclusions.

The findings show that the risk of GERD development in 1-2 year students of different Kharkov universities is not high. The survey showed that Kharkiv students are becoming more health-conscious, they try to watch their diet, rationally choose the food products, do not abuse the harmful products, which implies that young people are unlikely to develop the GERD.

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**Частина III. TECHNICAL SCIENCES.**

УДК 004.056.55

**CRYPTOSYSTEM RSA. HISTORY OF DEVELOPMENT,  
DESCRIPTION, PRINCIPLE**

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**Abstract:** The paper overviews one of the most popular cryptosystems with public key – the RSA cryptosystem. At the beginning a prehistory of public-key-cryptography is presented. The next part of the article contains a description of a process of encrypting and decrypting. In the conclusion a correctness of the algorithm is proved.

**Key words:** RSA, cryptosystem, public key, trapdoor function

**Introduction**

**Subject-matter:** The article is devoted to achievements of cryptography of the last century.

**Object-matter:** To review the very first public-key cryptosystem – RSA.

**Objective:** To acquaint readers with the history and principle of RSA cryptosystem.

**Tasks:** To make a short overview of some developments in cryptography, particularly encoding with one-way function and RSA cryptosystem as the first one to have proved successful.

**Methods:** Descriptive.

**Materials:** Mathematical books of honored authors on the number theory and cryptography.

## Discussion and results

### Public key

First of all, we need to explore a principle of public-key-cryptography. Before this type of encrypting was invented most of cryptosystems had been made by the private key. What does that mean? Suppose two people, Alice and Bob, are going to exchange some secret messages. Functions, used for encrypting and decrypting, apply one and the same secret key. Moreover, both functions can be simply derived from each other. That is why Alice and Bob need to have an absolute protected way to send a key. However, a safe way to send a key in network is to encrypt it, and then another key should be delivered. This process appears to be endless.

However, how does a cryptosystem with public key work? If Alice wants to send some message to Bob, she knows Bob's public key which can be known by anyone. Further, Alice encrypts her message with Bob's key and sends it to him, and then only one man in the world can decrypt this cipher because only Bob has a private key to perform this operation. Therefore, Alice and Bob need not to exchange keys. In fact, Alice just encodes a message "special for him". In that case, if a third party is able to intercept a cipher only, it will fail to crack the message without knowing a private key. Such an encrypting function is termed a *one-way trapdoor function*. The invention of this type of cryptography became an inception of a real revolution in cryptography.

Firstly, this principle was described in a work by Whitfield Diffie and Martin Hellman titled *New directions in cryptography*, published in 1976. However, it was invented but it was not realized by anyone until 1977, when Ron Rivest, Adi Shamir, and Leonard Adleman published a description of the algorithm that now we know under the name of the initial letters of the surnames of its developers – RSA.

### Encrypting and decrypting

#### Before the beginning

To encrypt some message we need to choose some prime numbers  $p$  and  $q$ . Then these numbers are multiplied and we get a composite –  $n$ , with two prime dividers.  $p$  and  $q$  are kept in secret, but  $n$  becomes a part of our public key. Further, we should prepare the message to encrypting.

Since the RSA algorithm uses integers in some powers, we are going to get some set of integer numbers, which corresponds to our message. Therefore, we need to represent it in the number form. For example, we can set in bijection (mutually unique correspondence) some number code for every character. It would be better to choose codes with equal length. In that case, a problem of encoding by a recipient becomes easier. However, it is a question of agreement. Nowadays most people use *ASCII (American Standard Code for Information Interchange)* for this purpose.

In any way, we will have a relatively long sequence of numbers. Now we need to divide this sequence into such parts, every one of which is less than  $n$ . Otherwise the message cannot be encrypted in one way. Obviously, if we divide a message into blocks before the encryption, after the decryption it will be united as one number and then decoded (i. e. selected codes will be replaced by the corresponding characters). In fact, we are only preparing our message to be encrypted. Now we have a set of numbers, each less than  $n$ . Now we can start the encoding process.

#### The algorithm

By the method described above we have many blocks, each of them can be encrypted in the same way. Let us consider how we can proceed with one block. As it is mentioned, before we have to choose primes  $p$  and  $q$  and define  $n$ , so that  $n := p * q$ . At the next step we choose another natural number  $e$ , that  $GCD(e, \varphi(n)) = 1$  (there and further  $GCD$  means *greatest common divisor*;  $\varphi(n)$  is *Euler's function*).

With  $p$  and  $q$  known it is easy to calculate  $\varphi(n)$ :  $\varphi(n) = (p - 1) * (q - 1)$ . However, if/when  $p$  and  $q$  are not known to a codebreaker, he will have to factor  $n$ . But this process is almost impossible with regular computer resources for enough large primes. Thus, a pair  $(n, e)$  becomes a *public* or *encrypting key*. Now, for simplicity, let us define:  $E(b)$  – an encryption function,  $D(c)$  – a decryption one, where  $b$  – *block of plaintext* (a part of encoded message),  $c$  – *ciphertext* (a value of encrypted plaintext).

To get the private key, we need one more number  $d$ , which is an inverse number to  $e$  of the multiplication modulo  $\varphi(n)$ . I. e.  $d = e^{-1} \pmod{\varphi(n)}$ . The required  $d$  is easily figured out, knowing  $\varphi(n)$ , using the Euclid's extended algorithm. The same way we can make another pair of numbers  $(n, d)$ , which is called a *private* or *decrypting key*.

It has already been mentioned that encoding is computing number to some power. In the RSA algorithm  $E(b) = b^e \pmod{n}$  and  $D(c) = c^d \pmod{n}$ .

#### Why it works

Evidently, this cryptosystem should be correct to be useful. What do we mean by this term? To decrypt the same number, which was encrypted,  $E(b)$  and  $D(c)$  should be inverse functions:  $D(c) = E(b)^{-1}$ . Actually we need to prove that for any  $0 \leq b \leq n-1$  an equality  $D(E(b)) = b$  is satisfied. In other words, it is enough to prove that  $D(E(b)) \equiv b \pmod{n}$ . As we know  $D(E(b)) \equiv (b^e)^d \equiv b^{ed} \pmod{n}$ .

Since  $d \equiv e^{-1} \pmod{\varphi(n)}$  then there exist number  $k$ , that  $ed = 1 + k\varphi(n)$ . Thus, our equation is transformed into  $b^{1+k\varphi(n)} \equiv (b^{\varphi(n)})^k * b \equiv b \pmod{n}$ . Now we can use the Euler's theorem, which claims that  $b^{\varphi(n)} \equiv 1 \pmod{n}$ . Thereby  $(b^{\varphi(n)})^k * b \equiv b \pmod{n}$ . However, there is a little inaccuracy in our proving. According to the theorem,  $GCD(b, n) = 1$ , but actually we do not need to check every block of our message to be relatively prime with  $n$ , we just can prove that our system will work with any  $GCD$  of  $b$  and  $n$ .

Remember, that  $n = p*q$ , where  $p$  and  $q$  are different prime numbers. That is why  $ed = 1 + k\varphi(n) = 1 + k(p-1)(q-1)$ . Hence  $b^{ed} \equiv (b^{(p-1)})^{k(q-1)} * b \pmod{n}$ . Now we would like to apply a Fermat's theorem, but we can do it only in case, when  $p$  does not divide  $b$ . Let it hold, then  $b^{p-1} = 1 \pmod{p}$ , hence  $b^{ed} \equiv b \pmod{p}$ . Now we have to prove this fact for the numbers which are divided by  $p$ . Obviously, in this case  $b^{ed} \equiv b \equiv 0 \pmod{p}$ . That is why for any  $b$ :  $b^{ed} \equiv b \pmod{p}$ .

Evidently, these steps can be repeated for  $q$ . In other words,  $b^{ed} - b$  is divided by  $p$  and  $q$ , and  $GCD(p, q) = 1$ . Hence  $b^{ed} - b$  is divided by  $p*q = n$ . Finally, we have proved that  $D(E(b)) \equiv b^{ed} \equiv b \pmod{n}$ . That is why RSA cryptosystem is correct.

#### Conclusion

The paper has reviewed the first insight into the RSA cryptosystem problem, some works and researches are left behind. We can conclude that RSA is the first, but not perfect cryptosystem which employs trapdoor function. Nowadays, cryptography is more than an important branch of mathematics, and it will be developed in future.

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#### ZIKA VIRUS DISEASE AND ITS INFLUENCE ON HUMAN'S BODY

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**Abstract:** The article deals with Zika virus disease. The paper provides information on the history of the virus discovery, clinical manifestations of the disease as well as the means of the virus transmission to humans and methods of its detection in human's body. Particular attention is paid by the authors to the Zika virus influencing pregnant women and their fetuses. On the basis of the data analyzed some conclusions are made. The problem of neurological complications in infants requires close examination and further investigation. Another essential issue to be studied is the problem of vaccination and testing the disease.

**Key words:** Zika virus, microcephaly, neurologic complications, pregnancy, fetus.

**Introduction. The object-matter** of the research is Zika virus.

**The subject-matter** of the research is finding the consequences of Zika virus influence on a fetus and an adult's body.

**The objective** is to review the available information on Zika virus and the way it influences fetuses and adults.

**The tasks** are:

- to compare the data on the number of fixed birth cases of the infants with fetal cerebral abnormalities, e.g. microcephaly, during the outbreak of Zika fever in French Polynesia, Latin America and the USA;
- to describe the means of Zika virus detection in a human's body;
- to determine clinical manifestations of this disease.

**Methods and materials:**

- observation of the virus detection history;
- analysis of clinical manifestations of Zika fever in the area of French Polynesia, South and North America and Yap Island, testing people for the presence of ZIKV in their bodies and the vaccine development.
- the comparison of the number of cases of baby birth with inherited cerebral abnormalities in mothers infected by Zika virus during the outbreaks in French Polynesia, Latin America and the USA.

**Discussion and Results**

It is known that Zika virus (ZIKV) was firstly discovered in 1947 in Uganda. It was identified by the scientists researching yellow fever when they placed a rhesus macaque in a cage in the Zika Forest, near the East African Virus Research Institute in Entebbe, Uganda. The virus was observed to develop a fever in monkey's body and then researchers isolated a transmissible agent from its serum. In January, 1948, the similar agents were distinguished from a lot of *A. africanus* in the same forest. This agent was named as Zika virus after the locality from where the isolations were brought. The first case of isolating Zika virus from human's organism occurred in Nigeria in 1954.

Zika virus infection was only met in Africa (Nigeria) and Southeast Asia (Malaysia) till 2007, and it was rare. But 2007 became the year when the major epidemic has broken out in Yap Island, Micronesia. It was noticed that a lot of people with such symptoms as rash, conjunctivitis and arthralgia had been consulted by doctors, and they had been diagnosed dengue fever. Later epidemics touched Polynesia, Eastern Island, the Cook Islands and New Caledonia. In April 2015, a new outbreak of Zika virus infection occurred a long way from Africa and Asia, in Brazil. Thus, the virus continued spreading over the continent and its large, ongoing outbreak turned up in South and Central America, and on the Caribbean. So, the cause of such a rapid infection spreading was to be found. First of all it is tourism. An increasing flow of foreign visitors attracted by the 2014 FIFA World Cup as well as the large population of insects such as *Aedes aegypt* and *Aedes albopictus* mosquitoes inhabiting the region, gave a good chance to the virus to explore new territories.

Zika virus is known to belong to the virus family *Flaviviridae*. It is related to the dengue, yellow fever, Japanese encephalitis, and West Nile viruses. ZIKV can be transmitted in several ways. It may get into the body after the bites of infected mosquitoes, it is the most widespread case. There have been also cases of sexual, perinatal transmission and the probability of blood-transfusion transmission. In 2008 it was recorded that two American scientists who came back from Senegal, had been infected by ZIKV. One of them infected his wife when he returned home to Colorado [Foy, Kobylinski, Foy, Blitvich, Travassos da Rosa A, Haddow 2011: 880-882]. It was the first documented case of sexual transmission of the disease. Cases of perinatal transmission in French Polynesia were also described: 2 mothers and their newborns were found to have Zika virus infection within 4 days of birth. The infant's infections appear to have been acquired by transplacental transmission or during the delivery [Besnard, Lastère, Teissier, Cao-Lormeau, Musso 2014]. Blood-transfusion was observed to cause spreading infection among the population of French Polynesia. 1,505 asymptomatic blood donors (26%) were reported to be positive for Zika [WHO 2016]. The data proved the fact that Zika virus can be passed on through blood transfusion. During the Yap Island outbreak, 19% of people with serological evidence of recent infection (positive reaction on immunoglobulin M (IgM)) reported ZIKV symptoms [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 665]. It is the evidence of passing the disease without symptoms that makes it more dangerous.

As a whole, the disease proceeds in several stages. Symptoms appear in the period from 3 to 11 days (on average, in 6 days) after infection. Then in the period from 4 to 14 days (on average, in 9 days) after infection, the quantity of antibodies begins to increase. The period of immunity against Zika virus remains uncertain. For instance, for other *flaviviruses* it should be life-long. IgM will be the first detectable antibody. ZIKV can be extracted from blood, urine, saliva, semen, amniotic fluid, and neurologic tissue. The virus is likely to be absent in a human's body in 24 days after infection [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 665].

It is essential to analyze the most common symptoms for Zika fever on Yap Island: maculopapular rash (90%), arthralgia or arthritis (65%), non-purulent conjunctivitis (55%), myalgia (48%), headache (45%), retro-orbital pain (39%), edema (19%), and vomiting (10%) [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 665]. In general, symptoms are mild, so the acute phase of the disease finishes within 1 to 2 weeks of onset. Death cases are rare for Zika fever.

We have analyzed the data available to see how dangerous the virus is. Zika fever is considered to be dangerous for its neurologic complications, especially for Guillain-Barré syndrome. Statistics showed that during the outbreak in French Polynesia presence of Guillain-Barré syndrome in ZIKV infectious person was 24 per 100,000. It is more than 10 times the annual rate in the United States (1.8 per 100,000) [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 665]. It is important that Guillain-Barré syndrome was often found in symptomatic Zika virus cases. It was marked that Zika virus has the most injurious effect on pregnant women. The danger is that virus permeating in amniotic fluid and then in fetal brain tissue can cause severe birth defects. It was noticed that there is a possibility of baby birth with microcephaly in a woman infected by ZIKV. There is some evidence that this virus is responsible for such fetal diseases as intracranial calcifications, ventriculomegaly, ocular impairment, brainstem hypoplasia, intrauterine growth restriction (IUGR) and fetal demise.

We are to compare the cases of fetal brain abnormalities during the outbreaks in French Polynesia, Latin America and USA. For example, during the outbreak in French Polynesia, which lasted from October 2013 till April 2014, the number of cases of fetal cerebral anomaly rapidly increased. There were 13 suspected cases detected in 2014, 4 cases in 2013 and 3 cases in 2012 [Jouannic, Friszer S, Leparc-Goffart, Garel, Eyrolle-Guignot 2016: 1051]. On the other hand, World Health Organization declared about 1046 cases of microcephaly and other fetal malformations potentially associated with ZIKV infection in Brazil at the beginning of this year [WHO 2016]. Although the number of microcephaly cases in Columbia is much smaller [Bar-Yam, Erans, Parens, Morales, Nijhout 2016]. In the USA the outbreak only starts spreading. It was claimed that 234 pregnant women in the continental USA were infected by ZIKV. Three babies were born with defects, one of them had microcephaly [Tavernise 2016]. It should be emphasized that one cannot find any particular regularity in the occurrence of inherited defects in infants whose mothers were infected by Zika virus has been found, since the data varied in different areas. We can assume that as soon as the outbreak in North and South America is over, we will be able to make any exact conclusions.

Pregnant women have the same Zika virus symptoms as the population in general. According to the Brazilian researches, 74% of mothers whose infants had microcephaly, complained of a rash in the first or second trimester [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 666]. Two types of cases of the disease occurrence were identified: symptomatic and asymptomatic. We cannot say for sure, which of these types is safer for mother and her fetus. Some data suggest that the possibility of birth defects in asymptomatic pregnant woman is likely to be lower than in symptomatic ones, but not zero. Furthermore, in Columbia four cases of microcephaly were found in the infants whose mothers had been infected by ZIKV, but did not report symptoms [Lessler, Chaisson, Kucirka, Bi, Grantz, Salje, Carcelen, Ott, Sheffield, Ferguson, Cummings, Metcalf, Rodriguez – Barraquer 2016: 666]. The effect of Zika virus on a fetus is associated with the infection at gestational age. According to the evidence, microcephaly and brain abnormalities only appeared in the first- and the second-trimester infections. A big proportion of fetal abnormality cases occur in the second- and the third-trimester infections, but fetal death, IUGR and anhydramnios are found in the women infected at the 35th week. Columbian studies showed that there was a very small risk of infection in the third trimester. Unfortunately, we possess rather small amount of information to estimate the real threat of Zika virus for pregnant women.

ZIKV can be identified in a laboratory in two ways. The first test determines the presence of pieces of a virus's genetic code in a human's body with active infection. But when the body gets rid of the ZIKV (it happens in about 2 weeks after symptoms appear), that test will not work. The second test is the advanced version of the first one. It can define whether a person gets sick with dengue, chikungunya, or Zika fever instead of doing three different tests. There is also a test which searches for antibodies made by immune system to protect from ZIKV. These antibodies can remain in blood up to 3 months after a person was infected. But the results of this test are not accurate enough because the other related viruses like dengue and chikungunya can be specified in this way.

Another important issue seems to be the way to protect people from ZIKV disease. Scientists from all over the world try to develop vaccine against this disease. A research team from Maryland vaccinated 16 monkeys with three experimental vaccines and then infected them by Zika virus. They took 12 unvaccinated monkeys as

the control group. The result shows that none of the vaccinated monkeys became infected, but the unvaccinated ones had high levels of the virus in blood [Cohen 2016: 529]. These tests give us some hope that the vaccine against Zika virus fever will appear in several years.

### Conclusions

On the basis of the facts mentioned above we can conclude that it is worth paying serious attention to the problem of testing pregnant women to determine whether Zika virus is present in their bodies. It is also essential to identify all risks for the fetus whose mother is infected by this virus. And it is necessary to develop the vaccine, which will be able to prevent neurologic complications in babies and such diseases as Guillain-Barré syndrome in adults. People should be aware of the most common symptoms of Zika fever to protect themselves from the undesirable effects. This virus is rather young and it has not been studied completely yet, so there is still not enough information available on the problem and it is still much to be studied.

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## MODELING OF TRANSPORT NETWORK

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**Abstract:** A transport network or transportation network is a realization of a spatial network, describing a structure which permits either a vehicular movement or flow of some commodity. The network of roads and streets, railways, pipes, aqueducts and power lines are the examples of a transport network. Land, sea and air transportation networks are distinguished in the article.

Transport network analysis is used to determine the flow of vehicles (or people) through a transport network using the mathematical graph theory. It may combine different modes of transport, for example, walking and the car, to model multi-modal journeys. Transport network analysis falls within the field of transport engineering.

**Key words:** commodity, mathematical graph theory, spatial network, transport engineering, transport network.

### Introduction

In this article describes the Modeling of Transport Network, namely the flows in the transport networks. It investigates the nature of a transport network, what it represents and how it links with graphs. There is a lot of information about the flow, its size, and when the flow has a maximum value in this article. This paper will acquaint you with the theorem of Ford-Fulkerson (about a maximum flow and a minimum section) and its approving.

**Object matter:** a transport network

**Subject matter:** a modeling of transport network

**Objective:** to describe the modeling of a transport network.

**Tasks:** to learn how a transport network links with graphs, determine the flow of vehicles (or people) through a transport network.

**Materials:** the theory of graphs, the theorem of Ford-Fulkerson.

**Methods:** Descriptive, Comparative, Mathematical analysis.

### Flows in a Transport network

Transport network  $N$  is a connected directed graph that has no self-loops and that satisfies the following conditions:

1. There is only one vertex with a zero in-degree; this vertex is called the source and is denoted by  $s$ .
2. There is only one vertex with a zero out-degree: this vertex is called the sink and is denoted by  $t$ .
3. Each directed edge  $e = (i, j)$  in the network  $N$  is associated with a positive real number, called the capacity of the edge is denoted by  $c(e)$  or  $c(i, j)$ .

If there is no edge  $e$  directed from  $i$  to  $j$  then, we define  $c(e) = 0$ .

A transport network represents a network model for the transportation of a commodity from its production center to its market through communication routes. The capacity of an edge may be considered as representing the maximum rate at which can transport a commodity along the edge.

Flow  $f$  in transport network  $N$  is an assignment of a positive real number  $f(e) = f(i, j)$  to each edge  $e = (i, j)$  where the following conditions are satisfied:

$$1. f(i, j) \leq c(i, j) \text{ for each edge } (i, j) \text{ in } N \quad (1.1)$$

$$2. \sum_j f(j, i) = \sum_j f(i, j) \text{ for each } i \neq j, t. \quad (1.2)$$

The value  $f(e)$  if the flow in the edge  $e$  can be considered as the rate at which a material is transported along  $e$  under flow  $f$ . The condition (1.1), called the capacity constraint requires the rate of the flow along the edge which cannot exceed the capacity of the edge. The condition (1.2) called the conservation condition, requires that for each vertex  $i$  except the source and the sink the rate at which the material is transported into  $i$  is equal to the rate at which it is transported out of  $i$ .

As an example, transport network  $N$  with flow  $f$  is shown in Fig. 1.1. In this figure next to each edge  $e$  we have shown the capacity  $c(e)$  and the flow  $f(e)$  in that order.

The value of flow  $f$ , denoted as  $val(f)$ , is defined as

$$val(f) = \sum_j f(s, j). \quad (1.3)$$

We are going to prove using the conservation condition that

$$val(f) = \sum_j f(s, j) = \sum_j f(j, t). \quad (1.4)$$

This would only confirm the intuitively obvious fact, because of the conservation condition, the total amount of the material transported out of the source is equal to the total amount transported into the sink.

Flow  $f^*$  in transport network  $N$  is said to be maximum if there is no flow  $f$  in  $N$  such that  $val(f) < val(f^*)$ .

### Ford-Fulkerson Theorem.

Linear programming formulation of Ford-Fulkerson algorithm is given by expressing the maximum flow from Source node  $s$  to Sink node  $t$  as a linear program. The dual of this program yields a minimum cut value linear program and a strong duality establishes the Ford-Fulkerson theorem.

At each step it can be inferred that Ford-Fulkerson as finding a new flow (along the augmenting path) and adding it to the existing flow, where by adding two flows we mean adding them edge by edge. It is noticeable that the sum of two flows continues to satisfy the flow-conservation and skew-symmetry. The definition of a residual capacity ensures that the flow found by Ford-Fulkerson is legal (does not exceed the capacity constraints in the original graph).

Let  $r_{s,t}$  value of minimum (s-t)-section, thus  

$$r_{s,t} = \min[c(A_{s,t}^k)], \quad (1.5)$$

Ford-Fulkerson Theorem (about a maximum flow and a minimum section)

For each permissible distributions of flow F  

$$\max_F [f_{s,t}] = \min_k [c(A_{s,t}^k)] = r_{s,t} \quad (1.6)$$

Lemm 1.1  

$$f_{s,t} \leq r_{s,t} \quad (1.7)$$

Evidence.  

$$f_{s,t} = f(s,V) - f(V,s) \quad (1.8a)$$

And  

$$0 = f(i,V) - f(V,i) \text{ for } i \neq s,t. \quad (1.8b)$$

Thus for each X such that  $v_s \in X$  and  $v_t \in \bar{X}$   

$$\sum_{v(i) \in X} [f(i,V) - f(V,i)] = f_{s,t} \quad (1.9)$$

Or  

$$f(X,V) - f(V,X) = f_{s,t} \quad (1.10)$$

Replacing  $V = X \cup \bar{X}$  into (3.2.6) and using fact that  $X \cap \bar{X} = \emptyset$ , we have

$$f(X, \bar{X}) - f(\bar{X}, X) + f(X,X) - f(X,X) = f_{s,t}$$

Or  

$$f(X, \bar{X}) - f(\bar{X}, X) = f_{s,t} \quad (1.11)$$

However,  $f_{s,t} \leq (X, \bar{X}) = \sum_{\substack{v(i) \in X \\ v(i) \in \bar{X}}} f(i,j)$  thus (1.12)

Considering (3.2.8) and inequality

$$f(i,j) \leq c(i,j) \quad (1.13)$$

We have for any  $f_{s,t}$

$$f_{s,t} \leq \sum_{\substack{v(i) \in X \\ v(i) \in \bar{X}}} f(i,j) = c(X, \bar{X}) \quad (1.14)$$

Because (1.14) is true for any X the approving is completed.

The proposition: Let's prove the theorem about the maximum flow and minimum section, using the algorithm of increasing by Ford and Fulkerson. This algorithm gives resents a gradual increase  $f_{s,t}$  starting from an arbitrary value but less than  $r_{s,t}$ . Let's show that the algorithm ends its work in  $f_{s,t} = r_{s,t}$ . To approve this with the help of this algorithm it can be gained that  $f_{s,t} = r_{s,t}$ , we have to admit that  $c(i,j)$  has only an integer value for each  $i$  and  $j$ . Of course, if capacities of branches are expressed by rational numbers, they can be converted for work with the algorithm into integers and after completing the algorithm work they can be written as rational numbers. Limitation on the integer of capacities is not required in approving, according to the following paragraph.

**Algorithm of increasing.**

Step 1. Find any allowable flow of distribution [ $f(i,j) = 0$  for each  $(i,j) \in \Gamma$  is always possible]. If  $f_{s,t} = r_{s,t}$ , algorithm is ended. Otherwise, go to the next step.

Step 2. Find desaturated (s - t)-way  $\pi_{s,t}$  with a net through the given capacity  $r(\pi_{s,t}) > 0$ . This way is called the way of increasing.

Step 3. Increase the flow in way of increasing on  $r(\pi_{s,t})$ .

Step 4. Repeat the steps 2 and 3 until there will be no way of increasing

It is clear, that the algorithm of increasing gives an allowable flow and that  $f_{s,t}$  is increased by integer number every time when the way of increasing is found.

The next theorem with the lemma (1.1) approves the theorem about a maximum flow and a minimum section.

Theorem 1.2 Algorithm of increasing ends its work if and only iff  $f_{s,t} \geq r_{s,t}$ .

The proposition: If the algorithm of increasing is applied, then the number of its steps is finite, thus  $f_{s,t}$  is increased by an integer number every time, while  $f_{s,t}$  is limited by the number  $r_{s,t}$ .

To show that  $f_{s,t} \geq r_{s,t}$  defines a set of apexes L, while  $v_s \in L$  (1.15)

If  $v_j \in L$  and  $c(i,j) > f(i,j)$  or  $f(i,j) > 0$  then  
 $v_j \in L$  (1.16)

Let's show that  $f_{s,t} = c(L, \bar{L}) > r_{s,t}$ . Assume  $v_t \in L$ . Thus otherwise there would be (s - t)-way of increasing, that contradicts the fact that the algorithm of increasing has the finite number of steps. Thus  $\bar{L}$  is not empty. From (1.11)

$$f_{s,t} = f(L, \bar{L}) - f(\bar{L}, L) \quad (1.17)$$

But if  $(i,j) \in (L, \bar{L})$ , then  $f(i,j) = c(i,j)$ , else if  $(i,j) \in (\bar{L}, L)$ , then  $f(i,j) = 0$  by definition.

Therefore,

$$f(L, \bar{L}) = c(L, \bar{L}) \quad (1.18)$$

$$\text{And } f(\bar{L}, L) = 0 \quad (1.19)$$

Uniting (1.17), (1.18), (1.19), we are gaining the

$$f_{s,t} = c(L, \bar{L}) > r_{s,t} \quad (1.20)$$

The theorem is proved.

### Conclusion.

In the article we give the definition of a transport network, flow, edge capacity and many other valuable terms. We reviewed the example of a transport network. It was learned and approved with the help of the theorem of Ford-Fulkerson for each permissible distributions of flow  $F$ . Also, the theorem was approved by using the algorithm of increasing. By doing this it was concluded that the algorithm of increasing ends works if and only if  $f_{s,t} \geq r_{s,t}$ .

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## LOW-OBSERVATION (STEALTH) TECHNOLOGIES IN AVIATION

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**Abstract.** The article deals with the main issues of low-observation technology and its usage in constructing aircrafts. The basic physical principles of the operation and principles of opposition to planes are described. The review of some planes and the proof of efficiency of this technology is given. The methods of detection stealth planes are shown.

**Key words:** detecting, radar, radar cross section, stealth, visibility.

**Introduction.** Low observation (LO, also known as "stealth") technology is a technology which is aimed at reducing military vehicles (mainly airplanes and ships) visibility, basically for radars. Sometimes visibility is also reduced in IR-spectrum, visual (mainly for ground vehicles) and acoustic (submarines) spectrum.

The **object-matter** of the article is general usage of stealth technology in aviation.

The **subject-matter** of this article is specific features that allow some aircrafts to be almost invisible for radars.

The **objective** of the article is to provide information about stealth technology and to describe the basics of it.

The **tasks** are to compare and systematize existing information about stealth technology, to describe the methods of detecting stealth planes.

The **materials** of publications of leading experts (K. Zikkidis and E. Knott) were used.

The **method** of literature analysis was used in this article.

**Discussion and Results.** Nowadays the following several methods became compulsory for modern fighters: almost all new perspective aircrafts must be able to compete with others. The main objective of stealth is to reduce RCS that means an increase in the ability to attack from a shorter distance and from the vantage point. For bombers and attack aircraft it is also very important because it gives an opportunity to destroy enemy air defense before being detected and locked-on, also it guarantees successful strike on a target under the AD cover. Such an effective technology is quite real because of combination of special materials and methods.

Contra-stealth technologies are being devised in many countries and stealth-detection methods such as passive and multi-static radars, low-frequency radars and others are getting more common. The USA and their

NATO partners are more focused on LO technologies, while Russia and China are developing the methods of anti-stealth defense.

**History of stealth aircrafts.** The attempts to make military-purpose planes low-observable originated since the same time when radars became widely used (namely from WWII). The first prototype of it was Horten Ho-229, a German plane built in 1944 [1]. Until 1980th the devising of such planes was not in priority because the main advantage of jet fighters was maneuverability and it was not necessary for bombers to be low-observable.

The stealth technology is based on Peter Ufimtsev's Physical Theory of Diffraction [2], according to which a radar return depends on the configuration of an object, but not on its size. Soviet Union leaders were not interested in this technology because their own strategy was based on using tanks, wedges and powerful air defense. American engineers later studied Ufimtsev's theory carefully and realized that finite analysis of radar reflection was made. So, in 1975 the first LO technology research project was started. Two prototypes with a code name "Have Blue" were developed. In 1978, having obtained the positive result of testing, Lockheed Martin company signed a contract for developing F-117 stealth bomber. Having taken the first flight in 1981, the bomber was a total secret until 1988. Unfortunately, the design of this bomber was not very good: during the Kosovo war in 1999, one F-117 was shot down by Serbian AD. Considering the bugs of F-117 the Northrop Grumman company created B-2 "Spirit" strategic bomber. It was created on the basis of modified shaping technologies and better aerodynamics. With Spirit the era of stealth planes started.

Nowadays, the main country using LO-planes is the USA. With B-2 "Spirit" strategic bomber, F-22A "Raptor" (the 5th generation of super maneuverability interceptor) and F-35 "Lightning II" multi-purpose joint-strike fighter, the USA have the most powerful and battleworthy air forces. Also other countries (Russia – Sukhoi PAK FA, China – Shenyang J-31, France – Dassault Rafale) are trying to make their own LO planes and are doing some research.

#### **The main measurement: RCS**

The Radar Cross Section (RCS) is a unit of measure showing the amount of returning back to a radar energy. It is measured by square meters. RCS of a target is equal to an area of a perfect smooth metal surface (an ideal isotropic reflector) which is located perpendicular to a radar and reflects the same number of energy as a target does [3]. RCS is different for different directions of an exposure (for example, for jet planes the largest RCS is in rear hemisphere where a turbine is visible for a radar) and depends on a shape. An object with lower RCS is much harder to be detected at the same distance [4].

RCS could be calculated by computer CAD models or measured practically. When necessary RCS can be determined by decibels (an attenuation of a signal value on the target) with reference to one square meter (dBsm). Since there are different RCS from various directions, "RCS of a plane" usually means an average value of RCS from several directions. It is very important that RCS influences the maximum detection distance of a target [4].

Where  $R_{max}$  is the maximum detection range,  $P_t$  is the transmission power,  $G$  and  $A_e$  are the gain and the effective area of the transmitting and receiving antenna,  $\sigma$  is the RCS of the target and  $S_{min}$  is the minimal power of a signal detected by a radar. Therefore, for given parameters, the maximum detection range is proportional to the 4th root of the target RCS. For example, SA-21 Growler's (S-400 "Triumph") radar Gamma-DE under ideal conditions could find and lock-on a target of 5 m<sup>2</sup> RCS (large fighter) [6] at ~390-400 km, a target with RCS of 1 m<sup>2</sup> (lightfighter) could be detected theoretically at ~250 km. A reduced RCS plane of 0,1 m<sup>2</sup> RCS would be detected at ~110-140 km and an F-35 Lightning II with 0,0015 m<sup>2</sup> RCS would be detected at ~40-50 km. The

$$R_{max} = \sqrt[4]{\frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}}}$$

same logic is applied to any kind of radars. However, for plane on-board radars and the missile seekers respective ranges are shorter compared to the ones of a ground radar, so stealth technology will surely be more effective [7]. In fact, the RCS depends on the following:

- target geometry;
- target material composition, especially for the surface;
- position of radar antenna relative to target;
- angular orientation of target relative to radar antenna;
- frequency of the electromagnetic waves;
- radar antenna polarization [7].

Thus, changing some of these target parameters can provide less RCS that means less detection distance and much harder locking-on of the target.

There are two basic and the most effective principles of RCS reduction, namely the shaping of a target and the use of materials with radar-absorbing properties.

### **RCS reduction: Shaping**

According to Ufimtsev's work the most important factor increasing the RCS is the geometry or the shape of the target but not its size. To reduce the RCS, all the surfaces should be oriented in the way which will provide reflection of the radar signal at any direction, other than a direction of a radar antenna [8]. Watching at the facet-type surfaces and the sharp angles of the F-117, it is easy to understand that fuselage was designed to reflect radar beams to irrelevant directions and not to allow them to return to the radar antenna. The engineers tried to avoid any possible surface or edge whose normal vectors would face at a direction where a possible enemy radar might be found, especially at the frontal aspect. So, any bumps, curves and flexures will help to reduce RCS. In F-22 and B-2 instead of facet-types surface, surfaces with special curvature and other features are used, which is more effective in decimeter band, but is more complicated technologically from the other hand [9]. Moreover, any external load, such as pylons, bombs, missiles, fuel tanks or pods will enlarge the RCS. This is the reason why LO aircrafts carry their armament internally in special bays. Propellers and any rotating external parts are strictly forbidden (they couldn't have LO shape or be covered by special paint, and their rotation makes their detection by Doppler-method easier). That is the very reason why all stealth-helicopter projects failed. Because of this engine intake turbine must be hidden carefully inside the intake duct. The whole air intake construction is crucial while designing a low RCS aircraft.

Dihedral sharp corners and parallel surfaces will enlarge RCS. This is the reason why the twin vertical fin empennage (like F-15 use) is prohibited to be used. A Stealth aircraft usually has canted tail fins or no tail fin at all (as B-2 Spirit) [7]. Mechanically-stirring radars are not in use too because the antenna itself is an ideal radar energy reflector, and so it makes it easier to be detected by the other radar. For example, F-117 lacks its own radar. Stealth fighters need it, that is why they usually carry an AESA (an active electronically scanned array) radar. The latter must be hard to be intercepted with passive radar warning receivers which detect a signal emitted by the radar (many AESA radars allow this function). Stealth planes have poor aerodynamics and are completely unstable. It is impossible to control this aircraft without electronic equipment (which makes the flight stable and prevents it from spontaneous evolutions). The technology using this kind of equipment is known as Fly-by-Wire technology.

### **Radar absorbing materials**

Radar absorbing material is a special coating or paint which absorbs most of radar energy and converts it into heat. Converted energy can not return to a radar, so a plane appears harder to be detected. Moreover, radar absorbing materials never absorb all radio waves and are effective only in a narrow frequency band.

Such materials along with a shaping method are used to reduce RCS.

This technology was used for the first time during the WWII when snorkels of German submarines were covered by a paint with carbon in a rubber substrate to reduce their visibility for radars [10]. Today there has been developed a number of such paint types for various purposes. Some of them still contain carbon. The examples are a foam absorber (urethane foam with ~1% of graphite particles cut into pyramids with dimensions defined by absorbing signal wavelength) and a nano-tube cover [11]. Some of these absorbing covers, such as Jaymann absorber, use interference and resonance. The Jaymann absorber consists of two conducting surfaces and a grounded layer between them and absorbs radio waves,  $\lambda/4$  of which is equal to a distance between surfaces.

The most common covering type is known as "iron ball paint" [8]. It is made up of iron (or ferrite) powder which is dispersed in a non-conductive substrate. The alternating magnetic field (radio waves) induce oscillations of iron microspheres, and using their friction converts radar energy into heat which dissipates on aircraft body. This process is similar to heating water in a microwave oven. The covering paint of such type functions effectively only with high-frequency radars, and is useless for radars with a meter wavelength.

The drawbacks of such covers are an increased weight of an aircraft, a performance reduction and the cost. Besides, aircrafts with such covers require special maintenance and storage conditions. For example, the B-2 "Spirit" is kept in specifically equipped hangars with a precise control of temperature and humidity to retain paint properties [12]. Nowadays there are some planes (namely, F-22 and F-35) which are painted with special nano-cover (called "fiber mat") and they don't require special storage conditions [13].

### **Detecting method: a passive radar**

A passive radar is a type of radar which does not have its own transmitter. It uses side sources of radio waves illuminating a target. The sources of such signals can be FM radio, GSM and 3G mobile stations, TV (it uses K-band with 10-18 GHz frequency which is perfect for radiolocation) towers. Since many signal sources in preferable frequency already exist, passive radars are very perspective [14].

There are many sources of signal which irradiate target from various directions (unlike a monostatic radar), so a special shape will not protect an aircraft. The main drawback of a passive radar system is distinguishing two signals: the first one coming from a source and a reflected one coming from a target. When a target moves fast distinguishing is easier by using Doppler effect. Also it is very important to reduce side noises created by non-target objects which also reflect the signal.

The other minus of a passive radar system is a very low operating range (usually not more 150 km) and low accuracy. During the war time 3G stations, TV towers and other signal sources may not work, so these systems prove to be unreliable and are good just for the first strike detection.

**Conclusions.** Stealth technology is a very perspective military technology which allows to keep planes undetectable, strike from shorter ranges, come in contact with enemy from vantage point and win "dogfights" (air combats). Also it allows to destroy enemy air defense for bombers and attack planes. This technology is a combination of high-tech methods and to put them into practice it is necessary to use scientific potential and to train personnel to cope with this technology. It should be stated that every action force has a reaction force, and some methods to counteract planes now are being designed but all of them have considerable drawbacks while stealth planes now are ready to take part in the battles with success.

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## HISTORY OF NEURAL NETWORKS

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**Abstract:** The article is about neural networks, their history, base principles, types and the differences in functions based on types. It deals with the possible employments of neural networks and reviews of theoretical fields of modeling and statistics that use these networks. Few examples of problems neural networks can solve are given and tasks are explained in the article as well.

**Key words:** abstract learning, learning paradigms, network functions, neural network, perceptron.

#### Introduction:

**Object-matter:** neural networks as a calculating method to build an artificial model on how a human brain processes information.

**Subject-matter:** neural networks are rapidly growing approach in the field of artificial intelligence.

**Objective:** to give a description of this computing technique and reveal its advantages and disadvantages.

**Tasks:** to get acquainted with the mathematical model which is the basis of the above promising method.

**Methods:** description and analysis

Neural networks are calculating approach which is based on a large set of neural components loosely modeling the process of how a biological brain solves problems. Each neural unit is linked with many others, and connections can be enforcing or inhibitory in their effect on the activation state of linked neural units. Each single neural unit may have a summation function which aggregates the values of all its inputs together. There may be a limiting function on each connection and on the unit itself such that it must outreach it before it can transmit to other neurons. These systems are self-learning and trained rather than definitely programmed and transcend in fields where the solution or feature detection is difficult to express in a traditional computer program. Neural networks typically consist of several layers, and the signal path passes from front to back. Back propagation is where the forward stimulation is used to rearrange weights on the front neural units and this is sometimes done in conjunction with training where the correct result is known. More modern networks are a bit more expansive in terms of stimulation and inhibition with connections interacting in a much more chaotic and complex mode. Dynamic neural networks are the most advanced in that they dynamically can, based on rules, form new connections and even new neural units while excluding others.

Warren McCulloch and Walter Pitts in 1943 created a calculating model for neural networks based on mathematics and algorithms called threshold logic. This model blazed a trail for neural network research to divide into two specific ways. One of them focused on biological processes in the brain and the other concentrated on the application of neural networks in artificial intelligence [McCulloch, Pitts 1943]. In the late 1940s Donald Hebb, a psychologist, developed a hypothesis of learning based on the mechanism of neural plasticity that is now known as Hebbian learning [Hebb 1949]. Researchers began to apply these concepts to calculating models in 1948 with Turing's B-type machines. Farley and Wesley A. Clark first used calculating machines to reproduce a Hebbian network at MIT [Farley 1954]. Frank Rosenblatt in 1958 developed the perceptron, an algorithm for pattern recognition based on a two-layer computer learning network using simple addition and subtraction [Rosenblatt 1958]. With mathematical notation, Rosenblatt described circuitry not in the basic perceptron as well, such as the exclusive-or circuit, a circuit which could not be processed by neural networks until after the backpropagation algorithm was developed by Paul Werbos [Werbos 1975]. Neural network research stand still after the publication of machine learning research by Marvin Minsky and Seymour Papert in 1969, who discovered two main problems with the calculating machines that processed neural networks [Minsky, Papert 1969]. The first one was that basic perceptrons were unable of processing the exclusive-or circuit. The second important problem was that computers didn't have suitable processing power to effectively manage the long run time required by large neural networks. Neural network research slowed until computers gained greater processing power. A key advancement that came later was the backpropagation algorithm which effectively solved the exclusive-or problem, and more generally the problem of quickly training multi-layer neural networks [Werbos 1975]. In the mid-1980s, parallel distributed processing became popular under the name connectionism. The textbook by David E. Rumelhart and James McClelland provided a full description of the employment of connectionism in computers to simulate neural processes [Rumelhart, McClelland 1986]. Neural networks, as used in artificial intelligence, have commonly been considered as simplified models of neural processing in the brain, even though the correspondence between this model and the biological architecture of the brain is questioned; it is not clear to what rate artificial neural networks imitate brain function [Russel 2012].

### **Discussion and results:**

Neural network models in artificial intelligence are usually referred to as artificial neural networks; these are essentially simple mathematical models defining a function from a set X to a set Y, but sometimes models are also intimately associated with a particular learning algorithm or learning rule. The word network in the term 'artificial neural network' refers to the interconnections between the neurons in the different layers of each system. Usually the first layer is the input one, and the 'last' one is output, but the others can be them as well.

An ANN is typically defined by three types of parameters:

1. The interconnection pattern between the different layers of neurons;
2. The learning process for updating the weights of the interconnections;
3. The activation function that converts a neuron's weighted input to its output activation.

Mathematically, a neuron's network function 'f(x)' is defined as a composition of other functions 'g(x)', which can further be defined as a composition of other functions. This can be conveniently represented as a network structure, with arrows depicting the dependencies between variables. A widely used type of composition is the nonlinear weighted sum,

$$f(x) = K\left(\sum_i w_i * g_i(x)\right)$$

where 'K' (commonly referred to as the activation function) is some predefined function, such as the sigmoid. Networks are commonly called feedforward, because their graph is a directed acyclic graph. Networks with cycles are commonly called recurrent.

What has attracted the most interest in neural networks is the possibility of learning. Given a specific task to solve, and a class of functions 'F', learning means using a set of observations to find 'f\*' in 'F' which solves the task in some optimal sense. This entails defining a cost function 'C' from 'F' to the set of real numbers such that, for the optimal solution 'f\*' so no solution has a cost less than the cost of the optimal solution. The cost function is an important concept in learning, as it is a measure of how far away a particular solution is from an optimal solution to the problem to be solved. Learning algorithms search through the solution space to find a function that has the smallest possible cost. For applications where the solution is dependent on some data, the cost must necessarily be a function of the observations, otherwise we would not be modelling anything related to the data. It is frequently defined as a statistic to which only approximations can be made. While it is possible to the cost function define some arbitrary for this cost function, frequently a particular cost will be used, either because it has desirable properties or because it arises naturally from a particular formulation of the problem.

There are three major learning paradigms, each corresponding to a particular abstract learning task. These are supervised learning, unsupervised learning and reinforcement learning. In supervised learning, we are given a set of example pairs and the aim is to find a function in the allowed class of functions that matches the examples. A commonly used cost is the mean-squared error, which tries to minimize the average squared error between the network's output and the target value over all the example pairs. When one tries to minimize this cost using gradient descent for the class of neural networks called multilayer perceptrons (MLP), one obtains the common and well-known backpropagation algorithm for training neural networks. Tasks that fall within the paradigm of supervised learning are pattern recognition (also known as classification) and regression (also known as function approximation). In unsupervised learning, some data is given and the cost function to be minimized, that can be any function of the data and the network's output. The cost function is dependent on the task (what we are trying to model) and our a priori assumptions (the implicit properties of our model, its parameters and the observed variables). Tasks that fall within the paradigm of unsupervised learning are in general estimation problems; the applications include clustering, the estimation of statistical distributions, compression and filtering. In reinforcement learning, data are usually not given, but generated by an agent's interactions with the environment. At each point in time, the agent performs an action and the environment generates an observation and an instantaneous cost, according to some (usually unknown) dynamics. The aim is to discover a policy for selecting actions that minimizes some measure of a long-term cost. The environment's dynamics and the long-term cost for each policy are usually unknown, but can be estimated. Tasks that fall within the paradigm of reinforcement learning are control problems, games and other sequential decision making tasks.

The utility of artificial neural network models lies in the fact that they can be used to infer a function from observations. This is particularly useful in applications where the complexity of the data or task makes the design of such a function by hand impractical. The tasks artificial neural networks are applied to tend to fall within the following broad categories: function approximation, or regression analysis, including time series prediction, fitness approximation and modeling; Classification, including pattern and sequence recognition, novelty detection and sequential decision making; Data processing, including filtering, clustering, blind source separation and compression; Robotics, including directing manipulators, prosthesis; Control, including computer numerical control [Zissis, Dimitrios 2015; Balabin, Lomakina 2009].

The multilayer perceptron is a universal function approximator, as proven by the universal approximation theorem. However, the proof is not constructive regarding the number of neurons required, the network topology, the settings of the weights and the learning parameters. Hava Siegelmann and Eduardo D. Sontag provided a proof that a specific recurrent architecture with rational valued weights (as opposed to full precision real number-valued weights) has the full power of a Universal Turing Machine using a finite number of neurons and standard linear connections. Further, it was shown that the use of irrational values for weights results in a machine with super-Turing power [Siegelmann, Sontag 1991; Balcázar 1997]. Artificial neural

network models have a property called 'capacity', which roughly corresponds to their ability to model any given function. It is related to the amount of information that can be stored in the network and to the notion of complexity. Nothing can be said in general about convergence since it depends on a number of factors. Firstly, there may exist many local minima. This depends on the cost function and the model. Secondly, the optimization method used might not be guaranteed to converge when far away from a local minimum. Thirdly, for a very large amount of data or parameters, some methods become impractical. In general, it has been found that theoretical guarantees regarding convergence are an unreliable guide to practical application. In applications where the goal is to create a system that generalizes well in unseen examples, the problem of over-training has emerged. This arises in convoluted or over-specified systems when the capacity of the network significantly exceeds the needed free parameters. There are two schools of thought for avoiding this problem: the first is to use cross-validation and similar techniques to check for the presence of overtraining and optimally select hyperparameters such as to minimize the generalization error. The second is to use some form of regularization. This is a concept that emerges naturally in a probabilistic framework, where the regularization can be performed by selecting a larger prior probability over simpler models; but also in statistical learning theory, where the goal is to minimize over two quantities: the 'empirical risk' and the 'structural risk', which roughly corresponds to the error over the training set and the predicted error in unseen data due to overfitting. Supervised neural networks that use a mean squared error (MSE) cost function can use formal statistical methods to determine the confidence of the trained model. The MSE on a validation set can be used as an estimate for variance. This value can then be used to calculate the confidence interval of the output of the network, assuming a normal distribution. A confidence analysis made this way is statistically valid as long as the output probability distribution stays the same and the network is not modified. By assigning a softmax activation function, a generalization of the logistic function, on the output layer of the neural network (or a softmax component in a component-based neural network) for categorical target variables, the outputs can be interpreted as posterior probabilities. This is very useful in classification as it gives a certainty measure on classifications.

### **Conclusions:**

To implement large and effective software neural networks, considerable processing and storage resources need to be committed [Edwards 2015]. While the brain has hardware tailored to the task of processing signals through a graph of neurons, simulating even a most simplified form on von Neumann architecture may compel a neural network designer to fill many millions of database rows for its connections – which can consume vast amounts of computer memory and hard disk space. Furthermore, the designer of neural network systems will often need to simulate the transmission of signals through many of these connections and their associated neurons – which must often be matched with incredible amounts of CPU processing power and time. Jürgen Schmidhuber notes that the resurgence of neural networks in the twenty-first century, and their renewed success at image recognition tasks is largely attributable to advances in hardware: from 1991 to 2015, computing power, especially as delivered by GPGPUs (on GPUs), has increased around a million-fold, making the standard backpropagation algorithm feasible for training networks that are several layers deeper than before (but adds that this does not overcome algorithmic problems such as vanishing gradients "in a fundamental way") [Schmidhuber 2015]. The use of GPUs instead of ordinary CPUs can bring training times for some networks down from months to mere days [Edwards 2015]. Computing power continues to grow roughly according to Moore's Law, which may provide sufficient resources to accomplish new tasks. Neuromorphic engineering addresses the hardware difficulty directly, by constructing non-von-Neumann chips with circuits designed to implement neural nets from the ground up. Google has also designed a chip optimized for neural network processing called a Tensor Processing Unit, or TPU [Metz 2016].

In general, a neural network is a way to solve non-standard programming tasks which has been developed in recent years due to the increase in computing power. It has already proved successful in solving the problems of computer vision, speech recognition, statistics. Due to the above way the models of an in-game artificial intelligence have been successfully built to beat people in checkers, chess, go; the development of such an artificial intelligence for real-time strategy StarCraft 2 is going to happen in the nearest future [Vinyals 2016]. Such development can be a very potent example illustrating the very high training capacity the neural networks have.

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## ADAPTIVE CHASSIS CONTROL SYSTEM DCC

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**Abstract:** This article deals with adaptive chassis control system DCC. The implementation of adaptive algorithms to optimize the dynamic system by constructing an adaptive control system chassis DCC is considered. The problem statement of the adaptive control system chassis DCC has been given. The research results have been suggested.

**Key words:** adaptive chassis control system DCC, adaptive algorithms, dynamic system, vehicle, road environment.

**Introduction.** Currently, the use of a car system chassis retains its relevance. In matters of the car chassis it is still a pattern - a marked increase in its sportiness by reducing the comfort which is a significant drawback of a car system chassis.

**The objective** of this article is to determine the implementation of adaptive algorithms to optimize the dynamic system by constructing an adaptive control system chassis DCC.

**The object** of the research is a new chassis control system. It is a DCC adaptive chassis control in which the chassis is continuously adapted to the parameters of the road situation and the driver intentions.

**The subject** of the research is to optimize the dynamic system by constructing an adaptive control system chassis DCC.

### Discussion

The advantage of a DCC adaptive chassis control system is that it has improved the Adaptive Shift Control adaptive electronic control system with the elements of artificial intelligence which simplify driving. The electronic unit of the system is equipped with two control algorithms:

- the Optimum Shift Control algorithm ("optimal choice of programs")
- the Adaptive Shift Control algorithm ("adaptive selection algorithm")

Thus, the automatic transmission can be adapted to the individual driving style of different people; providing a smooth ride and maximum compliance with their character and mood.

### Content analysis

To perform this adaptation of motion, we use necessary adjustable shock absorbers, which are designed to easily reduce the energy of the bodywork and wheels. Also adjustable dampers prevent uncontrolled body movements and rebound wheels caused by irregularities in the road surface. In addition, the efforts of damping provide additional stabilization of the body during dynamic maneuvers [1].

A further increase in efficiency is achieved through the damping adjustable dampers telescopic performance, allowing better take into account the actual situation on the road. The control unit of the electronically controlled damping determines within milliseconds and provides the necessary degree of damping at each wheel.

Adjustable shock control signals are obtained from the control unit to regulate the damping in accordance with the developed control algorithm. At the same time, it depends on the input signals used by all parametric field adjustable shock absorbers.

The switch from the current algorithm can adjust by selecting the "Sport" or "Comfort", "Normal" mode with the key, adapting thereby damping to customer requests. Adjusting the system is available as well as when the vehicle is stationary or in the movement mode.

**Problem statement**

The adaptive DCC control system chassis is always active. It is an intelligent, self-regulating system controlling the car shock absorbers, depending on the following factors: the quality of the road surface, the current situation on the road (such as braking, accelerating or turning movement), requests the driver. This ensures an optimal adjustment of the chassis.

The input data for the simulation of DCC adaptive control system chassis are the request of the driver, as well as the quality of the road surface and the situation on the road. The output of the reference voltage serves to regulate the damping.

The driver can select the mode of DCC in the system, depending on personal needs by pressing the right of the gearshift lever. The keys must be pressed until the desired mode is selected. You can switch between any number of times. Switching will always occur in the sequence of modes "Normal", "Sport", and "Comfort".

The difference in the modes is expressed in varying rigidity damping adjustment base. At the same time, depending on the situation on the road, the event of special requirements for the damping force adjustment is performed.

The main unit of modeling is a model of the vehicle. This block consists of the following classes which are shown in Figure 1.

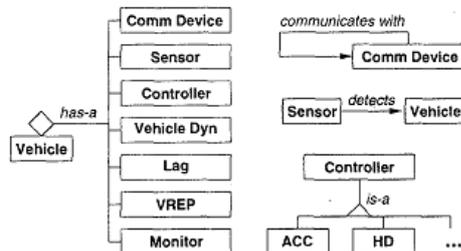


Fig.1. Vehicle: Classes and Communications

The information flow among the components is fixed connections I/O (see Fig.2).

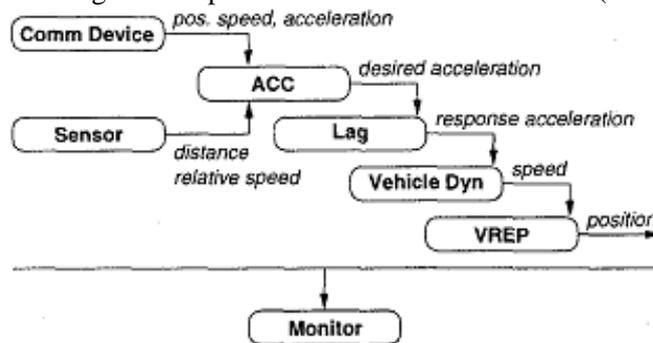


Fig.2. Vehicle: Traffic information

The algorithm and its implementation are shown in Figure 3.

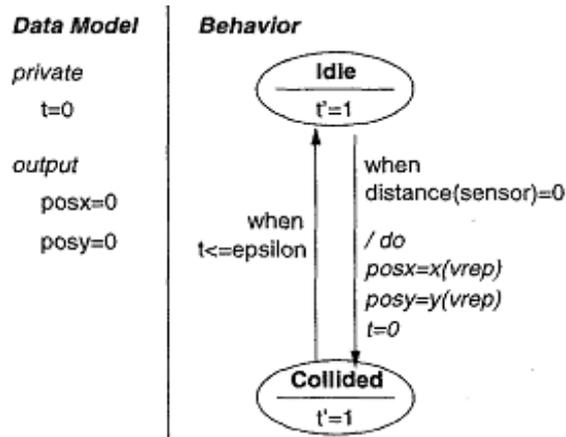


Fig.3. Automatic algorithm for collision detection

Synchronization of data and implementation of the process are shown in Figure 4.

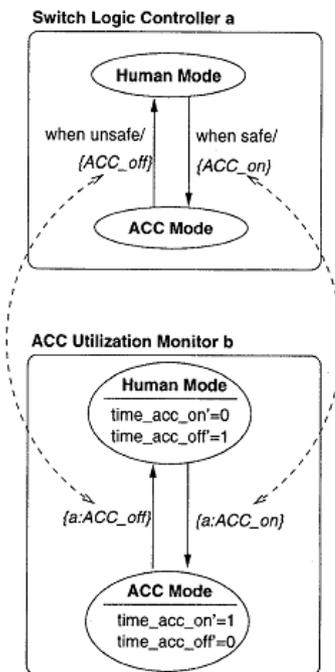


Fig.4. Example of synchronizing data between the controller and the monitor

**Research results**

The simulation results are a program to simulate the programming language C#. The simulation results are shown in Fig.5-10.

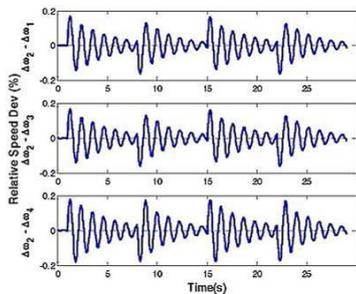


Fig.5. Change the speed of the generator (without adaptive control)

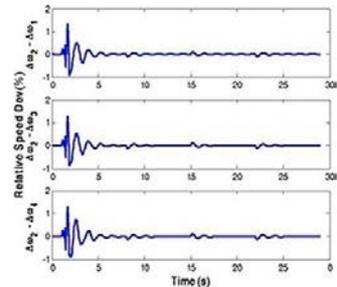


Fig.6. Change the speed of the generator (including adaptive control)

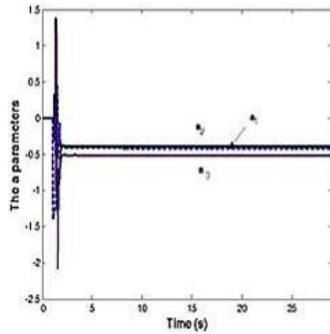


Fig.7. Change of a-parameters

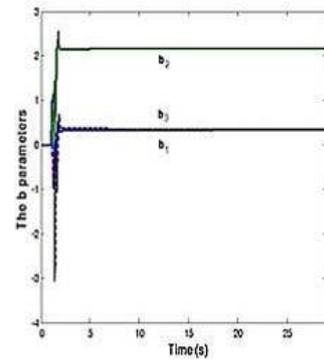


Fig.8. Change of b-parameters

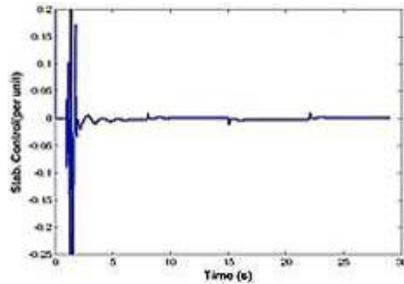


Fig.9. Stabilization of b-parameters

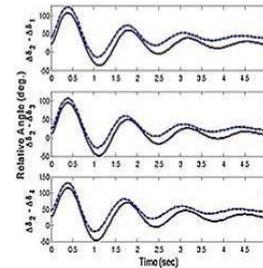


Fig.10. Angle variation (given control) for two different initial conditions

In order to assess the accuracy of the results that we have obtained with the help of software tools created in C#, compare them with the results, written with the help of SHIFT / Smart-AHS (Automated Highway System) (Fig.11 - 1: C#; 2: SHIFT/Smart-AHS) [1].

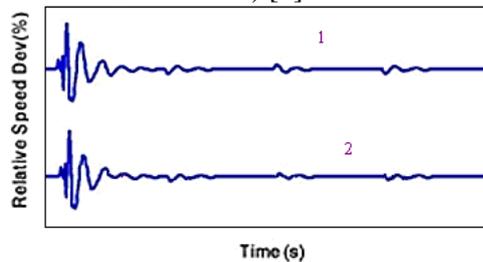


Fig.11. Comparison of the results

### Conclusions

Write a program in C# programming language for the implementation of the functionality of the scheme. To perform such an adaptation movement, we use the adjustable shock absorbers, which are designed for the rapid reduction of the oscillation energy of the body and wheels, telescopic shock absorbers and performance, to better take into account the actual situation on the road.

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**Abstract.** The concept of eliminating the contradiction between the rapid development of means and methods of computerization of compound elements and systems and the heterogeneous nature of modern automotive computer systems.

**Keywords:** computerization, interactive monitoring, mechatronics, telematics, systems engineering, synergetic, vehicle.

### **Introduction**

By today there has formed the situation when the practice of creating modern vehicle computer systems is ahead of the theory of information analysis and the synthesis of complex systems. The existing individual solutions for traffic information support require generalization, standardization and unification, determination of new special requirements for creation of computer systems and networks in transport. So, it is important to create an information and communication technology (ICT) of vehicular traffic on the basis of data recording and analysis on board the vehicle in real time with the assistance of resources of the distributed data processing system through the Internet portal. Let us consider the concept of creating such a system as the use of Cloud Computing for traffic computerization.

### **Sources of development and literature review**

The accumulated experience of traffic computerization makes it possible to recommend publications on automotive mechatronics and telematics, distributed computer systems for identifying the problems of transport processes management, traffic flows management [Aleksiyev2012:144] to ACS developers. In these studies, they analyzed the problem of both creating individual automotive ICC, and general problems of ICT development in road transport. It is ICT that enables the road participants to obtain additional personal computer resources through interaction of ICC and the Internet, the appropriate transport portal, gives the users the relevant services to determine the location of the car as well as the characteristics of the traffic environment, the current and related traffic flows, as well as road situations. In the work [Bogomolov2009:59–63] there is information about both creation of appropriate distributed computer systems, the basis of Cloud Computing application, and the features of creating vehicle computer systems, deployment of relevant sites.

Systems engineering such as ACS are considered in the publications [Vlasov2013: 80]. The experience of creation of new automotive computer systems based on automotive mechatronic technologies is analyzed in the above works. In work [Ketlin2014:8] they analyzed the opinion of IBM systems as an engineering tool for creating successful computer systems.

### **Statement of the problem**

Due to the constant information development of the society and its industrial component, new transport systems and vehicles have reached a high information level of sophistication. Accordingly, there appeared a new contradiction between the rapid development of means and methods of computerization of compound elements and systems and the heterogeneous nature of existing subsystems and elements of the transport sector. Resolving this contradiction will make it possible to improve servicing of residents of large cities and regions at all levels of transport infrastructure of Ukraine, upgrade the transportation processes, avoid such negative impacts as: disruptions in traffic management; the poor state of communication routes; inefficient use of funds allocated for the maintenance, operation and improvement of transport routes. In this paper the problem of determining both the concept of eliminating this contradiction, and creation of the relevant ICT for this purpose.

### **Synergetics of ACS**

Let us consider the engagement of computing resources of the Internet portal for solving ACS problems (road ICC). The system, due to the synergetic combination of distributed computing resources of the transport portal and means of on-board data recording systems, will provide the traffic participants and transport enterprises with the service functions for ensuring the rhythm, operational effectiveness, manageability and predictability of transportation processes (data about the location of mobile units and the nature of the traffic environment). Let us define the basic components of the relevant research.

**The target of research** is the process of information development of transport systems, which consists in improving the information component of the transport infrastructure in large cities.

**The subject of research** is development and implementation of the information and communication technology of vehicular traffic in large cities.

**The purpose** is to provide the rhythm, operational effectiveness, manageability and predictability of operation of the transport complex of cities and regions by improving the informativeness of road users.

The method of research consists in the application of information analysis and synthesis of complex computer systems in transport. To do this, one should use an analogy, a generalized synergetic approach, simulation modeling, the operator theory, mechatronics and telematics. It is based on the main provisions and principles of automotive mechatronics, telematics by applying the means of road traffic management, electronic appliances and devices that provide information interaction of diverse units and aggregates of motor vehicles and the work of all road users. This is the basis of ICT of the vehicular traffic, which continues the development of computerization and intellectualization of vehicles, systems and the road infrastructure.

The content and implementation of ICT of the vehicular transport includes:

- 1) development of the functional structure and architecture of the hardware and software complex;
- 2) schemed and layout solutions;
- 3) performance of a computational experiment to determine the information flows and the amount of computer resources required to monitor traffic situations;
- 4) production of an experimental sample of on-board ICC of the vehicle, which is designed to collect data on the state of highways and ensures interaction of all the participants of the transportation process, using the transport portal.

The ICT of the vehicular transport is focused not only on providing additional services to traffic participants, but also on assessment of the traffic environment. There are no universal systems available in the world at present, and its creation is the most attractive thing for Ukraine. Another advantage of information and communications technology of the land transport, offered for development and implementation, is the distributed nature of the system of recording, evaluation and formation of the content of data storage, and its availability for users.

#### **Conclusions**

We forecast that the basic scientific result of such scientific and technical work for development and implementation of ICT technology of the vehicular transport consists in scientific justification and proving the possibility of synergistic combining of computer resources of all road users in a single information space of the global Internet network - from an individual vehicle to the enterprise-level of the transport organization. This idea is the basis for resolving the contradiction between the rapid development of information resources and the existing state of providing transport systems with information. The bottom line consists in creation of the following chain: intelligent machines → road → Internet information space. This is more efficient than conventional solving the problem of passenger transportation and goods in transport systems based on traditional progressive rational management and automation of transport processes. Combining computer resources of each road user will greatly enhance the informativeness of individuals who use transportation services or take decisions as for their arrangement.

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УДК 711.4=111

### **THE BASIC PRINCIPLES OF SUSTAINABLE DEVELOPMENT IN CITIES**

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**Abstract.** This article deals with the basic principles of sustainable development in cities. The peculiarities of any city are analyzed. Three basic principles of sustainable development are being underlined.

**Key words:**eco-friendly transport, mobility,sustainable development, vehicle.

**Introduction.**One of the most important features of modern economic development of society is the development of the theory and implementation of strategies for sustainable development at allit levels to ensure the security of society.The principles of sustainable development of human settlements have proliferated thanks to the United Nations. Created by the UN World Commission on Environment and Development in 1983 it first coined the concept of sustainable development to have been defined as follows: "Humanity is able to make the development sustainable ensuring that it meets the needs of the present without compromising the ability of future generations to meet their own needs".

**Object-matter:** city development.

**Subject-matter:** city.

**Objective:** to underline the basic principles of sustainable development in cities.

**Tasks:** to analyze the main idea of sustainable development in cities.

**Materials:** book on Sustainable Development.

**Discussion and Results.** The status of the fundamental concepts of the modern world of sustainable development principles were adopted at the 1992 UN Conference on Environment and Development in Rio de Janeiro attended by delegations of 179 countries of the world, as well as numerous international and non-governmental organizations. There were identified the global challenges of sustainable development and adopted a policy document "Agenda - XXI», containing recommendations for all countries to develop strategic programs for sustainable development.The urgency of the problem of sustainable development of the economy lies in the fact that in conditions of limited resources, it is impossible to satisfy all the growing needs of humanity, which in future can lead to an unstable state, not only the economic sphere, but also social, environmental and political.The concept of sustainable development is based on three principles:

- balancing economic and ecology to achieve such a degree of development when people being busy in manufacturing or other economic activities stop destroying the environment;
- balancing of economic and social spheres, which means maximum utilization for the benefit of the population of the resources ensuring the economic development;
- solution of problems related to the development to be provided not only in the interests of now living people but also for future generations with equal rights to resources.

Approaches to balance economic, social and environmental factors in the transition to sustainable development are on the way to social justice, sustainable economies and environmental sustainability [DeSimone,Popoff 2000: 47-53]. At the conference on the sustainable development of cities and towns in the Danish Aalborg (Olberg) May 27, 1994 it was adopted the "Charter of European Cities for Sustainability (Aalborg Charter)." Just the same year the second World Summit on the problem of "Cities and Sustainable Development" was held in Manchester (UK). The summit discussed issues of sustainable development concerning the problems of transport, poverty reduction, health objectives, employment, consumption and allocation of resources. A number of cities and regions presented their programs of sustainable development. The consequence of the attention of the world community to this issue was the appearance of the program "Sustainable Urban Development", supported by the United Nations Human Settlements (HABITAT) center, which brings together many cities in the world.

According to the UN definition "sustainable city is a city where achievements in social, economic, and physical development are constant. Sustainable City maintains long-term safety of the residents, including natural disasters". In other words, sustainable development of the city provides its public safety and quality of life while preserving the natural environment, of resources and the ecological balance of the entire economic and social activities of citizens.

The transition to sustainable development of the city is required to develop strategic guidelines, taking into account the nature of the global and national trends and expected changes in social life, technological structure, economy and politics; climatic conditions; living standards, technological, intellectual and social potential of the urban population, resource capabilities of the settlement; the state of the urban environment. This is achieved in the process of strategic planning for sustainable urban development and the implementation of the strategic plan. In the basis of the strategic plan there should be a humanitarian and ecological imperative, i.e. the principle of conservation and restoration of normal life of people.

The average person in a large city is exposed to numerous influences that cause chronic stress. Therefore, a strategic plan for sustainable development should be aimed at changing urban environment, improving quality of life. In Ukraine there is a network of sustainable cities of Ukraine. It was created in 2001-2002 by local authorities in Kyiv, Kharkiv, Mariupol and Nikolaev by the financial support of the British Council in Ukraine project 'SEPS 415' with Global to Local UK company. It aims at the introduction of environmental management according to DSTU ISO 14001-97 «Environmental Management Systems». Work of four cities with the intensive exchange of experience has led to a rapid expansion of the network, and in 2011, their participation in it was officially confirmed by 27 cities of Ukraine.

It is necessary to underline that mobility is a basic need of any city dweller. Urbanized areas are expanding on our planet, growing population, increasing movement speed. This reduces the opportunities for expansion of urban areas, fewer new modes added to the existing ones.

In such circumstances, it requires a rethinking of approaches that are used in the construction of new districts. Urban mobility should be based on the principles of participant planning, sustainable development, accessibility and security. Mobility should contribute to the efficient allocation of time of citizens and dissemination of a healthy and active lifestyle. Mobility is the ability to move from one place to another to justify the time and at a reasonable price.

Sustainable mobility is the satisfaction of the population needs to move with the least amount of resources, with the least amount of money (loans); with the least environmental pollution, as well as lower risk for life.

### **Environmentally sustainable transport**

Transport systems are to be the major source of greenhouse gases, responsible for 23% of global greenhouse gas emissions in 2004, and about three-quarters of it falls on the vehicles. Currently, 95% of the energy consumed by the transport of oil falls. The energy consumed in the production, as well as the use of vehicles, and is embodied in the transport infrastructure, including highways, bridges and railways.

The environmental impact of transport can be reduced by improving the system of walking and cycling in urban areas, as well as by strengthening the role of public transport, especially the electric railway.

Eco-friendly cars are designed to have less environmental impact than the equivalent standard vehicles.

In practice, there is a sliding scale of green transport, depending on the variant of stability. Green vehicles have greater fuel efficiency but only in comparison with conventional vehicles and they also contribute to the formation of traffic jams and road accidents. Public transport network under the control based on traditional diesel buses use less fuel per passenger than private cars, as a rule, they are safer and require less road space than private vehicles. Green public transportation, including electric trains, trams and trolley buses, combines the advantages of green vehicles with the advantages of the choice of sustainable transport. Other options of transport with very low impact on the environment are bicycles and other vehicles powered by human muscle power, as well as horse-drawn carts. The most common choice of green transport with the least impact on the environment is walking. The second place with dignity occupies a bicycle enjoying the benefit of its use it is not just the environmental aspect but also in healthy lifestyle. The advantages of a bicycle in the city are as follows:

- economically it is more advantageous to have a bike;
- cyclists don't know bureaucracy. In Ukraine, the cyclist does not pay taxes on his vehicle and the bicycle is not needed to be registered;
- patency of the bike is clearly higher, because it avoids congestion and can travel through the narrow section of the path;
- biking strengthens the immune system, which is a nice bonus for the owner.

### **Transport and social sustainability**

Cities with an excess of roads have become suddenly suffer from the consequences connected with a radical reduction in public transport, walking and cycling. In many places street become "lifeless". Shops, schools, government offices and libraries have moved from city centers, and the people who can not escape to the suburbs experience decline in the quality of public space and public services. As old schools were closed they were replaced by mega-schools in remote areas, generating additional traffic.

Another blow was the increase in sedentary lifestyles, causing the ever-growing national problem of obesity. As a consequence, there increased the cost of health care.

Therefore, it is necessary to understand the importance of sustainable transport development in a city. It should be taken into account the factor of the transport planning of a city, which includes a systematic, interdisciplinary approach to the design of the transport network.

**Conclusions.** Sustainable development – development policy of the international community, designed to regulate the relations between the environment and man in order to improve the quality of each representative of the international community and the preservation of environment for present and future generations.

Building a society of sustainable development consists of solving many problems, which are closely linked. For this transition these factors are equally important in the regulation of population growth, greening energy, resource conservation, food security, strengthen international cooperation and improve the environmental human morality.

Principles of sustainable development may require a higher moral character than natural resources.

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УДК 004.451.9

**THE UNIX OPERATING SYSTEM  
AND ITS IMPORTANCE IN THE SOFTWARE DEVELOPMENT HISTORY**

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**Abstract:** The article deals with the history of developing Unix-like operating systems, their meaning in software developing. The results of the study are as follows: UNIX historically is one of the most important operating systems that caused actually a revolution in the forms of developing software including creation of GNU GPL and Free Software Movement.

**Key words:** operating system, unix, linux, free software.

**Introduction**

The **object-matter** of the research is operating systems and communities.

The **subject-matter** of the research is the process of collaborative development of software and the Free-Software and Open Source movements.

The **objective** is to figure out what had made the collaborative development itself and what it brought to the world.

**The tasks are** to study scientific articles and gather some information on UNIX-like operating systems; figure out unique features of Linux; find proofs of Free-Software movement and Open Source to influence greatly on the software development.

**The methods** include the analysis (which was applied to distinguish the unique features of OS), deduction, logic, comparison, bibliographic analysis.

**Discussion and results**

**C history & Unix**

The origin of C is closely tied to the development of the Unix operating system, originally implemented in assembly language on a PDP-7 by Ritchie and Thompson, incorporating several ideas from colleagues. Eventually, they decided to port the operating system to a PDP-11. The original PDP-11 version of Unix was developed in assembly language. The developers were considering rewriting the system using the B language, Thompson's simplified version of BCPL. However B's inability to take advantage of some of the PDP-11's features, notably byte addressability, led to C. The name of C was chosen simply as the next after B.

In around 1977, Ritchie and Stephen C. Johnson made further changes to the language to facilitate portability of the Unix operating system. Johnson's Portable C Compiler served as the basis for several implementations of C on new platforms.

In the late 1960s, Bell Labs was involved in a project with MIT and General Electric to develop a time-sharing system, called Multiplexed Information and Computing Service (Multics), allowing multiple users to access a mainframe simultaneously. Dissatisfied with the project's progress, Bell Labs management ultimately withdrew.

In 1972, Unix was rewritten in the higher-level language C, contrary to the general notion at the time that an operating system's complexity and sophistication required it to be written in assembly language. The C language appeared as part of Version 2. Thompson and Ritchie were so influential on early Unix that

McIlroy estimated that they wrote and debugged about 100,000 lines of code that year, stating that "[their names] may safely be assumed to be attached to almost everything not otherwise attributed". Although assembly did not disappear from the man pages until Version 8, the migration to C resulted in much more portable software, requiring only a relatively small amount of machine-dependent code to be replaced when porting Unix to other computing platforms.

Unix was originally meant to be a convenient platform for programmers developing software to be run on it and other systems, rather than for non-programmer users. The system grew larger as the operating system started spreading in academic circles, as users added their own tools to the system and then shared them with colleagues.

Unix was designed to be portable, multi-tasking and multi-user in a time sharing configuration. Unix systems are characterized by various concepts: the use of plain text for storing data; a hierarchical file system; treating devices and certain types of inter-processing communication (IPC) as files; and the use of large number of software tools, small programs that can be strung together through a command-line interpreter using pipes, as opposed to using a single monolithic program that includes all of the same functionality. These concepts are collectively known as the "Unix philosophy". Brian Kernighan and Rob Pike summarize this in "The Unix Programming Environment" as "the idea of the power of a system comes more from the relationships among programs than from the programs themselves". [1]

It should be pointed out that OS X developed by Apple is based on Mach, FreeBSD and NeXTSTEP which are Unix-like operating systems [2].

### **Richard Stallman and Free-Software movement**

In the late 1970s and early 1980s, the hacker culture that Stallman thrived on began to fragment. To prevent software from being used on their competitors' computers, most manufacturers stopped distributing source code and began using copyright and restrictive software licenses to limit or prohibit copying and redistribution. Such proprietary software had existed before, and it became apparent that it would become the norm. This shift in the legal characteristics of software can be regarded as a consequence triggered by the U.S. Copyright Act of 1976, as stated by Stallman's MIT colleague Brewster Kahle.

Stallman argues that software users should have the freedom to share with their neighbors and be able to study and make changes to the software that they use. He maintains that attempts by proprietary software vendors to prohibit these acts are antisocial and unethical. The phrase "software wants to be free" is often incorrectly attributed to him, and Stallman argues that this is a misstatement of his philosophy. He argues that freedom is vital for the sake of users and society as a moral value, and not merely for pragmatic reasons such as possibly developing technically superior software. Eric S. Raymond, one of the creators of the open source movement, argues that moral arguments, rather than pragmatic ones, alienate potential allies and hurt the end goal of removing code secrecy.

In February 1984, Stallman quit his job at MIT to work full-time on the GNU project, which he had announced in September 1983. Since then, he has remained affiliated with MIT as an unpaid visiting scientist in the Computer Science and Artificial Intelligence Laboratory. Until around 1998, he had maintained an office at the Institute that doubled as his legal residence [3].

Stallman pioneered the concept of copyleft, which uses the principles of copyright law to preserve the right to use, modify and distribute free software, and is the main author of free software licenses which describe those terms, most notably the GNU General Public License (GPL), the most widely used free software license[3][4].

In 1989 he co-founded the League for Programming Freedom.

Essentially, Richard Stallman stands for free (free in the means of freedom but not in the means of unpaid) software, when people have access to source code and can modify it in the way they want to.

C programming language along with Unix OS brought him to these ideas. If there were neither C nor Unix, there would be no Open Source – world of software would be proprietary, ruled by Microsoft, Apple along with Google.

### **Linux**

At the beginning of the millennium fairly small OS – Linux, was brought to public. Small companies such as Red Hat Linux and Linux VA, which were doing business around Open Source, demonstrated rapid growth on financial market – starting on 20\$ and ending day with 320\$ per share.

Linux is a phenomenon in software development. There is no geographical development center. This dynamic and flexible developing model, that is impossible in projects with a closed source, determines an exclusive effective economic model of Linux. Low cost of free developing, smoothly running ways of testing

and distribution, attracting people all around the world having different points-of-view, GPL license – these are the reasons of free software success.

Linux programs are the results of work of thousands of projects. Creation of your own project or joining to the existing one is not a difficult task. And in case of success, your work results will be known to the millions of people all around the world.

According to the statistics, 98% of world supercomputers runs Linux as operating system due to its real multi-tasking [5].

Linux also occupies the server market – 75% of world WEB-servers based around Linux [6].

### Conclusions

In conclusion, it is worth noting that despite of small market share of Unix-like operating systems it brought to world more than just an environment for running programs but ideas that are changing the world around.

Dennis Ritchie created a tool, a powerful tool for building the future – C programming language. Almost everything known today is based on C – almost all high-level programming languages, Windows, MacOS/OS X, Linux. As well, NASA uses C as its main language for developing software [7].

Richard Stallman created an idea, philosophy, ethical codex for programmers and software developers. He created Free Software Foundation, founded GNU project, which gave us: Mozilla, Chromium – two most popular web-browsers, R – programming language for data analysis, GCC – GNU compiler collection, collection of the widely used programming languages compilers.

### Resources

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УДК 524.33-56

## STATISTICAL TIME-SERIES ANALYSIS OF PHOTOMETRIC DATA FOR VARIABLE STARS DETECTION

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**Abstract:** 18 statistical parameters for detecting variability of an object were suggested in the work. Our preliminary analysis showed that the most comfortable coefficients are:  $\chi^2$ -test, standard deviation  $\sigma$ , median absolute deviation MAD, normalized excess variance  $\sigma_{NXS}^2$ , peak-to-peak test, lag-1 autocorrelation  $l_1$ , the von Neumann ratio  $\eta$ .

Candidates to the variable stars were selected on every field using 7 parameters listed above. For predicting of an expected amount of variables in each field a star population was modeled via Besancon Model of Stellar Population Synthesis. A predicted amount of variable stars in each field was calculated by using “Kepler” spacecraft empiric data.

**Key words:** data analysis, statistical parameters, variable stars

### Introduction

For the last years a broad range of astronomical surveys has been released (for example, these surveys are CSS (Catalina Sky Survey), Gaia (Global Astrometric Interferometer for Astrophysics), Pan-STARRS

(Panoramic Survey Telescope and Rapid Response System), etc.). These surveys have one similar objective: determining physical and kinematical parameters for the maximal possible objects. Discoveries of the new variable stars, asteroids, comets and other variable targets on the sky will be an important result of any survey.

The amplitudes and timescales of these variable events could vary from tens of magnitudes and weeks for supernovae explosions to a fraction of a magnitude and minutes for stellar pulsations.

Photometric measurements are prone to systematic errors that are difficult to characterize. This makes it challenging to distinguish a true low-amplitude variability from the apparent one caused by systematic effects and measurement errors. Imaging artifacts such as cosmetic defects of a CCD, diffraction spikes from bright objects and cosmic ray hits as well as blending between images of nearby objects can corrupt photometry and mimic high-amplitude variability. Three different lines of attack on the problem of variable object detection are described in the literature: a direct image comparison, (“transient detection”), lightcurve analysis using variability indices and periodicity search. **The main method** of our research is a second one.

As a fact a huge amount of a data is unresolved for now. In practice all of these methods can be used in the analysis of any photometric data. Measurements obtained by the telescopes of a whole world for the last 20 years are a potential source for discoveries of the new variable objects without extensive surveys releasing.

Therefore our **objective is** a full analysis of the datasets of images for variable objects distinguishing. **The main object-matter** of our research is variable stars discovery and the analysis of variability detection techniques.

We compare the performance of popular variability detection techniques on various real photometric datasets. We refer to any value that quantifies “how variable” a given object is as a “variability index”. Finally, we want to resolve the **next task**: “Is a statistical method effective enough for detection of a variability in any dataset?”

**The main subject-matter** of our investigation is a statistical method in variability detection described by Sokolovsky [Sokolovsky 2016].

## Discussion and results

All data sets were obtained at Chuguev Observational Station of Astronomical Institute of V.N. Karazin Kharkiv National University using 0.7m reflector AZT-8. The main mirror diameter is 70 cm. The telescope has three changeable operational modes: two of them use the Cassegrain focus and have focal distances 11.2m (aperture ratio – 1:16, field of view – 40’) and 28m (aperture ratio – 1:40, field of view – 18’) and one uses the Newtonian mode (aperture ratio– 1:4, field of view – 40’). The telescope was equipped with a MicroLine ML4710 CCD-camera.

To sum up, we got about ~1500 16`x16` images in the R-band with exposition equal 180 second of eight star fields that were observed during about 6<sup>h</sup>-8<sup>h</sup> each between 2013 and 2015. All of these fields are distanced near a Galactic equator.

First of all, for getting photometric data of an image we used C-Munipack software (<http://c-munipack.sourceforge.net/>). Photometric data includes coordinates, intensities, relative magnitudes, signal-to-noise ratios, magnitude errors, full width at half maximum (FWHM) for detecting stars. After that we produced a lightcurve for each star as a time-series table of magnitude where one string complies with one star matching on the one image.

All 18 statistical indices described by Sokolovsky [Sokolovsky 2016]. We used only the most comfortable seven parameters of these set:  $\chi^2$ -test, standard deviation  $\sigma$ , median absolute deviation MAD, normalized excess variance  $\sigma^2_{NXS}$ , peak-to-peak test, lag-1 autocorrelation  $l_1$ , the von Neumann ratio  $\eta$ .

For each variability index A we computed its dispersion  $\sigma_A$  as functions of magnitude. The operation is performed for each dataset that includes real variable objects. For each point in the magnitude vs. index (mag–A) plot we use points within  $\pm 0.25$  mag from it to compute  $\langle m \rangle$  as an average value of magnitudes. Next we calculated dispersion  $\sigma_A$  for some amount of targets, contained into  $\pm 0.25$  mag interval. Threshold line constructed on points average magnitude vs. dispersion ( $\langle m \rangle - \sigma_A$ ). All stellar objects located above (or under – its condition depends on the index’s characteristic) the cut-off line are candidates to the variable stars.

Further some candidates were tested on variability by a dint of aperture photometry method using AstPhot package software [Mottola 1995]; in this program we also built lightcurves for visual detecting the variable stars. We plan to finish our invagination for each candidate soon, but we are having 26 discovered variables.

For predicting of an expected amount of variables in each field a star population was modeled via the synthetic model of our Galaxy – Besancon Model of Stellar Population Synthesis [<http://model.obs-Besancon.fr>].

The model is a powerful tool to constrain evolutionary scenarii or a galactic structure hypothesis through the comparison between model predictions and a large variety of observational constraints such as star counts, photometry or astrometry.

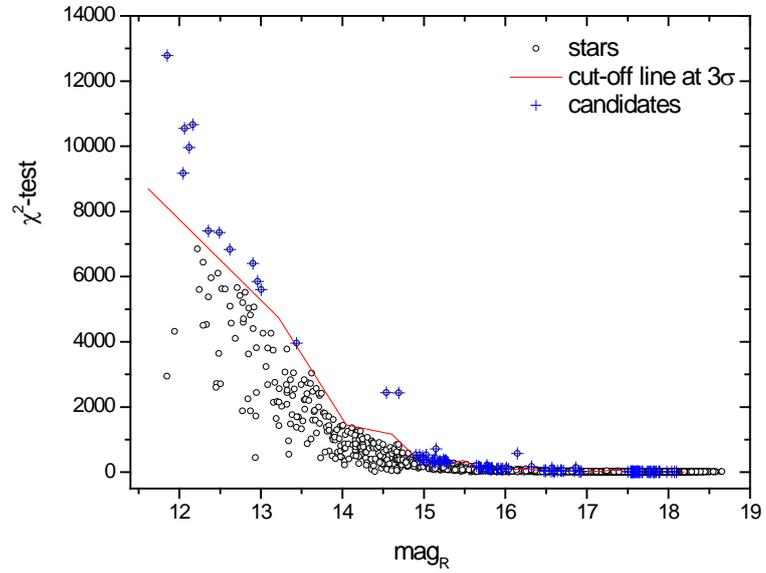


Figure 1. Variability indices  $\chi^2$  plotted as function of magnitude for 2015C dataset. Candidates to the variable stars marked with '+'; threshold at  $3\sigma$  marked with red line.

Index	Errors	Order	Time
Scatter-based indices			
$\chi^2_{\text{red}}$	✓		
$\sigma_w$	✓		
MAD			
$\nu$	✓		
$\sigma^2_{\text{NXS}}$	✓		
Correlation-based indices			
$\eta$			✓
$l_1$			✓

Figure 2. Information included in investigated variability indices

Model simulations are produced in the form of:

- catalogues of pseudo-stars, from Monte-Carlo simulations;
- tables of statistical distributions as a function of either observables (magnitudes, colours, proper motions, radial velocities) or intrinsic parameters (distances, spectral type, age, absolute magnitude);
- integrated luminosity in any specified photometric band among UBVRIJHKL.

Model form requires coordinates of the field, size of the one, physical properties of stellar objects \ interstellar space into the area. For more accurate modeling we use non-average galactic dust extinction got from the extinction maps of an  $A/E(B-V)$  value (<http://irsa.ipac.caltech.edu/applications/DUST/>).

Amount of the predicting variable stars in each stellar field was calculated by using “Kepler” spacecraft of empiric data [Ridgway 2014] that shows quantity of variables with certain amplitude and with certain spectral class.

### Conclusions

We discovered 26 variable stars with using of 7 statistical parameters on the eight fields. The predicted amount of the variables equals 65.512 stars by the Besancon Model of Stellar Population Synthesis together with empiric data about rate of variable stars.

Thus, there was a need to explain the difference between our predicted quantities of variables and discovered ones. Besides the random errors (caused by the background and photon noise) that are usually easy to estimate, photometric measurements are always exposed to a systematic error (due to an atmospheric and instrumental variation) that are hard to quantify. Since the overall measurement errors are not accurately known, it is not possible to apply statistical parameters to select variable objects with enough accuracy.

The absence of an accurate error estimates can be substituted with the assumptions:

- the majority of field stars are non-variable;
- stars of similar brightness in a given field are measured with about the same photometric accuracy.

If these assumptions hold, the field stars may be used to measure the actual accuracy of a given set of photometric observations. The variability indices can be used to select objects showing larger-than-expected brightness variations.

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### THE GENERALIZED RING PENDULUM

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Language advisor: Orach Yu.V.

**Abstract.** Although the frequency of small oscillations of a pendulum is known to essentially depend on the position of the suspension point and on the pendulum’s shape and size, a vertically symmetrical partial ring amazingly defines this rule when suspended through the center of its arc. In this paper we consider a general case of a physical pendulum, whose period of oscillations is not dependent of its mass distribution along the arc of a circle of a radius  $R$ . Since this period equals to that of a mathematical pendulum of the length  $2R$ , it seems only natural to call the system *the generalized ring pendulum*.

**Key words:** mathematical pendulum, physical pendulum, period of small oscillations

**Introduction:** Some of the most important properties of an oscillating pendulum were first noticed by the all-time great scientist and inventor Galileo Galilei. It was Galileo who observed that the period of small

oscillations of a pendulum does not depend on the magnitude of its swing and thus is a basic characteristic of a specific pendulum. In the simple case of the mathematical pendulum, a massive body suspended on the negligibly light string much longer than the size of a body, the period of small oscillations is directly proportional to the square root of the string's length. Those two discoveries led Galileo to suggest pendulums to be a core part of a reliable time measuring device, a project later fulfilled by the outstanding Dutch scientist Christiaan Huygens [C.G.Gidkinin 1974: 2-13]. Thanks to his ingenuity and persistence, starting from the year 1657, pendulum clocks became the irreplaceable apparatus to keep precise timing on board of the sea ships letting their crew reliably measure the geographical longitude. Later on, they became dominant time measuring devices in science, engineering and in household. Even nowadays, an oscillating pendulum remains a symbol of the 'ticking away' Time Almighty.

Although every kid enjoying the swing ride has a good idea that the longer the swing, the bigger its period of oscillations is, this seemingly undisputable knowledge may be shattered by some simple and natural pendulum designs.

Our original interest in the topic is mostly due to *The partial ring pendulum* section of the Robert Ehrlich's book [R.Ehrlich 1997:197], which presents the following incredible demonstration: "pendulums made from partial rings having a common radius oscillate with identical periods independent of the fraction of the ring". More specifically, the period of small oscillations of the homogeneous ring of the radius  $R$  suspended vertically on the axis perpendicular to its own plane equals to the period of oscillations of a mathematical pendulum of a length  $L = 2R$ , which is non-trivial by itself. And after the symmetric circumcision of the ring the period of small oscillations of the remaining arc does not change at all, however big or tiny is the produced partial ring.

The **object-matter** of the study is the small oscillations of physical pendulum, and the **subject-matter** is mathematical methods of vibration theory.

#### Discussion and Results

Our studies are aimed at the generalization of the problem presented in [Walkiewicz, Wagner 1994: 142-144, Wagner, Walkiewicz, Giltinan 1995: 1014-1017]. To do this, we consider the pendulum consisting of

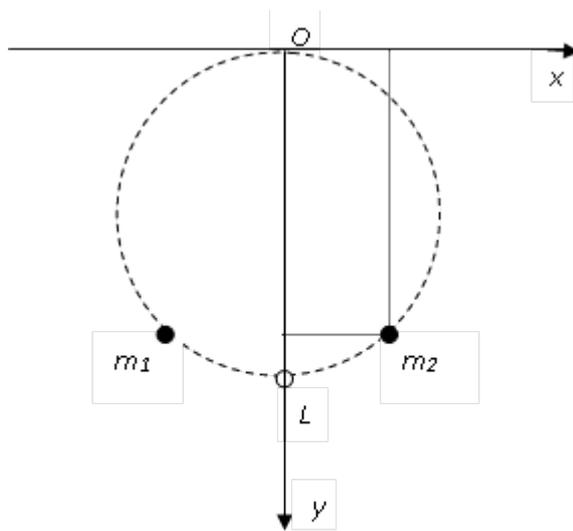


Fig.1

two small masses  $m_1 = m_2 = m/2$  positioned on a negligibly light ring and oscillating within its plane when suspended at the point O (Fig.1). Equilibrium positions of the masses are symmetrical in respect to the OY axis,  $x_1 = x_2$ . When  $x_1 = x_2 = 0$  the ordinate of the masses  $y_1 = y_2 = L$ , and the physical pendulum

transforms into a mathematical one with the mass  $m$ . Its period of small oscillations

$$T = 2\pi\sqrt{\frac{L}{g}}.$$

Let us find the relation between  $x$  and  $y$  coordinates satisfying the condition of the period of the considered physical pendulum to equal that of a mathematical one:

$$T_{physical} = T.$$

The period of the physical pendulum is determined by the well-known formula [D.V.Sivyhin 1979: 520.]

$$T_{physical} = 2\pi\sqrt{\frac{J}{mgl}}, \quad (3)$$

where  $J$  is the moment of inertia of a physical pendulum,  $m$  is the total mass of the pendulum,  $g$  is acceleration due to gravity,  $l$  is the distance from the point of suspension  $O$  to the center of mass of a pendulum.

The momentum of inertia of a physical pendulum with respect to an axis perpendicular to the ring's center

$$J = m_1 r^2 + m_2 r^2 = m r^2 = m(x^2 + y^2). \quad (4)$$

Symmetry of the pendulum mass positions requires its center of gravity to be on the  $OY$  axis and gives  $l = -y$ .

Further transformations give

$$x^2 + \left(y + \frac{L}{2}\right)^2 = \left(\frac{L}{2}\right)^2, \quad (5)$$

which reveals the locus of the pendulum masses to be a circle [V.A.II'in, E.G.Pozniak 1971: 232, N.D.Parfyonova 2011: 52.] of the radius  $L/2$ , centered at the point  $(0, L/2)$  (see. Fig.1). Note that the period of such a physical pendulum is definitely independent of the specific values of masses of the point bodies 1 and 2 given  $m_1=m_2$ . This makes it possible to carry out the following reasoning. Let us place another couple of masses  $m_3=m_4$  (not necessarily equal to  $m_1$  and  $m_2$ ) symmetrically on the same circle. Period of oscillations of a new physical pendulum remains unchanged. These considerations prove that any vertically symmetric distribution of masses on the circle of a radius  $R$  produces a pendulum oscillating with a period of the mathematical pendulum of length  $L = 2R$ . So we have completely solved the problem suggested by Ehrlich [R.Ehrlich 1997:197] and found its generalization. Next consider a physical pendulum in which a pair of masses  $m_1=m_2$  is positioned symmetrically with respect to the circle's center (Fig.2).

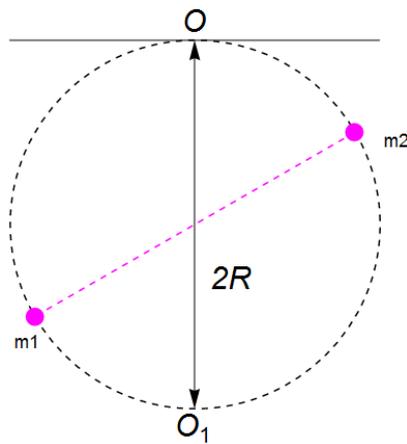


Fig.2

$L=2R$ . Here again, any mass distribution symmetric with respect to the circle's center, produces a physical pendulum with the same period of oscillations.

It seems interesting to find out how strongly the period of oscillations depends on the masses positions on the circle for an arbitrary, nonsymmetrical case.

Let us now consider the physical pendulum, in which two equal masses are fixed on a circle at

$\alpha, \beta \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$  (Fig.3). We

right semi plane angles  $\alpha$  and  $\beta$  positive in the left semi plane. The physical pendulum is calculated masses lie on the circumference,

The coordinates of the center of gravity (in the case of  $m_1=m_2$ ) are defined as

The period of oscillation of such a system could be calculated by the formula (3).

Moment of inertia of the system of masses  $m_1=m_2=m/2$  with respect to the point O is

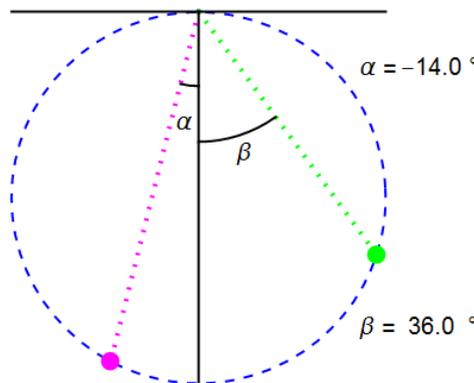
$$J = m_1 r_1^2 + m_2 r_2^2 = \frac{m}{2} (r_1^2 + r_2^2). \quad (6)$$

As it is seen in Fig.2, an angle  $\angle m_1 O m_2 = 90^\circ$ , because  $m_1$  and  $m_2$  are the terminal points on the diameter of the circle.

Thus finally, we get:

$$T_{physical} = 2\pi \sqrt{\frac{J}{mgl}} = 2\pi \sqrt{\frac{2R}{g}} = 2\pi \sqrt{\frac{L}{g}}. \quad (7)$$

That is, the period of oscillation of such a physical pendulum also equals to the period of oscillations of a mathematical pendulum of a length



pendulum, in which two equal masses are fixed on a circle at

define that for the points in the

are negative while they are positive in the right semi plane. The period of oscillations of such a physical pendulum is calculated according to (3). Since both

$$(8)$$

$$(9)$$

center of gravity (in the case of

$$\begin{cases} x_c = \frac{1}{2}(x_1 + x_2) \\ y_c = \frac{1}{2}(y_1 + y_2) \end{cases} \quad (10)$$

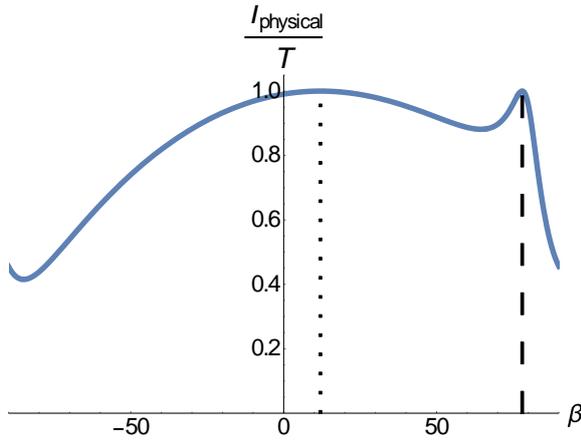


Fig.4

$$\begin{cases} x_1 = L \sin \alpha \cos \alpha \\ x_2 = L \sin \beta \cos \beta \end{cases} \quad (14)$$

Finally, the ratio of the periods (see Fig.4 for  $\alpha = -78^\circ$ ) equals to

$$\frac{T_{physical}}{T} = \sqrt{\frac{\cos^2 \alpha + \cos^2 \beta}{\sqrt{\cos^2 \alpha + \cos^2 \beta + 2 \cos^2 \alpha \cos^2 \beta + 2 \sin \alpha \cos \alpha \sin \beta \cos \beta}}} \quad (15)$$

It should be noticed that this formula describes the symmetrical situation examined earlier. Thus, for the case of  $\alpha = -\beta$  (vertically symmetrical masses (see Fig.4 dashed line).

$$\frac{T_{physical}}{T} = \sqrt{\frac{\cos^2(-\beta) + \cos^2 \beta}{\sqrt{\cos^2(-\beta) + \cos^2 \beta + 2 \cos^2(-\beta) \cos^2 \beta + 2 \sin(-\beta) \cos(-\beta) \sin \beta \cos \beta}}} = 1. \quad (16)$$

For the masses symmetrical with respect to the circle's center,  $\beta - \alpha = \pi/2$  (see Fig.4 dotted line),

$$\frac{T_{physical}}{T} = \sqrt{\frac{\cos^2 \alpha + \cos^2\left(\frac{\pi}{2} + \alpha\right)}{\sqrt{\cos^2 \alpha + \cos^2\left(\frac{\pi}{2} + \alpha\right) + 2 \cos^2 \alpha \cos^2\left(\frac{\pi}{2} + \alpha\right) + 2 \sin \alpha \cos \alpha \sin\left(\frac{\pi}{2} + \alpha\right) \cos\left(\frac{\pi}{2} + \alpha\right)}} = 1 \quad (17)$$

Analysis of a somewhat bulky expression (11) reveals a strong angular dependence of the physical pendulums (Fig.3) period of oscillations for the certain mass distributions, examples given in Fig.4.

#### Conclusions

The conditions were determined for the system of circularly distributed masses to retain its period of small oscillations constant over a wide variation of parameters, giving grounds to call this system a generalized ring pendulum. Periods of oscillations of two equal masses fixed on the negligibly light circular ring were calculated for their arbitrary positions. It was shown that while the symmetrical arrangement of the masses on the circle inevitably results in the same value of the period of oscillations, their asymmetrical placement may cause a strong dependence of the period on the masses' relative positions.

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Then the distance from the rotational axis (point O) to the center of gravity is equal to

$$l^2 = x_c^2 + y_c^2. \quad (11)$$

Substituting (10) and using (8) and (9) we obtain

$$l^2 = \frac{1}{4}(2y_1y_2 + 2x_1x_2 - y_1L - y_2L), \quad (12)$$

where  $x_1 = -y_1 \operatorname{tg} \alpha$ ,  $x_2 = -y_2 \operatorname{tg} \beta$ .

Then we have

$$\begin{cases} y_1 = -L \cos^2 \alpha \\ y_2 = -L \cos^2 \beta \end{cases} \quad (13)$$

Thus from (13) we find

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## QUANTUM TELEPORTATION

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Language supervisor: Orach J.V.

**Summary:** This paper focuses on the overview of the phenomenon of quantum teleportation. In particular, the article discusses the research history and the fundamental physical essence of the phenomenon. A pictorial diagram of the quantum teleportation for a single photon is presented. The article also describes the prospects of the practical application of the phenomenon in quantum communication and quantum computation.

**Key words:** EPR pair, nonlocal correlations, quantum entanglement, quantum state, quantum teleportation, quantum state

### Introduction

**The object** of the article is the phenomenon of quantum teleportation, i.e a process by which quantum state can be transmitted from one location to another, with the help of classical communication and previously shared quantum entanglement. **The subject** of the paper is the history of the research, prospects and the fundamental physical essence of the phenomenon.

Our **aim** is to describe the phenomenon of quantum teleportation. The following **tasks** were set to achieve the objective: to study and to describe the research history of the phenomenon, to study and to describe the physical essence of the phenomenon, to make a pictorial diagram and to describe the prospects of application. The articles from journals of physics were used as a source of information.

### Discussion and Results

In 1935 Albert Einstein, Boris Podolsky and Nathan Rosen proposed a thought experiment to demonstrate the incompleteness of the quantum mechanical theory [Einstein and others 1935: 777]. The essence of the paradox is that particles can interact in such a way that it is possible to measure both their position and their momentum more accurately than Heisenberg's uncertainty principle allows [Sen 2014, p. 204].

$$\sigma_p \sigma_q \geq \frac{\hbar}{2}$$

This consequence had not previously been noticed and seemed unreasonable at the time, but the phenomenon is now known as quantum entanglement, that occurs when groups of particles are generated or interact in such a way that the quantum state of each particle can not be described independently of the others, it must be described for the system as a whole. For example, entanglement occurs when a particle decays into a pair of other particles. These decay events obey the various conservation laws, so the measurement outcomes of one daughter particle must be correlated with the measurement outcomes of the other daughter particle, and we can say that daughter particle has no its own momenta, angular momenta or energy before measurement but both particles together can be described by superposition of their quantum states.

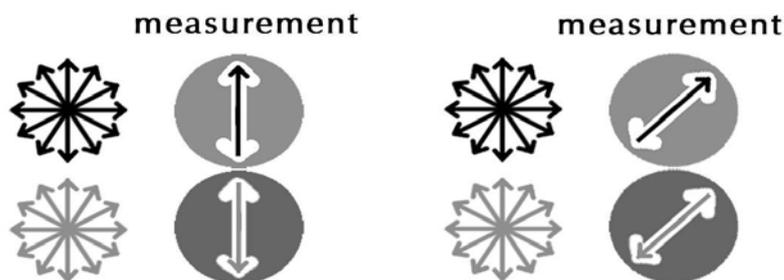


Figure1. The directions of the spins of the two entangled particles (with zero total spin) "before" and "after" measurements.

The idea of quantum teleportation is to utilize the nonlocal correlations between an Einstein-Podolsky-Rosen pair of particles (entangled particles) to prepare a quantum system in some state, which is the exact replica of an arbitrary unknown state of a distant individual system [Kim and others 2001: 1370].

Quantum teleportation is one of the most interesting manifestations of the quantum nature of matter, it provides a means of transporting quantum information efficiently from one location to another, without the physical transfer of the associated quantum-information carrier [Barrett and others 2004: 737].

Suppose one observer (Alice) has been given a quantum system (such as a photon prepared in certain state unknown to her) and she wishes to give to another observer (Bob) sufficient information about the quantum system to make an accurate copy of it. Knowing the state vector itself would be sufficient, but due to the Heisenberg's uncertainty principle there is no way to learn it. Nevertheless the unknown quantum state can be disassembled into purely classical information and purely nonclassical Einstein-Podolsky-Rosen correlations and then it can be reconstructed. To accomplish this the sender (Alice) and the receiver (Bob) should prearrange the sharing of an EPR-correlated pair of particles [Bennett and others 1993: 1895].

To couple the first particle with the EPR pair, Alice performs a complete measurement on the joint system consisting of the particle in the state which she wants to transfer and her own EPR particle. Then Alice sends Bob the classical result of this measurement. Each possible resultant state for Bob's EPR particle (its state was directly related to the state of Alice's EPR particle) is now related in a simple way to the original state which Alice sought to teleport. Depending on the outcome of Alice's measurement Bob must either do nothing with his particle or apply one of the unitary operators corresponding to rotations around the z, x, and y axes in order to convert his EPR particle into a replica of Alice's original state. Alice, on the other hand, is left with two particles in one of the states without any trace of the original state of the teleported particle [Bennett and others 1993: 1896]. The last remark is very important. A single quantum cannot be cloned [Wootters, Zurek 1982: 802]. The original state of Alice's particle has been destroyed.

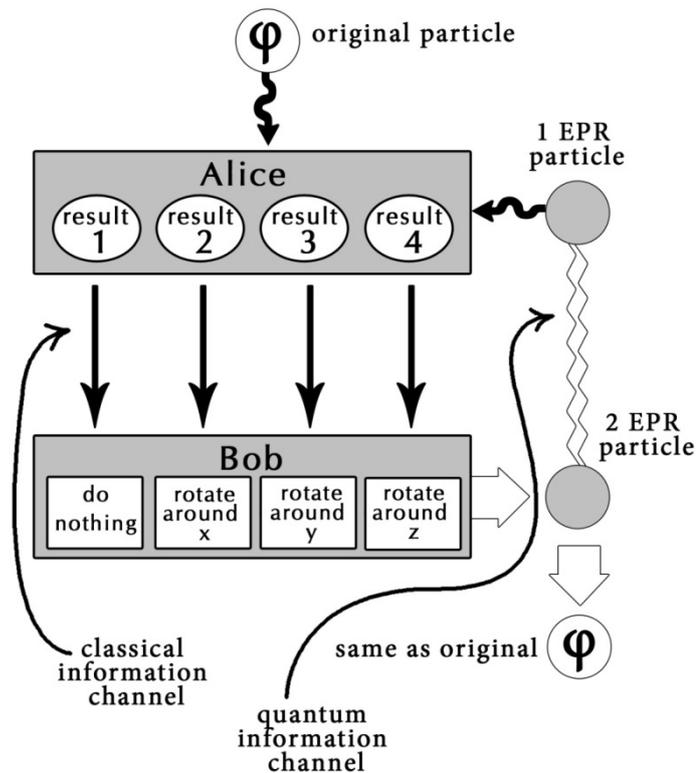


Figure 2. Quantum teleportation scheme (for a single photon)

In 1997 quantum teleportation was first experimentally realised. The researchers have also used teleportation to transmit information between clouds of gas atoms, i.e macroscopic atomic ensembles. In 2015

scientists reported the first experiment of teleporting multiple degrees of freedom of a quantum particle [Wang and others 2015: 516].

Teleportation is expected to play an integral role in quantum communication and quantum computation. Quantum cryptography based on the phenomenon of quantum teleportation is very useful for security because it is impossible to copy data encoded in a quantum state. The act of reading changes the quantum state. Quantum teleportation is now successfully used in the laboratories to send encrypted messages.

Quantum computer is one of the most promising technological objects. It would theoretically be able to solve certain problems much quicker than any classical computer what is very useful for data processing. Quantum computer could solve many problems in physics, mathematics and other sciences that were once thought intractable, revolutionizing information technology and illuminating the foundations of physics [Knill 2015: 441].

A possible application of quantum teleportation mostly associated with the word “teleportation” is fast transportation of massive objects, for example, people. Today it does not seem realizable.

### Conclusions

Quantum teleportation is one of the most interesting manifestations of the quantum nature of matter, it provides a means of transporting quantum information without the physical transfer of matter. The basis of the phenomenon is the nonlocal correlations between an Einstein-Podolsky-Rosen pair of particles. Quantum teleportation is expected to play an integral role in quantum communication, cryptography and quantum computation.

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### FAHRZEUGE DER ZUKUNFT

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**Annotation:** Es ist die Probleme der zukünftigen Automobilindustrie untersucht. Neben der Elektromobilität sind Vernetzung und autonomes Fahren wichtige Zukunftsthemen der Branche. Es werden sowohl die Nachteile des Fahrzeugs mit Elektroantrieb und seine Vorteile, als auch innovative Technologien analysiert. Aktuell erforschen die Autohersteller eine neue Generation von Informationssystemen.

**Schlüsselwörter:** der Elektromotor, selbstfahrendes Auto, der Sensor, die Batterie, die Brennstoffzelle

**Einleitung.** Alternative Antriebe, vernetzte Autos und selbstständig fahrende Wagen: Die Mobilität von übermorgen ist ungewiss.

Es besteht kein Zweifel, je höher die Mobilität eines Landes, desto höher der Wohlstand. Die Erfindung des Autos hat uns Freiheit, Unabhängigkeit, Freizügigkeit bei der Wahl des Wohnortes und beim Reisen gegeben. Immer niedrigere Preise und die große Konkurrenz auf dem Automarkt haben verursacht, dass dieses

Fahrzeug für alle zugänglich wurde. Im Laufe der Zeit gewann das Auto als Hauptverkehrsmittel an Bedeutung [1].

Jeder weiß, dass die Anzahl der Autos wächst. Die Wissenschaftler versuchten immer ein Fahrzeug zu konstruieren, das sicher, komfortabel, jederzeit verfügbar, rentabel und modern ist, so ist es unser **Ziel**, die Entwicklungen in der Automobilindustrie zu analysieren.

Wir erwarten, dass das Auto der Zukunft mit vielseitigen Sensoren wie Radar, Laser, Ultraschall, Mikrowellen ausgestattet sein wird. Das Auto der Zukunft wird so zum Beispiel selbständig einparken können, den richtigen Abstand auf der Autobahn berechnen und selbständig einhalten und – falls nötig – eine Notbremsung einleiten.

Aber die Ingenieure haben sich noch komplexere Aufgaben gestellt. Autos sollen in der Zukunft auch Gegenstände wie Bälle und sogar Menschen erkennen, die plötzlich auf die Straße laufen. Solche Fahrzeuge werden Verkehrszeichen lesen und dafür sorgen, dass ihre Fahrer sich daran halten. Das Auto wird seinen Fahrer gut unter Kontrolle haben. Es veranlasst ihn zu einer Pause, wenn er zu müde wird.

Die Automobilindustrie steht vor einer Zeitenwende. Noch fahren in Deutschland mehr als 98 Prozent der Pkw mit Benzin oder Diesel, aber die Zahl der zugelassenen Autos mit zumindest teilweise elektrischem Antrieb steigt.

So z.B. hat die Bundesregierung das Ziel ausgegeben, dass im Jahr 2020 eine Million Elektroautos auf deutschen Straßen fahren sollen. Dazu zählen neben reinen batterieelektrischen Fahrzeugen auch Plug-in-Hybride, also Fahrzeuge mit einem herkömmlichen Verbrennungs- und einem Elektromotor [1].

Neben der Elektromobilität sind Vernetzung und autonomes Fahren wichtige **Zukunftsthemen** der Branche. Künftig sollen Fahrzeuge miteinander kommunizieren, um vor allem den Verkehr sicherer zu machen. Zudem testen die Hersteller selbstfahrende Autos. Zu den traditionellen Unternehmen kommen neue Player wie Google oder Apple hinzu.

**Überblick.** Was klingt nach Szenen aus einem Science-Fiction-Film, könnte bald schon die Norm sein, sich ins Auto zu setzen, den Autopiloten einzuschalten, der die Fahrt bewerkstelligt, während der Insasse sich entspannt oder seiner Arbeit zuwendet. Doch entwickeln immer mehr Hersteller Prototypen, um die Möglichkeiten selbstfahrender Autos zu testen. So hat zum Beispiel Google seinen ersten Prototypen letztes Jahr vorgestellt: Ein Zweisitzer mit Elektroantrieb. Besitzt die erste Baureihe mit 100 Fahrzeugen noch klassische Bedienelemente, entfallen Lenkrad sowie Pedale, Rücksitze, Musikanlage oder Handschuhfach in der zweiten vollständig.

Google stellte schon 2009 seine ersten Autos mit Robotertechnik auf die Straße. Von der Technik für autonome Fahrzeuge will der Konzern dennoch profitieren: Er lagert die Entwicklung für selbstfahrende Autos in die neue Firma Waymo aus. Seit das Unternehmen die Arbeit an Roboterautos aufgenommen hat, haben die ersten Modelle mehr als 3,2 Millionen Kilometer Fahrweg zurückgelegt. Inzwischen gab es selbst eine Testfahrt mit einem Blinden. Die Sensoren des Wagens und die Software waren sein Chauffeur. Google musste auch empfindliche Rückschläge wegstecken. Zuletzt im Februar 2016: Ein selbstfahrendes Auto des Unternehmens stieß mit einem Bus zusammen, und Google räumte eine Mitschuld an dem Unfall ein. Diese Technologie kann künftig nützlich sein für den Privatverkehr, Mitfahroptionen, Logistik und öffentlichen Nahverkehr bis vor die Haustür [2].

Neben Google erforscht auch das amerikanische Start-Up-Unternehmen Cruise die Einsatzfähigkeit von Autopiloten und hat dabei ein Allrounder-System entwickelt. Auch weitere Auto-Hersteller wie Daimler, BMW, Volvo, etc. arbeiten mit Hochdruck an der Entwicklung eines komplett selbstfahrenden Autos.

Durch Front-, Heck- und Dach-Kameras sowie mehrere Sensoren reagieren die Autopiloten wesentlich schneller auf Gefahren, als es die menschliche Reaktionszeit ermöglicht. Wenngleich in weiteren Testphasen noch an der Interpretation unberechenbarer Situationen gearbeitet werden muss, sind Autopiloten bereits in dieser frühen Forschungsphase sicherer als der Mensch [2].

Die Herstellung von Objekten unter Zuhilfenahme eines 3-D-Druckers verheißt für die Zukunft einen regelrechten Boom. Nach Kunststoffobjekten und Lebensmitteln hat das Oak Ridge National Laboratory jüngst ein vollkommen fahrtüchtiges Kraftfahrzeug aus 40 Einzelteilen mithilfe eines 3-D-Druckers erstellt. Dazu kam die Karosserie aus dem Drucker. Reifen, Motor und Getriebe wurden dem Gefährt auf konventionelle Art hinzugefügt.

Wenn bei klassischen Navigationssystemen das Problem besteht, den Blick des Fahrers nicht immer wieder von der Straße abzulenken, bündeln Head-Up-Displays die Konzentration voll und ganz auf die Straße. Aktuell erforscht der Hersteller Continental eine neue Generation von Informationssystemen, welche die komplette Windschutzscheibe nutzen, um mittels Augmented Reality Infos zu Verkehrsführung, Route und

Abstand zum voranfahrenden Fahrzeug auf die Straße zu projizieren. Die korrekte Ausrichtung der Informationen findet dabei über die Ermittlung der Kopfposition des Fahrers statt [1].

Nachdem sich bereits jetzt ein Trend hin zu weniger Verkehrstoten abzeichnet, nimmt auch die Sicherheit in Fahrzeugen künftig weiter zu. Neben akustischen Systemen, die den Abstand zum Vordermann und die Einhaltung der Gurtpflicht überwachen, intelligenten Beleuchtungssystemen, die die Straßen übersichtlicher gestalten, und stetig verbesserten Bremssystemen sind aktuell smarte Sicherheitsgurte und vorausschauende Navigationssysteme Entwicklungsgegenstand der Forschungseinrichtungen.

Die smarten Gurte überprüfen über Sensoren permanent die Körperfunktionen des Fahrers (Atmung, Herzfrequenz). Bei einem Unfall oder im Falle eines Herzstillstandes senden sie automatisch einen Notruf aus und geben bei Übermüdung einen Impuls an den Fahrer.

Vorausschauende Navigationsinstrumente hingegen berücksichtigen die Verhaltensmuster und Präferenzen der Fahrer. Zugleich bieten sie aber das Potenzial, als Notbremsassistenten oder automatisierte Fußgängererkennung zu fungieren. Wenngleich bis zur Marktreife noch Zeit vergeht, hat die EU hohe Forschungsgelder bereitgestellt, um die Entwicklung derartiger Technologien voranzutreiben [3].

Wenn sich die Nano-Beschichtung für Autolacke durchsetzt, sind regelmäßige Besuche in der Waschanlage zukünftig überflüssig. Der japanische Hersteller Nissan testet derzeit eine als Ultra Ever Dry bezeichnete Technologie, bei der eine Luftschicht Flecken durch Wasser, Schnee und Regen verhindert – das Auto erstrahlt stets in vollem Glanz. Nachdem in der Vergangenheit Versuche mit einer selbstreinigenden Heckkamera schon erfolgreich abgeschlossen wurden, verläuft auch diese Testphase vielversprechend. So stellt der Hersteller in Aussicht, die Beschichtungen zukünftig als Sonderlackierung anzubieten [1].

Die ersten Hersteller gehen zur Markteinführung von Brennstoffzellen-Fahrzeugen über. Die Machbarkeit bewies Mercedes bereits im Jahr 1994, werbewirksam rollte dann 2011 eine Flotte der F-Cell-Variante der B-Klasse um die Welt. Mit 134 PS, einer Maximalgeschwindigkeit von 160 km/h, einer Reichweite von 480 Kilometern und Tankzeiten von drei bis zehn Minuten bei gleichzeitig geringerer technischer Anfälligkeit in Kälteperioden bieten die Brennstoffzellen-Modelle eine attraktive Alternative zu Elektroautos. Die Fahrzeuge basieren auf einem Elektroantrieb, dessen Energie aus reinem Wasserstoff über die Brennstoffzelle erzeugt wird, als Abgas entsteht reiner Wasserdampf [3].

Konkurrenz erhalten die Brennstoffzellen-Fahrzeuge durch eine neue Batterie-Generation für Elektroautos. Die in Japan entwickelten „Ryden Dual Karbon“-Batterien bieten im Vergleich zu herkömmlichen Lithium-Ion-Batterien die Vorteile von Reichweiten um die 500–600 km sowie kürzere Aufladezeiten mit etwa 1/20 der bisherigen Dauer; gleichzeitig lassen sich die Batterien bis zu 3.000-mal aufladen.

Vollständige Recyclefähigkeit, der Verzicht auf Schwermetalle sowie umweltfreundliche Materialien bieten weitere Vorteile zu herkömmlichen Batterien. Eine Kooperation für den Einsatz in Elektroautos ist dabei mit Tesla geplant, wenngleich das Potenzial besteht, durch die bedeutsame technologische Innovation nachhaltig auf mehrere Industriezweige einzuwirken.

**Zusammenfassung. Die wichtigsten Punkte auf einen Blick sind:** autonome (fahrerlose) Autos könnten bald die Norm sein; in wenigen Monaten könnten Autos standardmäßig per 3D-Drucker entstehen; innovative Navigations- und Sicherheitssysteme sind weiter auf dem Vormarsch; Autowaschen wird durch selbstreinigende Lacke der Nano-Technologie überflüssig; Brennstoffzellen-Autos stehen vor der seriellen Markteinführung; „Ryden Dual Karbon“-Batterien revolutionieren Markt der Elektroautos.

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УДК 3937

#### GRAVITATIONAL WAVES

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**Abstract.** This article is devoted to the nature of gravity and gravitational waves. The topic is considered in the theory of relativity which results in developing physics in this important direction. The

knowledge in this sphere contributes to elaborating a new stage in astronomy. Gravitational waves and their reflections make possible to obtain a three-dimensional picture of the observed objects.

**Key words:** astronomy, black hole, gravitation wave, gravity, LIGO.

**Introduction.** Physics is a science which studies interaction among bodies. There are four types of interaction among them: gravitational, electromagnetic, strong nuclear force and weak nuclear force. Due to gravitational interactions the planets revolve around the sun, the bodies have the weight and fall to the ground. A person constantly experiences the gravitational interaction and this type of interaction will be the **object-matter** of the article.

In 1916 Albert Einstein made up the theory of gravity. His theory supplemented Newton's theory of gravity. He made it mathematically correct: it met all requirements of physics. This theory took into account the fact that gravity propagates with a very large but finite velocity. This is one of the most amazing hypothesis of Einstein because he developed a theory of gravity, which covers all the phenomena of physics that we can see today. This theory also predicted the existence of gravitational waves. It's the **subject-matter** of this article. The basis of this prediction was that gravitational waves exist as a result of gravitational interaction, which appears as a result of the confluence of two massive bodies.

The **objective** of the article is to outline the details of the gravitation theory.

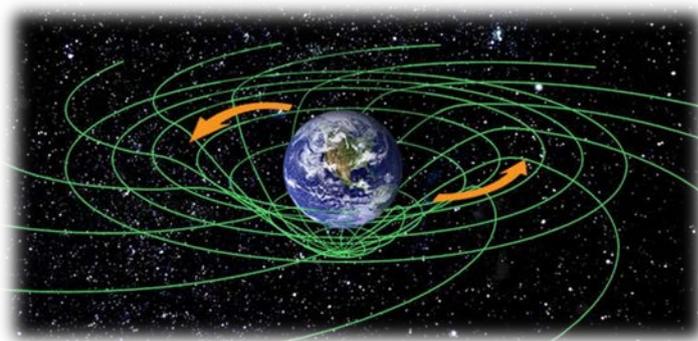
The **tasks of the article are** to explain the nature of the phenomenon of gravitation and to analyze the results of theoretical and practical work of scientists dealing with the gravitational interactions of different bodies.

**Discussion and Results.** In the first approximation the difference between a complicated Einstein's theory of gravitation and elementary Newton's theory is very small. To launch rockets to Mars the Newton's theory together with the laws of celestial mechanics of Kepler are enough, the Einstein's theory is not necessary here. But as usual the most interesting things are hidden in details.

In the theory of relativity gravity is considered much deeper. According to this theory, each body with a mass bends a single space-time. And the greater the mass is, the more distorted it will be. A casted apple is not attracted by the Earth and flies always along a straight line. The space is curved and with attenuation of impulse the apple backs into the Earth. To feel gravity means to get into the bends of this matter. Rotating masses twist time and space around themselves as whirlpools. In such a way satellites rotate around the planets, planets around the stars, stars around the galactic center – and this goes to infinity (pic. 1).

Gravitational waves are not just the energy oscillation, but oscillation in time and space. They are generated by the movement of massive bodies with variable acceleration that is quite rare. For example, in the solar system all planets slow down at aphelion, the farthest point from the Sun's orbit, and are accelerated at the perihelion. However, the masses of the planets compared to the mass of the Sun are too small and the rate differences are insignificant. Therefore, the Sun does not lose even a hundredth part of the energy which is emitted in the form of gravitational waves [1], [2].

Another thing is a double system of massive objects such as stars and black holes. Being relatively close to each other, they rotate in two directions simultaneously – around a common center of gravity between it and around its own axis. Since binary systems tend to reduce the distance between them, they move closer to each other and the rotation becomes more and more intense. This dance of giants creates strong gravitational waves. Also, powerful cataclysms like supernovae can serve as a source of oscillations. Gravitational waves propagate freely through space with the speed of light. Due to the relative weakness of the gravitational forces these waves are too hard to be registered [3].



By 2015, most of the phenomena predicted by the theory of relativity were discovered. Among the remaining ones were gravitational waves. These are the most subtle vibrations that exist in nature. But in September 2015 LIGO registered gravitational waves. They were difficult to be detected because gravity as a force is incredibly weak – 1040 times weaker than any electromagnetic force. In addition, the powerful sources of gravitational perturbations, as a rule, are so far from the Earth that the waves are becoming weaker and

weaker due to the Inverse-Square Law. If the sources of gravitational perturbations were closer, the Earth would suffer from more severe physical phenomena. Therefore, scientists from the LIGO who looked for gravitational waves had to build a titanic installation representing two 4-km perpendicular pipes, filled with the vacuum (pic. 2).



Laser beams are passed through them, the time of passage is recorded accurately. This installation is called the gravitational-wave interferometer. When a gravitational wave passes through the Earth, the space is distorted, and the laser at first slows down in the first pipe, and then is accelerated in the second or vice versa.

The sensitivity of the final device is that vibrations can be recorded even on the level of protons. This, however, creates a problem for scientists: a sensitive device captures a lot of external noise. The researchers of LIGO took into consideration the movement inside the Earth, weather factors, etc. The scientists tried to run away from roads and towns in the desert, but even there the signal sometimes was mingled with phone calls or the sounds of a motorcycle that drove a few kilometers far from the vacuum pipes.

However, the LIGO functioned in the best way after the start. An important event was the confluence of two black holes with masses which exceeded the mass of the Sun at 36 and 29 ( $\pm 5$ ) times! And gravitational waves of this confluence were detected. Approaching each other, they rotate next to each other at speeds reaching up to 40% of the speed of light. During the clash the spilled energy was 50 times more powerful than the emission of all the stars in the visible universe for the same length of time. This point was also the peak of intensity and power of the waves. After this event gravitational field became static and stable [4].

### Conclusions.

The possibility to register gravitational waves opens "a new dimension" in astronomy. Telescopes are limited in the optical range, which is full of obstacles and distortions. Gravitational waves and their reflections make possible to obtain a three-dimensional picture of the observed objects. The technology which is now applied by researchers isn't completely perfect, but in the future gravitational waves will allow to explore the objects that are hidden beyond galaxies and nebulae. Thus, the possibility of existence of binary black holes systems is true. They even can absorb each other. Also the position of the general theory of relativity about gravity has strengthened. And the possibility to "hear" the waves of gravity will make it possible to penetrate the mysteries of dark matter which is still tormented by scientists from all around the world.

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## NUCLEAR BURNING WAVE AS THE WORK MODE OF THE NEW TYPE OF NUCLEAR POWER PLANTS

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**Abstract:** The concept of nuclear burning wave, proposed by the L.P. Feoktistov, is described. This issue is one of possible solutions to some nuclear energy problems. The possibility of nuclear burning wave in the fast spectrum reactor is shown with a simple reasoning. It is demonstrated that the nuclear burning wave excludes the possibility of nuclear explosion. The ability of the reactors that work in the nuclear burning wave mode makes them most promising in terms of safety.

**Key words:** nuclear burning wave, nuclear power plant, critical concentration, equilibrium concentration

### Introduction

Fire discovery has brought great changes to humanity growth. Since then much time has passed, but humanity still uses the energy produced by heat sources such as coal power plants or gas engines in cars. At the beginning this gave impetus to the Industrial Revolution, and now people cannot imagine the life without these power sources, as they give us electricity and fast traveling methods.

Humanity population had grown greatly and mankind encountered significant problems associated with the burnable fuel. The main problem lies in the limited resources of Earth's resources. By some predictions we will have enough burnable fuel (oil, coal, gas) for another 30-40 years. First signs of this deficit can be seen in the increasing prices of oil, and conflicts in some of the countries that have large reserve of these resources. Another global problem is the pollution. By burning carbon-containing fuels the carbon oxides are released into the atmosphere, which causes the greenhouse effect. Along with that other substances that are harmful to the health released into air.

At present time about 80% of the world's total electricity is produced by the non-renewable "fire" energy sources. So a solution for mentioned problems is being searched urgently. One of the most popular directions is to use the renewable sources of energy: solar, wind or geothermal etc. But they have flaws e.g. cost, environment influence, space requirements. And regardless of these flaws, energy production by these sources is only 1.2% of the world's total energy production.

Another solution that has been well known to humanity for 60 years, is heat produced by a reaction of the neutron-induced nuclear fission. This form of energy is denser than the common sources of chemical (burning) or gravitational (hydroelectric) sources. Because of this even with the small mean density of the actinide elements present in the Earth crust, the price of the nuclear energy is considerable low.

After the first power plants had been built people were quite enthusiastic as the nuclear power plants produced a lot of energy and were considered as the most promising energy source for future. But the accidents at Chernobyl and Fukushima showed humanity that there are great risks in taming of the nuclear energy. Not only that, but nuclear power plants also produce spent nuclear fuel, which is hardly recyclable as it consists of transuranic elements that have half-lives of thousands years. Adding to that, at the present time most of the power plants use U-235 as a fuel which is only 0.7% of natural uranium (U-238). Which by the specialists' prediction will be able to provide us with energy till 2035.

But even with the mentioned problems, nuclear power plants are still most realistic future energy sources at current time. And in this paper a possible solution to the said problems will be discussed.

### Feoktistov's nuclear burning wave

In 1958 S. Feinberg [Feynberg, Kunegin 1958] has proposed breed'n'burn reactor in which fertile fuel is enriched by the neutrons from core by moving unenriched U-238 into the active zone. After that several mentions on this topic were made, but they were not popular, as the nuclear power plants worked steadily and produced energy enough for the mankind demand. But after the Chernobyl accident construction of new nuclear power plants reduced until stricter safety rules will be developed and all the nuclear power plants projects will be reconsidered according to these rules.

Concerned by the safety of producing nuclear energy, L. Feoktistov in 1988 proposed concept of reactor [Feoktistov 1998], in which breeding and burning will be done not by the mechanical manipulations but by the internal physics.

Main fuel in this reactor is U-238. By absorbing external neutron U-238 becomes U-239, which is after two  $\beta$ -decays (through Np-239) with the half-life of 2.35 days becomes Pu-239. Plutonium by its nature is a prone to fission material. After certain amount of plutonium is accumulated, it starts to decay as result of neutron-induced fission reactions.

These two processes (decay and accumulation) could be expressed through the simplified Pu-239 concentration balance equation:

$$\frac{dN_{Pu}}{dt} = \bar{v} \cdot n \left[ \sigma_{a8} N_8 - (\sigma_a + \sigma_f)_{Pu} N_{Pu} \right] \quad (1)$$

where  $N_{Pu}$  and  $N_8$  is the concentration of the plutonium and uranium-238 nuclei,  $\bar{v}$  and  $n$  are average speed and density of neutrons,  $\sigma_{a8}$ ,  $\sigma_{aPu}$  is the absorption cross-sections of U-238 and Pu-239 accordingly and  $\sigma_{fPu}$  is the cross-section of Pu-239 fission reaction.

It is easy to derive from the equation (1) expression for the equilibrium concentration of the plutonium nuclei (the condition is  $\frac{dN_{Pu}}{dt} = 0$ ):

$$\tilde{n}_{Pu} = \frac{\tilde{N}_{Pu}}{\tilde{N}_8} = \frac{\sigma_{a8}}{(\sigma_a + \sigma_f)_{Pu}}. \quad (2)$$

The condition for the equation (2) means that regardless of the starting concentration of plutonium it tends to the equilibrium concentration.

Another important equation for the U-Pu environment is a plutonium critical concentration. If the concentration of plutonium is less than critical  $n_{cr}$  then the system is under-critical i.e. after initial excitation the neutron flux decays with time. In case when the concentration of plutonium is greater than critical  $n_{cr}$  the system becomes over-critical and able to self-replication i.e. number of neutron increasing exponentially. The equation is:

$$\frac{dn}{dt} = \bar{v} \cdot N \cdot n \left[ (\nu - 1) \sigma_{fPu} - \sum_i \sigma_{ai} n_i \right], \quad (3)$$

where  $N$  is the density of all nuclei,  $n_i$  is relative density of different nuclei,  $\nu$  is the number of neutrons per fission reaction.

The critical concentration of the plutonium can be found under assumption of constant neutron flux  $\frac{dn}{dt} = 0$  which is with the equation (3) gives us:

$$n_{cr} = \frac{\sum_i \sigma_{ai} n_i}{(\nu - 1) \sigma_{fPu}}. \quad (4)$$

The equation (4) shows, that critical concentration of plutonium is defined by different combinations of constant. It should be mentioned that these constants are strongly dependent on the neutron energy.

In case of under critical reaction external source is required to sustain chain reaction. For the thermal neutrons reactions on plutonium is always under-critical as can be seen in the estimations. On the other hand, Feoktistov has shown [Feoktistov 1998], that in case of the fast spectrum neutrons it is possible to select concentrations  $n_i$  so the system will be over critical  $\tilde{n}_{Pu} > n_{cr}$ .

Over-critical reactor means that the chain “explosion” reaction will occur in the system. But in reality, the length of the neutron absorption in such environment is around several centimeters, and with the half-life of Np-239 of 2.35 days means that the plutonium will be burned out by the fission reactions under the critical concentration until (after 2.35 days) new Pu-239 will be accumulated.

So the overall picture of Feoktistov’s concept looks like this: first layer of U-238 is irradiated by external source, then after 2.35 days Pu-239 is accumulated, after that it decays in fission reactions, and neutrons being released are irradiating next layer, and this process repeats itself starting next layer. It is similar to the wave movement so it was called nuclear burning wave.

In his work Feoktistov made a lot of simplifications which might put doubts onto plausibility of his results. So more precise calculations were required to prove if such nuclear burning wave could be achieved. Such calculations were made by several scientific groups Teller et al. [Teller, Ishikawa, Wood 1995], Fomin et al. [Fomin, Mel'nik, Pilipenko, Shul'ga 2009] calculated development of the non-stationary case of nuclear burning wave. Takaki and Sekimoto [Takaki, Sekimoto 2008] have taken into consideration a lot of parameters. Andin2006, private company TerraPower launched a project of traveling-wave reactor or TWR [Gilleland et. al. 2008].

### Conclusions

One of the most important problems of humanity is generating energy. At present the most realistic source of energy that can satisfy this requirement is nuclear energy.

Many problems remain unresolved or solved partially in the nuclear energy field. One of the solutions that remain on the development stage is the nuclear burning wave.

Reactor working on the nuclear burning wave uses U-238 as a fuel, which can satisfy growing energy demand for another thousand years. The chain "explosive" reaction is impossible due to the internal physics. In such a reactor fuel burnout is much higher, which means higher energy production per mass of fuel, which decreases cost of the energy production. The fast spectrum neutrons provide higher burnout of the transuranic elements, which simplifies the problem of the spent fuel recycling.

Recent calculations show that in such reactor radiation dose is very high, and there are no materials that can withstand such irradiation. The possibility to decrease power of such reactor at the same time decreasing the irradiation doses is being considered as the solution.

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## ON THE DISTRIBUTION OF ELECTRIFIED DIELECTRIC POWDER MATERIALS OVER THE DIELECTRIC SURFACES

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**Abstract:** This article deals with the simplified theoretical methods of investigation of the distribution of electrified dielectric powder materials over the dielectric surfaces. As the result, the expressions for the mass of the average particle adhered to the surface and the evaluative surface concentration of the particles have been obtained. The results could be useful in the industrial sphere for the factories producing powder and granular solid materials, such as sugar, detergent powder, talc, corn starch and others.

**Key words:** Electrization, powder, surface density, dielectrics, polarization.

### Introduction

The phenomena of electrization of powdery or granular materials could be an urgent and highly undesired problem in the processes of sifting the powder. This feature leads to entering the manufacturing material into the machine parts, its systematic dispersal, and in case of large volumes of the material and dry air – even to the electrical sparks, which can destroy electrification or machine tools. Special dielectric properties of the material, such as ferroelectricity or piezoelectricity, could also affect the electrization process and could be

the reason for the accumulation of large electric charges and, hence, may lead to particularly significant implications.

However, if studied numerically and taken into account, these phenomena could be either reduced or used in the manufacturing process for the efficient delivery of the material within the inclined transport belts, conveyors and other plants. The latter could be done by means of calculating the average mass of the powder particles or granules and the evaluative distance between them. Knowing both these values, one can calculate particles of what sizes remain on the inclined conveyor belt and how many particles are situated on the unit of the surface area of the belt. This could give the necessary information on the effective surface mass density of the granules that adhere to the belt and, therefore, may either give an idea about the order of the magnitude of the powder loss or provide the basic theoretical estimation for the later precise theory for computing the device that could be developed for the secondary collection of the products. Moreover, these results could give a pre-theoretical basis for the methods of separation of powdery materials based on the electrization of granules.

In this article, we will consider one of the possible analytical methods of estimation of the aforementioned values, studying the problem for the general case of the inclined belt and uniform distribution of the electric charge along the belt and within the volume of powder. The aim of this work is to give the final expressions for the mass of the average particle adhered to the surface and for the evaluative surface concentration of the particles. The special case of electrically neutral belt and extremely charged particles has been examined. We will not consider the problem of electrization of both the surface and the granule. Nonetheless, we will outline the main factors influencing this effect.

## **Discussion and Results**

### **Electrization of powdery materials**

It is well known that the powdery materials have a tendency to charge during different processes of electrization. In industry these phenomena could occur during such procedures as electrization of granules by air while moving along the pipes, electrization by rubbing against the surfaces while moving along them, self-triboelectrization of the particles, electrization by strong incident electromagnetic radiation or strong outer electrostatic field. These types of powder electrization have already been studied in detail.

The theoretical proceedings and the experimental results on different types of electrization were well presented in a number of works [Mizutani, Yasuda, Matsusaka 2013; U. Ghorı, Šupuk, Conway 2015; Dwari, Hanumantha Rao 2008]. In this broad number of articles, the main factors affecting the electrization process were detected. An extremely precise set of experiments in a work [Aurnob 2014] has shown that the main and the most important factor is the air humidity. The values of the charge loss per unit of time are much higher for the elevated humidities of surrounding air, and lower for the reduced ones. Other factors are sharpness and material of a transporting appliance, clearness of its surface, frequency of its vibration, the geometry of particles, material of particles and others.

### **Problem of the charged powder lying on the charged surface**

Previous works dealing with the distribution of electrified powdery materials and dusts showed mostly the electrization aspect of the problem, but only several of them are trying to calculate the actual values of average particle sizes and surface densities. However, experimental approaches and results are quite productive [Korevaar, Paddingz, Van der Hoefx, Kuipers 2013].

In this part we shall consider dielectric particles of the powder in rest relatively to the inclined plain dielectric surface on which they are lying. Let the surface be charged uniformly with the charge density  $\sigma$ , and let the angle between a surface and the horizontal plane be  $\alpha$ . The electrostatic field near this surface could be obtained using the formula for the field of the infinite charged plane:

$$E = \frac{\sigma}{2\epsilon_0}$$

Now we shall consider the forces acting on a single particle of a charge  $q$  and mass  $m$  resting on the surface. These forces are the gravitational force  $m\vec{g}$ , the normal reaction force  $\vec{N}$ , the electric force  $\vec{F}_{el} = \vec{E} \cdot q$  which is a force of attraction directed normally to the surface, and the friction force of absolute value  $F_{fr} = \mu N$ . When  $\tan \alpha < \mu$ , even without any electric force acting on it, the particle would always remain in rest.

Let us consider a more interesting case when  $\tan \alpha > \mu$ . The equations of balance of a particle written in projections on the vertical and horizontal lines give the final equation:

$$mg = \frac{\mu \cdot E \cdot q}{\sin \alpha - \mu \cos \alpha}$$

Using the formula for the field  $E$  we get:

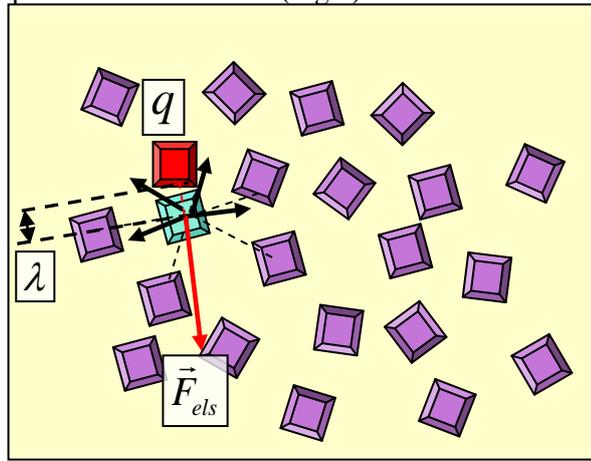
$$m = \frac{\mu \cdot \sigma \cdot q}{2\varepsilon_0 g (\sin \alpha - \mu \cos \alpha)}$$

Consequently, for the average linear size of the particles (with density  $\rho$ ) stuck to the surface we get:

$$a \approx \left[ \frac{\mu \cdot \sigma \cdot q}{2\varepsilon_0 g (\sin \alpha - \mu \cos \alpha) \rho} \right]^{\frac{1}{3}}$$

It is very important that these calculations are true only for the powder that is not too small for the molecular forces between the particles themselves and between the particles and the surface to prevail.

Let us find the average distance  $\lambda$  between the particles. For this purpose, we will consider the spontaneous distribution of the powder on the surface (Fig.1).



**Fig.1** The spontaneous distribution of powder. (Red square is the “deciding” particle; the blue one is the treated particle).

The net electric force that is the sum of all the forces from almost all of the surrounding particles is zero on the average. Nevertheless, there is, again on average, one particle, which we shall call the “deciding” particle, which is the closest to the particle treated. The electric force, which these two particles interact with, is much stronger than any of the electrical forces of interaction of other particles. The average value of the projection of gravity force on the surface is zero. Consequently, by writing the balance of average forces acting on the treated particle we get:

$$F_{fr} \approx F_{els}$$

As mentioned above, friction force has a value  $F_{fr} = \mu \left( \frac{\sigma}{2\varepsilon_0} \cdot q + mg \cos \alpha \right)$ . The “deciding” particle-

related force is  $F_{els} = \frac{1}{4\pi\varepsilon_0} \frac{q^2}{\lambda^2}$  and we could obtain:

$$\frac{1}{4\pi\varepsilon_0} \frac{q^2}{\lambda^2} \approx \mu \left( \frac{\sigma}{2\varepsilon_0} \cdot q + mg \cos \alpha \right)$$

Finally, we get the value of  $\lambda$  :

$$\lambda^2 \approx \frac{q}{\pi\mu \left( 2\sigma + \frac{4\varepsilon_0}{q} mg \cos \alpha \right)}$$

Consequently, we get the value of the surface concentration of the particles  $\kappa$  :

$$\kappa \approx \frac{1}{\lambda^2} \approx \frac{\pi\mu}{q} \left( 2\sigma + \frac{4\varepsilon_0}{q} mg \cos \alpha \right)$$

### Problem of the extremely charged powder lying on the polarized surface

In this additional part, we shall consider a special problem that has a following formulation: we have extremely charged dielectric particles lying on an electrically neutral dielectric surface. These particles have such a big charge that the electrical polarization of the surface is considerable. Under these conditions, particles could stick to the surface.

The surface density of the powder is relatively small due to the strong electrical forces or their interaction; thus, the external electric field  $E_{pol}$  polarizing the small element of the area of the surface then could be estimated as follows:

$$E_{pol} \approx \frac{q}{4\pi\varepsilon_0 \left( \frac{m}{\rho} \right)^{\frac{2}{3}}}$$

Consequently, the induced charge surface density is:

$$\sigma' = \varepsilon_0 (\varepsilon - 1) E_{pol} = \frac{q(\varepsilon - 1)}{4\pi \left( \frac{m}{\rho} \right)^{\frac{2}{3}}}$$

Now we could use all of the previous calculations to find the final equation for the average size of a particle  $a$ :

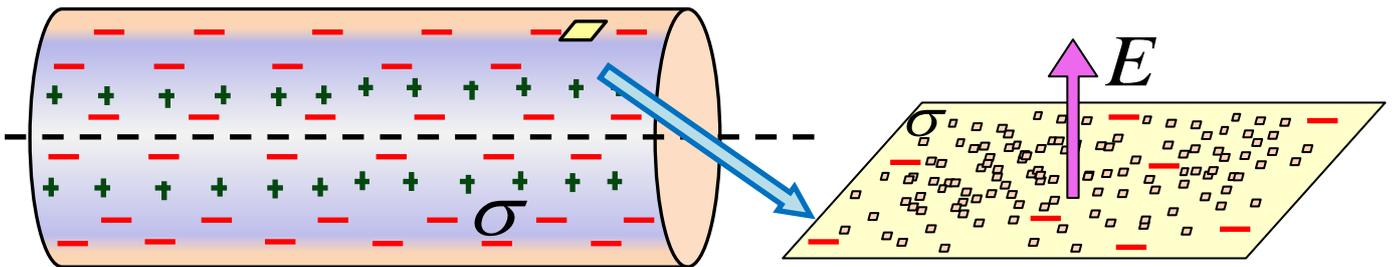
$$m = \frac{\mu \cdot q^2 (\varepsilon - 1)}{8\pi\varepsilon_0 g \left( \frac{m}{\rho} \right)^{\frac{2}{3}} (\sin \alpha - \mu \cos \alpha)} \Rightarrow a = \left( \frac{m}{\rho} \right)^{\frac{1}{3}} = \left[ \frac{\mu \cdot q^2 (\varepsilon - 1)}{8\pi\varepsilon_0 g (\sin \alpha - \mu \cos \alpha) \rho} \right]^{\frac{1}{5}}$$

Moreover, we could find the value of the surface concentration of the particles  $\kappa$ :

$$\kappa \approx \frac{1}{\lambda^2} \approx \mu \left( \frac{(\varepsilon - 1)}{2 \left[ \frac{\mu \cdot q^2 (\varepsilon - 1)}{8\pi\varepsilon_0 g (\sin \alpha - \mu \cos \alpha) \rho} \right]^{\frac{6}{5}} + \frac{4\varepsilon_0 \pi g \cos \alpha}{q^2} \left[ \frac{\mu \cdot q^2 (\varepsilon - 1) \rho^{\frac{2}{3}}}{8\pi\varepsilon_0 g (\sin \alpha - \mu \cos \alpha)} \right]^{\frac{3}{5}}} \right)$$

### Possible extensions of the theory

The short evaluative theory obtained could be applied not only in case of an inclined plain surface, but also in surfaces that have more complicated geometry, i.e. for the cylindrical or conic ones. The main idea of considering the electric field acting on the particles as a field of infinite uniformly charged plane in the first part is preserved; however, the relevance and adequacy of such an assumption is explained in a different way. The electrization of a dielectric surface happens in such a way that there are some lines where the surface charge is positive and some lines where it is negative.



**Fig.2** The cylindrical electrified surface with differently charged lines. (For the explanation of estimation of the average field near the surface)

This could be easily verified experimentally by observing the pattern in which the powder is arranged: after the electrization, there are steady lines where powder does not stick. The net field from these differently charged lines is on average zero; therefore, we may take into account only the “decisive” field of the nearby zone. The idea of the second part is the same. The only changes that must be done in this theory are due the factual geometrical differences of a certain system.

If the value of a surface mass density  $\eta$  of the powder is required, one could obtain the latter in a following way:

$$\eta = m\kappa$$

### Conclusions

As a result, an estimative theory of the dielectric powder distribution over the dielectric surfaces was proposed. Two main cases of the electrization of both the material and a surface and the extremely strong electrization were considered.

The work developed a basic theoretical technique for the calculation of the average size of the particles, their surface concentration, and their surface mass density. Possible theoretical applications of this method to the cases of more geometrically complicated systems were outlined.

This technique opens the possibility of the improvements of the production processes at the plants where powdery materials are moving along the dielectric elements. Three possible ways of improvement by means of the theory discussed along with the theories of electrization of materials are: getting an idea of the order of the magnitude of the powder loss, calculating the later precise theory for computing the devices collecting the secondary raw materials, and developing the methods of separation of powdery materials based on electrization of granules.

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## FIRST OBSERVATION OF GRAVITATIONAL WAVES AND PERSPECTIVES OF THEIR APPLYING IN THE FUTURE

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**Abstract:** This article is devoted to an important discovery in physics and astronomy – the first observation of gravitational waves. The existence of gravitational waves was predicted by Albert Einstein in his general theory of relativity, but had only indirect confirmation. Direct detection of gravitational waves occurred in September 2015. Gravitational waves are not electromagnetic radiation. They are not scattered or absorbed. This allows us to observe the universe in a completely new way.

**Key words:** Gravitational waves, general theory of relativity, binary black hole merger, neutron stars, gravitational-wave detector.

**Introduction.** Gravitational waves are 'ripples' in the fabric of space-time caused by some massive objects moving with violent accelerations. Albert Einstein predicted the existence of gravitational waves in 1916 in his general theory of relativity. Einstein's mathematics showed that massive accelerating objects (such as neutron stars or black holes orbiting each other) would disrupt space-time in such a way that 'waves' of distorted space would radiate from the source (like the movement of waves away from a stone thrown into a pond). Furthermore, these ripples would travel at the speed of light through the Universe carrying with them information about their cataclysmic origins as well as invaluable clues to the nature of gravity itself.

The strongest gravitational waves are produced by catastrophic events such as colliding black holes, the collapse of stellar cores (supernovae), coalescing neutron stars or white dwarf stars, the slightly wobbly rotation of neutron stars that are not perfect spheres, and the remnants of gravitational radiation created by the birth of the Universe itself.

Historically, scientists have relied primarily on observations with electromagnetic radiation (visible light, x-rays, radio waves, microwaves, etc.) to learn about and understand objects and phenomena in the Universe. (In recent years, even subatomic particles called neutrinos have begun to be used to study aspects of the heavens.) Each of these sources of information provides scientists with a different and complementary view of the Universe, with exciting new discoveries occurring as each new 'window' has been discovered, introduced, and utilized. They are a completely different phenomenon carrying information about cosmic objects and events that is not carried by electromagnetic radiation. Colliding black holes, for example, emit little or no electromagnetic radiation, but the gravitational waves they emit will cause them to "shine brightly" like beacons on an utterly dark cosmic sea. More importantly, since gravitational waves interact very weakly with matter (unlike electromagnetic radiation), they travel through the Universe virtually unimpeded giving us a clear view of the gravitational-wave Universe. They carry information about their origin that is free of the kinds of distortion or alteration suffered by electromagnetic radiation as it traverses intergalactic space. With this completely new way of examining astrophysical objects and phenomena, gravitational waves will truly open a new window on the Universe, providing astronomers and other scientists with their first glimpses of previously unseen and unseeable wonders, and greatly adding to our understanding the nature of space and time itself.

**Analysis of recent achievements.** Before now, the strongest evidence of gravitational waves came indirectly from observations of superdense, spinning neutron stars called pulsars. In 1974 Russell Alan Hulse and Joseph Hooton Taylor Jr. discovered the first binary pulsar. Observations have shown that the pulsar's orbit is gradually contracting, possibly an evidence for the emission of energy in the form of gravitational waves, as described by Einstein's theory of general relativity – a discovery that won Taylor and Hulse the 1993 Nobel Prize in Physics.

**The object-matter** of the article is to study gravitational waves as a physical phenomenon.

**The subject-matter** of the article is to describe the phenomenon of gravitational waves during its evolution: from the first prediction of the existence of gravitational waves to the first direct observation and confirmation of the existence.

**The objective of the article** is to review the first observation of gravitational waves and the impact of this discovery on future cosmological observation.

**The tasks are** to consider in details the first observation of gravitational waves and to outline the applications of gravitational waves in observational cosmology and other fields of physics.

**The presentation of the main research material.** On September 14, 2015 at 09:50:45 Greenwich Mean Time the LIGO Hanford and Livingston Observatories both detected a signal from GW150914. Obtained signal is shown in Fig. 1.

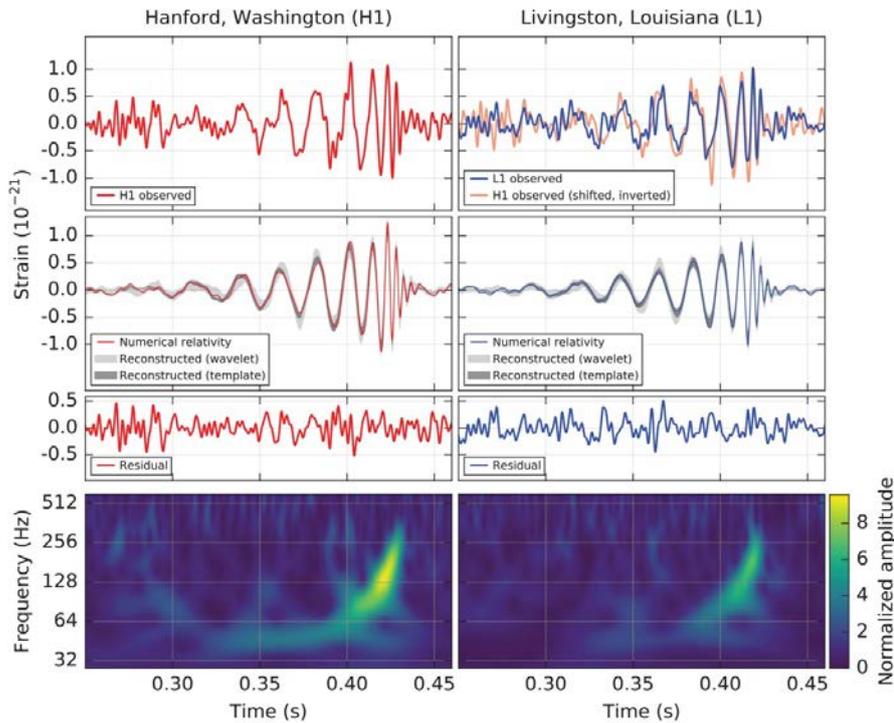


Figure 1.

The signal was identified first by low-latency search methods that are designed to analyse the detector data very promptly, looking for evidence of a gravitational-wave like pattern but without modeling the precise details of the waveform. These prompt searches reported the candidate event within only three minutes of the signals arriving at the detectors. The gravitational-wave strain data acquired by the LIGO interferometers were then compared with an extensive bank of theoretically predicted waveforms – a process known as matched filtering – with the goal of finding the waveform that best matched the data.

Results indicated that GW150914 was produced by the merger of two black holes with masses of about 36 times and 29 times the mass of the Sun respectively, and that the post-merger black hole had a mass of about 62 times the Sun’s mass. Moreover, it was inferred that the final black hole is spinning – such rotating black holes were first predicted theoretically in 1963 by a mathematician Roy Kerr. Finally, results indicated that the GW150914 occurred at a distance of more than one billion light years. If we compare the masses of the pre- and post-merger black holes, we see that the coalescence converted about three times the mass of the Sun (or nearly six million trillion trillion kilograms) into gravitational-wave energy, most of it emitted in a fraction of a second. By contrast, the Sun converts a mere two billionths of one trillionth of its mass into electromagnetic radiation every second. In fact, the gravitational wave power radiated by GW150914 was more than ten times greater than the combined luminosity (i.e. the light power) of every star and galaxy in the observable Universe.

The project used two detectors, one located in Washington State and the other in Louisiana, to sense the distortions in space that occur when a gravitational wave passes through the Earth. Each detector was shaped like a giant L, with legs four kilometers long. Laser light bounced back and forth through the legs, reflecting off mirrors, and amazingly precise atomic clocks measured how long it took to make the journey. Normally, the two legs were exactly the same length, and so the light took exactly the same amount of time to traverse each. If a gravitational wave passes through, however, the detector and the ground beneath it will expand and contract infinitesimally in one direction, and the two perpendicular legs will no longer be the same size. One of the lasers will arrive a fraction of a second later than the other. LIGO must be unbelievably sensitive to measure this change in the length of the legs, which is smaller than one ten-thousandth the diameter of a proton. In fact, the experiment was so delicate that unrelated events such as an airplane flying overhead, wind buffeting the building or tiny seismic shifts in the ground beneath the detector could disturb the lasers in ways that mimic gravitational signals. The researchers carefully weed out such contaminating signals and also took advantage of the fact that the detectors in Washington and Louisiana were unlikely to be affected by the same contamination at the same time.

**Results.** The detected waveform matches the predictions of general relativity for the inspiral and merger of a pair of black holes and the ringdown of the resulting single black hole. These observations demonstrate the

existence of binary stellar-mass black hole systems. This is the first direct detection of gravitational waves and the first observation of a binary black hole merger.

Detecting and analyzing the information carried by gravitational waves will allow to observe the Universe in a way which was never possible before. It will open up a new window of study the Universe, give us a deeper understanding of these cataclysmic events, and usher in cutting-edge research in physics, astronomy, and astrophysics.

**Applying gravitational waves in other fields of physics.** One of the most important scientific consequences of detecting a black-hole merger would be confirmation that black holes really do exist—at least as the perfectly round objects made of pure, empty, warped space-time that are predicted by general relativity. Another one would be that mergers proceed as predicted. Astronomers already have plenty of circumstantial evidence for these phenomena, but so far that has come from observations of the stars and super-heated gas that orbit black holes, not of black holes themselves.

Black holes and neutron stars form when massive stars stop shining and collapse in themselves. Astrophysicists think that this process is what powers a common type of supernova explosion, known as Type II. The simulations of such supernovae have not yet clearly explained what ignites them, but listening to the gravitational-wave bursts that real supernovae are expected to produce could help to provide an answer. Depending on what the bursts' waveforms look like, how loud the bursts are, how frequent they are and how they correlate with the supernovae as seen with electromagnetic telescopes, the data could help to validate or discard various existing models.

The expansion of the Universe means that distant objects that are receding from our Galaxy look redder than they really are because the light they emit stretches as it travels. Cosmologists estimate the rate of the Universe's expansion by comparing this redshift of galaxies with how far the galaxies are from us. But that distance is usually gauged from the brightness of 'Type I' supernovae—a technique that leaves large uncertainties. If several gravitational-wave detectors across the world detect signals from the same neutron-star merger, together they will be able to provide an estimate of the absolute loudness of the signal, which will reveal how far away the merger occurred. They will also be able to estimate the direction it came from; astronomers could then deduce which galaxy hosted the merger. Comparing that galaxy's redshift with the distance of the merger as measured by the loudness of the gravitational waves could provide an independent estimate of the rate of cosmic expansion, possibly more accurate than current methods.

Neutron stars are the remnants of bigger stars that collapsed under their own weight, becoming so dense that they pushed their constituent electrons and protons to fuse into neutrons. Their extreme physics is poorly understood, but gravitational waves could provide unique insights. For example, the intense gravity at their surface tends to make neutron stars almost perfectly spherical. But some researchers have theorized that there could still be 'mountains'—at most a few millimetres high—that make these dense objects, themselves about 10 kilometres in diameter, slightly asymmetrical. Neutron stars usually spin very rapidly, so the asymmetric distribution of mass would deform space-time and produce a continuous gravitational-wave signal in the shape of a sine wave, which would radiate energy and slow down the star's spin. Pairs of neutron stars that orbit each other would also produce a continuous signal. Just like black holes, the stars would spiral into each other and eventually merge, sometimes producing an audible chirp. But their final instants would differ dramatically from those of black holes. For example, the resulting merged star could be a huge neutron star, or it could immediately collapse and turn into a black hole.

### **Conclusions**

The first direct detection of gravitational waves and the first observation of a binary black hole merger are remarkable achievements, but they represent only the first page of an exciting new chapter in astronomy. They give us a chance to usher in an era where astronomers can use gravitational waves, rather than light, to "see" black holes and other invisible components of the hidden universe. The nascent field of gravitational wave astronomy has a very bright future.

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## LES PROBLEMES DES TRANSPORTS URBAINS EN UKRAINE

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**Résumé :** Dans cet article nous présentons les problèmes de transport urbain en commun ukrainiens dans leur fonctionnement ainsi que la place qu'ils occupent dans le monde du transport . Ces problèmes sont abordés en insistant sur les enjeux sociaux liés à l'évolution de la mobilité et les enjeux technologiques ou pratiques. Après un bref aperçu des besoins, les solutions sont proposées.

**Mots clés :** le trafic, le transport urbain, l'organisation des transports, les transports en commun, l'infrastructure de transport.

**Introduction.** Le transport urbain de l'Ukraine fonctionne dans 53 villes. Les bus et taxis vous emmèneront dans les coins les plus éloignés de la ville. Si vous ne vous dépêchez pas, c'est une magnifique visite de la ville, car les bus ne peuvent pas se déplacer rapidement en ville et parfois sont obligés d'attendre dans les embouteillages sur les routes. Mais dans les petites villes et même dans une ville, avec le nombre des habitants de plus de 1 300 milles d'habitans, comme Kharkiv, les tramways et les trolleybus sont devenus obsolètes, le parc n'est pas à jour, et parfois ils ont l'air étrange, comme une curiosité, un écho de l'ère soviétique.

**Le but de cet article** est de rassembler et d'ordonner un certain nombre d'idées des problèmes de gestion des transports urbains en commun et sur les problèmes liés aux précédents concernant les coûts de transport. Le gouvernement de nombreuses villes de l'Ukraine depuis plus de 25 ans de l'indépendance n'a pas accordé suffisamment d'attention au développement des transports urbains. Les fonctions de la municipalité sont transmises aux entreprises privées. Ils ne sont absolument pas axés sur la fourniture du transport de qualité, alors que dans toutes les villes européennes l'organisation des transports urbains est une fonctionnalité exclusive de la ville.

La ville se caractérise par une démographie importante qui implique une certaine attention concernant l'organisation des transports. Les transports en commun permettent de transporter un grand nombre de voyageurs à un moindre coût économique et environnemental. Une autre caractéristique de la ville est qu'en plus d'accueillir des individus, c'est un lieu d'activités économiques importantes, et donc c'est une cause de déplacements, que l'on peut prévoir en fonction des zones résidentielles ou d'activités[6].

L'histoire de la région kharkovienne montre que le développement des infrastructures de transport reflète avant tout une réalité géographique et industrielle. Il arrive aussi que les réseaux de transport s'adaptent avec beaucoup de retard et plus ou moins de succès à la localisation de l'habitat. Par contre, il n'existe que très peu d'exemples où les transports ont été utilisés pour orienter le développement urbain (c'est le cas de la première lignes de métro ). Ainsi, dans les années d'avant guerre, la localisation des usines reflétait les facilités de transport routier et ferré. La mise en place des réseaux avait précédé l'installation des usines. En revanche, les premiers banlieusards ont dû attendre pendant des années qu'on ouvre des gares et crée des trains de banlieue avec des horaires adaptés à leurs besoins. Les lendemains de la deuxième guerre mondiale ont vu le développement extrêmement rapide de la banlieue avec des lotissements répartis le long des voies ferrées et des grands axes routiers. En raison du prix des terrains, les lotissements furent souvent construits à plusieurs kilomètres de la voie ferrée. Le parcours du domicile à la gare se faisait en vélo ou à pied.

Le choix du mode de transport dépend de la distance à parcourir. Les déplacements de moins d'un kilomètre et demi sont effectués à pied (67 % des déplacements) ou en transports en commun (27 % des déplacements) mais pratiquement pas en voiture (4 %). Au-delà d'un kilomètre et demi, la marche disparaît. Les transports en commun sont majoritaires (60 % des déplacements), suivie par la voiture (34 %). La part des transports en commun augmente avec la distance.

En moyenne, la distance parcourue à pied est de 600 mètres, elle est de 2 km en vélo et de 7,2 km pour un deuxroues motorisé. La longueur moyenne des déplacements en voiture est de 6,4 km et elle atteint 8,7 km pour les transports en commun. Globalement, la part des transports en commun diminue depuis des années[3].

La part relative des modes de déplacements change selon la taille des zones urbaines et la région. En moyenne deux tiers des déplacements domicile-travail se font en transports en commun, un quart utilise plusieurs modes de transport et le reste se fait à pied, en voiture particulière ou en deux-roues. Il y a encore un petit pourcentage qui correspond aux personnes qui travaillent à domicile. Les déplacements domicile-travail en voiture sont plus nombreux dans les grandes agglomérations. Les deux-roues restent cependant un mode de transport minoritaire.

**Solution des problèmes de transport.** Pour l'utilisateur, l'important est le temps nécessaire pour aller d'un point à un autre. Ce temps peut être raccourci en modulant la vitesse du trafic, la distance séparant les stations et le temps passé aux arrêts. Le trafic peut être rapide lorsque le transport se fait en site propre et totalement à l'écart (train, métro). En revanche, la vitesse dépasse difficilement 20 km/h lorsque la voie peut être franchie par d'autres véhicules ou des piétons (la vitesse tombe dans les zones où circulent beaucoup de piétons)[1]. La vitesse du trafic peut aussi être augmentée par la réduction du temps perdu en amont des carrefours. Ainsi, la synchronisation du passage au vert des feux avec l'arrivée des véhicules augmente de 10 % à 20 % la vitesse commerciale des transports en commun sans ralentir le trafic automobile. Pour être pleinement efficace, ce système nécessite un couloir de bus. La mise en place d'une desserte par zone améliore considérablement le service lorsque les lignes sont longues. Ce système réduit la durée du trajet et il est très économique[2].

Comment améliorer l'accessibilité des transports en commun ? Un plancher plat surbaissé et des places réservées pour les poussettes et les fauteuils roulants sont des préalables indispensables à l'accessibilité. Pour les fauteuils roulants, il faut aussi que la différence de niveau entre le plancher et le trottoir ne dépasse pas 5 cm et que l'écart entre le bord du trottoir et l'entrée du véhicule ne dépasse pas 10 cm. Cette précision est obtenue sans problème avec les systèmes guidés (tramways, autobus guidés). En revanche, elle est difficile à atteindre avec un autobus (l'écart dépasse souvent 50 cm). Il faut alors recourir à un dispositif mécanique (palette). Environ 35 % des personnes rencontrent des difficultés lorsqu'elles utilisent les transports en commun et cette proportion devrait augmenter avec le vieillissement de la population. Parmi elles, une sur sept souffre d'un handicap d'ordre médical. Mais la grande majorité sont des personnes accompagnées d'enfants en bas âge (landau, poussette), encombrées de bagages ou simplement âgées. Les principales difficultés rencontrées sont, en ordre d'importance décroissante, monter et descendre les escaliers, monter et descendre d'un autobus, passer une barrière de péage, emprunter un escalator, marcher plus de 200 mètres, utiliser une billetterie automatique, faire face à une perturbation du trafic [4].

Comment améliorer la qualité du service pour les usagers des transports en commun ? Le respect des horaires et l'augmentation de la fréquence des services sont des revendications récurrentes des usagers des transports en commun depuis le début du XXe siècle. Les opérateurs n'ont jamais réussi à répondre à ces attentes. Leurs efforts se sont portés depuis le milieu des années 1980 sur l'amélioration du cadre de vie des usagers et des prestations offertes dans les lieux d'attente (billetterie, commodités offertes aux stations, information des usagers, etc.). L'organisation de la billetterie influe fortement sur la commodité des déplacements.

L'idéal pour le voyageur est de pouvoir faire l'ensemble du déplacement avec un seul billet, quels que soient les moyens de transport utilisés. Mais cet objectif est difficile à atteindre à cause de la multiplicité des structures gérant les transports dans une aire urbaine. Différents services peuvent être offerts aux usagers pour leur permettre d'utiliser au mieux les temps d'attente : billetterie et commerces dans les gares ou aux arrêts de bus, affichage du temps d'attente des prochains passages. Dans l'idéal, un usager voulant optimiser ses déplacements devrait pouvoir contacter une centrale de mobilité, c'est-à-dire un centre d'information sur tous les modes de transport et proposant toutes sortes de prestations[5].

**Conclusion.** Il n'est pas possible de tirer une conclusion définitive sur un sujet en plein développement à l'heure actuelle. Pour améliorer l'efficacité des transports en commun avant tout on a besoin d'investissements pour améliorer l'infrastructure de la région. Il faut créer un climat d'investissement favorable et toutes sortes d'assistance de la part de l'état, ce qui assure le développement des transports en commun. Autrement dit, il faut créer les conditions pour que cette industrie devienne profitable pour intéresser les investisseurs potentiels dans le transport en commun urbains ainsi que les travailleurs eux-mêmes grâce à l'augmentation des salaires avec une augmentation simultanée des exigences de qualité de l'exécution des travaux.

Parmi les mesures prioritaires on peut citer la création d'un organe de gestion des transports urbains; l'annulation des prestations de voyage de tous les citoyens, à l'exception des ayant besoin des allocations sociales garanties par l'état ; promouvoir un régime de responsabilité uniforme et transparent pour tous les opérations de transport urbain, qui garantisse des chances égales à tous les modes utilisés ; améliorer la qualité de service[3].

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## TRIP DISTRIBUTION MODELLING

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**Abstract:** Mode choice as an aggregate problem is discussed. Methods to estimate generation, distribution and modal split simultaneously are given and analyzed.

**Key words:** factors influencing the choice of mode, trip-end modal-split models, trip interchange modal-strip models, synthetic models.

### Introduction

The article deals with the problem of investigating people travel demand and factors influencing the choice of the mode of transportation. This problem is very relevant and needs a very deep theoretical and practical research of studying people's preferences in choosing a suitable route network.

**The object-matter** is the factors influencing the choice of the mode of transportation on the trip matrix

**The subject-matter** is the trip matrix

**The objective** is to test the effects of changes in the trip matrix.

**The tasks** are the following:

- to investigate different trip purposes and person types;
- to estimate trip attractions;
- to study trip-end modal-split and trip interchange modal-split models as well as synthetic models;
- to determine model parameters.

**Materials** to be used are national and foreign scientific resources on the given problem and practical study options of Kharkiv and Sumy transport networks.

**Methods** to be used are the analytical one, the observation method of existing scientific theories, systemizing method and statistical method of data processing.

### FACTORS INFLUENCING THE CHOICE OF MODE

The factors influencing mode choice may be classified into three groups:

1. Characteristics of the trip maker. The following features are generally believed to be important: car availability and/or ownership; possession of a driving licence; household structure (young couple, couple with children, retired, singles, etc.); income; decisions made elsewhere, for example the need to use a car at work, take children to school, etc; residential density.

2. Characteristics of the journey. Mode choice is strongly influenced by: the trip purpose ( for example, the journey to work is normally easier to undertake by public transport than other journeys because of its regularity and the adjustment possible in the long run); time of the day when the journey is undertaken (late trips are more difficult to accommodate by public transport); characteristics of the transport facility which can be divided into two categories (Firstly, quantitative factors such as relative travel time that is in-vehicle, waiting and walking times by each mode; relative monetary costs (fares, fuel and direct costs); availability and cost of parking. Secondly, qualitative factors which are less easy to measure, such as comfort and convenience; reliability and regularity; protection, security).

A good mode choice model should include the most important of these factors.

Mode choice models can be aggregate if they are based on zonal (and inter-zonal) information. Models can also be disaggregate if they are based on household and/or individual data.

#### TRIP-END MODAL-SPLIT MODELS

The application of mode choice models over the whole of the population results in trips split by mode, hence modal-split modelling. In the past, in particular in the USA, personal characteristics were thought to be the most important determinants of mode choice and therefore attempts were made to apply modal-split models immediately after trip generation. In this way the different characteristics of the individuals could be preserved and used to estimate modal split: for example, the different groups after a category analysis model. As at that level there was no indication to where those trips might go, the characteristics of the journey and modes were omitted from these models.

This was consistent with a general planning view that as income grew, most people would acquire cars and would want to use them. The objective of transport planning was to forecast this growth in demand for car trips so that investment could be planned to satisfy it. The modal-split models of this time related the choice of mode only to features like income, residential density and car ownership. In some cases the availability of reasonable public transport was included in the form of an accessibility index.

In the short run these models could be very accurate, in particular if public transport was available in a similar way throughout the study area and there was little congestion. However, this type of model is, to a large extent, defeatist in the sense of being insensitive to policy decisions; it appears that there is nothing the decision maker can do to influence the choice of mode. Improving public transport, restricting parking, charging for the use of roads, none of these would have any effect on modal split according to these trip-end models.

#### TRIP INTERCHANGE MODAL-SPLIT MODELS

Modal-split modelling in Europe was dominated, almost from the beginning, by post-distribution models; that is, models applied after the gravity or other distribution model. This has the advantage of facilitating the inclusion of the characteristics of the journey and that of the alternative modes available to undertake them. However, they make it more difficult to include the characteristics of the trip maker as they may have already been aggregated in the trip matrix (or matrices).

The first models included only one or two characteristics of the journey, typically (in-vehicle) travel time. It was observed that an S-shaped curve seemed to represent this kind of behaviour better, as in Figure 1, showing the proportion of trips by mode 1 ( $T_{ij}^1/T_{ij}$ ) against the cost or time difference.

These were empirical curves, obtained directly from the data and following a similar approach to the curves used to estimate what proportion of travellers would be

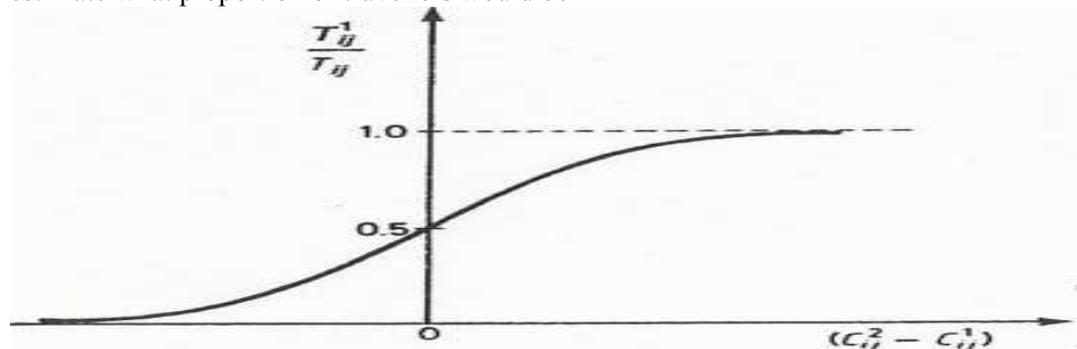


Figure 1 Modal-split curve

diverted to use a (longer but faster) bypass route: hence their name of diversion curves. For example, the London Transportation Study (Phase III) used diversion curves for trips to the central area and non-central trips (the former more likely to be made by public transport) and for different trip purposes.

#### SYNTHETIC MODELS

##### Distribution and Modal-split Models

The entropy-maximising approach can be used to generate models of distribution and mode choice simultaneously. In order to do this we need to cast the entropy-maximising problem in terms of, for example, two modes as follows:

$$\text{Maximise } \log W \left\{ T_{ij}^k \right\} = - \sum_{ijk} (T_{ij}^k \log T_{ij}^k - T_{ij}^k) \quad (1)$$

subject to 
$$\sum_{jk} T_{ij}^k - O_i = 0 \quad (2)$$

$$\sum_{jk} T_{ij}^k - D_j = 0 \quad (3)$$

$$\sum_{jk} T_{ij}^k C_{ij}^k - C = 0 \quad (4)$$

It is easy to see that this problem leads to the solution:

$$T_{ij}^k = A_i O_i B_j D_j \exp(-\beta C_{ij}^k) \quad (5)$$

$$P_{ij}^1 = \frac{T_{ij}^1}{T_{ij}} = \frac{\exp(-\beta C_{ij}^1)}{\exp(-\beta C_{ij}^1) + \exp(-\beta C_{ij}^2)} \quad (6)$$

Where  $P_{ij}^1$  is the proportion of trips travelling from  $i$  to  $j$  via mode 1. The functional form in (6) is known as logit. However, it is useful to reflect here on some of its properties:

- it generates an S-shaped curve, similar to some of the empirical diversion curves of Figure 1;
- if  $C_1 = C_2$ , then  $P_1 = P_2 = 0,5$ ;
- if  $C_2 \gg C_1$ , then  $P_1$  tends to 1,0;
- the model can easily be extended to multiple modes.

#### Conclusions

One important limitation of these models is that they can only be used for trip matrices of travellers with a choice available to them. This often means the matrix of car-available persons, although modal split can also be applied to the choice between different public-transport modes.

The models have little theoretical basis and therefore their forecasting ability must be in doubt. They also ignore a number of policy-sensitive variables like fares, parking charges, and so on. Further, as the models are aggregate they are unlikely to model correctly the constraints and characteristics of the modes available to individual households.

However, it is interesting to note that most such formulations, which were used in many studies up to the end of the 1970s, are in fact inappropriate.

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## EQUIVALENCE OF HAMILTONIAN AND LAGRANGIAN MECHANICS

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**Abstract:** In this article different methods of solving mechanical problems are analyzed on the basis of Hamiltonian and Lagrangian mechanics. Both methods are compared and the advantages of each one are shown. On the simple example equivalence of two different ways is observed to write equations of motions. Exploring the criteria of equivalence it is proved that in some cases it fails.

**Key words:** equivalence, generalized coordinates, Hamilton function, Hamilton's principle. Lagrange function.

**Introduction:** Lagrangian mechanics is a reformulation of classical mechanics, introduced by the Italian-French mathematician and astronomer Joseph-Louis Lagrange in 1788. No new physics is introduced in Lagrangian

mechanics compared to Newtonian mechanics. But it gives us advanced deep understanding of physics. The general equation of motion comes from Hamilton's principle. It states that the dynamics of a physical system is determined by a variational problem for a functional based on a single function, the Lagrangian, which contains all physical information concerning the system and the forces acting on it. Variational calculus helps us to derive differential equations of motion of the physical system. Although the Hamilton's principle is equivalent in classical mechanics to Newton's laws, it is better suited for generalizations and plays an important role in modern physics, particularly in quantum mechanics and the theory of relativity.

From this principle it can be shown that the equations of motion are second order differential equations in the generalized coordinates.

$$\frac{d}{dt} \left( \frac{\partial L}{\partial \dot{q}_i} \right) = \frac{\partial L}{\partial q_i}$$

Lagrangian mechanics is ideal for systems with conservative forces and for passing constraint forces in any coordinate system. Generalized coordinates can be chosen arbitrary, unlike Newton's laws.

Hamiltonian mechanics is also a reformulation of classical mechanics and it predicts the same outcomes as non-Hamiltonian classical mechanics. Hamilton's equations can be derived by considering how the total differential of the Lagrangian depends on time, generalized positions and generalized velocities.

$$\begin{aligned} \dot{q}_i &= \frac{\partial H}{\partial p_i} \\ \dot{p}_i &= - \frac{\partial H}{\partial q_i} \end{aligned}$$

The main motivation to use Hamiltonian mechanics instead of Lagrangian mechanics comes from the symmetric structure of Hamiltonian systems.

The **object-matter** of the study is the Lagrange and Hamilton mechanics, and the **subject-matter** is exploring the symmetry of two methods.

**Discussion and results:** Suppose we know the Lagrange function of our system. To derive Hamilton function we should do the following: 1) evaluate the energy of the system:  $E = \sum_i \frac{\partial L}{\partial \dot{q}_i} \dot{q}_i - L$ ; 2) change general velocities to momentum, using this equation:  $p_i = \frac{\partial L}{\partial \dot{q}_i}$ .

The reverse problem is to find Lagrange function from Hamilton function.

Using the same equation we obtain:  $L = \sum_i p_i \dot{q}_i - H$ . Then we change momentum to general velocity using Hamilton Equation:  $\dot{q}_i = \partial H / \partial p_i$ .

Consider we have linear oscillator. The Lagrange function of this system

$$L = \frac{\dot{q}^2}{2} - \frac{\omega^2 q^2}{2}$$

Energy and momentum of the system:

$$E = \frac{\partial L}{\partial \dot{q}} \dot{q} - L = \frac{\dot{q}^2}{2} + \frac{\omega^2 q^2}{2}$$

$$p = \frac{\partial L}{\partial \dot{q}} = \dot{q}$$

By changing general velocity to momentum we obtain:

$$H = \frac{p^2}{2} + \frac{\omega^2 q^2}{2}$$

Inverse operation looks the same:

$$L = p\dot{q} - H = p\dot{q} - \frac{p^2}{2} - \frac{\omega^2 q^2}{2}$$

$$\dot{q} = \frac{\partial H}{\partial p} = p$$

Finally:

$$L = \frac{\dot{q}^2}{2} - \frac{\omega^2 q^2}{2}$$

In this simple example we can observe the equivalence of two methods.

### Criteria of equivalence

Let us try to understand when the equivalence fails. The first step is always feasible, because we can always write the energy of the system. The second step is possible when our equation contains general velocity. But if Lagrangian depends on velocity linearly:  $L = c\dot{q}_1 + f(q, \dot{q}, t)$ , then  $p_1 = c$  and we can not exclude  $\dot{q}_1$  from our equation.

$$E = \sum_i \frac{\partial L}{\partial \dot{q}_i} \dot{q}_i - L = c\dot{q}_1 + \sum_i \frac{\partial f(q, \dot{q}, t)}{\partial \dot{q}_i} \dot{q}_i - (c\dot{q}_1 + f(q, \dot{q}, t))$$

So, we obtain that

$$E = \sum_i \frac{\partial f(q, \dot{q}, t)}{\partial \dot{q}_i} \dot{q}_i - f(q, \dot{q}, t)$$

Function  $f(q, \dot{q}, t)$  doesn't depend on  $\dot{q}_1$  so we exclude this velocity even without using our relation between velocity and momentum. So, if we have Lagrange function we always can write Hamilton function.

On the other hand, the same trouble may occur, when we want to write Lagrange function.

When  $H = cp_1 + f(q, p, t)$ , our relation is  $\dot{q}_1 = c$ . So from this equation we can not express  $p_1$ . The next step is to write

$$L = \sum_i p_i \dot{q}_i - cp_1 - f(q, p, t)$$

In this case Lagrange function still contain momentum  $p_1$  in combination  $p_1(\dot{q}_1 - c)$ . And we can not replace  $\dot{q}_1$  to  $c$  because we know this only from Hamilton equation, but not from Lagrange. So we can not express Lagrangian from Hamilton function, when it depends on momentum linearly. It means, that there is no Lagrange function for this system.

An example from real world, for which we know Hamilton function, but not Lagrangian, is photon. Hamilton function of this particle:  $H = pc$ , where  $c$  is speed of light. Hamiltonian changes with momentum directly, so we can not express Lagrangian.

Also we can try to write Lagrange function of a relativistic particle:

$$L = -mc^2 \sqrt{1 - \frac{\dot{q}^2}{c^2}}$$

But photons have  $m = 0$  and we just get  $L = 0$ . From this form of Lagrange function we can not derive any equation of motion. If mass of the particle is nonzero (even when  $m \rightarrow 0$ ) we can write Hamilton function in this form:

$$H = c^2 \sqrt{c^2 m^2 + p^2}$$

And equivalence still exist.

## Conclusions

In this paper we show, that in some cases there is no equivalence between Lagrangian and Hamilton methods. We can easily write Hamilton function for photon but there is no Lagrange function for this particle. But in the most problems of classical mechanics Lagrangian proportional to square of velocity so equivalence exist. It means that we can use both methods to solve mechanical problems, like oscillation or rotation of rigid body. But when try to extend our method outside classical mechanics equivalence disappears. So Hamilton method is more general and suitable for different system, such as light. Also the formulation of this method later contributed to the formulation of statistical mechanics and quantum mechanics.

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## ARTIFICIAL NEURAL NETWORKS

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**Abstract:** This article deals with artificial neural networks and their applications. The results of the study are as follows: artificial neural networks can help us solving real-life problems and are applied in many medical, financial and educational branches; however, they have a few disadvantages: the neural network model is relatively new; and we do not have enough power to learn algorithms for providing neural networks with data yet.

**Key words:** artificial neural network, machine learning, data mining.

## Introduction

Neural networks are a programming paradigm which enables a computer to learn from observational data. Artificial neural networks are inspired by the early models of sensory processing by the brain. An artificial neural network can be created by simulating a network of model neurons in a computer. By applying algorithms that mimic the processes of real neurons, we can make the network 'learn' to solve many types of problems.

A neural network operates similar to the brain's neural network. A "neuron" in a neural network is a simple mathematical function capturing and organizing information according to an architecture. The network closely resembles statistical methods such as curve fitting and regression analysis.

A neural network consists of layers of interconnected nodes. Each node is a perceptron and resembles a multiple linear regression. The perceptron feeds the signal generated by a multiple linear regression into an activation function that may be nonlinear.

In a multi-layered perceptron (MLP), perceptrons are arranged in interconnected layers. The input layer receives input patterns. The output layer contains classifications or output signals to which input patterns may map. For example, the patterns may be a list of quantities for technical indicators regarding security; potential outputs could be "buy," "hold" or "sell." Hidden layers adjust the weightings on the inputs until the error of the neural network is minimal. It is theorized that hidden layers extract salient features in the input data that have predictive power with respect to the outputs. This describes feature extraction, which performs a function similar to statistical techniques such as principal component analysis.

**Object-matter:** Neural networks as new approach of solving problems.

**Subject-matter:** How neural networks work.

**Objective:** To investigate both advantages and disadvantages of ANNs.

**Tasks:** To describe the idea and principles behind neural networks.

**Methods:** Descriptive and comparative ones.

## Learning

Learning is essential to most of these neural network architectures and hence the choice of a learning algorithm is a central issue in network development. Learning implies that a processing unit is capable of

changing its input/output behavior as a result of changes in the environment. Since the activation rule is usually fixed when the network is constructed and since the input/output vector cannot be changed, to change the input/output behavior the weights corresponding to that input vector need to be adjusted. A method is thus needed by which, at least during a training stage, weights can be modified in response to the input/output process. A number of such learning rules are available for neural network models.

There are several strategies for learning:

- **Supervised learning** — essentially, a strategy that involves a teacher that is smarter than the network itself. For example, let us take the facial recognition example. The teacher shows the network a bunch of faces, and the teacher already knows the name associated with each face. The network makes its guesses, and then the teacher provides the network with the answers. The network can then compare its answers to the known “correct” ones and make adjustments according to its errors.

- **Unsupervised learning** — required when there is not an example data set with known answers. Imagine searching for a hidden pattern in a data set. An application of this is clustering, i.e. dividing a set of elements into groups according to some unknown pattern.

Simulation of learning by a computer involves making small changes in the weights and the threshold each time a new example is presented in such a way that the classification is improved. The training can be implemented by various different algorithms, one of which will be outlined below.

Let us consider an example problem, for which an artificial neural network is readily applicable. Of two classes of cancer, only one responds to a certain treatment. As there is no simple biomarker to discriminate the two, you decide to try to use gene expression measurements of tumor samples to classify them. Assume you measure gene expression values for 20 different genes in 50 tumors of class 0 (nonresponsive) and 50 of class 1 (responsive). On the basis of these data, you train a threshold unit that takes an array of 20 gene expression values as input and gives 0 or 1 as output for the two classes, respectively. If the data are linearly separable, the threshold unit will classify the training data correctly.

But many classification problems are not linearly separable. We can separate the classes in such nonlinear problems by introducing more hyperplanes; that is, by introducing more than one threshold unit. This is usually done by adding an extra (hidden) layer of threshold units each of which does a partial classification of the input and sends its output to a final layer, which assembles the partial classifications to the final classification. Such a network is called a multi-layer perceptron or a feed-forward network. Feed-forward neural networks can also be used for regression problems, which require continuous outputs, as opposed to binary outputs (0 and 1). By replacing the step function with a continuous function, the neural network outputs a real number. Often a 'sigmoid' function — a soft version of the threshold function — is used. The sigmoid function can also be used for classification problems by interpreting an output below 0.5 as class 0 and an output above 0.5 as class 1; often it also makes sense to interpret the output as the probability of class 1.

In the above example, one could, for instance, have a situation where class 1 is characterized by either a highly expressed gene 1 and a silent gene 2 or a silent gene 1 and a highly expressed gene 2; if neither or both of the genes are expressed, it is a class 0 tumor. This corresponds to the 'exclusive or' function from logic, and it is the canonical example of a nonlinearly separable function. In this case, it would be necessary to use a multi-layer network to classify the tumors.

### **Backpropagation**

The backpropagation algorithm was originally introduced in the 1970s, but its importance was not fully appreciated until the famous 1986 paper by David Rumelhart, Geoffrey Hinton, and Ronald Williams. That paper describes several neural networks where backpropagation works far faster than earlier approaches to learning, making it possible to use neural nets to solve problems which had previously been insoluble. Today, the backpropagation algorithm is the workhorse of learning in neural networks.

This learning algorithm works for feed-forward networks with continuous output. Training starts by setting all the weights in the network to small random numbers. Now, for each input example the network gives an output, which starts randomly. We measure the squared difference between this output and the desired output—the correct class or value. The sum of all these numbers over all training examples is called the total error of the network. If this number was zero, the network would be perfect, and the smaller the error, the better the network.

By choosing the weights that minimize the total error, one can obtain the neural network that best solves the problem at hand. This is the same as linear regression, where the two parameters characterizing the line are chosen such that the sum of squared differences between the line and the data points is minimal. This can be

done analytically in linear regression, but there is no analytical solution in a feed-forward neural network with hidden units. In backpropagation, the weights and thresholds are changed each time an example is presented, such that the error gradually becomes smaller. This is repeated, often hundreds of times, until the error no longer changes.

In backpropagation, a numerical optimization technique called gradient descent makes the math particularly simple; the form of the equations gave rise to the name of this method. There are some learning parameters (called learning rate and momentum) that need tuning when using backpropagation, and there are other problems to consider. For instance, gradient descent is not guaranteed to find the global minimum of the error, so the result of the training depends on the initial values of the weights. However, one problem overshadows the others: that of over-fitting.

Over-fitting occurs when the network has too many parameters to be learned from the number of examples available, that is, when a few points are fitted with a function with too many free parameters. Although this is true for any method for classification or regression, neural networks seem especially prone to overparameterization. For instance, a network with 10 hidden units for solving our example problem would have 221 parameters: 20 weights and a threshold for the 10 hidden units and 10 weights and a threshold for the output unit. This is too many parameters to be learned from 100 examples. A network that overfits the training data is unlikely to generalize well to inputs that are not in the training data. There are many ways to limit over-fitting (apart from simply making small networks), but the most common include averaging over several networks, regularization and using methods from Bayesian statistics.

To estimate the generalization performance of the neural network, one needs to test it on independent data, which have not been used to train the network. This is usually done by cross-validation, where the data set is split into, for example, ten sets of equal size. The network is then trained on nine sets and tested on the tenth, and this is repeated ten times, so all the sets are used for testing. This gives an estimate of the generalization ability of the network; that is, its ability to classify inputs that it was not trained on. To get an unbiased estimate, it is very important that the individual sets do not contain examples that are very similar.

### **Applications**

Both the simple perceptron with a single unit and the multi-layer network with multiple units can easily be generalized to prediction of more than two classes by just adding more output units. Any classification problem can be coded into a set of binary outputs. In the above example, we could, for instance, imagine that there are three different treatments, and for a given tumor we may want to know which of the treatments it responds to. This could be solved using three output units—one for each treatment—which are connected to the same hidden units.

The most common application of neural networks in computing today is to perform one of these “easy-for-a-human, difficult-for-a-machine” tasks, often referred to as pattern recognition. Applications range from optical character recognition (turning printed or handwritten scans into digital text) to facial recognition. Neural networks have been applied to many interesting problems in different areas of science, medicine and engineering and in some cases, they provide state-of-the-art solutions.

### **Limitations**

There are many advantages and limitations to neural network analysis and to discuss this subject properly we would have to look at each individual type of network. In reference to backpropagational networks however, there are some specific issues potential users should be aware of:

- Backpropagational neural networks (and many other types of networks) are in a sense the ultimate 'black boxes'. Apart from defining the general architecture of a network and perhaps initially seeding it with a random numbers, the user has no other role than to feed it input and watch it train and await the output. In fact, it has been said that with backpropagation, "you almost don't know what you're doing". Some freely available software packages do allow the user to sample the networks 'progress' at regular time intervals, but the learning itself progresses on its own. The final product of this activity is a trained network that provides no equations or coefficients defining a relationship (as in regression) beyond its own internal mathematics.

- Backpropagational networks also tend to be slower to train than other types of networks and sometimes require thousands of epochs. If run on a truly parallel computer system this issue is not really a problem, but if the BPNN is being simulated on standard serial machine (i.e. a single SPARC, Mac or PC) training can take some time. This is because the machines CPU must compute the function of each node and connection separately, which can be problematic in very large networks with a large amount of data. However, the speed of most current machines is such that this is typically not much of an issue.

## Conclusions

We have looked at what artificial neural networks are and how they work. As we could see, neural networks are a powerful paradigm, which can help us solving complex problems that ordinary algorithms cannot handle. However, they have some limitations: ANNs are quite new and there are not many algorithms for teaching them.

Today this branch of machine learning is very popular. Neural networks have contributed a lot to the development of artificial intelligence and facial recognition and further study of these structures may lead us to the solutions of previously insolvable problems.

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УДК – 514.114

## PEDAL TRIANGLE

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**Abstract:** This article is examined pedal triangle and its properties in detail. Practical usage of pedal triangle properties is shown by the example of some math problems. It should be noted that it can solve complex math problems easy and clearly. Significant simplification of the method of dealing with math problems due to the pedal triangle properties by the example of some math problems is shown in the article.

**Key words:** Brocard point, Brocard angle, direct Simson, pedal triangle, triangle.

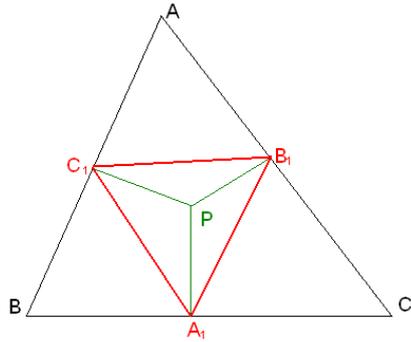
## Introduction

Triangle is the first geometric figure which was found in ancient ornaments. In Egypt it was a symbol of the triad of spiritual freedom, love, intuition, and the highest mind of person. In other words we may say about personality and soul. The Aztecs used the image of a triangle with the top above, coupled with the inverted triangle as a symbol of temporary cycle.

Relevance of the research is due to the annual testing complexity of **tasks** that require in-depth knowledge not only in algebra, but in geometry too. **Object matter** is examined pedal triangle. The theoretical aspects of pedal triangle and Brocard point and their practical application can be defined as **a subject matter** of this article. Triangle is the main research object of our paper. The main **objective** of our work is to study the properties of pedal triangle. **Materials:** example of some math problems. **Methods:** Descriptive, Comparative, Math analysis.

Let  $P$  is a point inside this triangle  $ABC$  and let perpendiculars dropped from point  $P$  on side  $BC$ ,  $AC$ ,  $AB$  of the triangle will be  $PA_1$ ,  $PB_1$  and  $PC_1$ .  $A_1B_1C_1$  is a triangle whose vertices are the foundations of the perpendicular. This triangle we can call "Pedal Triangle"  $A_1B_1C_1$  for pedal point  $P$ . The  $n$ th pedal triangle of  $ABC$ , defined inductively as the pedal triangle of its  $(n - 1)$ th pedal triangle, has angles that were investigated in Hobson's work [Hobson 1957: 203].

Kingston and Synge suggested that expressions for the angles of the  $n$ th pedal triangle and realized that this triple is periodic in  $n$  provided the angles of  $ABC$  are a rational number of degrees. They also said that the map of triples is four-to-one, because  $ABC$  has the sample pedal triangle as do  $HAB$ ;  $PHC$  and  $HCA$  where  $H$  is its orthocenter, the point where the perpendiculars meet [Kingstone, Synge : 609-620].



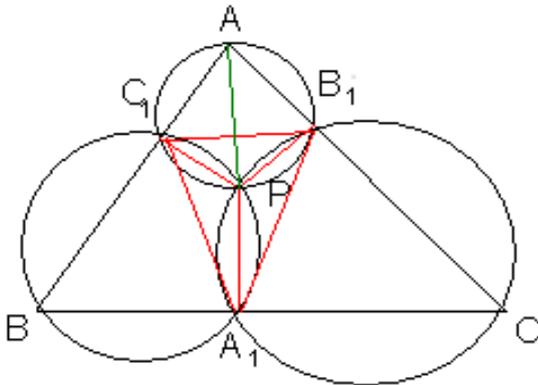
It is very important to identify the properties of pedal triangle.

Property 1. If the distance from the pedal point to the vertices of a triangle ABC is equal to x, y, z, then the lateral length of the pedal triangle is

$$\frac{ax}{2R}, \frac{by}{2R}, \frac{cz}{2R} \quad \text{where } R \text{ is the radius of the circumscribed circle.}$$

Proof.

The circle can be circumscribed around each received quadrangles  $AC_1PB_1$ ,  $BA_1PC_1$ ,  $CB_1PA_1$ .



Right angles at points  $B_1$  and  $C_1$  indicate that these points lie on a circle with a diameter of  $AP$ ; in other words, the point  $P$  lies on the circle circumscribed around  $\triangle AB_1C_1$ . Similarly, the point  $P$  lies on the circles circumscribed around  $\triangle CA_1B_1$ ,  $\triangle BC_1A_1$ . Let circumscribe a circle around the quadrangle; the diameter of it will be  $AP$ .

Let  $B_1C_1 = a_1$ , then the law of sine to  $\triangle C_1AB$ :

$$AP = \frac{a_1}{\sin \angle A} \quad (1)$$

$$\text{When we apply the sine theorem to } \triangle ABC, \text{ it will get } \frac{a_1}{\sin \angle A} = 2R \quad (2)$$

$$\text{Divide equality (1) by equality (2) term by term: } \frac{a_1}{a} = \frac{AP}{2R}; a_1 = \frac{a \cdot AP}{2R}$$

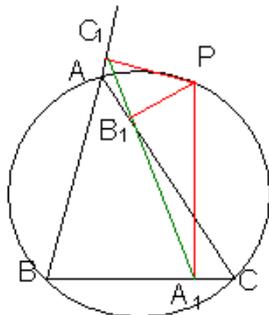
$$\text{Similarly } b_1 = \frac{b \cdot BP}{2R}; c_1 = \frac{c \cdot CP}{2R}, \text{ where } b_1 = C_1A_1, c_1 = B_1A_1.$$

If  $AP = x$ ,  $BP = y$ ,  $CP = z$ , then the lateral length of the pedal triangle will be:  $a_1 = \frac{ax}{2R}$ ;  $b_1 = \frac{by}{2R}$ ;  $c_1 = \frac{cz}{2R}$ .

Thus, the property is proved.

Property 2. Fundamentals of perpendiculars dropped from point  $P$  on the side of triangle are collinear if and only if this point lies on the circumscribed circle. Line containing these bases is known as Simson's line of this point of the triangle. It is said to be Simson's line because it seemed typical for his geometric ideas. However, historians cannot find it in the works of the scientist. In fact, it was discovered in 1797 by William Wallace.

Proof.



Consider the case where point  $P$  lies on the circumscribed circle.

Let's assume that the point P lies on the curve CA, which does not belong to point B. Since the angles  $\angle A_1, \angle B_1$  and  $\angle C_1$  are right then point P is also on the circle circumscribed around  $\triangle A_1BC_1, \triangle A_1B_1C$  and  $\triangle AB_1C_1$ . So,  $\angle APC = 180^\circ - \angle B = \angle C_1PA_1$  and if we subtract  $\angle APA_1$ , we have  $\angle A_1PC = \angle C_1PA$ . But since points  $A_1, C, P, B_1$  lie on the circle so  $\angle A_1PC = \angle A_1B_1C$ , and since points  $B, A, P, C$  lie on the circle so  $\angle C_1PA = \angle C_1B_1A$ , in this way  $\angle A_1B_1C = \angle C_1B_1A$ .

It follows that the points  $A_1, B_1, C_1$  are collinear, that is the pedal triangle is "degenerate." Conversely, if the point P is located so that the pedal triangle ABC is degenerated, it is obvious that the point P must be inside one of the corners of the triangle ABC and beyond the opposite side. Then we can assume that this "one corner" is the angle B and  $C_1$  is the point in continuing side BA at point A. It is obvious from the foregoing that the point P lies on the circumcircle.

Consequently, the property is proven and fair.

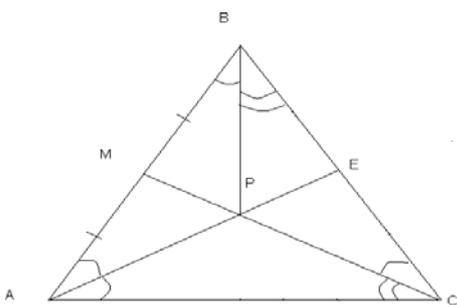
### Theorems on the pedal triangle and calculation of its area. Brocard point.

If at the construction of pedal triangle the angles are equal they are called Brocard angles and the pedal point is Brocard point. If you need to build Brocard point, you should draw a circle through two vertices of triangle ABC, then a line which is parallel to the opposite side of a selected peak. Connect the third vertex with the point of intersection of the parallel line and the circle. This line crosses the circle inside of the triangle. The point of intersection will be Brocard point.

Brocard angle is determined by the formula  $\sin^2 \varphi = \frac{4S^2}{b^2c^2 + c^2a^2 + a^2b^2}$ , and the square of pedal

triangle of the point of Brocard is  $S_1 = \frac{4S^3}{a^2b^2 + b^2c^2 + c^2a^2}$ .

#### Theorem 1.



If Brocard point P is the intersection point of the medians, the triangle ABC is regular.

The proof: since  $\triangle APD \sim \triangle BAD$ , so  $AD : BD = PD : AD$ ,  $AD^2 = BD \cdot PD = BD \cdot \frac{BD}{3}$ ,  $BD = AD \cdot \sqrt{3}$  and  $AD = DC$ . so  $BD = DC \cdot \sqrt{3}$  and  $BD^2 = DC^2 \cdot 3$ .

We will write the last equality in this form  $\frac{BD}{3} : DC = DC : BD$ . According to this proportion  $\triangle DBC$  and  $\triangle DCP$  are

similar. So  $\angle DBC = \angle DCP$ . we have  $\angle B = \angle C$  and  $AB = BC$ .

The theorem is proved.

#### Theorem 2.

Perpendicular dropped from the point that lies in the triangle on its side, on the sides define six segments so that the sum of the squares of the three segments, with no common end equal the sum of the squares of the other three.

Proof. Let OL, OM, ON – perpendiculars dropped from an arbitrary point O according to the sides AB, BC, AC. According to the Pythagorean theorem from  $\triangle AOL$  and  $\triangle BOL$  follows that  $AO^2 - AL^2 = BO^2 - BL^2$ . Much as  $\triangle BMO$  and  $\triangle CMO$ :

$BM^2 - CM^2 = BO^2 - CO^2$ . Similarly  $\triangle CON$  and  $\triangle AON$ :  $CN^2 - AN^2 = CO^2 - AO^2$ . Adding these equations we get

$$AL^2 - BL^2 + BM^2 - CM^2 + CN^2 - AN^2 = 0$$

$$AL^2 + BM^2 + CN^2 = BL^2 + CM^2 + AN^2.$$

The theorem is proved

#### USING.

Inside the triangle ABC is the point O. The points L, M, N lie on sides AB, BC and AC, respectively. From the O perpendiculars dropped to the sides of the triangle so that  $AL / LB = 1/2$ ;  $AN / NC = 1/3$ . Find S and if  $BM = 6 = 9 AB$ ,  $AC = 12$ . [Фетисова.И. Геометрия в задачах.-М.: Просвещение, 1977]

Solving

Let the random  $\triangle ABC$ . Point O – any point lying inside the triangle. Since the  $\frac{AL}{LB} = \frac{1}{2}$ , Make the equation:  $AB = x + 2x$ ;  $9 = 3x \Rightarrow x = 3$ . So,  $AL = 3$ ,  $LB = 6$ . On conditions that  $\frac{AN}{NC} = \frac{1}{3}$ , so let  $AN = y$ ,  $NC = 3y$ .

We have equation  $AC = y + 3y$ ;  $12 = 4y$ ;  
 $y = 3$ . So,  $AN = 3$ , a  $NC = 9$ .

Then there are two ways of solving the problem.

1<sup>st</sup> way:

Draw BO. Consider  $\angle BLO = \angle BON = 90^\circ$ .  $BL = BN$ , BO is a common hypotenuse. So  $\triangle BLO = \triangle BNO$  of the hypotenuse and legs. So  $LO = ON$ .

Draw AO. Consider  $\triangle ALO$  i  $\triangle AON$ :  $\angle ALO = \angle AON = 90^\circ$ .  $AL = AN$ , AO is a common hypotenuse. So  $\triangle ALO = \triangle AON$  of the hypotenuse and legs. So  $LO = ON$ .

Point O is the equidistant from the sides of the triangle, therefore, the point O is the center of the inscribed circle. According to the purposes of radius drawn to the point of contact  $LO = OM = ON = 3$ .  $AC = BM + MC = 15$ .

2<sup>nd</sup> way

Since  $L \in \triangle ABC$  та  $OL \perp AB$ ,  $OM \perp BC$ ,  $ON \perp AC$ , so L is the pedal point. Then according to the theorem  $AL^2 + BM^2 + CN^2 = BL^2 + MC^2 + AN^2$ . Hence:

$$CM^2 = AL^2 + BM^2 + CN^2 - BL^2 - AN^2$$

$$CM^2 = 9 + 36 + 81 - 36 - 9, CM^2 = 81$$

$CM = 9$ , so,  $BC = BM + MC = 15$ .

Answer: 15.

### CONCLUSION

In this work a pedal triangle and its properties, Brocard point were thoroughly reviewed.

Practical usage of pedal triangle in the abovementioned tasks and the ways of solving them are shown and properties to solve them. It should be noted that it can solve complex task easily. Thus, the hypothesis was confirmed in this study, and all the goals and objectives have been successfully resolved.

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УДК 537.533.7

## NEGATIVE REFRACTION OF ELECTRONS IN GRAPHENE

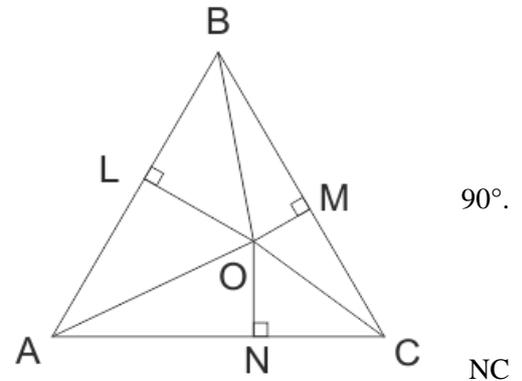
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**Abstract.** The article concerns the behavior of the electrons in the interaction with graphene. The study of Colombian scientists showing that in the interaction with graphene an electron flow behaves like a light beam is reviewed. Further progressive development of science and technology in the field of electronics is analyzed.

**Key words:** graphene, electron, p-n junctions, refraction, research

**Introduction.** Now an urgent problem for many scientists in the world is investigating the properties of graphene which is a highly conductive material whose conductivity can be controlled. One of the most



interesting and promising areas of study graphene properties is the research directed to study the electrons flow behavior in interaction with graphene. Researchers observed the effect in graphene demonstrating that electrons in the atomically thin material behave like light rays, which can be manipulated by such optical devices as lenses and prisms. This can create a breakthrough technology that gives an opportunity to create new production.

Considering this **the object-matter** of the article is graphene and **the subject-matter** is the behavior of the flow of electrons in their interaction with graphene.

**The objective of the article** is to outline the results of the research and **the tasks** are to analyze the properties of graphene, to inform the public about the results and to emphasize the promising perspectives of this scientific discovery.

**The materials** used in the article include the publications of the leading experts in this field.

**The methods** such as the analysis of various Internet sources, scientific online journals and research papers, organizing and summarizing the information were used in the article.

**Discussion and Results.** Graphene is an almost transparent material and absorbs light of about 2% in a wide temperature range, the absorption coefficient is equal to  $\pi$  (pi) times the fine structure constant. Graphene (carbon modification) is the thinnest material, its structure has a crystal lattice, one atom is thick. Graphene is one of the most durable materials. It bends well.

The ability to manipulate electrons in a conducting material like light rays provides absolutely new ways of thinking about electronics. For example, the switches that make up computer chips operate by turning the entire device on or off, and this consumes significant amount of power. Using lensing to steer an electron 'beam' between electrodes could be dramatically more efficient and provide the ability of devising faster and more energy efficient electronics.

These findings could also enable new experimental probes. For example, electron lensing could enable on-chip versions of an electron microscope, with the ability to perform atomic scale imaging and diagnostics. The other components such as beam splitters and interferometers, inspired by optics, could additionally enable new studies of the quantum nature of electrons in the solid state. While graphene has been widely explored for supporting high electron speed, it is notoriously hard to turn off the electrons without hurting their mobility. The natural follow-up is to see if the scientists can achieve a strong current turn-off in graphene with multiple angled junctions. If that works, the scientists will use it to create a low-power, ultra-high-speed switching device for both analog (RF) and digital (CMOS) electronics, potentially mitigating many of the challenges we face with the high energy cost and thermal budget of present day electronics.

The development of two-dimensional conducting layers in high-purity semiconductors such as GaAs (Gallium arsenide) in the 1980s and 1990s allowed researchers to demonstrate electron optics including the effects of both refraction and lensing. However, in these materials electrons travel without scattering only at very low temperatures, limiting technological applications. Furthermore, the presence of an energy gap between the conduction and valence band scatters electrons at interfaces and prevents observation of negative refraction in semiconductor p-n junctions. In this study, the researchers' use of graphene, a 2D material with unsurpassed performance at room temperature and no energy gap, overcame both of these limitations.

The possibility of negative refraction at graphene p-n junctions was first proposed in 2007 by theorists working both at the University of Lancaster and Columbia University. However, the observation of this effect requires extremely clean devices, so that the electrons can travel ballistically, without scattering, over long distances. Over the past decade, a multidisciplinary team at Columbia has worked to develop new techniques to construct extremely clean graphene devices. This effort culminated in the 2013 demonstration of ballistic transport over a length scale in excess of 20 microns. Since then, they have been attempting to develop a Veselago lens, which focuses electrons to a single point using negative refraction. But they were unable to observe such an effect and found their results puzzling.

In 2015 a group at Pohang University of Science and Technology in South Korea reported the first evidence focusing in a Veselago-type device. However, the response was weak, appearing in the signal derivative.

A team led by Cory Dean, an assistant professor of physics at Columbia University, has directly observed – for the first time – negative refraction for electrons passing across a boundary between two regions in a conducting material. First predicted in 2007, this effect was difficult to confirm experimentally. The researchers were able to observe the effect in graphene, demonstrating that electrons in the atomically thin material behave like light rays, which can be manipulated by such optical devices as lenses and prisms. The

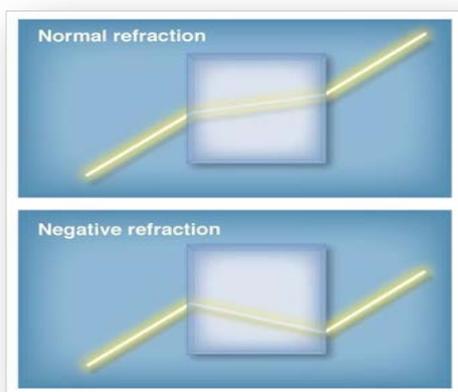
findings, which were published in the September 30 edition of *Science*, could lead to the development of new types of electron switches, based on the principles of optics rather than electronics.

Crucial to the Columbia effort was the theoretical support provided by Ghosh's group at the University of Virginia, who developed a detailed simulation techniques to model the Columbia team's measured response. This involved calculating the flow of electrons in graphene under the various electric and magnetic fields, accounting for multiple bounces at edges, and quantum mechanical tunneling at the junction. The theoretical analysis also shed light on why it had been so difficult to measure the predicted by Veselago lensing in a robust way, and the group was developing new multi-junction device architecture based on this study. Both the experimental data and theoretical simulation gave the researchers a visual map of the refraction and enabled them to be the first to quantitatively confirm the relationship between the incident and refracted angles (known as Snell's Law in optics), as well as confirmation of the magnitude of the transmitted intensity as a function of angle (known as the Fresnel coefficients in optics). In many ways, this intensity of transmission is a more crucial parameter since it determines the probability that electrons actually make it past the barrier, rather than just their refracted angles. The transmission ultimately determines many of the performance metrics for devices based on these effects, such as the on-off ratio in a switch, for example.

There is an effect when light changes a direction – or refracts – while passing from one material to another. This process allows us to use lenses and prisms to focus and steer light. A quantity known as the index of refraction determines the degree of bending at the boundary, and is positive for conventional materials such as glass. However, it is also possible to create optical "metamaterials" with a negative index, in which the angle of refraction is also negative. This can have unusual and dramatic consequences. Optical metamaterials can enable important new technologies such as super lenses, which can focus beyond the diffraction limit, and optical cloaks, which make objects invisible by bending light around them.

Electrons travelling through pure conductors, such as graphene conductors, can move in straight lines like light rays, enabling optics-like phenomena to emerge. Electron transport through the magnetic vector potential barriers in graphene can be understood in terms similar to light propagation in periodic stratified media. In materials, the electron density plays a similar role to the index of refraction, and electrons refract when they pass from a region of one density to another. Moreover, current carriers in materials can manifest the behavior of both negatively charged (electrons) and positively charged (holes) particles, depending on whether they inhabit the conduction or the valence band. In fact, boundaries between hole-type and electron-type conductors, known as p-n junctions ("p" positive, "n" negative), form the building blocks of electrical devices such as diodes and transistors.

Unlike optical materials where creating a negative index a metamaterial is a significant engineering challenge, negative electron refraction occurs naturally in solid state materials at any p-n junction.



**Conclusions.** The scientists can achieve a strong current turn-off in graphene with multiple angled junctions. If that works, the scientists will use it to create a low-power, ultra-high-speed switching device for both analog (RF) and digital (CMOS) electronics, potentially mitigating many of the challenges we face with the high energy cost and thermal budget of present day electronics. Using lensing to steer an electron “beam” between electrodes could be dramatically more efficient and provide the ability of achieving faster and more energy efficient electronics. It can create a breakthrough technology that gives an opportunity to create new production.

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УДК 577.33

## A REVIEW OF STUDIES ON QUANTUM BIOLOGY

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Language supervisor: Orach Yu. V.

**Abstract:** In this article experimental and theoretical studies of quantum effects in biological systems are overviewed. The description of quantum processes in biological systems is usually focused on specialized molecules, e.g., chlorophylls, which are embedded in larger protein environment. Enzymes catalyse a broad spectrum of hydrogen-tunnelling reactions. Quantum mechanical phenomena, such as quantum entanglement and superposition, may play an important part in the brain's function and could form the basis of an explanation of consciousness.

**Key words:** consciousness, enzyme catalysis, magnetoreception, photosynthesis, quantum effects

## Introduction

Fundamental biological processes that involve the conversion of energy into forms that are usable for chemical transformations are quantum mechanical in their nature. These processes involve chemical reactions themselves, light absorption, formation of excited electronic states, transfer of excitation energy, transfer of electrons and protons, etc. Some other biological processes, e.g. orientation of birds in the magnetic field of Earth, have been also suggested to require quantum mechanics.

The **object-matter** of the study is biological systems, and the **subject-matter** is experimental and theoretical studies of quantum effects.

The **objective** of this article is to overview experimental and theoretical studies of quantum effects in biological systems. In this brief review we summarize the latest results of the main experimental and theoretical works on functional quantum biology:

- 1) Coherent excitation transfer in photosynthesis;
- 2) Avian magnetoreception;
- 3) Tunnelling in biological systems;
- 4) Consciousness and quantum theory.

We applied two **methods of research** in the course of this article: description and analyzing.

## Coherent excitation transfer in photosynthesis

Photosynthesis is a key process for life and often considered as a role model for future light-harvesting technologies [Blankenship 2002].

The photosynthetic complex is a membrane-bound system with many embedded functional subunits. The energy conversion starts with the absorption of an incident photon by a pigment molecule, e.g., a chlorophyll, porphyrin, or a carotenoid molecule embedded in a protein structure, the antenna complex.

The reaction center is a pigment-protein complex, which contains a dimer, called the “special pair.” When it is excited, it donates an electron to a neighboring acceptor molecule. Fast secondary processes prevent the recombination of the ion pair and trigger the release of protons that are first transferred across the membrane and later used to fuel, for instance, the synthesis of adenosine triphosphate (ATP) from adenosine diphosphate (ADP).

One of the simplest and most well-studied examples is the light-harvesting apparatus of green-sulphur bacteria. These have a very large chlorosome antenna that allows them to thrive in low-light conditions. The energy collected by these chlorosomes is transferred to the reaction centre through a specialized structure called the Fenna–Matthews–Olson (FMO) complex Fig.1.

Recent studies have demonstrated that energy moves through antennae using not only a classical hopping mechanism but also a manifestly quantum mechanical wave-like mechanism at cryogenic temperatures.

Using the Fenna–Matthews–Olson antenna complex (FMO) as a model system, theoretical studies incorporating both incoherent and coherent transfer as well as thermal dephasing predict that environmentally assisted quantum transfer efficiency peaks near physiological temperature; these studies also show that this

mechanism simultaneously improves the robustness of the energy transfer process. One of the simplest and most well-studied examples is the light-harvesting apparatus of green-sulphur bacteria. These have a very large chlorosome antenna that allows them to thrive in low-light conditions. The energy collected by these chlorosomes is transferred to the reaction centre through a specialized structure called the Fenna–Matthews–Olson (FMO) complex Fig.1.

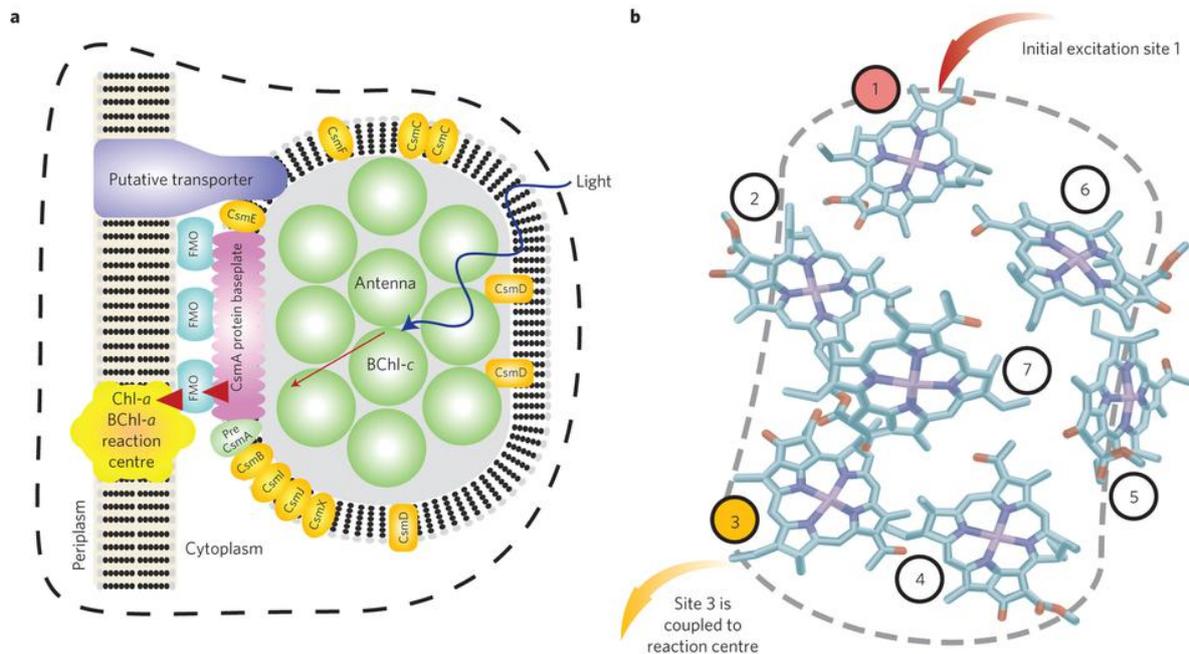
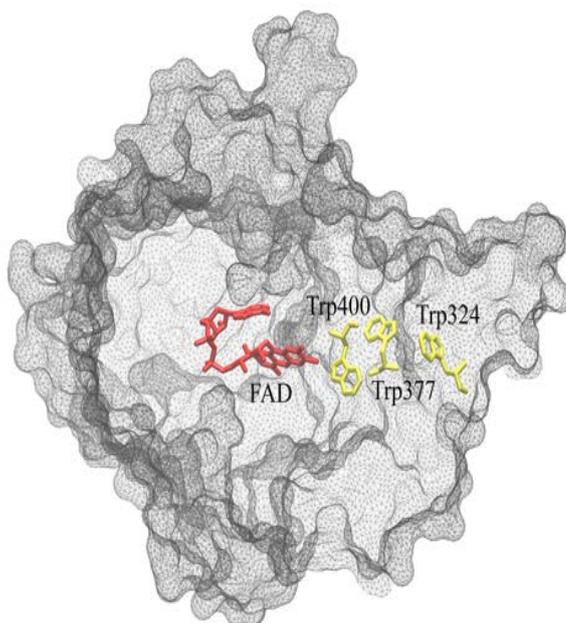


Fig.1. Description of the photosynthetic machinery of green-sulfur-bacteria (left) and its light harvesting complex FMO (right)[Lambert N. ,Chen Y. Nor F.,2013]

Fig. 2. A chain of three tryptophan residues, Trp400, Trp377 and Trp324 are involved in the photoreduction of the FAD cofactor. During the electron-transfer process, radical pairs are formed between FADH and each of the tryptophans. The formation of these radical pairs permits a magnetic field effect in cryptochrome.



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Using the Fenna–Matthews–Olson antenna complex (FMO) as a model system, theoretical studies incorporating both incoherent and coherent transfer as well as thermal dephasing predict that environmentally assisted quantum transfer efficiency peaks near physiological temperature; these studies also show that this mechanism simultaneously improves the robustness of the energy transfer process. This theory requires long-lived quantum coherence at room temperature, which never has been observed in FMO. Scientists present evidence that quantum coherence survives in FMO at physiological temperature for at least 300 fs, long enough to impact biological energy transport. These

data prove that the wave-like energy transfer process discovered at 77 K is directly relevant to biological function. Microscopically, they attribute this long coherence lifetime to correlated motions within the protein matrix encapsulating the chromophores, and we find that the degree of protection afforded by the protein appears constant between 77 K and 277 K. The protein shapes the energy landscape and mediates an efficient energy transfer despite thermal fluctuations [Tessa 2007].

### **Avian magnetoreception**

In contrast with most other senses in animals, we know very little about magnetoreception mechanisms. The main problem of geomagnetic field perception is the fact that the Earth's magnetic field is very weak and that a magnetoreceptor needs to be able to detect absolute values or small variations of such a field.

Migratory birds are known to use the geomagnetic field as a source of compass information.

When magnetic north of the ambient field is experimentally shifted, the birds alter their directional preference so as to maintain their heading with respect to magnetic north, thus demonstrating that they use the magnetic field as a compass

The two main models for avian magnetoreception are a magnetite-based model and a radical-pair-based model. The former suggests that the compass has its foundation in small particles of magnetite located in the head of the bird. The latter idea is that the avian compass may be produced in a chemical reaction in the eye of the bird, involving the production of a radical pair. A radical pair, most generally, is a pair of molecules, each of which have an unpaired electron. If the radical pair is formed so that the spins on the two unpaired electrons in the system are entangled (i.e. they begin in a singlet or triplet state), and the reaction products are spin-dependent (i.e., there are distinct products for the cases where the radical pair system is in an overall singlet vs. triplet state), then there is an opportunity for an external magnetic field to affect the reaction by modulating the relative orientation of the electron spins.

It has been suggested that the radical pair reaction linked to the avian compass arises in the protein cryptochrome in retina Fig.2. [Ritz 2009].

### **Tunnelling in biological systems**

Enzymes catalyse a broad spectrum of hydrogen-tunnelling reactions. In one type of model that describes hydrogen tunnelling in enzymes, the transferring hydrogen nucleus is represented by a quantum-mechanical wavefunction that depends on the solvated enzyme environment. The quantum-mechanical effects of the electrons must also be included in these models to allow the breaking and forming of chemical bonds. In general, these models require reorganisation of the enzyme/solvent environment to provide configurations that are conducive to hydrogen tunnelling. Such reorganisation is necessary to bring the proton donor and acceptor atoms closer together, orient the ligands properly, and provide an appropriate electrostatic environment.

It is evident that long-range electron tunneling [Gray, Winkler 2003] and hydrogen tunneling [Allemann, Scrutton 2009] play important roles in biological redox reactions and enzyme catalysis, respectively.

Long-distance electron tunneling is a fundamental process which is involved in energy generation in cells. The tunneling occurs between the metal centers in the respiratory enzymes, typically over distances up to 20 or 30 Å such distances, the tunneling time—i.e., the time during which an electron passes through the body of the protein molecule from one metal center to another – is of the order of 10 fs [Stuchebrukhov 2010].

Studies of the alcohol dehydrogenases have played a very significant role in moving us beyond a classical and static view of enzyme catalysis toward one that embraces hydrogen tunneling and its intimate link to the dynamical features of proteins [Nagel, Klinman 2006].

### **Consciousness and quantum theory**

There is a classic physics is hopelessly insufficient to meet the mind-brain problem the consciousness obviously not appear classical physical laws.

Theoretical physicist Roger Penrose determined wave function collapse was the only possible physical basis for a non-computable process. Penrose proposed a new form of wave function collapse that occurred in isolation and called it objective reduction. He suggested each quantum superposition has its own piece of spacetime curvature and that when these become separated by more than one Planck length they become unstable and collapse [Penrose 1999].

Anaesthesiologist Stuart Hameroff provided a hypothesis that microtubules would be suitable hosts for quantum behavior. Microtubules are composed of tubulin protein dimer subunits. Tubulins have other smaller non-polar regions that contain pi electron-rich indole rings separated by only about 2 nm. Hameroff proposed

that these electrons are close enough to become entangled [Hameroff 2008]. Hameroff originally suggested the tubulin-subunit electrons would form a Bose–Einstein condensate, but this was discredited [Penrose, Hameroff 2011].

### **Conclusions**

Recent evidence suggests that a variety of organisms may harness some of the unique features of quantum mechanics to gain a biological advantage. In this brief review I summarize the latest results for quantum effects in photosynthetic light harvesting, avian magnetoreception, enzyme-catalysed reactions and consciousness. These effects, in turn, suggest practical uses. If we can figure out how biological systems achieve quantum coherence in ambient conditions this could allow scientists to build technology such as solar cells with improved energy-conversion efficiencies and another area of potential application is in quantum computing.

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## **A NEW APPROACH TO THE WIDE TRAIL STRATEGY DESIGN IN BLOCK CIPHERS**

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**Abstract.** The implementation of the wide trail strategy within a single transformation without separation into linear and nonlinear parts is proposed. This possibility consists of consistent S-boxes activation of round function one by one by using managed substitutions. The proposed construction allows obtaining maximum branch number. It means that one S-box input activates the subsequent S-boxes of transformation.

**Key words:** Wide Trail Strategy, Rijndael, SPN, S-box.

### **Introduction**

J. Daemen and V. Rijmen are considered to be the discoverers of the wide trail strategy [6: 89-117]. However, in our opinion, the origins of this strategy can be seen in Feistel's work [5: 15-23]. The SPN structure, which was proposed in this work, presupposed that S-boxes of a nonlinear layer were included so that to activate as much as possible number of S-boxes of the next cycle by their outputs (though in this case activation was implemented at the bit layer). The merit of J. Daemen and V. Rijmen is seen in the fact that they were able to show that separable codes with the maximum minimum distance (specified by MDS matrix) provide a way of building the optimal linear transformations with the branch number  $n + 1$ , where  $n$  is the number of ligaments (the number of S-boxes which entered to MDS transformation). Today the linear transformation constructed using multiplication by MDS matrix is considered optimal [6: 89-117].

J. Daemen's idea, natural in the context of differential and linear cryptanalysis, was to analyze a round function piece by piece: the S-box transformation and the linear transformation – separately, to ensure that cryptanalysis attack cannot “bypass” nonlinear aspects of the algorithm [2: 222-238]. AES's developers actually managed to offer the design of the round transformation amenable to clear analysis.

**The subject of this paper is a process of the wide trail strategy implementation in a round function without its separation into linear and nonlinear parts.**

### **Discussion**

We recall here the implementation of the wide trail strategy on the example of SL transformation used in Muhomor cipher [1: 147-157; 4: 221-225]. It is represented in Fig. 1. A similar transformation is used in Rijndael, but it hasn't got a special name there.

The input 32-bit value is divided into 4 bytes, each of which is substituted according to the given S-box. There are four different tables, one for each byte, used in transformation of Muhomor cipher (one S-box is used in Rijndael).

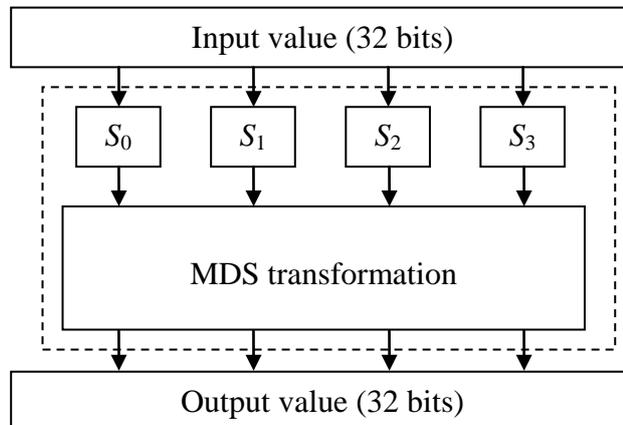


Fig. 1. SL transformation of Muhomor cipher

After substitution operation in S-boxes 4 bytes  $(a_0, a_1, a_2, a_3)$  are input to MDS transformation which performs matrix multiplication.

The matrix of MDS transformation of Muchomor cipher matches the matrix of Rijndael, but for calculating the product of vector's elements by matrix coefficients in Muchomor cipher another irreducible polynomial is used  $m(x) = x^8 + x^4 + x^3 + x^2 + 1$  or  $\{01\}\{1d\}$  in hex. For further consideration the kind of decomposable polynomial is not important.

The output 32-bit vector of MDS transformation  $(b_0, b_1, b_2, b_3)$  is the output value of SL transformation.

It can be seen that this transformation is the basic building block of 128-bit Rijndael round transformation. Practically it is the basis of the wide trail strategy applied in the construction of this cipher.

The properties of the transformation are shown in Table 1 which presents the distribution law of number of activated S-boxes because they become active S-boxes at the next cycle of transformations. The experiment was performed for 1000 texts for 16-bit input differences. Total turns  $1000 \times 2^{16} = 65536000$  values. Here active bytes are considered as bytes with non-zero differences in the output.

Table 1

Number of active bytes at the output	Number of repeats in %
0	0
1	0,0000167
2	0,00861
3	1,51
4	98,480

## Results

In this paper, it will be shown that there is the possibility of joint implementation of the principles of confusion and diffusion within a single construction that does not allow its division into linear and nonlinear parts and we assume that the branch number per one input byte of MDS transformation can be obtained greater than at least one as compared with the construction of SL transformation with MDS matrix. Further, this assumption will be checked.

The construction of the proposed SL transformation is shown in Fig. 2.

As it can be seen from the figure, 32-bit input data block is divided into four bytes, each of which is fed to a chain of S-block transformations, and includes its outputs to inputs of the subsequent one. At the same time the input of the first S-box consists of the sum modulo two of the four byte segments. The second, third and fourth byte segments are applied to the respective inputs of other S-boxes, where they were previously joined through modulo two adders with the outputs of the previous S-boxes. In addition, the output of the last S-box added by modulo two with the outputs of all previous S-boxes forms outputs of SL transformation.

Obviously, due to the addition of four-byte segments at the input of first S-box we have four bytes pass through a chain of S-boxes and at the output of the fourth S-box it will be result (sum) of passage of each input byte through four S-boxes, wherein the first byte will pass through the four S-boxes, the second one further passes through three S-boxes, the third one passes through two S-boxes and the fourth one passes through one S-box. But the output of the fourth S-box is also fed to the outputs (the sum modulo 2) of other S-boxes.

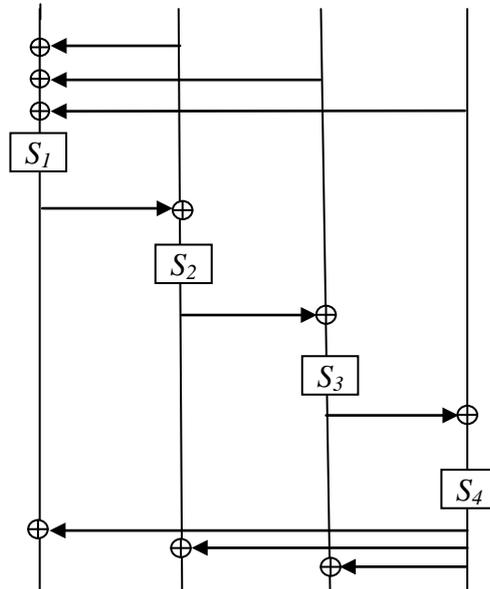


Fig. 2. Scheme of SL transformation using S-boxes

As a result, the formation of the output of SL transformation for the first byte will involve  $4 + 1 = 5$  S-boxes, for the second byte  $1 + 4 + 3 = 8$  S-boxes will be used, for the third byte  $1 + 2 + 4 = 7$  S-boxes and  $1 + 4 = 5$  S-boxes will participate in the formation of the output of the fourth byte. Thus, our SL transformation allows activating at least five S-boxes by a single input byte (each byte goes through 5 S-blocks). The actual number of involved S-boxes is considerably higher (if the passage of each byte in the same number of S-boxes is not required). Note that the same result - five S-boxes will be in the case when at the input of cycle transformation will be only one active byte. In principle, when bytes are added at the input of the first S-box, it is possible that this sum will be equal to zero. However, we are interested in differences passing through the S-boxes. Obviously, if you consider the bits of the blocks which are independent and equally probable, the probability of getting by chance a certain difference for addition of the 32-bit differences is  $2^{-64}$ . It can be considered almost as an incredible event.

Table 2 shows the distribution law of the number of active S-boxes for the second type of transformation. In this case, the experiment was performed for 16-bit differences for 1000 texts. Total considered  $1000 \times 2^{16} = 65536000$  values.

The comparison of the results in Table 1 and Table 2 clearly shows that the second transformation almost repeats characteristics of the first transformation. Only according to our initial assumptions its effectiveness was expected even higher than effectiveness of the previous optimum transformation with multiplication by MDS matrix. In the latter case the input bytes pass through the total number of 25 S-boxes.

Table 2

Number of active bytes at the output	Number of repetitions in %
0	0
1	0,0000198
2	0,0091
3	01,5458
4	98,445

Let us conclude on the performance indicators of the proposed design. Our experiments show that within the framework of generally accepted approaches of programming our version of transformation exceeds the cipher Rijndael. An optimized version of the Rijndael design [3: 1-45] is of course much faster than the proposed one. But our design can be optimized. The idea is that instead of processing one-dimensional array of substitutions with the addition of their two inputs on the module, you can go to the processing of two-dimensional arrays by applying Latin squares instead of byte S-box substitutions. Such a two-dimensional substitution can be obtained through the use of a single line which is not the usual substitution, and still 255 lines are used, which are cyclic shifts of the original, although it will have to pay for the increase in the required memory 28 times (if you do the conversion to nibble S-blocks, the memory of 128 bytes will be required). Table 3 shows the performance indicators in yet another experiment for non-optimized and optimized versions.

Table 3

	Optimized cycle function with a multiplication by MDS matrix	The cycle function on the basis of managed substitutions	The cycle function on the basis of a Latin square
Time of encryption of 100 million different blocks, sec	0,4	1,7	0,5 for byte S-box (1,3 for half-byte S-box)

It is seen that performance indicators in optimized variant differ by less than twofold.

#### Conclusions

It was found that it is possible to implement the principles of bytes activation (and subsequently S-boxes) of round transformations of ciphers in a single structure that does not allow its division into linear and nonlinear parts that are not inferior by the number of active bytes (S-boxes) to the scheme with multiplication by MDS matrix used in Rijndael. This possibility consists of consistent S-boxes activation of round function one by one by using managed substitutions. The proposed structure is allowed for the maximum branch number (when one S-box input activates the subsequent S-boxes of transformation).

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УДК 629.785

### RESULTS OF THE KEPLER SPACE MISSION

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**Abstract.** This article discusses the most important results of Kepler space mission launched by NASA in 2009 to detect planets habitable. It includes all the objectives and the methods used to detect exoplanets. The present article presents the information about the mission from the beginning to the run translated into K2 and provided data on discovered exoplanets in the habitable zone. The article presents the basic facts and the results for each year of the mission.

**Key words:** exoplanets, habitable, Kepler, results.

## Introduction

Kepler is a space observatory launched by NASA to discover Earth-size planets orbiting other stars. Named after astronomer Johannes Kepler, the spacecraft was launched on March 7, 2009, into an Earth-trailing heliocentric orbit.

Designed to survey a portion of our region of the Milky Way to discover Earth-size exoplanets in or near habitable zones and estimate how many of the billions of stars in the Milky Way have such planets, Kepler's sole scientific instrument is a photometer that continually monitors the brightness of over 145,000 main sequence stars in a fixed field of view. These data are transmitted to Earth, then analyzed to detect periodic dimming caused by exoplanets that cross in front of their host star [ Overbye, Dennis 2015: 3 ].

The scientific **objective** of Kepler is to explore the structure and diversity of planetary systems. This spacecraft observes a large sample of stars to achieve several **key goals**:

- To determine how many Earth-size and larger planets there are in or near the habitable zone (often called "Goldilocks planets") of a wide variety of spectral types of stars.
- To determine the range of the size and shape of the orbits of these planets.
- To estimate how many planets there are in multiple-star systems.
- To determine the range of the orbit size, brightness, size, mass and density of short-period giant planets.
- To determine the properties of those stars that harbor planetary systems.

**The methods** for exoplanets detection:

1. Direct method - provides an opportunity to see the planet, not just speculate about its existence. This method involves carrying out a complex research. In particular, we should distinguish between light and light planet star.

2. The radial velocity method is based on an assessment of radial velocity. If the stars are located near a major celestial body, for example, the giant planet, it will certainly make an impact on the speed of the stars, that is, the effect of gravity makes the planets a major star perform oscillations that can be observed on a periodic change characteristics of its radiation.

3. The method of microlensing observations. With the integrated search unseen objects in the universe of planets and especially massive bodies - extinct stars and black holes, it is also considered a possible microlensing effect (distortions caused by gravitational fields) light (infrared) radiation. This method can be used to search for single planets which do not rotate around the star, and free "drifting" in interstellar space.

4. The method of observation passage. Based on the fact that when observing planetary system "edge" in terms of planet earth observer may periodically take place on the disk stars, little (usually 1-3%) obscuring it and thereby weakening its luster.

## Discussion

The Kepler observatory was in active operation from 2009 through 2013, with the first main results announced on January 4, 2010. As expected, the initial discoveries were all short-period planets. As the mission continued, additional longer-period candidates were found.

2009

From the first few months of data, Kepler scientists determined that about 7,500 stars from the initial target list are such variable stars. These were dropped from the target list, and replaced by new candidates. On November 4, 2009, Kepler project publicly released the light curves of the dropped stars [ Borucki, William J.; et al. 2010:1].

2010

Kepler results, based on the candidates in the list released in 2010, it was implied that most candidate planets have radii less than half that of Jupiter. The results also imply that small candidate planets with periods less than thirty days are much more common than large candidate planets with periods less than thirty days and that the ground-based discoveries are sampling the large-size tail of the size distribution. This contradicted older theories which suggested that small and Earth-size planets would be relatively infrequent. Based on extrapolations from the Kepler data, an estimate of around 100 million habitable planets in the Milky Way may be realistic [Borucki, William J.; et al. 2011:1].

2011

By December 5, 2011, Kepler team announced that they had discovered 2,326 planetary candidates, of which 207 are similar in size to Earth, 680 are super-Earth-size, 1,181 are Neptune-size, 203 are Jupiter-size and 55 are larger than Jupiter.

On December 20, 2011, the Kepler team announced the discovery of the first [Earth-size exoplanets](#), [Kepler-20e](#) and [Kepler-20f](#), orbiting a [Sun-like star](#), [Kepler-20](#) [Johnson, Michele 2011: 4].

2012

The [Transit Timing Variation](#) (TTV) technique, which was used to discover [Kepler-9d](#), gained popularity for confirming exoplanet discoveries. A planet in a system with four stars was also confirmed, the first time such a system had been discovered.

As of 2012, there were [a total of 2,321 candidates](#). Of these, 207 were similar in size to Earth, 680 were super-Earth-size, 1,181 are Neptune-size, 203 were Jupiter-size and 55 were larger than Jupiter. Moreover, 48 planet candidates were found in the habitable zones of surveyed stars.

2013

The study, based on the planets orbiting the star [Kepler-32](#), suggests that the [planetary systems](#) may be common around stars in the Milky Way. The discovery of 461 more candidates was announced on January 7, 2013. The longer Kepler watches, the more planets with long periods it can detect.

In April 2013, NASA announced the discovery of three new Earth-size exoplanets – [Kepler-62e](#), [Kepler-62f](#), and [Kepler-69c](#) – in the [habitable zones](#) of their respective host stars, [Kepler-62](#) and [Kepler-69](#). The new exoplanets are considered prime candidates for possessing liquid water and thus a habitable environment. A more recent analysis has shown that Kepler-69c is likely more analogous to Venus, and thus unlikely to be habitable. [Kane, Stephen R.; Barclay, Thomas; Gelino, Dawn M. 2013: 2].

### **Kepler Input Catalog**

The Kepler team originally promised to release data within one year of observations. However, this plan was changed after the launch, with data being scheduled for release up to three years after its collection. This resulted in considerable criticism, leading Kepler science team to release the third quarter of their data one year and nine months after collection. The data through September 2010 (quarters 4, 5, and 6) was made public in January 2012.

Kepler Input Catalog (KIC) is a publicly searchable database of approximately 13.2 million objectives, Kepler used to program the spectral classification and Kepler mission

### **Conclusion**

Kepler Space Mission held monitoring from 2009 to 2013, did not happen until the device failure as a consequence of which the spacecraft got an assignment. Kepler's mission was aimed at finding extrasolar planets, and, in particular, to search for extrasolar planets suitable for life (in the zone suitable for life). This article reviewed the main objectives and methods of detection of exoplanets by Kepler space mission. The same article provides information on the data obtained through the publication. Released after analyzing the data directory consisting of 13.2 million objects, it has become accessible to all people.

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УДК 004.056

### **TYPES OF AUTHENTICATION IN THE WEB**

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**Abstract:** The article reveals the main authentication types and shows their advantages and disadvantages to be aware of possible dangers which may lead to critical or personal data leaks and loss of privacy. The article also emphasizes the danger of some authorization types and draws attention to the multi-factor authorization as a way of protecting crucial data with maximum simplicity and speed.

**Key words:** authorization, E-NUM, multifactor authentication, single-factor authentication, two-factor authentication.

**Introduction:** Nowadays Internet security is an extremely important issue. If we don't have any ways to protect our data, we will suffer from cybercriminals and Internet thieves. Some people think that if they aren't politicians or famous people they may not worry about their security. But we don't live in homes made of glass, do we? This is the reason why all data (especially banking data) needs to be safely protected. Even though someone doesn't care about his or her personal data being stolen, banks do. Different banks and financial companies offer their clients lots of ways to protect their personal information.

**Object-matter** is the authorization process; a **subject-matter** is the interaction between a user and a website.

**Objective** of our work is to research and find breaches in main authorization types and try to find alternatives.

This article considers the following **tasks**:

1. to research the core principles of different authorization types;
2. to discover advantages and disadvantages of each authorization type;
3. to find out alternatives for possible security breaches;
4. to compare different authorization types.

**Research methods:** Theoretical analysis and generalization of scientific literature and periodicals devoted to comparison, formalization and analysis of different authorization types and to discover advantages and disadvantages of each authorization type of today's web security.

**Material:** Empirical basis relies on research of different internet resources and security specialists' articles and companies like 'ChekPoint Software Technology', 'Clearswift', 'Comodo Group' and so on.

**Discussion and results:** Overall authentication and authorization concept is rather simple. Authentication is used by a server when the server needs to know exactly who is accessing the information or site. Authentication is used by a client when the client needs to know that the server is a system it claims to be. In authentication, a user or a computer has to prove its identity to the server or client. Usually, authentication by a server entails the use of a user name and password. Other ways of authentication can be through cards, retina scans, voice recognition and fingerprints. Authentication by a client usually involves the server giving a certificate to the client in which a trusted third party such as Verisign or Thawte states that the server belongs to the entity (such as a bank) that the client expects it to. Authentication does not determine what tasks the individual can do or what files the individual can see. Authentication merely identifies and verifies who the person or system is [1].

Authorization is a process by which a server determines if the client has permission to use a resource or access a file. Authorization is usually coupled with authentication so that the server has some concept of who the client is that is requesting access. The type of authentication required for authorization may vary; passwords may be required in some cases but not in others. In some cases, there is no authorization; any user may use a resource or access a file by simply asking for it. Most of the web pages on the Internet require neither authentication nor authorization [2].

There are several types of authentication: single-factor authentication, two-factor authentication and multi-factor authentication. All these have both advantages and disadvantages. Mostly the main disadvantage of most systems is either too low security or too much time needed to proceed. Nowadays there is no perfect way of authentication which would be fast, flexible and safe. Of course, there are modern ways such as E-Num or Google's two factor authorization but even they can't provide perfect service.

Single-factor authentication (SFA) is a process for securing access to a given system, such as a network or a website that identifies the party requesting access through only one category of credentials [3].

This is the most unsecure and easiest to hack method. Unfortunately, it's the most popular way used on many websites, social networks and blogs. Furthermore, due to many hacker attacks, which occur every day and are targeted both for companies and simple users, hackers from all over the world have millions of passwords in their hands and thus can do anything they want until the prey finds out he or she was hacked.

One of the main troubles with passwords is that most users either don't understand how to make strong and memorable passwords or underestimate the need for security. Extra rules that increase complexity are seen to drive call volumes for password-related issues to help desks proportionately [3].

However, it's almost never used in online banking because of its low security. It's impossible to imagine PayPal which uses only "login-password" combination. It could also be a trouble for public computers

in libraries or Internet centers. If you forget to log out and the website doesn't have any session limitations, any random user can access your data and control your money.

On the other hand, it's the simplest way of authentication, which lets access websites with noncritical info within several minutes. One of the main rules of IT security is that the price of data protection doesn't have to be greater than the price of data itself. According to this rule single-factor authorization is perfect for websites which don't contain extremely private info or banking data.

Two-factor authentication is a security process in which the user provides two means of identification from separate categories of credentials; one is typically a physical token, such as a card and the other is typically something memorized, such as a security code.

In this context, two factors involved are sometimes spoken of as something you have and something you know. A common example of two-factor authentication is a bank card: the card itself is a physical item and a personal identification number (PIN) is the data that goes with it. Including those two elements makes it more difficult for someone to access the user's bank account because they would have to have the physical item in their possession and also know the PIN [4].

This way is much more secure and can be used for banking. It's flexible and fast enough but not perfect according to the security concept. It used to be impossible to hack but with modern technologies it's not as safe as before. Many specialists say that everyone should change to multi-factor authorization even for email accounts and what is even more important is that two-factor authorization should be provided on every step.

Such thoughts sound wise but as was already mentioned they can break the rule of data worth and protection price. User should have an opportunity to choose preferred way according to his or her needs. It has no sense to protect email account used to chat with family but it's critically necessary to keep safe business correspondence and banking accounts.

Multifactor authentication (MFA) is a security system that requires more than one method of authentication from independent categories of credentials to verify the user's identity for a login or other transaction.

Multifactor authentication combines two or more independent credentials: what the user knows (password), what the user has (security token) and what the user is (biometric verification). The goal of MFA is to create a layered defense and make it more difficult for an unauthorized person to access a target such as a physical location, computing device, network or database. If one factor is compromised or broken, the attacker still has at least one more barrier to breach before successfully breaking into the target [5].

Nowadays MFA is considered to be the future of authorization. Many companies such as Inter or Google offer flexible MFA systems which can be easily modified or changed. Biometric authentication is considered to be the future of Internet privacy. It's widely used even in smartphones as a way to prevent access to contacts, emails and everything stored in phone.

However, such way of authentication has several disadvantages. The first one is time needed to complete all steps. It takes much longer to enter a password, get a disposable code and scan the fingerprint. The second one is a necessity to have additional devices or technologies like disposable code generators or fingerprint scanners. The third factor is higher necessity in server capabilities. It has to store passwords, secret questions, fingerprint scans and/or other biometric and knowledge data necessary to proceed as well as generate disposable codes. Although it's possible to use other services but such way can always bring additional breaches in security.

Anyway, this authentication method is the most breakthrough at this moment so every day more and more websites, especially online banks use and improve it. All these can be used in combination both for two-factor and multi-factor authentication. They can be interchanged or used simultaneously. The first block is disposable passcodes – most used way in banking and even in some email providers.

One of security methods is a disposable passcode. There are several types of disposable passcodes. For users SMS passcode is method simple enough. It needs just user's phone and generates disposable code which works only one time. The greatest advantage of SMS passcodes is the combination of speed and security. It's rough job for a hacker to know that special one-time code which you get on your phone.

This can involve physical access which is mostly impossible. However, if the data is valuable or the goal of a hacker to get into specific account of a specific person there is no problem to hack the phone, hijack that code and enter it.

So, SMS passcodes are great as the first line defense or additional method, used with some more secure.

These are physical devices which work like SMS passcodes but without phone involvement. This makes even harder to hijack one-time code because it's physically impossible to hack that small device while being far

away. However, the main disadvantage is that this way of authentication involves totally extraneous device which user needs to have in his pocket in order to be authorized.

Furthermore, this way is no longer needed due to many other reasons which appeared during last years. And such necessity can become main reason not to use disposable passcode generators.

E-NUM is a system used to log into closed online resources. E-NUM provides extra protection with a security key (unique code book) stored on the user's mobile device. You can easily integrate the E-NUM authorization on your resource.

It's a great way to migrate from disposable passcode generators to more flexible and faster ones. It doesn't need any physical device except your phone and it can be connected with any website if necessary.

However, E-NUM has the same disadvantage as SMS passcode – it bounds to mobile phone which can be hacked. And with app it's even easier for hacker to steal that disposable passcode.

Anyway, this method also can be a good addition to traditional password and/or SMS. It provides fast and easy authorization for any website.

An OpenID is a way of identifying on every website supporting this method. It's like a driver's license for the entire Internet. But, it means even more than that because user can associate information with his OpenID such as his name and e-mail address and then choose how much info websites get to see.

This is not the most secure but the easiest and fast authorization method. It follows the idea of unified Internet identity where the user has one online passport which lets him or her access any website without dozens of passwords and logins.

The threat is obvious – once OpenID provider's account is hacked (let's take Yahoo! Mail as example) a malefactor can access any website that the user used to log in with OpenID. However, the malefactor never knows on which websites OpenID was used that is why he will need to run an additional hacking session to find out that websites.

Furthermore, if you choose Google as OpenID provider it's completely safe to use it here and there because it uses additional account protection involving a password and mobile phone.

Combined ways consist of using all of mentioned methods together. Some can be interchanged or used differently. Such method provides most comprehensive security and makes authorization hackerproof. But if both users and website owners understand the importance of safe and secure authorization, it will be almost impossible for hackers to access data.

However, it is not a good idea to overprotect data which doesn't cost much. It's nonsense to protect accounts which don't contain any important or very personal info.

**Conclusions:** It is evident that dangers may lead to personal data leaks and loss of privacy is not going away and will only continue to grow and adapt. Over the past several years, the industry has already seen an enormous amount of adaptation from online criminals attempting to steal the information of unsuspecting consumer. We will never be able to stop the attacks but institutions can do more to control who accesses their sites by enhancing the authentication techniques and controls they use.

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## **MODERN CRYPTOGRAPHY**

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**Abstract:** Modern cryptography is being used extensively for securing our Internet payments, banking transactions, emails and even phone conversations. This paper analyzes some of the most popular crypto

algorithms used today, their working principles and what could become a potential threat to any modern cryptosystem.

**Key words:** Symmetric Key Cryptography, Asymmetric Key Cryptography, Advanced Encryption Standard (AES), RSA, quantum calculations.

## **Introduction**

Modern cryptography has become the savior of the Internet, promising to secure our most important information and communications by guarantying it may not be deciphered by any other than the intended recipient. However, constantly developing technologies and increase in computing power open new opportunities for attackers. Some algorithms, that considered to be robust, become vulnerable to brute force attacks.

Object-matter: Cryptography as a tool to ensure information confidentiality.

Subject-matter: Popular crypto algorithms in use today.

Objective: To investigate both advantages and disadvantages of the algorithms described in the article.

Tasks: To describe working principles of the algorithms under consideration.

Methods: Descriptive and comparative ones.

## **Discussions and Results**

### **Basic information on cryptography**

Cryptography is the scientific study of secret writing. It is an indispensable tool for protecting information in computer systems. Modern cryptography is heavily based on mathematical theory and computer science practice. Cryptographic algorithms are designed around computational complexity assumptions, making such algorithms hard to break in practice by any adversary. It is theoretically possible to break such a system, but it is infeasible to do so by any known practical means. Modular arithmetic, discrete mathematics, complex prime number calculations and elliptic curve algorithms form the basis of our current cryptographic algorithms. Such mathematics relies upon one thing – complexity. In order for an algorithm to provide security for data, it must be computationally infeasible to deduce the original message from knowledge of the algorithm and encrypted message. Such algorithms are relatively simple to compute in one direction, yet intangible in reverse without knowledge of another piece of information, typically a number or set of numbers known as the key. For as long as the calculations to reverse the cryptographic algorithm take longer than the valuable lifetime of the data it protects, it may be considered secure.

### **Types of cryptography**

The modern cryptography is classified into two types - Symmetric Key Cryptography and Asymmetric Key Cryptography.

Symmetric Cryptography is the most traditional form of cryptography. In a symmetric cryptosystem, the involved parties share a common secret (password, pass phrase, or key). Data is encrypted and decrypted using the same key. These algorithms tend to be comparatively fast, but they cannot be used unless the involved parties have already exchanged keys. Any party possessing a specific key can create encrypted messages using that key as well as decrypt any messages encrypted with the key.

Common examples of symmetric algorithms are DES, 3DES and AES. The 56-bit keys used in DES are short enough to be easily brute-forced by modern hardware and DES should no longer be used. Triple DES (or 3DES) uses the same algorithm, applied three times with different keys giving it an effective key length of 128 bits. Due to the problems using the DES algorithm, the United States National Institute of Standards and Technology (NIST) hosted a selection process for a new algorithm. The winning algorithm was Rijndael and the associated cryptosystem is now known as the Advanced Encryption Standard or AES. For most applications 3DES is acceptably secure at the current time, but for most new applications it is advisable to use AES.

Asymmetric cryptography, is an encryption scheme that uses two mathematically related, but not identical, keys - a public key and a private key. Unlike symmetric key algorithms that rely on one key to both encrypt and decrypt, each key performs a unique function. The public key is used to encrypt and the private key is used to decrypt.

It is computationally infeasible to compute the private key based on the public key. Because of this, public keys can be freely shared, allowing users an easy and convenient method for encrypting content and verifying digital signatures, and private keys can be kept secret, ensuring only the owners of the private keys can decrypt content and create digital signatures.

The most common asymmetric encryption algorithm is RSA. RSA derives its security from the computational difficulty of factoring large integers that are the product of two large prime numbers. Multiplying

two large primes is easy, but the difficulty of determining the original numbers from the total – factoring – forms the basis of public key cryptography security. The time it takes to factor the product of two sufficiently large primes is considered to be beyond the capabilities of most attackers, excluding nation state actors who may have access to sufficient computing power.

### **Advanced Encryption Standard**

The Advanced Encryption Standard (AES or Rijndael), is a specification for the encryption of electronic data established by the U.S. National Institute of Standards and Technology (NIST) in 2001. The AES algorithm operates on bytes. AES as well as most encryption algorithms is reversible. It is an iterated block cipher. All that means that the same operations are performed many times on a fixed number of bytes. These operations can easily be broken down to the following functions: Byte Substitution, Shiftrows, MixColumns, Addroundkey.

Byte Substitution: The 16 input bytes are substituted by looking up a fixed table (S-box) given in design. The result is in a matrix of four rows and four columns.

Shiftrows: Each of the four rows of the matrix is shifted to the left. Any entries that ‘fall off’ are re-inserted on the right side of a row. Shift is carried out as follows –

- First row is not shifted.
- Second row is shifted one (byte) position to the left.
- Third row is shifted two positions to the left.
- Fourth row is shifted three positions to the left.
- The result is a new matrix consisting of the same 16 bytes but shifted with respect to each other.

MixColumns: Each column of four bytes is now transformed using a special mathematical function. This function takes as input the four bytes of one column and outputs four completely new bytes, which replace the original column. The result is another new matrix consisting of 16 new bytes. It should be noted that this step is not performed in the last round.

Addroundkey: The 16 bytes of the matrix are now considered as 128 bits and are XORed to the 128 bits of the round key. If this is the last round then the output is the ciphertext. Otherwise, the resulting 128 bits are interpreted as 16 bytes and we begin another similar round.

An iteration of the above steps is called a round. The amount of rounds of the algorithm depends on the key size. There are 10 rounds for 128-bit keys, 12 rounds for 192-bit keys, and 14 rounds for 256-bit keys. The only exception being that in the last round the Mix Column step is not performed, to make the algorithm reversible during decryption.

### **RSA**

The most commonly used asymmetric algorithm is Rivest-Shamir-Adleman (RSA). It was introduced by its three inventors, Ronald Rivest, Adi Shamir and Leonard Adleman in 1977. It is mostly used in key distribution and digital signature processes. RSA is based on a one-way function in number theory, called “integer factorization”. A one-way function is a function, which is “easy” to compute one way, but “hard” to compute the inverse of it. Here easy and hard should be understood with regard to computational complexity, especially in terms of polynomial time problems.

The RSA algorithm is as follows: Key Generation Algorithm:

2. Randomly and secretly choose two large primes:  $p$ ,  $q$  and compute  $n = p \cdot q$
3. Compute  $\phi(n) = (p - 1) (q - 1)$ .
4. Select Random Integer:  $e$  such as  $1 < e < n$  and  $\text{gcd}(e, \phi(n)) = 1$ .
5. Compute  $d$  such as  $e \cdot d \equiv 1 \pmod{\phi(n)}$  and  $1 < d < \phi(n)$ .
6. Public Key:  $(e, n)$
7. Private Key:  $(d, n)$ .

Encryption process:

- Suppose entity R needs to send message  $m$  to entity S (represent  $m$  as an integer in the range of  $0 < m < n$ ).
- Entity S should send his public key to entity R.
- Entity R will encrypt  $m$  as  $c = m^e \pmod{n}$  and will send  $c$  to entity S.

Decryption Process: Entity S will decrypt the received message as  $m = c^d \pmod{n}$ .

The most important advantage of RSA is ensuring privacy of the private key because this key will not be transmitted or revealed to another user. However, this algorithm has some considerable weaknesses. The main computational costs of the RSA are the modular exponentiations found during the key generation,

encryption and decryption process. Moreover, this algorithm has some weaknesses against certain attacks (i.e., Brute force, Mathematical attacks, Timing attacks and Chosen Cipher-text attacks). To reduce these problems, many algorithms have been designed and introduced based on original RSA. The most popular algorithms identified for improving the main algorithm are RSA Small-e and Efficient RSA.

#### **Threat to modern cryptography**

As of 2016, the development of actual quantum computers is still in its infancy, but experiments have been carried out in which quantum computational operations were executed on a very small number of quantum bits. Both practical and theoretical research continues, and many national governments and military agencies are funding quantum computing research in an effort to develop quantum computers for civilian, business, trade, environmental and national security purposes, such as cryptanalysis.

Large-scale quantum computers would theoretically be able to solve certain problems much more quickly than any classical computers that use even the best currently known algorithms, like integer factorization using Shor's algorithm or the simulation of quantum many-body systems. Quantum computers may be able to efficiently solve problems which are not practically feasible on classical computers.

Conventional cryptographic systems offer computational security but does not ensure absolute or unbreakable security. The strength of the current cryptographic algorithms rely on complex mathematical problems, such as integer factorization and elliptic curve discrete logarithm problem.

These problems can be solved using large-scale quantum computers and therefore can easily crack conventional algorithms. Quantum computers will be a threat to both symmetric key algorithms, and asymmetric public key algorithms. These computers can break every single popular public key algorithm in a trivial amounts of time. Experts believe that the "serious" quantum computers will appear in about 25-30 years, and beyond this period future of modern cryptography is uncertain.

#### **Conclusions**

Advanced research in the field of cryptography is undoubtedly impressive and is an important investment into the future especially against the backdrop of modern cryptanalysis and inexorable growth of computing power. Nowadays, cryptography algorithms are based on computational hardness which makes it difficult for classical computers to unravel their secret keys. However, the invention of quantum computers is a real threat to cryptography. Their processing power will eventually defeat all "classical" encryption algorithms, and make current attempts to ensure information security absolutely nonsensical.

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УДК 629785

#### **GAIA MISSION. GAIA DATA RELEASE 1.**

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**Abstract:** Gaia is a proposed concept for a European Space Agency (ESA) cornerstone mission, building on the experiences of the highly successful Hipparcos space astrometry mission, but aiming at a considerably more powerful facility addressing a wide range of topics in astrophysical research.

Gaia gathers astrometric data (proper motions, trigonometric parallaxes) for some 50 million objects, as faint as 15-16 mag, with an accuracy of 5-20 micro-arcsec. At this moment Gaia supplies a data processing center photos of billions of stars, galaxies, quasars and asteroids of the Solar system with resolution of 1000 pixels. [Lindegren, Perryman 1993: 3]

**Key words:** Astrometry, astrophysical research. Gaia mission, parallaxes, proper motions.

## Introduction

The **object-matter** of this research is measuring astrometric parameters of stars due to spacecraft Gaia. The **subject-matter is the Gaia mission.**

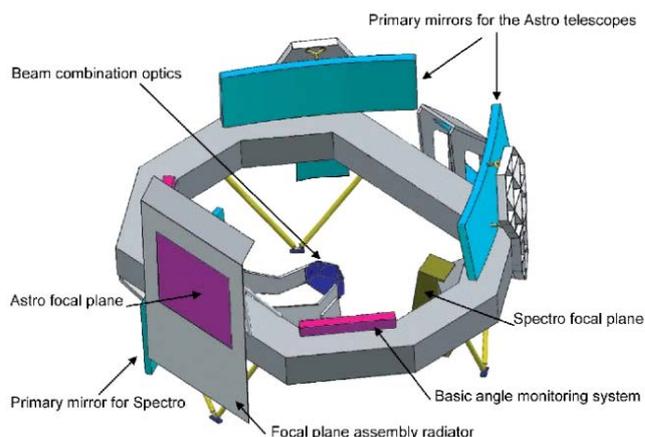
The Gaia mission [Prusti 2012; Gaia Collaboration et al. 2016b], launched on 19 December 2013 by the European Space Agency, aimed to revolutionize our knowledge of individual stellar objects and of the structure of the Milky Way by providing distance and velocity measurements of unprecedented precision for over a billion individual objects within the Milky Way [Jordi Carlos García García 2009: 7].

The **objective** of this research is to get more astrometric parameters of stars by analyzing data from first release of Gaia mission, what is the main **task. So, I will use Gaia DR1** to obtain information that we need.

### Gaia general features

The Gaia communications system transmits the science data to the ground station at about 4 Mbps during about 8 hours per day. The spacecraft is composed by three different modules: a payload module, a mechanical service module and an electrical service module.

The payload module consists basically of two telescopes, with a single focal plane. This scientific payload has three instruments: the astrometric instrument, the broad band photometer and the radial velocity spectrometer. The astrometric instrument is in charge of measuring five astrometric parameters: the projected position of the star in the sky (2 angles), the proper motion (2 time derivatives of position, one for each angle) and the trigonometric parallax (which provides the distance to each source). The broad band photometer provides continuous star multiband photometry in the 3201000 nm band, and it is also used to calibrate the chromaticity of the astrometric instrument. Finally, the radial velocity spectrometer is intended to provide radial velocity measurements and high resolution spectral data in the narrow band 847874 nm. [Jordi Carlos García García 2009: 8-9]



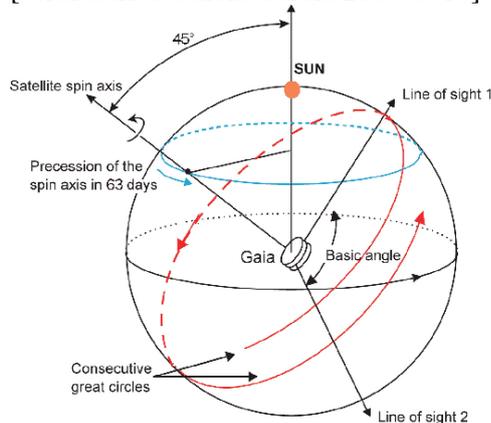
**Fig. 1.** Schematic figure of the Gaia payload.

The mechanical service module comprises the spacecraft main structure, which is hexagonal conical shaped and will be optimised to guarantee the stability of the basic angle (the angle between the two telescopes). This module also comprises a flat deployable sunshield which prevents illumination from the Sun of the payload module, a thermal tent which provides additional protection and the thrusters of the chemical propulsion system and the complete micropropulsion system. [Jordi Carlos García García, 2009: 9]

Finally, the electrical service module basically houses the communication subsystem, the central computer and data handling subsystem, and the power subsystem. [Jordi Carlos García García 2009: 9]

### Gaia scanning law

The Gaia scanning law, which you can see at Fig. 2, relies on the systematic and repeating observation of the positions of the star along the two fields of view. The spacecraft is slowly rotating at a constant angular rate around an axis perpendicular to those two fields of view (the spin axis). With a constant basic angle and a known spin rate it is easy to know how much time it takes for a star to transit the focal plane. The spacecraft spin axis will make an angle of  $45^\circ$  with the direction of the Sun. This is the optimal tradeoff between the astrometric requirements (basically, payload shading) and solar array efficiency. This scan axis further describes a slow precession motion around the spin axis. As already mentioned, Gaia will also describe a circular orbit around the Sun. Finally, the spacecraft itself will describe a Lissajous orbit around the EarthSun point L2. [Jordi Carlos García García 2009: 9-10]



**Fig. 2.** Gaia scanning law.

### Astrometric content of the data release

The content of Gaia DR1 as a whole is described in Gaia collaboration, Brown, et al. (2016). The astrometric content consists of two parts:

1. The primary data set contains positions, parallaxes, and mean proper motions for 2 057 050 of the brightest stars. This data set was derived by combining the Gaia observations with earlier positions from the Hipparcos [ESA 1997, van Leeuwen 2007a] and Tycho-2 [Høg et al. 2000b] catalogues, and mainly includes stars brighter than visual magnitude 11.5. The typical uncertainty is about 0.3 milliarcsec (mas) for the positions and parallaxes, and about 1 mas yr<sup>-1</sup> for the proper motions. For the subset of 93 635 stars where Hipparcos positions at epoch J1991.25 were incorporated in the solution, the proper motions are considerably more precise, about 0.06 mas yr<sup>-1</sup> (see Table 1 for more statistics) [Lindegren, Lammers, Bastian, et al. 2016].

The positions and proper motions are given in the International Celestial Reference System [ICRS; Arias et al. 1995], which is non-rotating with respect to distant quasars. The parallaxes are absolute in the sense that the measurement principle does not rely on the assumed parallaxes of background sources. Moreover, they are independent of previous determinations such as the Hipparcos parallaxes. The primary data set was derived using the primary solution, which is closely related to both TGAS and the Hundred Thousand Proper Motions (HTPM) project [Michalik et al. 2014].

2. The secondary data set contains approximate positions in the ICRS (epoch J2015.0) for an additional 1 140 622 719 stars and extragalactic sources, mainly brighter than magnitude 20.7 in Gaia's unfiltered (G) band. This data set was derived using the secondary solution, which essentially neglects the effects of the parallax and proper motion during the 14 months of Gaia observations. The positional accuracy is therefore limited by these effects, which typically amount to a few mas but could be much larger for some stars.

Gaia DR1 therefore contains a total of 1 142 679 769 sources. Neither data set is complete to any particular magnitude limit. The primary data set lacks the bright stars (G.6) not nominally observed by Gaia, plus a number of stars with high proper motion. The magnitude limit for the secondary data set is very fuzzy and varies with celestial position. A substantial fraction of insufficiently observed sources is missing in both data sets. [Lindegren, Lammers, Bastian, et al. 2016]

### Conclusions

The inclusion of positional information from the Hipparcos and Tycho-2 catalogues in the early Gaia data processing has allowed scientists to derive positions, parallaxes, and proper motions for about 2 million sources from the first 14 months of observations obtained in the operational phase of Gaia.

The trigonometric parallaxes derived for the primary data set have a median standard uncertainty of about 0.32 mas. This refers to the random errors. Systematic errors, depending mainly on position and colour,

could exist at a typical level of  $\pm 0.3$  mas. This includes a possible global offset of the parallax zero point by  $\pm 0.1$  mas, and the regional (spatially correlated) and colour dependent systematics of  $\pm 0.2$  mas revealed by the special validation solutions. These systematic cannot be much reduced by averaging over a number of stars in a small area, such as in a stellar cluster.

The many solutions and validation experiments leading up to the Gaia DR1 data sets have vastly expanded our understanding of Gaia's astrometric behaviour and boosted our confidence that Gaia will in the end provide results of extraordinary quality [Lindgren, Lammers, Bastian, et al. 2016].

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### DEEP NEURAL NETWORKS FOR MODELING PHYSICAL PROCESSES IN UNIVERSE

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**Abstract:** This article deals with the way of modeling real world as a deep neural network and possible issues it can have. The main restriction that a neural network approach has is that it has the finite and fixed number of inputs (e.g. data describing the system) and that it describes everything at fixed delays of time. In general, applying neural networks to describe basic principles of physics in nanoscale is impractical but is good as a theoretical model of real universe and shows the potential of artificial neural networks.

**Key words:** neural network, modeling, machine learning.

**Introduction:** The artificial neural networks is a powerful tool which is used for solving different problems including statistical physics, experimental high energy physics and modeling and controlling of particle accelerators. Such networks can be used as a way to determine the probability of different events or as a direct calculus tool creating logical gates and circuits [Edelen, Biedron 2016; Angelos, Anastassi 2013].

When talking about such huge system as our universe we should consider all the limitations we are forced to deal with. Starting from the fixed number of inputs and finishing with the fixed steps in time we should remember that neural network imperfections can in some way describe the phenomena standing out from generalized theoretical results [Delalleau, Bengio 2011].

All the data about the universe can be stored as a vector of numerical data and after being passed through the neural network they overwrite the previous data or create an additional instance of the data. It is obvious that the number of inputs and the number of outputs should be the same for such system. As a simplest example of two-body system and gravitational interaction between them the neural network will have a huge size because of evaluating  $r^{-3}$  between two bodies and requires at least 7 inputs for each body (1 for mass, 3 for coordinates, 3 for velocities).

The **object-matter** of the study is the artificial network modeling real world of physical processes, and the **subject-matter** is implementation of such network and restrictions connected with it.

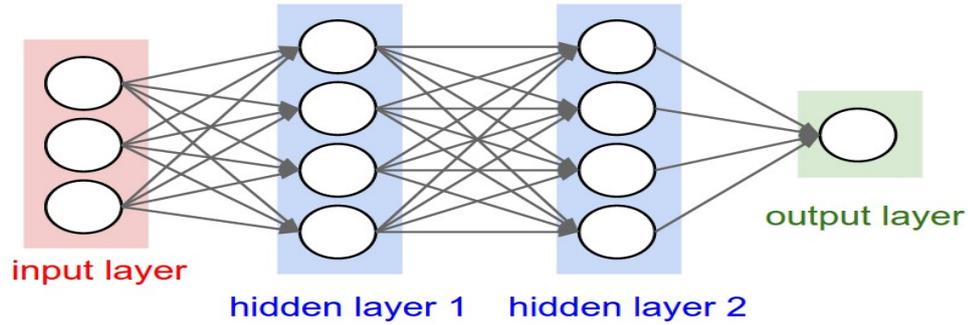
The **objective** of this article is to determine the effectiveness of artificial neural network as a system describing physical processes. The article suggests the following **tasks**:

- 1) to analyze artificial neural network structure;
- 2) to investigate methods already implemented;
- 3) to determine shortcomings of neural network modeling.

The **method of research** in the course of this article is qualitative research.

**Discussion and Results:** As for the definition and basic principles of neural network, the artificial neural networks are a computational approach which is based on a large collection of neural units loosely

modeling the way in which a biological brain solves problems with large clusters of biological neurons connected by axons. A typical neural network can be visualized as follows:



**Fig.1** The deep neural network consisting of 2 hidden layers. The number of inputs and the number of outputs are independent from the number of hidden neurons.

Each neuron has a fixed number of inputs and outputs. The value of the output is defined in a binary form (true or false) using following conditional expression:

$$\theta = \begin{cases} 1, & K\left(\sum_i w_i I_i\right) > T \\ 0, & \text{otherwise} \end{cases}$$

where  $I_i$  corresponds to the input of the neuron,  $w_i$  – the weight of the input (the value input is multiplied by),  $T$  – minimum at which the neuron returns 1 (true),  $K(x)$  – activation function (typically  $\tanh(x)$  and limiting values to (-1;1) thus showing the probabilistic nature of neural network). In rare cases an activation function can be essentially a null function and just returns the input value ( $K(x) = x$ ) if it is necessary for the results to be predictable [Anastassi 2013, Krasnopolsky, Fox-Rabinovitz, Belochitski 2008].

Next step is to create neural network for solving a specific task. It requires a huge analysis of input data to predetermine the required size of neural network and it is usually an experimental way of establishing all connections between neurons. If we want to create a two-body system, then it will take 13 neurons for evaluating the position of the bodies but only in 2D space. Solving a two-body problem in 3 dimensions will require much more neurons and will significantly bump up the evaluation time.

An interesting fact about the network for solving even such a simple problem is that every neuron is actually supposed to be in a different layer of the neural network because of all the intersections between them, which results in 13 layers for 6 inputs in total [Anastassi 2013].

In a similar way other forces can be injected into the system. But the real problem comes when we consider such phenomenon as waves and the possibility for particle to be not just a point mass but a compound of electrons and the nucleus, the latter being a compound on its own. The network designed for modeling universe must have a possibility to handle thermionic emission creating additional photons. Here we face the restrictions of the neural network – the limited and fixed number of inputs [Pasero, Zecchina 2002].

The main two restrictions of the theory describing real universe is that there is a fixed number of data describing it, meaning that there is a fixed number of elementary particles in the universe in terms of an artificial neural network. If the time travel would be possible then removing mass from the current point of time is impossible, and it would only be possible if the time-traveling mass is replaced with some other form of matter. Another fact is that it is supposed to be locked inside the neural network meaning that it can somehow influence existing events or it can be a part of them. With the same success time travel in terms of neural network can be straightforward impossible.

The next restriction comes from fixed steps of time. In real physics the entropy can describe the changes in time and it only increases over time while the system becomes more chaotic. Solving the two-body problem does not require fixed steps in time because of the methodology used for solving it, but when talking about really complex system it would be necessary to add fixed steps in time to allow the system to evolve properly. The whole idea is to create a model of the universe in terms of the discovered laws and phenomena. We do not know anything about the universe right after the Big Bang and we do not really know a minimum time required

for the smallest change in state of the system thus making a Planck time ( $t_p \approx 5,39 \cdot 10^{-44}$  s) the only reasonable fixed step in time for the neural network [Lin, Tegmark 2016].

**Conclusions:** The modeling of real universe as a deep neural network is a possible explanation of actual events happening in real world but cannot be easily created in real conditions requiring tracking each elementary particle on its own and considering all the interactions between them over insanely small periods of time of Planck time, meaning  $\approx 1,89 \cdot 10^{43}$  iterations per second. Also training such neural network will require insane amounts of pre-evaluated data, which is not practical under real conditions of the current computational power. The real application of such system is theoretical analysis and hypothetical predictions of physical phenomena.

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## SOLVING NP COMPLETE PROBLEMS

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**Abstract:** This article is about modern ways of solving NP-complete problems. It describes what is NP-complete class, says some words about importance of this class. In introduction there is a list of methods with short description, with all of them examined in the main part. The main goal of the article is to show benefits and problems of each method and find which ones are more effective and promising.

**Keywords:** NP-complete, computer science, effective algorithms.

### Introduction

In today's world computer technologies are used everywhere, in other words the spectrum of problems being resolved using them is extremely wide. For each task, we usually create an abstract model of the solving algorithm. This allows us to determine the effectiveness of the approach to the problem, not bounded to specific implementation. According to the complexity computing tasks are divided into several categories, the most important ones are: polynomial problem and NP-complete (from the non-deterministic polynomial). The first category problems have an algorithm that solves them for the number of operations, bounded from above by a polynomial. The second category includes the tasks for which a polynomial solution has not been found yet, but it is possible to solve them in polynomial time with a "tip": if we add to input the correct answer, then there is an algorithm able to confirm that the answer is suitable in polynomial time. The correct answer is this: it is not really an answer to the problem, because often problems are YES / NO, rather than an example of a situation in which conditions of the problem are possible. NP-complete problems have been the **object-matter**.

As previously mentioned, a complete solution does not exist for NP-complete problems in a reasonable time for any input. But it is important to understand that the "reasonable time" is not a very precise term, and small amount of data may be appropriate for a solution that works, for instance, in  $O(2^n)$ . However we often need to solve NP-complete problems, several different ways have been invented to get an answer, not all of which ensure that it is correct, but they work in the time that we can afford. The methods for solving NP-complete problems have been our **subject-matter**.

It is very important to understand which way we can solve NP-complete problems and which of them are more effective, as there is no "single" solution in this area, and a wrong way can cause a wrong answer or to

be slow. The **objective** is to emphasize the effectiveness of different approaches to solving NP-complete problems.

Firstly, we shall choose several methods for solving NP-complete problems and apply them to the applied tasks, to compare the results and to draw conclusions. The chosen **methods** are the following: approximate algorithms – such solutions, that do not guarantee the right answer, but give a fairly close value; heuristic algorithms, built on certain observations and laws, which often give the right answer; pseudo-polynomial algorithms, which do not work for the polynomial dependence on the input data, but look as if they were polynomial; randomized algorithms, which use random numbers for accelerated search for a solution; parametrized algorithms depend on a parameter which can be set in advance for all the input data; "Fast" exponential algorithms, which are exponential, but can run fast enough for large input data.

We have analyzed the methods chosen, and as a result it has been concluded that many NP-complete problems can be solved in "reasonable time", but each task requires its own approach and finding a suitable method to solve it.

## **Discussion and Results**

### **1. Approximate algorithms**

Approximate algorithms are those that do not provide a precise answer, but ensure that the obtained result is not very different from the exact one. Thus, we immediately get a major limitation in use of the method: there should be no strict requirements on the result accuracy, and it should be possible to call answers "similar", so for example for test-tasks with two possible answers we cannot say that the answer "false" is similar to "truth" or vice versa. But the main advantage of this method consists in the fact that it works in polynomial time for all inputs, without any "tricks", as well as the confidence that inaccuracy may be strictly limited.

For example, in traveling salesman problem we have graph and need to find a minimal cost path that passes through all the vertices. This problem is NP-complete, and to solve it exactly for an arbitrary graph is not possible. But there is an Christofides algorithm, which works on graphs with the triangle inequality (if there is a direct edge between vertices, then there cannot be any other path that would be shorter than the length of the direct edge), which is met for all graphs constructed from the points in the Cartesian coordinate system, which allows us to find a solution, not less than  $3/2$  of the optimum, in polynomial time ( $O(n^2 \log^2(n))$ ) [Nilsson 2003: 2].

### **2. Heuristic algorithms**

Heuristic method involves observing applications, which cannot guarantee the accuracy and optimal solutions. Quite often, the method is used to accelerate already working solutions. For example, it is known that in the input we have common simple case that can be solved much faster. Then, if we add solution only for this case we do not improve the asymptotic behavior of the entire algorithm, but significantly accelerate work in practice. This method is one of the most optimal in practice, but requires additional research on tasks, and we cannot be sure that we will find any.

In graph-coloring problem we have to find the minimum number of colors, with which you can paint each vertex so that there are no edges having the same color ends. This problem is also NP-complete, but it has a very simple heuristic solution that assigns vertex colors one by one, at each step assigning the minimum available color. This solution gives values close to the correct answer almost any time, although you can make an example in which it will work very poorly [Zaker, Manouchehr 2006: 3166-3173].

### **3. Pseudopolynomial-time algorithms**

Polynomial algorithm is one that works for a polynomial from number of bits of input data, which is not always the same as the "intuitive" understanding of the polynomial solution. This is evident in the problem of the division of the set of integers: you need to divide it into two sets with the specified sums. Although brute force works for  $2^n$ , and the task is itself NP-complete, but there is a solution in  $O(nM)$ , where  $n$  is the number of integers in the set, and  $M$  – the maximal integer. This is not a polynomial algorithm, since to write the number  $M$  we need only  $\log_2(M)$  bits, but for real data  $M$  is almost always limited, and in this sense the algorithm is polynomial. As you can see, these solutions have advantages like accurate solutions for any input, working in a relatively short time, but unfortunately, the scope of their application is very limited.

### **4. Randomized algorithms**

Randomized algorithms, as the name implies, are those algorithms that use random numbers to search for solutions. This is a very powerful method because random search does not depend on the order of the input data, thereby significantly improves the work of some heuristic algorithms. For instance, the mentioned method of the graph coloring running several times a randomly modified order is much more efficient. It is impossible to pick up the bad input, and since there are many such orders in which the greedy algorithm gives an optimal

response, this optimization allows us to look for an exact answer. In a problem with the maximum cut (necessary to divide the graph into two parts with the sum of the edges between the parts is maximal) random dividing on parts gives us result within 50% of the optimal with high probability. [Mitzenmacher, Upfal 2005: 129-130].

Thus, the randomization is applicable to a fairly wide range of tasks, and gives good results, although it is often more complementary than the basic ideas of the decision.

### **5. Parameterized Algorithms**

In some tasks it happens that the input serves a lot of different options, and there is a solution that is not polynomial by only one of them. Then we can assume that the problems where this parameter is constant are polynomial. Thus it is possible to solve the problem in the case when the parameter is relatively small, even if the amount of remaining data is sufficiently large. This method allows us to solve the problem accurately and in a relatively short amount of time, although it does not work equally well for any input, so it allocates a class of problems in which it is applicable. Unfortunately, parameterized algorithms exist not for all tasks, but if there are any, they are usually quite effective.

For instance, in the long path problem (you must find the path of a given length, which does not pass twice any vertex) there is a solution that is not polynomial only in terms of the length of the desired path [Alon, Yuster 1994: 326-335], thereby allowing us to solve this problem for small numbers in a short time, even if graph size is large enough.

### **6. "Fast" exponential algorithms**

Since the exponent has the form  $a^x$ , the maximum  $x$  that we can handle depends on the number  $a$ , which is a parameter of the algorithm. Less  $a$  is the bigger  $x$  we can use. So many researches are aimed to find algorithms with the smallest  $a$ . For instance, for the graph coloring problem in three colors, "stupid" solution will work in  $3^n$ , where  $n$  is the number of vertices. But there is an algorithm that does the same thing for  $1.3289^n$  [Beigel, Eppstein 2005] that allows us to process almost 4 times greater  $n$  in the same time. Or, for example, often  $n!$  can be reduced to  $2^n$ , which also increases the maximum allowable  $n$ .

As follows, this method yields an exact solution, but does work appropriate time only for small input, making it useful only in rare cases when no data is too big.

### **Conclusions**

The study analyzed the existing methods for solving NP-complete problems, identified the advantages and disadvantages of each, defined the terms of use. It was found that for the most tasks there are ways to solve it also in polynomial time, but not exactly, or not all for any inputs, or accurately, but only for a certain subclass of the problem. We can identify randomized method as a universal way for making algorithms independent from the input order and heuristic algorithms for practically endless possibilities for optimizations.

The most effective in our opinion is a method using pseudo polynomial algorithms, as it allows us to solve the problem for almost any input data precisely. Promising are exponential algorithms with a small factor, since a sufficiently strong progress in this way allows us to solve problems quickly and accurately for many inputs, and this trend is not restricted even if  $P$  does not equal  $NP$ , since this inequality says nothing about the fact that the exponential parameter should be very different.

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### **FACE RECOGNITION ALGORITHMS**

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**Abstract:** The article deals with the actual and important problem of face recognition that is widely used in ever-increasing practical needs and the algorithms to its solution. The paper reviews two approaches to the problem based on different image characteristics in order to analyze their advantages and disadvantages. Based on the analysis the cases are allocated where better to use one or the other method.

**Keywords:** Gabor filters, convolution of function, jets, global and local characteristics, space base.

## **Introduction**

Despite the obviousness of everyday phenomenon that a person perfectly distinguishes faces from other, surrounding objects, it is not obvious how to teach your computer to do it, including how to decode and store digital images of faces. Interest in the problem of face recognition in images always remains significant, because this problem appears widely in ever-increasing practical needs, with the most obvious areas of application being surveillance, forensics, computer graphics. The following unusual but interesting fields should be mentioned as well: computer- human interaction, virtual reality, computer games, driving license, passport and other documents identifying a person, immigration control, consumer devices personalization, data encryption, e-commerce, and even more global ones – fight against terrorism and international criminals.

The problem of optimal search for and identification of a low-contrast object, that is considered to be a human face on the basis of the cybernetic systems can be seen in the light of the classical perception of the problem, and in the light of new approaches. Universal solutions to prove effective in all cases, alas, have not yet been found, but gradually, new approaches and methods for maximizing efficiency of the existing algorithms have appeared.

**Object-matter** — face recognition problem.

**Subject-matter** — mathematical approaches as a tool to solve face recognition problem.

**Objective** — to reveal both advantages and disadvantages of each approach to be considered.

**Methods:** analysis, deduction and induction.

### **Tasks:**

- To consider the approach based on local characteristics (graph matching method);
- To review the method based on global parameters (method of own faces);
- To define the cases wherein the methods under consideration can be most effective.

## **Discussion and Results**

Face recognition problem has been considered early in Computer Vision. A number of companies for more than 40 years actively involved in developing face recognition automatization process invented the following automatic human face recognition systems: ImageWare (FaceID system), Imagis, Epic Solutions, Spillman, Vissage Technology (Vissage Gallery System) [7].

The study conducted by the National Institute of Standards and Technology (NIST) [8], revealed that the level of false identification or non-recognition of entities whose pictures were taken just 18 months ago, is 43%. The photos used in the study were shot in ideal conditions, which is very important, since the face recognition software fails to cope successfully with the assessment of changes in illumination or camera angle. "Difficulties" for them are pictures with lively background. NIST study also concluded that a change in the camera angle of 45 degrees makes such programs almost useless.

Today we can name the following companies engaged in the development of detection technology: Geometrix (USA), Genex Technologies (USA), Bioscrypt (Canada), L-1 Identity Solutions (England), Artec Group (Russia) [9].

Despite considerable efforts undertaken to develop face recognition algorithms, there has not yet been established a system that can operate without the artificial restrictions, taking into account all possible variations of image parameters such as sensor noise, distance and light level. The only system that manages well with its task is a person's vision. Therefore, scientists and researchers of our time are trying to use a strategy that applies this biological system to create artificial algorithms.

It should be noted that there are *two major challenges* in solving the problem of face recognition.

*Firstly*, any image is an array of pixels. At the same time one pixel image does mean nothing. This makes such a representation of images excessive and uneconomical. Thus, for effective facial recognition it is necessary to develop a compact and convenient format for images. Today we know many ways to image compression with losses, but they are used in the format which is not suitable for photos classification of people, because much less information is required to solve the problem of face recognition. This is primarily due to the fact that there is no need to determine how this person from the collection of photos looks like. The inverse problem is to be solved: who looks this way.

*The second problem* is that one and the same person's face can be photographed under various external factors, such as the posture, the emotion, the number and arrangement of the light sources, the color and intensity of the radiation reflected from the shade or the surrounding objects.

Abstract formulation of the problem might well help facilitate understanding of the algorithms in the

near future. Reviewing the solutions to the problem, we are going to consider a picture with a size of  $100 \times 100$  pixels with 256 shades of gray.

Let us assume that there is a certain collection of 400 pictures with 10 images of each of 40 people under different conditions.

We should concentrate on the preparatory stage — it is common for all algorithms related to our problem. The first step is to select the human face on the image. To normalize the image we should proceed as follows:

- \* To change image resolution up to  $100 \times 100$ ;
- \* To convert colors to 256 shades of gray;
- \* To change the total brightness of the image to an average value.

If the face is turned to a certain angle from the vertical position, rotation transformation will also be performed within this step.

The next step is to distinguish facial features. After that the picture is not needed any longer.

The final step of recognition is the use of the classifier, which provides us with the solution to the problem having analyzed the above characteristics. Let us try to specify the possible outcome:

- \* The image is not a face;
- \* The image is the face of a certain person from the collection;
- \* The image is a person, but it is not from the collection. In this case, it can be added to the collection.

Phase separation characteristics determine the difference between recognition algorithms.

Let us start with the **method of graph matching**. The algorithm is based on the receipt of Gabor filters. The convolution of function is function, in this case, is a core of convolution. A discrete analogue of the convolution operation is a weighted sum.

The vectors to get formula  $i$ -th Gabor filter should be considered further. Hence, the vectors are, where and  $(0 \leq i \leq 4, 0 \leq j \leq 7)$ . It is easy to notice that 40 vectors vary in length (5 values of  $i$ ) and the directions (8 values of  $j$ ).

Turn to the Gabor filters. Gabor filters are the convolutions with such kernels.

Gabor filters have excellent geometric stability, namely, they are resistant to operations of scale, rotation, change of brightness or contrast.

The next step of the algorithm is the creation of a single portrait.

Nearly all people have relatively the same ratio of the distance between the eyes to the length of the nose. Therefore, it is reasonable to mark nose, eyes, eyebrows, mouth, cheekbones, cheeks, and chin. After that, to identify a person, it is sufficient to consider the value of the Gabor filters at the above points. Then select some checkpoints on an arbitrary face. In order to determine where these points are, it is necessary to have some idea of their location and therefore to construct a single portrait.

Let us fix a set of the above points (this step determines the quality of the recognition algorithm). Then, for each image from the collection we indicate where these points are, and calculate the values of 40 Gabor filters at these points. The vector consisting of 40 Gabor filter values calculated in a specific point is called a jet of this point. Now we average distance between these checkpoints. We average the jet as well.

As a result we have a graph in which the vertices correspond to the above points, and the lengths of edges equal the average distances between the breakpoints. Moreover, each node is stored in a "middle" jet.

Thus, the graph obtained is called a single portrait.

Pay attention to the process of finding the checkpoints. After receiving a new face in the input we need to find the position of the check points on it.

Each checkpoint is known for its jet. We need to find a vector of points, each point of the jet of the vector was as close as possible to jet corresponding checkpoint. At the same time, it is necessary that the distance between the selected points should be as much proportional to the lengths of edges of the graph of a single portrait as possible. Thus, we are able to introduce some of the vectors from a set of points, and then to minimize them (to find a vector which minimum value is reached).

After finding the checkpoints on the image, we have a new image vector which is a set of jets in all checkpoints. We need to identify which face (person) corresponds to the vector. For this purpose we use the standard classification methods, such as the method of neighbors.

*Advantages of this approach:*

- Firstly, it is simple to be taught for achieving good results, it requires little initial collection;
- Second, it has good resistance to the postures.

The *disadvantages* are as follows: high computational complexity of the recognition procedure; low manufacturability in memorizing the new standards; the linear dependence of the time of the size of the database.

Now we consider a completely different, opposite approach based on the idea of extracting global rather than local characteristics — **method of the own faces**.

Let us start with the fact that, first of all, images have a dimension of  $100 \times 100 = 10000$ . Portraits are much smaller than the pictures. Let us assume that all the portraits are arranged in a plane, such as a 100-dimensional one. In such a case, the face can be decomposed according to the following components:

1. The projection of a 100-dimensional plane;
2. The distance to this plane (noise).

Thus, we will store the coordinates of the selected plane in the portrait, as well as the basic vector of this plane in the original space dimension - 10000.

The next stage is to construct the basis of the space of faces. We have portraits and corresponding vectors of the image space). We will construct the basis of the face subspace gradually (). The first vector of the basis is chosen so that it can do best in face recognition process. For this purpose it is necessary to maximize the dispersion. Then, we consider orthogonal complement in and repeat the operations of the other vectors. Thus, we construct the basis .

So, we have vector of the . We find its decomposition on the basis of the space. Now we need to determine which face from the existing collection corresponds to this vector. For this purpose the method of the neighbors can be used.

Among the *advantages* the following can be mentioned:

- \* The checkpoint increase caused by the difference in race, gender, emotions, lighting;
- \* Storage and retrieval of images in large databases, image reconstruction.

The key *disadvantage* is high requirements for image shooting conditions. Images must be made under similar lighting conditions, the same angle. High-quality image pre-treatment should be carried out properly.

### Conclusions

The approaches above, based on the global and local characteristics, have both considerable advantages and disadvantages. Graph matching method can be very effective for photos with complex lighting and shadow effects. Working with high-quality images within a limited time period method of the own faces is most favorable. However, none of the above algorithms can be the most preferable for all cases. Therefore, the scientists in the face recognition field continue to optimize the methods in use and find new solutions to the problem.

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**Abstract.** Fractals is a new branch of mathematics and art. Perhaps this is the reason why most people recognize fractals only as pretty pictures useful as backgrounds on the computer screen or original postcard patterns. Most physical systems of nature and many human artifacts are not regular geometric shapes of the standard geometry derived from Euclid. Fractal geometry offers almost unlimited ways of describing, measuring and predicting these natural phenomena.

This article describes how the four most famous fractals were created and explains the most important fractal properties, which make fractals useful for different domains of science.

**Key words:** Euclidean language fractals, in silico, self-similarity.

## Introduction

The word "fractal" often has different connotations for laypeople than for mathematicians, where the layperson is more likely to be familiar with fractal art than a mathematical conception. The mathematical concept is difficult to define formally even for mathematicians, but key features can be understood with little mathematical background. **The objective** of the paper is to describe how the four most famous fractals were created. **The tasks** are to explain the most important fractal properties, give the definition of self-similarity. **The object matter** is fractal geometry

**The subject-matter** is how fractal scales are compared and to what geometric shapes they are usually perceived.

**The methods** used are descriptive and comparative methods.

The feature of "self-similarity", for instance, is easily understood by analogy to zooming in with a lens or other device that zooms in on digital images to uncover finer, previously invisible, new structure. If this is done on fractals, however, no new detail appears; nothing changes and the same pattern repeats over and over, or for some fractals, nearly the same pattern reappears over and over [*Boeing 2016: 12-30*].

Self-similarity itself is not necessarily counter-intuitive (e.g. people have pondered self-similarity informally such as in the infinite regress in parallel mirrors or the homunculus, the little man inside the head of the little man inside the head...). The difference for fractals is that the pattern reproduced must be detailed [*Benoît 1983; Kenneth 2003; Donald 2008*].

This idea of being detailed relates to another feature that can be understood without mathematical background: Having a fractional or fractal dimension greater than its topological dimension, for instance, refers to how a fractal scales compared to how geometric shapes are usually perceived.

A regular line, for instance, is conventionally understood to be 1-dimensional; if such a curve is divided into pieces each  $1/3$  the length of the original, there are always 3 equal pieces. In contrast, consider the Koch snowflake. It is also 1-dimensional for the same reason as the ordinary line, but it has, in addition, a fractal dimension greater than 1 because of how its detail can be measured. The fractal curve divided into parts  $1/3$  the length of the original line becomes 4 pieces rearranged to repeat the original detail, and this unusual relationship is the basis of its fractal dimension.

This also leads to understanding a third feature, that fractals as mathematical equations are "nowhere differentiable". In a concrete sense, this means fractals cannot be measured in traditional ways [*Benoît 1983; Tamás 1992; Nigel 2000*].

To elaborate, in trying to find the length of a wavy non-fractal curve, one could find straight segments of some measuring tool small enough to lay an end to end over the waves, where the pieces could get small enough to be considered to conform to the curve in the normal manner of measuring with a tape measure.

But in measuring a wavy fractal curve such as the Koch snowflake, one would never find a small enough straight segment to conform to the curve, because the wavy pattern would always re-appear, albeit at a smaller size, essentially pulling a little more of the tape measure into the total length measured each time one attempted to fit it tighter and tighter to the curve [*Benoît 1983*].

## Discussion and Results

One often cited description that Mandelbrot published to describe geometric fractals is "a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole" [*Kenneth 2003*], which is generally helpful but limited. Authors disagree on the exact definition of fractal, but most usually elaborate on the basic ideas of self-similarity and an unusual relationship with the space a fractal is embedded in [*Gouyet 1996; Benoît 1983; Kenneth 2003; Tamás 1992*].

One point agreed on is that fractal patterns are characterized by fractal dimensions, but whereas these numbers quantify complexity (i.e. changing detail with changing scale), they neither uniquely describe nor specify details of how to construct particular fractal patterns [Kenneth 2003].

In 1975 when Mandelbrot coined the word "fractal", he did so to denote an object whose Hausdorff–Besicovitch dimension is greater than its topological dimension [Gouyet 1996]. It has been noted that this dimensional requirement is not met by fractal space-filling curves such as the Hilbert curve.

According to Falconer, rather than being strictly defined, fractals should, in addition to being nowhere differentiable and able to have a fractal dimension, be generally characterized by a gestalt of the following features [Kenneth 2003].

Self-similarity, which may be manifested as *Exact self-similarity*, is identical at all scales, e.g. Koch snowflake. *Quasi self-similarity*, which approximates the same pattern at different scales, may contain small copies of the entire fractal in distorted and degenerate forms, e.g. the Mandelbrot set satellites are approximations of the entire set, but not exact copies.

Statistical self-similarity: repeats a pattern stochastically, so numerical or statistical measures are preserved across scales, e.g. randomly generated fractals, the well-known example of the coastline of Britain, for which one would not expect to find a segment scaled and repeated as neatly as the repeated unit that defines, for example, the Koch snowflake [Tamás 1992].

*Qualitative self-similarity*: as in a time series [Donald 2008] *Multifractal scaling*: characterized by more than one fractal dimension or scaling rule: fine or detailed structure at arbitrarily small scales. A consequence of this structure is that fractals may have emergent properties [Gouyet 1996] (related to the next criterion in this list).

Irregularity is local and global, which is not easily described in traditional Euclidean geometric language. For images of fractal patterns, this has been expressed by phrases such as "smoothly piling up surfaces" and "swirls upon swirls" [Lewis 2000]. For simple and "perhaps recursive" definitions see Common techniques for generating fractals.

As a group, these criteria form guidelines for excluding certain cases, such as those that may be self-similar without having other typically fractal features. A straight line, for instance, is self-similar but not fractal because it lacks detail, is easily described in Euclidean language, has the same Hausdorff dimension as topological dimension, and is fully defined without any need for recursion [Kenneth 2003; Nigel 2000].

Fractal patterns have been modelled extensively, albeit within a range of scales rather than infinitely, owing to the practical limits of physical time and space. Models may simulate theoretical fractals or natural phenomena with fractal features. The outputs of the modelling process may be highly artistic renderings, outputs for investigation, or benchmarks for fractal analysis.

Some specific applications of fractals to technology are listed elsewhere. Images and other outputs of modelling are normally referred to as being "fractals" even if they do not have strictly fractal characteristics, such as when it is possible to zoom into a region of the fractal image that does not exhibit any fractal properties. Also, these may include calculation or display artifacts which are not characteristics of true fractals.

### **Simulated fractals**

Modelled fractals may be sounds, [Gouyet 1996] digital images, electrochemical patterns, circadian rhythms [Donald 2008], etc. Fractal patterns have been reconstructed in physical 3-dimensional space [Kenneth 2003]:10 and virtually, often called "in silico" modelling [Donald 2008]. Models of fractals are generally created using fractal-generating software that implements techniques such as those outlined above [Nigel 2000; Donald 2008; Kenneth 2003].

As one illustration, trees, ferns, cells of the nervous system [Benoît 1983], blood and lung vasculature [Donald 2008] and other branching patterns in nature can be modelled on a computer by using recursive algorithms and L-systems techniques [Benoît 1983]. The recursive nature of some patterns is obvious in certain examples – a branch from a tree or a frond from a fern is a miniature replica of the whole: not identical, but similar in nature. Similarly, random fractals have been used to describe/create many highly irregular real-world objects. A limitation of modelling fractals is that resemblance of a fractal model to a natural phenomenon does not prove that the phenomenon being modelled is formed by a process similar to the modelling algorithms.

### **In creative works**

Early research on Fractal Expressionism attempted to show that the paintings of American artist Jackson Pollock have a definite fractal dimension [Tamás 1992; Nigel 2000]. These claims have been countered by later research showing that those methods are insufficient and unreliable in authenticating his art [Tamás 1992].

Decalcomania, a technique used by artists such as Max Ernst, can produce fractal-like patterns [Lewis 2000]. It involves pressing paint between two surfaces and pulling them apart.

Cyberneticist Ron Eglash has suggested that fractal geometry and mathematics are prevalent in African art, games, divination, trade, and architecture. Circular houses appear in circles of circles, rectangular houses in rectangles of rectangles, and so on. Such scaling patterns can also be found in African textiles, sculpture, and even cornrow hairstyles [Benoît 1983; Gouyet 1996]. Hokky Situngkir also suggested the similar properties in Indonesian traditional art, batik, and ornaments found in traditional houses [Nigel 2000; Mandelbrot 1982].

In a 1996 interview with Michael Silverblatt, David Foster Wallace admitted that the structure of the first draft of *Infinite Jest* he gave to his editor Michael Pietsch was inspired by fractals, specifically the Sierpinski triangle (a.k.a. Sierpinski gasket), but that the edited novel is "more like a lopsided Sierpinsky Gasket" [Turner 2000].

### Conclusions

Many scientists have found that fractal geometry is a powerful tool for uncovering secrets from a wide variety of systems and solving important problems in applied science. The list of known physical fractal systems is long and growing rapidly. Fractals improved our precision in describing and classifying "random" or organic objects, but they may not be perfect. Maybe they are just closer to our natural world, not the same as it is. Some scientists still believe that true randomness does exist, and no mathematical equation will ever describe it perfectly. So far, there is no way to say who is right and who is wrong. Perhaps for many people fractals will never represent anything more than beautiful pictures.

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УДК 656=111

## TRANSPORT INFRASTRUCTURE IN UKRAINE

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**Abstract.** This article deals with the problem of formation of a modern system of transport communications in Ukraine. The peculiarities of development of transport in Ukraine are analyzed. The focus of the work is to find the solutions to these problems. Benefits of different modes of transport are considered.

**Key words:** transport communications, transport hubs, transport items, transport system, vehicle.

**Introduction.** Transport is a specific branch of our economy. It doesn't create new material assets, which differs it from other manufacturing sectors. The result of transport operation is movement of goods and people. Freight transport belongs to the sphere of production. Passenger transport, which carries out people transportation, belongs to the service industry.

The main concern of transport is to provide connection between industries, enterprises, different regions of the country, and between foreign countries as well. Without transport it would be impossible to carry out the process of modern manufacturing which needs contacts to supply raw materials and products. This branch has a great role in improving population living standards. Nearly 9.4 % of workers, engaged in the economic branch of our country, are involved in the transport infrastructure.

Modern transport is characterized by a wide variety of types. Every type has its own specific industrial features. That is why it can be considered a set of interrelated industries. It is divided into some components, according to, first of all, the environment where movement of cargo or people is carried out.

Transport system consists of air, water and land transportation. A specific branch of transport system is public municipal passenger transport. Modern transportation system is rather well developed thanks to rapid scientific and technological progress.

The **object** of the study is the transport complex of Ukraine.

The **subject** of the research is to form a modern system of transport communications.

The **objective** of the research is to analyze transportation, its features, advantages of each mode of transport, to determine the problems of this sphere and find the ways to solve them.

To achieve this goal, the following **tasks** were set:

- to analyze a transport system,
- to determine its advantages,
- to determine the system of initial conditions of formation,
- to find solutions to these problems.

**Methods.** In the work the following research methods were used: theoretical, the method of analysis, classification, comparison of information in scientific and technical literature. Using these methods allows generalizing and systematizing the issue studied.

**Discussion and Results.** The production process in transport means movement of cargo and people. That is why, to determine the role of transport system in the national economy, it is necessary to use relevant indicators. One of them is traffic volume. It means the amount of freight (passengers) transported over a particular period of time (year, month, day) [Bourne 2013].

To calculate transport operation, it is also necessary to take into account the distance of transportation. The result of traffic volume over the distance of its transportation is called a freight or passenger turnover and is calculated in ton- kilometers or passenger-kilometers. The greatest role in movement of freight and passengers is played by rail transport. Railways crossing Ukraine provide connection with many European countries, which is shown in Figure 1.

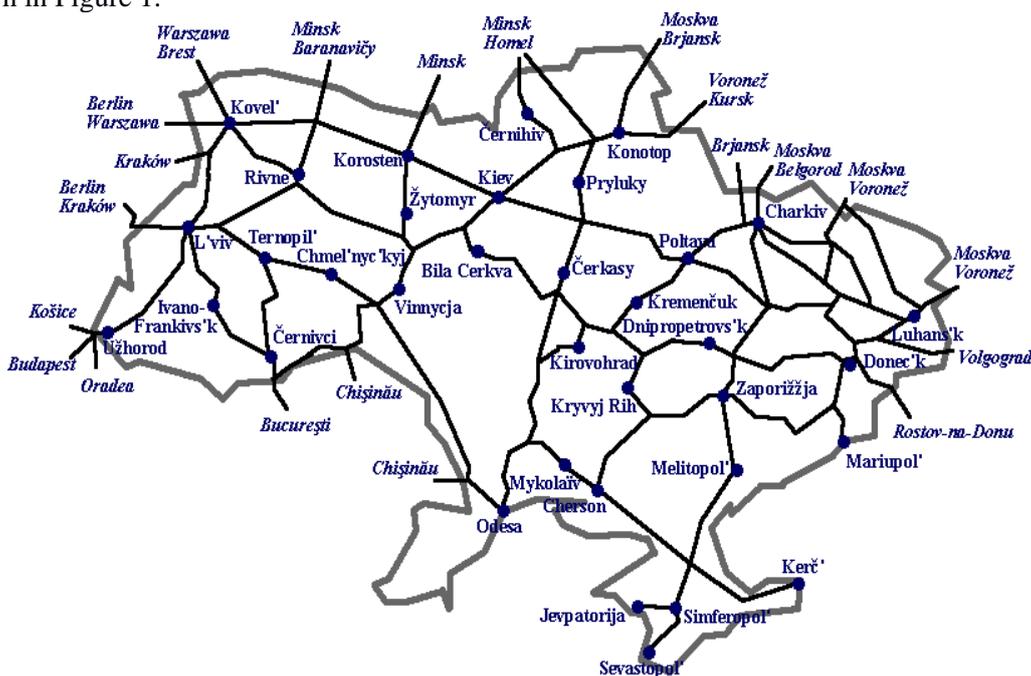


Figure 1: Transport hubs for train traffic in Ukraine

The largest railway junctions are Kyiv, Kharkiv, Lviv, Dnipropetrovsk, Zaporizhzhia.

Road transport is important over short distances. Buses are one of the principal forms of passenger transport within regions.

Air transport has become one of the principal means of passenger and mail delivery. Ukraine has many airports, the largest being in Kyiv, Lviv, Kharkiv.

Motor transport is characterized by high maneuverability. It makes it advantageous to be used at short distances. Pipelines provide transportation of liquid and gaseous freights and they have the lowest transportation cost. Sea transport is also characterized by small prime cost of transportation. Its disadvantage implies rather small speed of movement and dependence on weather conditions. There is a tendency to distinguish between

coastal transportation and foreign transportation. Coasting is sailing between ports of one country. However, it works seasonally and the directions of the ways do not always coincide with demands.

The advantage of air transport is high speed of transportation and its disadvantage is a high cost. Therefore, it is mainly used only to transport passengers.

The combination of interconnected modes of transport, which satisfy requirements of the economy and population in transporting goods and passengers, form a peculiar transportation infrastructure of the country. It is formed by linear elements (ways of communication of all modes of transport), point elements (points of concentration of loading and unloading works), the rolling stock (cars, locomotives, etc.), shipping service. Among point elements there are distinguished transport points (railway stations, river piers, river and seaports, bus stations, airports) and junction points (a point of intersection of various or identical transport ways). The major factors affecting the process of formation of a transport system are social and economic, natural, historical, and others. First of all, the branch structure of transport, density of transportation routes are influenced by the level of development of the economic complex and specialization of the territory. Transport also depends on the economic and geographical location of the region (central or border territory).

In Ukraine there are all necessary conditions to form a modern system of transport communications which would conform to European standards. First of all, these standards include the following elements: a demand for radical technical modernization of this sector and essential organizational changes in all modes of transport; sufficient resource base and level of development of the equipment and technology; presence of qualified staff and advanced scientific and technical developments; favorable climatic and geographical characteristics of the territory; existence of the competitive scientific and technical projects which have undergone the corresponding examination and are ready to be put into practice; interest of foreign investors in placing capital in Ukraine; a steady tendency to recognize Ukraine by the world community as a European state with which it is desirable to have stable business relations on a wide and long-term basis and which will exert a serious impact on key problems of the European policy in years to come; existence of the approved concept of creating and functioning a national network of international transport corridors in Ukraine [Daganzo 1997].

**Conclusions.** Favorable geostrategic location of the territory of Ukraine through which old trade routes between the East and the West, the South and the North pass, must have a big influence on formation of the long-term strategy of development of transport communications in Ukraine. Existence of international transport corridors on the territory of Ukraine makes impact on the functioning of the entire network of transport communications of the state. In particular, it obliges it to work in the harmonious, synchronous mode, with bigger responsibility as for the adhering to the schedule of work and cargo delivery to banching points. It will make the entire transport system work in the mode and at the level of functioning of the international transport corridors, that is, at the European level. It means that the level of technologies, regulatory support should correspond to the European one.

To set up the problems connected with the development of the transport system, to determine the tasks and ways of their solution, to provide them with an appropriate management (financial, inventory and logistics, resources, organizational, legal, etc), to organize and carry out the process of tasks and activities fulfilment is possible only on condition of development and implementation of the state program of development of the transport system in Ukraine. Their realization demands big investments and complex organizational decisions. Objectively it happened so that now it is necessary to solve the problems which must have big influence on organizational, technical, technological aspects of the policy in the sphere of transport communications. Improvement in transport enterprises depends directly on the economic stability of the country.

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УДК 004.75

## **THE MODERN AND PERSPECTIVE TECHNOLOGIES OF CREATION OF WIRELESS SENSOR NETWORKS**

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**Abstract:** The article is concerned with sensor networks, which represent the set of sensors and actuation mechanisms integrated among themselves by means of a radio channel distributed in space. Similar networks can be applied in a huge range of applications: house and industrial automation, monitoring of a microclimate, security and fire systems, account and optimization of consuming water energy resources, etc. The ideology of sensor networks allows getting rid everywhere of wire interfaces and the related expenditures (creation of cable channels, dressing, mounting of wires, purchase and mounting of specialized switches, routers, etc.).

**Key words:** wireless communication, secure network, smart house.

**Introduction.** Sensor networks represent the set of the sensors and actuation mechanisms integrated among themselves by means of a radio channel distributed in space. Similar networks can be applied in a huge range of applications: house and industrial automation, monitoring of a microclimate, security and fire systems, account and optimization of consuming of water energy resources, etc. In addition, the area of covering of a similar network can make up to several kilometers from units of meters. The ideology of sensor networks allows getting rid everywhere of wire interfaces and the related expenditures (creation of cable channels, dressing, mounting of wires, purchase and mounting of specialized switches, routers, etc.). For example, we should have a look at installation of system of the security fire warning to come down to simple layout of sensors. In addition, replacement of batteries needs to be made even less than to make the regular standard service necessary for a system. Rather strict and specific requirements are imposed on the nodes, which are a part of sensor networks. First, it is this long functioning from the independent power supply, ample network capabilities, including self-organization, dynamic authentication, flexible mechanisms of routing, etc. In addition, each entire similar node must have extremely low cost and have the minimum size. The object-matter is development of wireless sensors whose amount does not exceed 1 cm<sup>3</sup>. In the remote perspective it is "smart dust" that is sensor networks whose nodes do not exceed 1 mm. Now sensor networks are becoming a reality. Already now, there are 2 large standards of implementation of these networks: ZigBee and Z-Wave. The subject-matter is standard ZigBee network. The **subject-matter** of the article is to build a wireless sensor network standard ZigBee. The **method** is oriented to the development of a registration system and organizing packages.

As it is possible to see from the table and is confirmed by the support by the leading vendors of microelectronics, the IEEE 802.15.4/ZigBee standard has considerably bigger flexibility. At the same time, the full monochip decision (an analog of the radio modem figured in fig.1) is possible to acquire from 5 dollars at cost. It is worth noting, however, that not everything is so smooth. Actually, the standard physical and channel level, responsible for the device, is only IEEE 802.15.4. And ZigBee is only a program superstructure. And it is worth dwelling upon it. First, there is no uniform supplier of a stack. The stack is developed parallelly by a huge number of large and small-sized companies according to specifications of alliance. As a result — devices from different vendors often cannot correctly interact even at the level of a radio channel. In addition to it, profiles of devices have not been worked out yet. That is, the controlled valve bought from one vendor on the battery will not be able to understand a command from the temperature sensor of the other vendor. But with this, problems do not come to an end. By development of the standard they were repelled from line items of the maximum universality that did not decelerate to affect the protocol. It did not acquire desirable universality, but became rather resource-intensive and not really effective from the energetic point of view. For example, by means of the standard it is impossible to realize completely independent networks. It is necessary that the coordinator and retranslators work from a stationary power. Besides, most of vendors deliver the stack in the form of object libraries, that is without any possibility of modification of a code under the specific application.

**Hardware-software tools.** The specialized configured stack of protocols is oriented to independent wireless networks with limited energy resources. Possibilities of self-organization and selfrecovery of a network are provided in a stack and the multilayer customized system of dynamic authentication is provided.

**Simulator of the terminal unit of a network.** Each prototype of a node of a sensor network turns on in the composition the low-powerful transceiver, a basic set of sensor elements, the information exchange interface with the PC, means of indication and simulation of events. For information exchange between elements of system the radio channel with the frequency range around 2.4 is used... 2.5 GHz. The number of working radio-frequency channels is 16. The maximum emitting power of the radio-transmitting paths of devices are no more than 2 mW. Working range of communication in open space equals at least 200 m.

**Discussion and results.** The universal system of registration and systematization of packets provides debugging of specialized wireless networks of data transfer. The system turns on the hardware whose basis is

the broadband transceiver and the appropriate system software. The receiver provides incorrect reception of the data sent by prototypes of a sensor network's nodes. The system continuously, except for the time necessary for system procedures, makes also registration of off-the-air activity in one of 16 radio-frequency channels.

Besides, the software for a PC is a part of system. The project already found support within the "U.M.N.I.K." program which is carried out by Fund of assistance to development of small forms of enterprises in the scientific and technical sphere. With the use of the modules, which are a part of tools, the development of completely autonomous wireless system of the security fire warning is made. In this stack of protocols mechanisms of self-organization and selfrecovery of a network, mechanisms of automatic power control, dynamic authentication and data encryption, protocols of temporal synchronization of devices, routings, algorithms of energy saving and methods of the organization of channel access of data transfer are realized. Unlike the analogs which are available today, the possibility of implementation of functions of retranslators in ordinary independent nodes of a wireless sensor network is worked out. In other words, the system does not require an application of a stationary power even to retranslators, whose role can be execute by any sensor.

The sensor network can be organized as set of subnets or clusters (figure 1), the connected TsSI executing a role of gateways of interaction "a sensor network — a corporate network". Gateways representing more difficult hardware-software devices than sensors have the considerable computing potential and support standard interfaces (such as Ethernet, GPRS, IEEE 802.11, USB, etc.), and also possess more powerful radio transmitter and are less dependent on restrictions in energy consumption.

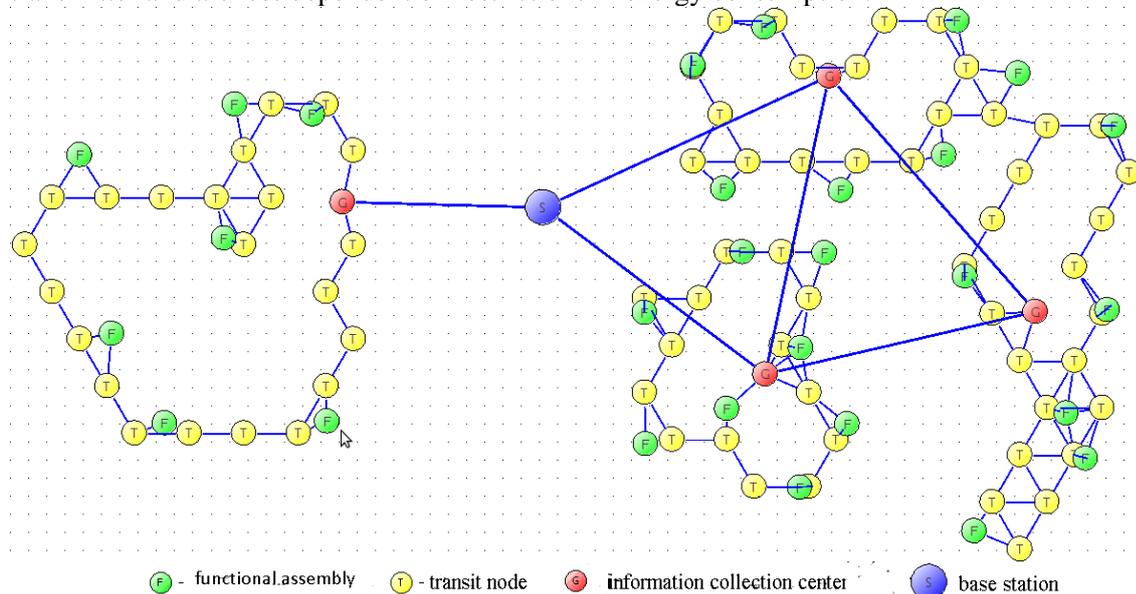


Figure 1

The wireless sensor network is placed on some object distributed in heterogeneous space. The heterogeneous space determines space constraints by the placement of the BSS nodes and function of attenuation of an electromagnetic signal in this space. Quality and range of communication are influenced by a set of physical factors: radio-frequency noise, number of walls, overlappings and other objects through which the signal shall pass.

The popularity of geo-navigation applications in the past 2-3 years generated the new task of a possibility of navigation not only on open space, but also in locations [Perkins 2009: 35-36, Hutchison 2009: 11]. It means an opportunity to quickly find the place at football stadium, the machine on the multilevel parking, shop in a shopping center or the necessary front desk at the airport for the end user. The traditional means of GLONASS, GPS and GALILEO, which perfectly proved in outside geo-navigation, do not allow the devices which are behind several layers of steel concrete overlappings to catch a signal from the satellite. This problem can be solved with the help of placement in a certain territory of the functioning sensor network [Fdida 2009: 196].

One of the options of creation of navigation system and monitoring is provided in figure 2. The system consists of three functional units: a sensor network, the controlling server, the mobile app working at the tablet PC. The controlling server executes the program which interacts with the gateway BSS and exercises monitoring and control of operation of a sensor network. On the tablet PC of the mobile user the application is installed which can be safely connected to the controlling server as through the technologies of data transfer,

which are built in the tablet PC (Wi-Fi, 3G, Bluetooth), and through a sensor network by means of the transceiver working according to the same protocol as a sensor network.

In case of confirmation of forecasts for distribution of sensor networks and tablet PCs it is possible to expect appearance of tablet PCs with the built-in transceivers. The external transceiver can be connected to the tablet PC either by means of a cable, or according to the wireless standard, such as Bluetooth already now. In this case, being moved on the territory in which the sensor network is torn, the tablet PC of the user can set up to 2 network connections [Hutchison 2009: 230].

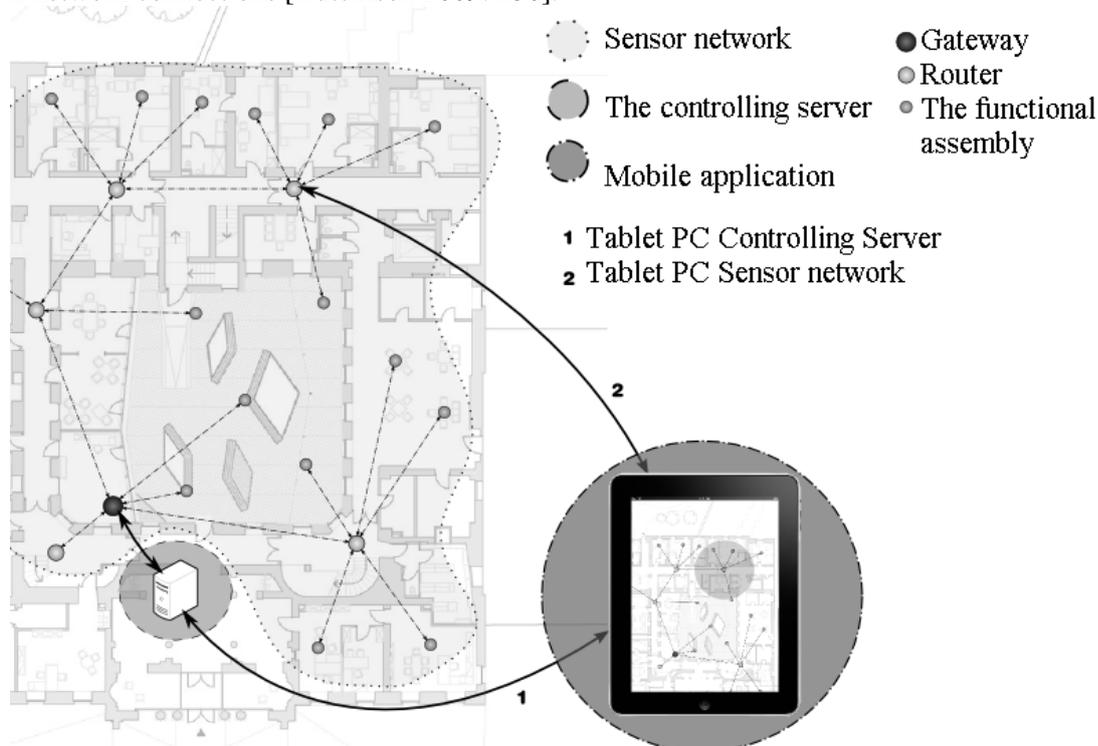


Figure 2

For monitoring the locations of clients of the telecom operator, and office locations of the operator it is recommended to use the following types of sensors:

- motion sensor,
- the penetration sensor (opening/closings of doors and windows, implemented on the basis of the sealed-contact and a magnet),
- sensor of breaking glass,
- humidity sensor,
- lighting sensor,
- system of climate monitoring,
- sensor of monitoring of a leakage of water,
- electricity measuring instrument,
- temperature sensor indoors,
- temperature sensor of outside air,
- smoke detector

For monitoring the trunk communication lines by means of a wireless sensor network it is expedient to use sensors for monitoring neighboring environmental space, such as:

- smoke detector,
- temperature sensor,
- humidity sensor.

The created structure of BSS by means is shown in (Figure 3). The quantity of the placed T-nodes is equal to 132. [Hutchison 2009: 402-403].

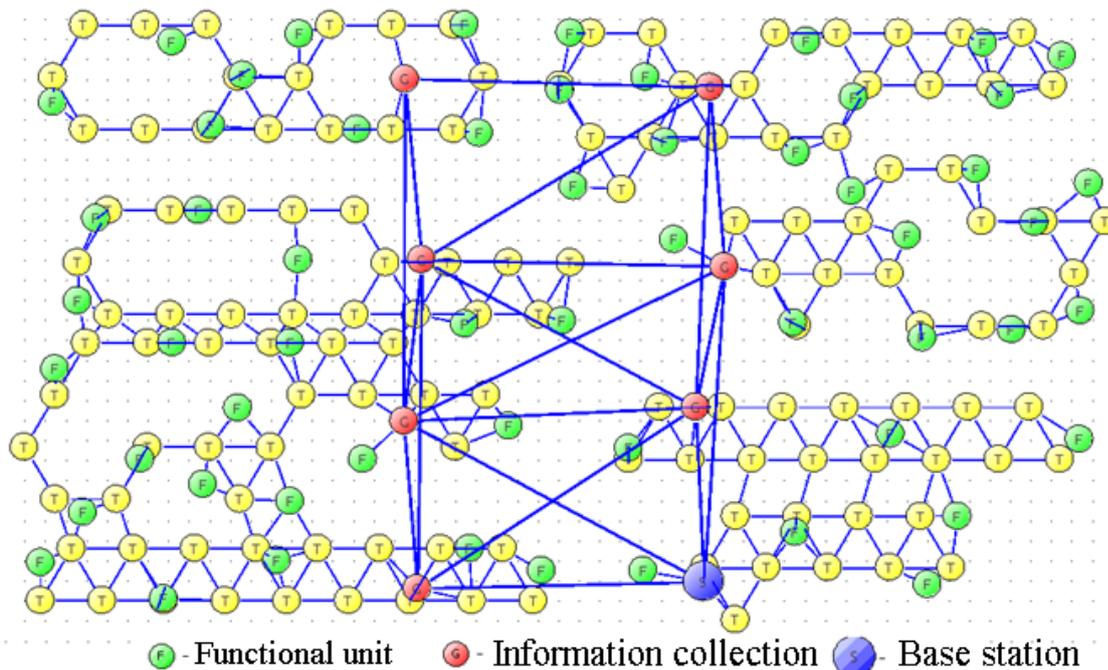


Figure 3

**Conclusion.** At the moment, modules and ZigBee devices in Ukraine in the main weight are on sale for operation at frequencies of 2.4 GHz that in case of the same emitting power gives smaller range of sure communication in comparison with 868 MHz Z-Wave modules. The electromagnetic interferences are created everywhere by the used wireless local area networks and other equipment, working at frequency of 2.4 GHz reduce communication quality of ZigBee of a network. Electromagnetic waves at frequencies of 2.4 GHz fade in locations, when overcoming barriers are stronger (especially metal or steel concrete) in comparison with 868 MHz

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**TRIP DISTRIBUTION MODELLING**

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**Abstract.** Trips are not normally loaded onto the network as they move from a centroid to itself. This makes it less essential to model them in detail. However, in reality, some of these trips use the modelled network. Nevertheless, this problem is probably significant only for rather coarse zoning systems.

**Key words:** different models, k- factor, origin-destination matrix, stability of trip matrices synthetic models.

**Introduction**

The article deals with the problem of investigating people travel demand and their route choice which influences the transport means option. This problem is rather relevant and needs a very deep research for practical application in designing a route network.

**The object-matter** is the influence of K factors on the trip matrix.

**The subject-matter** is the trip matrix.

**The objective** is the use of sensitivity analysis to test the effects of changes in the trip matrix.

**The tasks** are the following:

- to investigate different trip purposes and person types;
- to estimate trip attractions;
- to study synthetic models;
- to determine gravity model parameters;
- to study K factors influence.

**Materials** to be used are national and foreign scientific resources on the given problem and practical study options of Kharkiv and Rivne transport networks.

**Methods** to be used are the analytical method, observation method of existing scientific theories, systemizing method and statistical method of data processing.

### **Discussion and Results**

Different models are normally used for different trip purposes and/or person types. Typically, the journey to work will be modelled using a doubly constrained gravity model while almost all other purposes will be modelled using singly constrained models. This is because it is often difficult to estimate trip attractions accurately for shopping, recreational and social trips and therefore proxies for trip attractiveness are used: retail floor space, recreational areas, population.

The synthetic models have been developed under the assumption that each has a production and an attraction end. The models essentially link trip productions to attractions. For home-based trips the production end is always the home. However, the origin of these trips is only the home for journeys to the place of work (or education, shops, etc.) but on the journey back the destination of the trip is now the home.

Before the resulting trip matrix is assigned onto the network, it must be converted into an origin-destination matrix. In the 24-hour case, the two are practically the same as it is assumed that each production-attraction trip is made once in each direction during the day. This is of course, an approximation but probably a reasonable one. However, when a shorter-period O-D matrix is required, some trips made in different approaches can be used to overcome this problem. The first is to produce a matrix for just a single purpose, typical 'to work', and then assume that these trips follow just one direction of travel, thus producing, for example, the morning journey to work from generation to attraction. Survey data must be used to correct for shift work, flexible working hours trips for other purposes being made during the morning peak; however, the pattern of the morning peak is still dominated by this journey to work purpose. A second approach is to use survey data directly to determine the proportions of the matrices for each purpose which are deemed appropriate for the part of the day under consideration. For example, a typical morning peak matrix may consist of 70% generation-to-attraction movements and only 15% of attraction-to-generation movements.

The gravity model can provide a reasonable representation of trip patterns provided they can be explained mainly by the size of the generation and attraction power of zones and the deterrence to travel generated to distance (generalised cost). We recognise that most individual decisions on residential location and/or choice of employment incorporate many other factors; therefore, the gravity model could only model destination choice at an aggregate level if the importance of these other factors were much reduced on aggregation. However, there are always aggregate effects that do not conform to a simple gravity model. In some circumstances, there may be pairs of zones which have a special association in terms of trip making; for example, a major manufacturer may be located in one zone and most of its employees in another, perhaps as a result of housing estate developed by the company. In this case, it is likely that more trips will take place between these two points than predicted by any model failing to consider this association, for example the gravity model. This has led to the introduction of an additional set of parameters  $K_{ij}$  to the gravity model as follows:

(1)

Some practical studies have used these K factors in an attempt to improve the calibration of the model. This, of course, is done by them; with the full set of K factors we now have even more flexibility than necessary to reproduce the observed trip matrix. In fact, just the K factors are enough to achieve this; the other parameters are surplus to requirement:  $K_{ij}$  factor identical to the observed  $T_{ij}$  will do the trick, but then we no longer have a model nor any forecasting ability left.

The best advice that can be given in respect to K factors is: do not use them. If a study area has a small number of zone pairs (say, less than 5% of the total) with a special trip making association which is likely to remain in the future, then the use of a few K factors might be justified, sparingly and cautiously. But the use of a model with a full set of K factors cannot be justified.

The stability of trip matrices over times is an issue seldom discussed in transport demand modelling. We know from experience that reality is not stable or constant. We can observe significant day-to-day variations at

the level of traffic flows on any link in a network. One would typically expect some 10% variation on flow levels on similar days and on the same day of the week over similar weeks (i.e. excluding seasonal variations). These variations are easily observed, as permanent and semi-permanent automatic traffic counters are easy to install and maintain and are mostly reliable. These variations in traffic flows may result from at least two sources: variations in the trip matrices that originate them and day-to-day changes in route choice. The question arises, therefore, about the extent of day-to-day variations at the level on trip matrix cell values. This information is much more difficult to come by as very rarely repeated data is collected on trip matrices, in the same location, on different days.

Traffic counts are the result of an aggregation of trips into trip matrices and therefore this aggregation process will tend to compensate some of the random variations at the trip matrix level. Leonard and Tough (1979) report on collection of detailed origin destination (trip table and traffic count) data on four consecutive days in the centre of Reading, UK. The data was collected to help in the development of a detailed simulation model. Observers recorded car number plates, thus tracking the route vehicle took through the centre of Reading together with their points of entry/exit and parking. Therefore, there were no interviews or reporting errors but only a 10% sample was collected over four days (Monday to Thursday) for some 80 links and 40 zones. However, the data were independently analysed by Willumsen (1982) to look at day-to-day variations at link flow and O-D matrix level. He used the percentage mean absolute error (%MAE) for both traffic levels and trip matrices:

(2)

and

(3)

where the indices  $a$  and  $b$  relate to observed flows  $V$  and O-D trips  $T_{ij}$  on different days.

### Conclusions

Here we see that the day-to-day variations at flow level are consistent with expectations, whereas those at the trip matrix level are much larger. This is partly because, at trip matrix level, we are dealing with small values and sparse matrices, but even then the evidence suggests that variations at this level can be quite significant.

These results suggest that efforts to obtain a very accurate trip matrix may not be warranted as it will only be a snapshot. The objective for a destination choice model in this context should not be to replicate an observed or underlying trip matrix, but to estimate one that captures the main features of the underlying trip matrices that, when loaded onto the network, produce link flows consistent with observations.

The results also suggest that one should be more careful when testing how the value of a scheme or plan changes with variations in the estimated trip matrix used during assessment. Sensitivity analysis seems a particularly appropriate way to investigate the effects of varying the trip matrix.

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## PROBLEMS OF MODERN SOCIETY: WHAT ARE THE IMPLICATIONS?

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**Abstract.** Knowledge summarizing global problems of our time, their identifying characteristics and conditions necessary for their solution are presented in this article. The problems of human development, the relationship of population and economic growth are also discussed. The main humanity characteristics are defined.

**Key words:** economic growth, human development, humanity, population.

**Introduction.** The problems of modern society are caused by humans consuming attitude to the environment and changes in life priorities. Many years ago a man was struggling to survive by hunting wild animals and growing grains. Now his aim is wealth and power.

**The object-matter** of the article is society development.

**The subject-matter** is humanity.

**The objective** is to summarize the knowledge of the global problems of our time.

**The tasks** are to analyze the progress influence on society; to summarize the knowledge of current global problems; to identify the main humanity characteristics.

The materials are books and articles in Social Studies.

Characteristics of modern society. Sociologists who study the problems of modern society, called it post-industrial [Maltsev 1997: 11]. They were unable to find a better word to describe the existing model of relations. The transition to a society of services marked the emergence of a post-industrial formation, in which the first place is occupied by informatization and technology innovation. The characteristic features of modern society are globalization of the economy, dominance of the industry and agriculture service sector. When we talk about the field of services, we keep in mind, first of all, information.

**Discussion and results.** Under the global challenges of our time one should understand a set of problems, the solution of which depends on the ongoing existence of civilization. Global problems are generated by uneven development of different life areas of modern humanity, and contradictions generated by socio-economic, political, ideological, socio-natural and other human relationships. These problems affect the life of humanity as a whole. It would seem that the progress and the shift towards information technologies had a positive impact on the state of society. However, the results have been mixed [Nizhnikov 1997: 21]. Information was not able to feed and provide basic needs – it is the prerogative of the agricultural sector and industry, and they have not gone away, just moved from one country to another. Developed countries, with the aim to reduce the price of their products at the expense of low-cost labor force and to reduce the environmental burden on their territory, have suffered most of the production in the countries of the "second" and the "third" world.

The global problems of today are:

- The problem of poverty;
- The food problem;
- The demographic problem;
- The problem of human development.

This set is not constant, and with the development of human civilization we can notice changing the understanding of current global challenges, priorities, adjusting as well as emerging of new global challenges (space exploration, weather, and climate control, etc.). The world food problem is the inability of mankind to provide itself with vital food. This problem appears as a problem in practice, the absolute lack of food (hunger and malnutrition) in less developed countries, and imbalances in supply in developed countries. The decision will depend largely on the efficient use of natural resources, scientific and technological progress in the field of agriculture and the level of state support. The global demographic problem is divided into two aspects: the demographic explosion in the number of countries and regions of the developing world and the demographic aging of the population in developed and transitional countries. For the first the solution is to increase economic growth and slow population growth. For the second – immigration and reformation of the pension system. The relationship of the population growth and economic growth for a long time is a matter of economic research. As a result, a study has been developed of two approaches to assess the impact of population growth on economical development. The first approach is to some extent linked with the theory of Malthus, who believed that population growth outstripped the growth of food and therefore the world's population would inevitably be impoverished. The modern approach to the role of population is complex and reveals both positive and negative influences of population growth on economic growth. Many experts believe that the real problem is not population growth itself, but:

- underdevelopment – falling behind the development;
- depletion of global resources and environmental destruction.

The problem of human development is a problem of conformity of quality characteristics of the modern economy labor nature. In the post-industrial environment the requirements to physical qualities and especially to educators, include their capability of constant skills improving. However, the development of qualitative characteristics of the labor force in the world economy is extremely uneven. The worst performance in this regard is demonstrated by the developing countries, which, however, are the main sources of replenishment of the global workforce. This shows the global nature of the problem of human development. Increasing globalization, interdependence, time reducing and space barriers create a situation of collective insecurity. Because of a variety of threats, a person can not always save own state. This requires the creation of conditions that increase a person's ability to confront their own risks and threats.

*Environmental threat.* However, this does not solve environmental problem: the states do not exist in isolation from each other, and the greenhouse effect has the same negative impact on all countries. Where is the exit? To transfer to environmentally friendly modes of transport – electric cars and bikes, to look for natural sources of energy to generate its power from wind and solar heat.

*Overcrowding.* Another problem of modern society is overpopulation. Scientists warn that the population excess of the 12 billion will lead to the destruction of the planet's ecosystem, and about 5 billion people will be on the verge of death because of the heat and hunger. Today in the world there are more than 7 bln. people, according to the UN forecasts. At the current rate of population growth in 2100 the number of people on the Earth will reach 11 billion. There will be an environmental disaster. We can hear about awful ways of this problem solving: resettlement to other planets and cruelty of the World War III. Sometimes, birth control is mentioned as the most optimal way of population control. There the humanity will have to choose: to prevent the birth of a child or give it to be born and die in agony [Kravchenko 1995:19].

*Lack of energy.* Deficiency of energy can cause the collapse of civilization. There will be enough coal and gas stocks in the depths of the planet for about 170 years. Without these minerals power stations will be stopped and it will be impossible to exchange the information virtually; humanity, devoided of comfort will find itself on the verge of extinction and degradation.

How can it be avoided? The answer is to develop alternative sources of energy. However, the researches in this direction are moving slowly for the reasons mentioned above.

*The social problems of modern society.* The development of society has led to a shift in priorities and moral values of the substitution material. The desire to provide you and your family with comfortable living conditions has grown into greed, status and position in society and are valued higher than moral qualities. The developed nations survive mainly due to the third world countries, using their labor and natural resources.

*The scale of values changing.* Calling their actions as the human right of freedom choice, some states have legalized prostitution and drugs, thereby forming in the minds of the younger generation a new system of values, where the sale of their own body is equal to the work of teachers and smoking marijuana is becoming the norm [Ursul 1996: 57].

*High levels of crime.* In the world there is still a high level of crime. According to this index the absolute leader is Honduras, which accounts for 90 intentional murders per 100 thousand people. There is a traced pattern: the lower a level of spirituality in society and the degree of development of the society, the more crimes are there. Lack of spirituality leads to a loss of compassion and degradation of society. The main human illnesses are AIDS, prostitution growth and kidnapping.

**Conclusion.** Can the problems of modern society be solved? Yes, they can. We can see this on the scale of the individual prosperous countries: Sweden, Switzerland and Norway. Does humanity have a chance to survive? Yes, it has. But you need to stop blind chasing for profit under social slogans and ostentatious charity, and throw all available resources to fight for the environment, assistance to underdeveloped countries and the revival of spirituality. Is humanity ready to do this? The answer will be known over time.

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УДК 374

## CULTUROLOGICAL COMPETENCE AS A CORE COMPONENT OF PROFESSIONAL COMPETENCE OF THE ENGINEER-TEACHER

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**Abstract.** In this article various approaches are covered to the definition of such notions as “competence”, “competency”, “professional competence”. The essence is identified of the concept of “professional competence of the engineer-teacher”. The importance of culturological competence of the engineer-teacher is stressed. The role of culturological competence in the structure of professional competence of the engineer-teacher is specified.

**Key words:** competence, competency, culturological competence of the engineer-teacher, professional competence of the engineer-teacher.

**Introduction.** The modern world is experiencing a global change of approaches to education, which is associated with the reorientation of social development to the development of human personality, their moral and cultural qualities. A lot of attention is paid to the quality of education today, which leads to a change of the traditional model of teaching to a personality-oriented one.

Profound changes in society and educational domain could not but affect the state of the modern engineering and teacher-training education. The profession of the engineer-teacher is one of the most complex and very important professions, which requires not only proficiency in engineering, but also deep pedagogical knowledge and skills, as well as the availability of certain personal qualities.

The development of communication culture of the engineer-teacher, the acquisition of communicative skills of interaction with other people is of prime importance. According to A. Seyteshev, the engineer-teacher is often assessed only as a teacher of general technical and special disciplines or a labor training instructor. However, today the engineer-teacher must be a professional with a broad scientific culture, have the ability to find creative ways of presentation and interpretation of academic, extracurricular material, as well as to be a virtuoso, a performer of labor practices, and herein the engineer-teacher is above all an educator. S/he teaches not only to know and be able to do something, but also to think, not only to understand but also to feel [Igolkina 2008:248].

A future engineer-teacher must be prepared to perform such professional and educational activities as: vocational training, methodical work, production and technological, organizational and management, research, cultural and educational activities. All this involves the integration in the name of the teacher of vocational education of general high level professional pedagogical culture; therefore a fundamental part of future engineers-teachers training is the formation of his/her culturological competence.

In recent years, domestic science has yielded many works that deal with the problem of culturological specialist training (V. Andruschenko, G. Vasyanovych, G. Degtyarova, V. Kizima, V. Maslov, L. Masol, L. Rudenko, A. Shevnyuk). A large number of scientific papers deal with the problem of general and professional specialist culture formation (I. Zyazyun, S. Honcharenko, H. Vasyanovych, H. Dehtyarova, A. Muzaliov, L. Rudenko). The researchers paid considerable attention to various aspects of pedagogical culture formation (V. Sukhomlinskii, A. Rudnitskaya, E. Bondarevskaya, A. Harmash, I. Isayev, Ya. Kolominskii, V. Liventsova, N. Nychkalo, V. Hryniova, A. Gorbachiova, V. Yagupov, P. Shcherban, S. Vitvitskaya).

However, despite a considerable interest towards the development of cultural knowledge and the culture of future specialists, there are few research works that deal with the problem of culturological training of future engineers, formation of their personal and professional pedagogical culture. This problem does not have a systemic and holistic solution both on the level of theory and on the practical level of searching conditions and technologies of appropriate organization of the educational environment at the university. Therefore, we consider that it is necessary to pay considerable attention to theoretical and practical aspects of culturological competence formation of future engineers-teachers [Bobina 2006: 45-47].

**The objective** of this paper is to determine the role of culturological competence in the structure of professional competence of the engineer-teacher.

**Discussion and Results.** To study the culturological competence as a component of the professional competence of engineer-teacher, we consider it necessary to analyze the definitions of such notions as "competence", "competency", "professional competence", "professional competence of the engineer-teacher" presented in the scientific and educational literature.

The concept of "competence" is interpreted by scientists differently. Let us analyze multiple views on the interpretation of the given term.

Competence as a personality characteristic is broader than the concept of "knowledge", "proficiency", "skills"; it includes them all. Competence is a notion that is used to characterize a person as a result of efficiency and effectiveness evaluation of his performance directed to address a range of issues and problems [Leschenko 2011: 119]. According to the definition of E. Ogariov, competence is an assessment category which describes a person as a subject of specialized activities, where the development of human capabilities gives him the ability to perform skilled work, to make decisions in problem situations, plan and develop actions that lead to the successful achievement of goals set. Competence is an integrative characteristic which, as noted by I. Drakin and E. Shmakova, "reflects a real mastery of generic skills, gaining of appropriate experience and development of skills necessary for this activity to ensure a successful creative solution of various problems and

challenges". As D. Ivanov put it, competence is a notion that is used to characterize a personality as a result of efficiency and effectiveness of his actions aimed at achieving a particular goal and addressing relevant for the given society problems.

Competence is an integral characteristic of the person, which falls into the spectrum of individual competencies. A specialist who has a certain set of professional, personal and other competencies may be called competent. The outstanding scientist E. Zeer considers competence as an integral part of self-regulated learning, in which the result is not learning as such, but the ability of the specialist to implement it in a particular practical activity "Competence is knowledge in action, skills and abilities to carry out activities, integrative activity-related constructs, which are aimed at achieving a particular result. Thus, the author focuses on the competence as a link between knowledge and the situation, presenting it as a measure of the individual's ability to establish on the basis of existing knowledge a specific sequence of actions to solve a problem situation.

In the study of I. Agapov, the term "competence" is defined as "general ability and willingness of the individual to activity based on knowledge and experience that are acquired through learning, focused on independent participation of the individual in the teaching and learning process as well as directed towards its successful inclusion in the work activities" [Tkachiova 2011:119]. The concept of "competence" is defined by V. Kalney and S. Shishov as the total capacity, based on knowledge, experience, values, and inclinations acquired through learning. According to them, competence can be reduced neither to knowledge, nor to abilities or skills. They consider competence as an opportunity to establish a link between knowledge and the situation or, in a broader sense, as the ability to find, identify the process (knowledge plus action), which is suitable for solving a particular problem. According to V. Kalney and S. Shishov, to be competent means the ability to mobilize in a given situation both knowledge and experience.

The concept of "competence" is defined by V. Kalney and S. Shishov through the concept of ability: "competence is a common ability based on knowledge, experience, values and dispositions that are acquired through learning".

The researcher of the competence approach I. Zimniaya in her psycho-pedagogical studies rightly notes that competence is some internal, potential, hidden psychological formations (knowledge, understanding, action (algorithms) programs, values and attitudes), which then appear in the competence of a person as actual activity-related manifestations. Competence is always relevant identifying of competency.

We agree with the A. Hutorskiy who defines competence as "a predetermined social demand for educational preparation of students necessary for his/her efficient productive activity in a particular area", and under the competence he understands the direct availability of relevant expertise affected by personal attitude to the subject of activity.

So, based on the research of relationship between the concepts of "competence" and "competency" one can assert that competence is the basis for formation and development of competence.

In the most general terms, any competence consists of three main components [Sysoyeva 1994:112]:

- 1) cognitive component associated with knowledge and methods of its acquisition;
- 2) integrative and activity based component that defines the process of skills formation based on the knowledge obtained and the ways to implement these skills;
- 3) learner-centered component, which represents a property, motives and values of an individual that appear in the process of competence implementation.

The cognitive component determines the level of the knowledge base and intellectual development of the student, as well as his creative abilities. It assumes knowledge of theoretical and methodological foundations of the subject area, determining the degree of formation of scientific-theoretical and practical readiness for professional activity.

The integrative and activity component involves the ability to use the gained knowledge arsenal not only in areas of their direct application, but also in interdisciplinary areas as well as in situations of uncertainty and ambiguity. This component determines whether there is possibility of using the accumulated knowledge and modes of action in practice.

**Conclusions.** On the basis of theoretical analysis of scientific sources we determined the essence of professional competence of the engineer-teacher, defined the role of culturological competence in the structure of professional competence of the engineer-teacher.

The professional competence of the engineer-teacher is defined as a set of interrelated engineering and pedagogical competences, as well as professionally significant personal qualities, the fundamental basis of which is general and vocational-pedagogical culture of the future specialist.

Thus, the cultural competence acts as a systemically important component of professional competence of the engineer-teacher and is the basis for implementation of high-quality professional and educational activities.

The structure of culturological competence and the development of techniques of its formation require further research.

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### STUDY OF THE IMPACT OF DRIVER – ROAD SUBSYSTEM PARAMETERS ON THE ACCIDENT RATE

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**Abstract.** According to the results of the conducted research, one can draw the following conclusions: analysis of numerous studies performed by domestic and foreign scientists show that the straight road sections of rural highways present the most serious danger to traffic. The most dangerous situations arise due to adverse road conditions coupled with inadequate actions of drivers. Particularly, this tendency is observed on two-lane roads.

**Key words:** driver, factor, road, safety, threat.

#### Introduction

In this paper, the regularities of the impact of road conditions and the time of driver's reaction on the road safety is under consideration. According to the statistics of road traffic accidents (RTA) about 15-20% of all accidents are caused by the poor state of roads as well as road conditions. As the results of national and international research in the field of road safety (RS) reveal, these data take into account only the factors directly related to the road accidents. Given the concomitant or indirect road factors, i.e. those that are potential carriers of road traffic threats and can result under unfavorable circumstances, combined with the same factors of the car or inadequate actions of the driver, into accidents, the number of road accidents increases by 10-15% [Wargo 1967: 221 - 238 ].

Investigating the factors that contribute to the increase of the accident risk on the roads, it should be noted that the road conditions coupled with the errors of drivers greatly affect the occurrence of road traffic accidents (RTA).

In conducting autotechnical examinations, the experts use guidelines. These guidelines govern the following indicators: for the automobile - braking and maneuvering parameters of the vehicles; for the road - mostly the coefficient of vehicle wheels friction with the road surface; for the driver - primarily the differentiated value of the driver's reaction time. Whereby, the last index is differentiated depending on the degree of the road-accident complexity and ignores the psychophysical abilities of a particular road-accident participant. Lack of implemented expert research techniques of circumstances leading to road accidents on the basis of data on driver's physiological abilities greatly impoverishes the research results. Using a system analysis of the complex Driver - Car - Road - Environment (DCRE) while conducting an autotechnical expertise will make it possible to improve the reliability of the findings of expert studies. Improving the expertise makes it possible to increase the level of determination of those responsible for the road accident occurrence [Hick 1952: 11-26].

Many experts are inclined to consider the driver to be responsible for 60 - 90% of accidents. Thus, the complexity of road conditions is underestimated, making it difficult to choose the correct solution for driving the car.

**Objective** – to study the human factor as the main cause of accident rate.

The most difficult and poorly understood today a group of factors include the group associated with the human factor. The study of this group of factors in combination with other groups, and especially with road conditions is of great importance.

Thus, the subsystem Driver - Road (D-R) has a significant importance on the road accident occurrence on rural highways. Adverse effects of a number of factors that characterize the state of the driver are visibly evident on horizontal lines and rounded corners in terms of roads in the layout. Driving on the long line for a long time causes fatigue of drivers. In addition, on the straight sections of roads drivers are more prone to glare. On curves in the terms of layout driving outside the carriageway due to the above reasons are mainly related to the driver's inattention. Almost half of the road accidents occurring on straight road sections were recorded on the slippery roadway [Human 1953: 188-196].

If the coupling coefficient factor turned out to be predominant then it is obvious that to reduce the value of the resulting coefficient of the accident rate (i.e., to reduce the number of accidents) it is necessary to increase the friction coefficient of the vehicle tires with the road surface. It is necessary to work in different fields, as the same value of the coefficient of friction, in turn, is influenced by a number of other factors. Analysis of numerous data shows that the coefficient of friction depends primarily on the type of coating and its condition, tire material and design, air pressure and the loads applied to the wheel, the speed, the temperature conditions and the values of wheels slipping. However, despite the complexity of the friction factor as a factor of influence on the accident rate on the roads already in use it is possible to use preventive measures, the main of which are as follows:

- Periodic inspection of the road coating state was carried out by road maintenance services;
- Traffic speed regulation conducted by police officers, depending on the degree of road coating slipperiness by installing road signs 1.13 "Slippery Road" and 3.29 "Limit of Maximum Speed" with a sign 7.13 "Wet Coating";
- High-quality training of drivers at driving schools, providing a unified concept of knowledge. It should be based on understanding the relationship between the studied subjects (traffic rules, devices and maintenance of vehicles, road safety, medical training). Prospective drivers must be aware of their integral role both in the complex DCRS as a whole, as well as in its subsystems. This understanding is possible only by implementing nowadays new educational methods [Merkel 1885: 73-127].

Somewhat the less important role of the carriageway width in the event of accident occurrence compared with the friction coefficient is primarily concerned with the training of drivers. As far as we know, due to visual sensation humans receive about 85% of all information necessary for driving. The driver that has noticed a narrowing of the road reduces the speed and increases the lateral spacing at counter road traffic, acting in such cases according to the requirements of the Highway Code. Movement under reduced vehicle tire friction is more dangerous due to the fact that, unfortunately, not every driver, even knowing the basic reasons for friction intensity changing, can from a technical point of view take up the necessary measures to maintain control over the car movement [Mittenecker 1973: 56].

In case of a narrow roadway, the lateral spacing between cars at opposite road traffic decreases, which results in the reduction of the vehicle speed and reduce the traffic capacity.

The given "narrow" analysis of factors makes it possible to more clearly visualize the impact of the considered "expert" features of the road on the accident rate, and thus will help to efficiently, and which is most important, more efficiently influence on the number of road accidents considered reasons [Lister 1950: 115-116].

**Conclusions.** According to the results of the research conducted, one can draw the following conclusions:

Analysis of numerous studies performed by domestic and foreign scientists show that the straight road sections of rural highways present the most serious danger to traffic. Here, the most dangerous situations arise due to adverse road conditions coupled with inadequate actions of drivers. Particularly, this tendency is observed on two-lane roads.

The systems approach to solving the problem of road safety allows evaluating the processes occurring in a traffic flow. As the studies conducted show, the share of an individual element as a causing factor of the road accident occurrence is negligible compared with the share that is embedded in the subsystem.

Definition of objective laws between the road conditions and drivers psychophysiological indicators of drivers makes it possible to:  
- conduct more efficiently the planning methods to provide road safety (especially its passive safety);

- carry out professional selection of drivers more efficiently;
- improve the reliability of expert studies findings.

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**ELECTRIC CAR AND TRENDS OF THEIR DISTRIBUTION IN UKRAINE**

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**Abstract:** This article is devoted to electric cars and trends of their distribution in Ukraine. The publication is focused on physical, economical, scientific aspects of electric car usage and production of electric transport in Ukraine.

**Key words:** electric car, transport, energy efficiency, safety, batteries, electricity generation.

**Introduction.** An electric car is an automobile that is propelled by one or more electric motors using electrical energy stored in rechargeable batteries or another energy storage device. Electric motors give instant torque, creating strong and smooth acceleration to electric cars. They are also around three times as efficient as cars with an internal combustion engine. The first practical electric cars were produced in the 1880s [Roth 2011]. Electric cars were popular in the late 19th century and early 20th century until advances in internal combustion engines, electric starters in particular, and mass production of cheaper gasoline vehicles led to a decline in the use of electric drive vehicles. The energy crises of the 1970s and 1980s brought a short-lived interest in electric cars; although, those cars did not reach the mass marketing stage, as is the case in the 21st century.

**Object-matter:** electric cars production.

**Subject-matter:** an electric car.

**Objective:** to analyse physical, economical and scientific aspects of electric car usage.

**Tasks:** to trace the history of electric transport development; to analyse trends of electric transport distribution in Ukraine.

**Materials:** books and articles devoted to electric transport.

**Discussion and Results.** Since 2008, a renaissance in electric vehicle manufacturing has occurred due to advances in batteries and energy management, concerns about increasing oil prices and the need to reduce greenhouse gas emissions [Guarnieri 2012]. Several national and local governments have established tax credits, subsidies, and other incentives to promote the introduction and adoption in the mass market of new electric vehicles depending on battery size and their all-electric range. Electric cars are significantly quieter than conventional internal combustion engine automobiles. They do not emit tailpipe pollutants giving a large reduction of local air pollution, and can give a significant reduction in total greenhouse gas and other emissions (dependent on the method used for electricity generation) [5]. They also provide independence from foreign oil, which in several countries is a cause for concern about vulnerability to oil price volatility and supply disruption. Recharging can take a long time and in many places there is a patchy recharging infrastructure. For long distance driving, many cars support fast charging that can give around 80% charge in half an hour using public rapid chargers. While battery cost is decreasing fairly rapidly, it is still relatively high, and because of this, most electric cars have a more limited range and a somewhat higher purchase cost than conventional vehicles. Drivers can also sometimes suffer from range anxiety – the fear that the batteries will be depleted before reaching their destination.

As for December 2015, there were over 30 models of highway legal all-electric passenger cars and utility vans available for retail sales, mainly in the United States, China, Japan and Western European countries.

By the end of 2015, almost 60% of the global stock of light-duty plug-in electric vehicles had been pure electric cars and vans. Cumulative global sales of highway-capable light-duty pure electric vehicles passed the one million unit milestone in September 2016. The world's all-time top selling highway-capable electric car is the Nissan Leaf, released in December 2010, with almost 240,000 units sold worldwide through September 2016. The Tesla Model S, released in June 2012, ranks second with global sales of over 145,000 units through September 2016. [Sperling, Gordon 2009].

*Electricity generation for electric cars.* Electric cars usually show significantly reduced greenhouse gas emissions, depending on the method used for electricity generation to charge the batteries [4]. For example, some battery electric vehicles do not produce CO<sub>2</sub> emissions at all, but only if their energy is obtained from sources such as solar, wind, nuclear or hydropower.

Even when the power is generated using fossil fuels, electric vehicles usually, compared to gasoline vehicles, show significant reductions in overall well-wheel global carbon emissions due to the highly carbon-intensive production in mining, pumping, refining, transportation and the efficiencies obtained with gasoline. Researchers in Germany have claimed that while there is some technical superiority of electric propulsion compared with conventional technology that in many countries the effect of electrification of vehicles' fleet emissions will predominantly be due to regulation rather than technology. Indeed, electricity production is submitted to emission quotas, while vehicles' fuel propulsion is not, thus electrification shifts demand from a non-capped sector to a capped sector. This means that the emissions of electrical grids can be expected to improve over time as more wind and solar generation is deployed.

Many countries are introducing CO<sub>2</sub> average emissions targets across all cars sold by a manufacturer, with financial penalties on manufacturers that fail to meet these targets. This has created an incentive for manufacturers, especially those selling many heavy or high-performance cars to introduce electric cars as a means of reducing average fleet CO<sub>2</sub> emissions.

*Vehicle safety.* Great effort is taken to keep the mass of an electric vehicle as low as possible to improve its range and endurance. However, the weight and bulk of the batteries themselves usually make an EV heavier than a comparable gasoline vehicle, reducing range and leading to longer braking distances. However, in a collision, the occupants of a heavy vehicle will on average suffer fewer and less serious injuries than the occupants of a lighter vehicle; therefore, the additional weight brings safety benefits despite having a negative effect on the car's performance. They also use up interior space if packaged ineffectively. If stored under the passenger cell, not only is this case, they also lower the vehicles' center of gravity, increasing driving stability, thereby lowering the risk of an accident through loss of control. An accident in a 2,000 lb (900 kg) vehicle will on average cause about 50% more injuries to its occupants than a 3,000 lb (1,400 kg) vehicle. In a single car accident and for the other car in a two car accident, the increased mass causes an increase in accelerations and hence an increase in the severity of the accident.

Some electric cars use low rolling resistance tires, which typically offer less grip than normal tires. Many electric cars have a small, light and fragile body, and therefore offer inadequate safety protection. The Insurance Institute for Highway Safety in America had condemned the use of low speed vehicles and "mini trucks," referred to as neighborhood electric vehicles (NEVs) when powered by electric motors, on public roads. Mindful of this, several companies (Tesla Motors, BMW) have succeeded in keeping the body light, while making it very strong [Sperling, Deborah 2009].

*Batteries.* While most current highway-speed electric vehicle designs focus on lithium-ion and other lithium-based variants a variety of alternative batteries can also be used. Lithium-based batteries are often chosen for their high power and energy density but have a limited shelf life and cycle lifetime which can significantly increase the running costs of the vehicle. Variants such as Lithium iron phosphate and Lithium-titanate attempt to solve the durability issues with traditional lithium-ion batteries.

*Are electric cars needed for Ukrainians?* The logical answer to this question is "certainly necessary". There are many causes, like, including the above-mentioned environmental friendliness, high efficiency, simple structure and low cost electricity. Every year, the automotive infrastructure is becoming friendlier for electric cars. In five years, the number of vehicles with electric drive must increase at least twice.

The authorities are doing everything possible to expand the current grid. Most of all fossil fuels used on highways are imported. To reduce energy dependency it should be possible to replace the use of gasoline for environmental energies. In this regard, the Ukrainian electric cars are the best solution: reduced dependence on oil-exporting countries, reduced fuel costs for motorists, improving the environmental situation in the country [5].

**Conclusions.** Today, there are certain limitations associated with the use of electric cars. Ukrainian power system will not be able to allocate large amounts of electricity to car batteries. According to the forecast of the authorities, the power system can withstand only 10% of electric vehicles, the total number of cars in Ukraine. But nevertheless electric transport is believed to be the future of Europe and Ukraine.

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**BIOTELEMETRY**

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**Abstract:** The article deals with remote control systems – telemetry systems which are widely applied in various fields of science, technology and everyday life. Medicine is one of these fields. Specific biotelemetry systems aimed at monitoring the state of hospital patients are used here. Biological telemetry is mostly applied in the field of cardiology and its prospective using can be found in neurophysiology resulting in forecasting and neutralizing sudden changes in a patient's condition.

**Key words:** telemetry systems, data transfer, biological parameters, operational monitoring.

**Introduction.** Biotelemetry is discussed here as it has become a powerful instrument for diagnostics and control of hospital patients. The **object-matter** is methods of controlling the state of patients at medical institutions. The **subject-matter** is providing continuous patient control by means of special devices and telemetry meters for checking biological parameters of the patients. The **objective** of this research is finding the main requirements for all biological telemetry devices and physical principles of their implementation. **Tasks:** to specify physical principles of biotelemetry device function on the basis of the studies available, their positive and negative effects which showed themselves during their implementation and application, optimizing their drawbacks in prospective fields. **Materials:** the information collected is based on generally known facts and definitions, previous theoretical and practical investigations as well as the prospective developments in the field. **Methods:** collecting, analyzing information and making conclusions concerning further prospects of biotelemetry.

**Discussion and results.** First of all, the term 'telemetry' is to be discussed. According to the Wikipedia, telemetry is an automated process wherein measurements and other data are collected at remote or inaccessible points and transmitted to receiving equipment for monitoring. The term commonly refers to wireless data transfer mechanisms, which make use of radio, ultrasonic, or infrared systems and also encompasses the data transferred by means of other media such as a telephone or a computer network, optical links or other wired communications like power line carriers. The equipment can be wireless or hard-wired, analog or digital [Bakshi 2009: 23]. Telemetry may be commutated to allow the transmission of multiple data streams in a fixed frame. It is successfully used in metrology, oil and gas industry, motor sports, logistics, agriculture, space exploration and medicine.

I am particularly interested in biotelemetry or medical biotelemetry. Biotelemetry involves the application of telemetry in biology, medicine, and other sciences connected with health care to remotely monitor various vital signs of ambulatory patients [Singh 2005: 2]. We consider biotelemetry to be a promising direction as it has already shown its great potential. Biotelemetry in stationary departments of health care institutions is used for the operational monitoring of patients with the threat of severe disruption of vital functions.

According to the available information, a typical biotelemetry system comprises:

- Sensors appropriate for the particular signals to be monitored;
- Battery-powered and patient-worn transmitters;
- A radio antenna and receiver;

- A display unit capable of concurrently presenting information from multiple patients.

An alarm system which provides alert medical staff of life-threatening conditions. The accumulated data are used to confirm the diagnosis, the status of the dynamics of the patient's condition [Kamal, Sabaresh, Johnson, Prakash 2013: 361].

Several radio channels are applied for data transmission. Among them are the following ones: VHF, Industrial Scientific Medical Band (ISM Band), digital channels Wi-Fi, Bluetooth [Grossmann, Kunze, Stork 2002: 363]. The features of today's clinical systems are their light weight, ergonomics, algorithms for digital data to maximize the elimination of artifacts and noise influences. In general, biotelemetry electrocardiography systems are complexes consisting of several independent radio transmitters worn on a patient's body. ECG signal is transmitted to the central station providing a continuous monitoring of the current electrocardiogram surveyed patients. Typically, the system allows recording a single channel or a standard 12-lead electrocardiography. The receiving station includes a personal computer or a printer and a set of radio receiving equipment, e.g. receiver unit, antenna-feeder device, power supply and charger software [Vladimirskiy 2011: 410-412]. The transmitter includes an electrocardiography amplifier transmitter, cable leads and a disposable electrode set. It should be emphasized that the information about the condition of a patient can also be obtained by corresponding mobile applications on a smartphone or a tablet. The device automatically downloads the necessary data from a biotelemetry underwear module at pre-defined regular intervals, and then forwards them to the server in the cloud, and gets back the results of processing. Thus, the history of the health status is automatically generated from the module during wears. [Lou, Chen, Zhao, Xuana, Xua, Jina, Gou, Fanga 2013: 209] Obtaining information on the current state of health is available on request from a mobile app, starting from the current time, or at any time when the module underwear is applied making it possible to view the data: electrocardiography, heart rate, respiratory rate and temperature in real time [Karaoguz 2001, 98].

On the basis of the information collected we can classify the whole biotelemetry system using various criteria. The most remarkable of these is the interrelation a transmitter and a receiver. Transmitter systems can be located at a short distance from the object or inside the object. They may be classified by the interrelation of a transmitter and the receiver: either mutually fixed or movable [Kamal, Sabaresh, Johnson, Prakash 2013: 361-362]. In accordance with the application of biotelemetry system they are exploring the body's systems, such as radio electrocardiography and the field of biology and medicine, such as sports biotelemetry or space biotelemetry. Furthermore, they can also be subdivided according to the process of the information transmission, e.g. radio waves, a wired connection, light transmission; according to the method of the transmitter power supply: independent or inductive; as well as according to other methods, either a transmitter control method (manual or automatic) or by a modulation method etc. [Kamal, Sabaresh, Johnson, Prakash 2013: 362-363]

We know biotelemetry to be especially useful for the patients with a risk of abnormal heart activity, usually in a coronary care ward. Telemetry specialists often face the problem of monitoring many patients in a hospital. Currently, such patients are outfitted with measuring, recording and transmitting devices. Systems are available in a medical-surgical nursing not to miss any complications in a heart condition or to monitor a response to antiarrhythmic medications such as amiodarone [Segall, Hobbs, Granger, Anderson, Bonifacio, Taekman, Wright 2015: 1039-1040].

At the moment the use of telemetry is being developed. We are to describe the existing instruments and compare them from the point of view of their applicability and reliability. We find a new and emerging application for telemetry in the field of neurophysiology, or neurotelemetry. Neurophysiology is the study of the central and peripheral nervous systems through the recording of bioelectrical activity, whether spontaneous or stimulated. In neurotelemetry the electroencephalogram of a patient is monitored through a registered electroencephalogram by a technologist who uses the advanced communication software. The aim of the neurotelemetry is to recognize a decline in a patient's condition before physical signs and symptoms appear [Chestek, Vikash, Nuyujukian, Kier, Ryu, Harrison, Shenoy 2009: 330-331]. Thus, neurotelemetry is synonymous to real-time continuous video electrocardiography monitoring and has its application in the epilepsy monitoring unit, Intensive Care Unit (ICU), pediatric ICU and newborn ICU. However, the constant monitoring is costly in time and labor resources. According to the factors mentioned above, it can be carried out in the large academic hospitals using in-house programs that include qualified technologists, IT-support staff, neurologists and neurophysiologists and monitoring support staff. A major disadvantage is the fact that it is impossible to use biotelemetry systems widely, in a large scale [Singh 2005: 4]. Due to the up-to-date microprocessor speed, software algorithms and video data compression hospitals are able to record and monitor continuous digital electrocardiographs of a large number of patients' simultaneously. Neurotelemetry and

continuous electrocardiography monitoring provides dynamic information about brain functioning that permits early detection of changes in neurologic status, which is especially useful when the clinical examination is limited. Another important application of biotelemetry can be found in resuscitation devices [Shpakov, Burmaka: 1]. Modern mobile telemedicine complexes combine a powerful computer interface with a variety of medical equipment wireless communications, video conferencing tools and means of IP-broadcasting.

**Conclusions.** In conclusion, we should specify the promising fields which include the remote control of the telemetry medical diagnostic equipment. Medical procedure can also be provided. It is vital to proceed with improving the systems based on robotics remote applications in medicine for large scale operation [Shpakov, Burmaka: 1]. The two-way telemetry approach must be extensively applied. No doubt, we can hardly imagine the situation in medicine when a patient is diagnosed completely and properly without a doctor's help. However, the data obtained on the basis of bioanalytical measurements enable us to sort out the problems correctly and make corresponding decisions. The up-to-date systems are supposed to be cheap and widespread as the GSM networks apply by SMS for processing information as well as for its reception and transmission [Townsend, Abawajy, Kim 2011: 4237-4238]. Using a telemeter we are able to take measurements of various amounts at long distances. Mechanical, hydraulic, and optical technologies are worth mentioning too. Due to telemetry multiple data transmitting is provided within a fixed frame, there are numerous and miscellaneous fields to apply it. Among them there is logistics, agriculture, medicine, space exploration, etc. Developments of analytical measuring information systems to support telemetry technology play an important role in medical industry and other fields of science and technology.

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УДК 3937

## INTRODUCTION TO METAMATERIALS

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**Abstract:** The article is devoted to metamaterials, that is the relatively new area in the world and it is developing rapidly. It raises issues associated with the true discoverer of the theory, theory - that is the main component of the operating principle of metamaterials. It describes the main component of operating principle of metamaterials, the unique characteristics, scopes of application and future perspectives of application.

**Keywords:** metamaterials, discoverer of the theory, operating principle, characteristics, scopes of application.

**Introduction.** In recent years, the number of publications on the subject of metamaterials has been growing exponentially due to new prospects for their application. But in Ukraine it is still not very developed.

**The object-matter** of the article is metamaterials which open up new scopes of applications in physics due to their unique characteristics.

The subject-matter of the article is physical properties of metamaterials.

The **objective of the article is to inform the readers about metamaterials**, when and by whom they were actually created, their unique characteristics and scopes of application.

**The tasks are** to consider in details the physical properties of metamaterials, to give information about the discoverer of the theory, to emphasize the particular points of the theory explaining the behavior of metamaterials.

**The materials** of physical literature and the publications of leading experts in the field of metamaterials are used.

**The following methods** were used in writing the article: systematic analysis of the physical literature, analysis of concept and terminology systems to study the basis of the principles of metamaterials, the study of theoretical understanding their practical use.

More than 40 years ago, a Soviet scientist Viktor G. Veselago hypothesized the existence of material with a negative refractive index. Light waves in these materials are moving against the direction of the beam and generally have rather unusual properties. However, in all known substances refractive index is positive. During several years of intensive research, Veselago did not find any relevant material with electromagnetic properties and his hypothesis was forgotten. People got to remember about this hypothesis only at the beginning of the XXI century.

Discussion and Results. Semiconductor properties are described by the value of  $\epsilon$  - permittivity and magnetic properties by value  $\mu$  - magnetic permeability. These values are generally positive, but there are substances with negative  $\epsilon$  and positive  $\mu$ , or vice versa. V. Veselago wondered: what would happen if both values are negative? From a mathematical point of view this is possible but is it possible from physical point of view? V. Veselago showed that this condition does not contradict the laws of nature, but the electrodynamics of materials is significantly different from those where  $\epsilon$  and  $\mu$  are both positive. Firstly, their phase and group velocity of electromagnetic waves have different directions (under normal ambient conditions, they have the same direction).

Materials with a negative refractive index were called by V. Veselago "left" and positive, respectively, "right", which is based on the relative position of the three vectors describing the dissemination of electromagnetic waves. Refraction at the border of two environments is the mirror relative to the axis z.

One of the most important features of metamaterials is a negative refraction of light at the border between ordinary matter and metamaterials.

Not many people know that the founder of the theory of negative refraction was not V. Veselago, and the theory had been invented much earlier by L.I. Mandelstam, a Soviet physicist, an academician of the Academy of Sciences of the USSR [3].

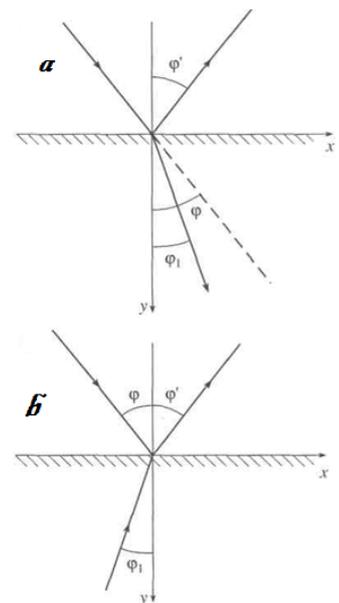
L. Mandelstam first gave a detailed analysis of the possibility of existence of negative refraction in one of his lectures. The first picture shows the direction of vectors of the falling, the refracted and reflected waves (pic. 1), and the fact, that when a negative refraction take place, a stream of energy flows from the border between ordinary matter and metamaterials and the phase flowing on this boundary is explained in details(pic. 1b) [4].

### Negative refractive index

The metamaterial is an artificially created material, electromagnetic properties of which are determined not so much by the properties of its components, as their spacial arrangement.

Consider the mechanism of interaction of electromagnetic radiation intending to understand how negative refraction occurs. The electromagnetic wave that passes through a substance causes the electrons of atoms or molecules to move. Part of the wave energy is consumed on this process. The process affects its properties and nature of distribution.

The field of electromagnetic waves has both electric and magnetic component. The electrons move in a circle under the effect of the magnetic field, as well as they move back and forth by the electric field in the



material. The extent of the interaction is determined as it was mentioned earlier by two characteristics of matter: the permittivity  $\epsilon$  and magnetic permeability  $\mu$ .

The optical properties of a substance are characterized by the refractive index  $n$ , which is associated with  $\epsilon$  and  $\mu$  simple relation:  $n = \pm\sqrt{\epsilon\cdot\mu}$ . For all known materials sign before the square root must be "+", and therefore the refractive index is positive. However, in 1968 V. Veselago showed that the index of refraction  $n$  must be less than zero for all substances with negative  $\epsilon$  and  $\mu$ . Negative  $\epsilon$  or  $\mu$  obtained in the case where electrons in the material move in a direction opposite to the forces, that are generated by electric and magnetic fields. Despite the fact that such behavior does not seem correct or valid, to make electrons move against the forces of the electric and magnetic fields is not too difficult. For example: if you push the pendulum, it will move in the direction of the push and will start to oscillate so-called resonance frequency. Pushing the pendulum to swing in a beat you can increase the amplitude of the oscillation, but if you push it in a higher frequency, the tremors will stop coincide with variations in phase and at one point the pendulum, that is moving to the arm will hit her.

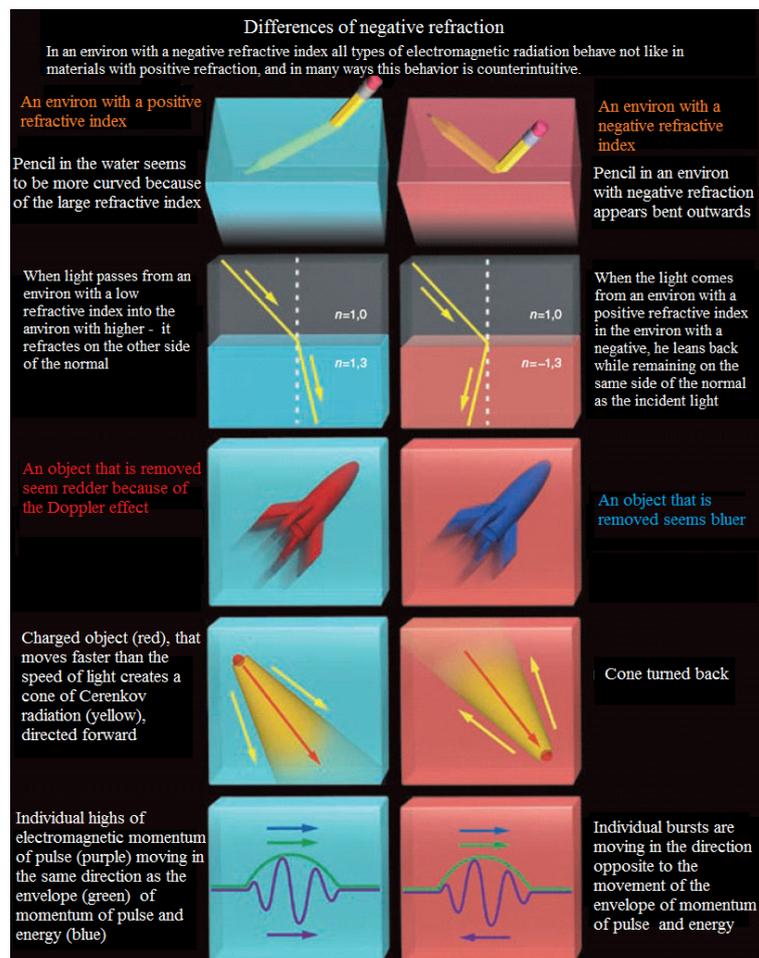
The electrons in the material with a negative refractive index also enter into anti-phase and begin to resist the action of the electromagnetic field.

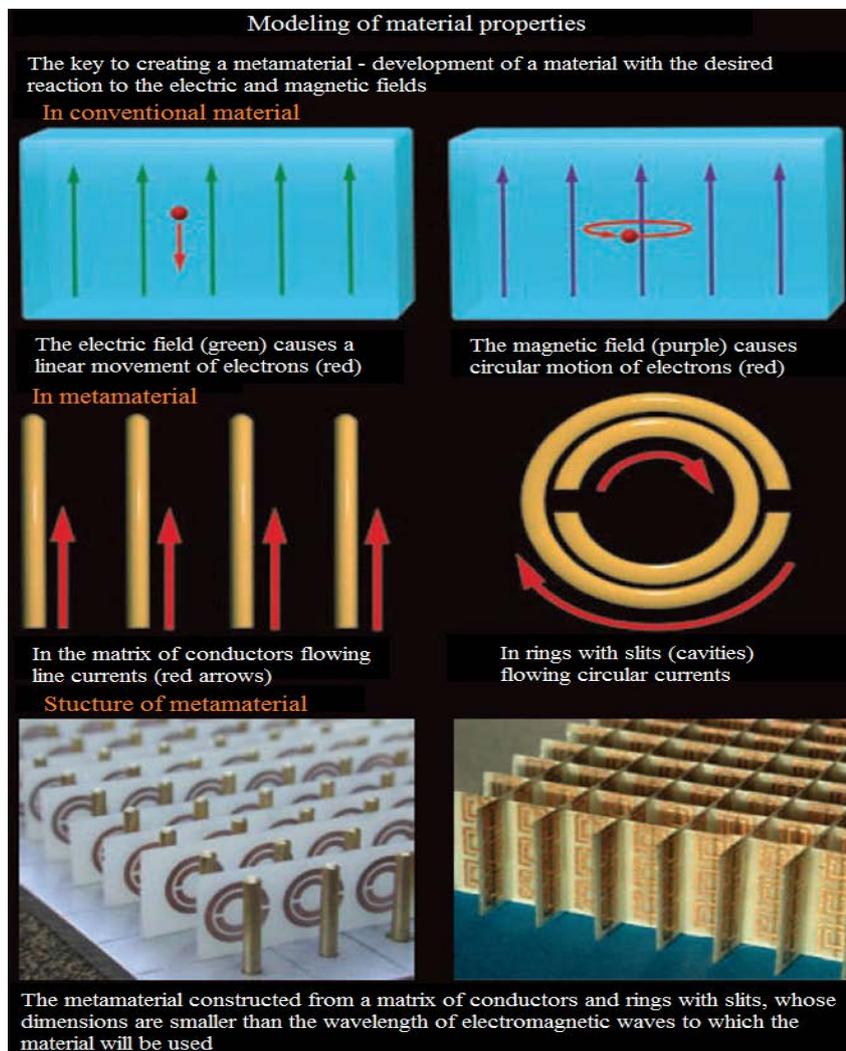
Materials that are constructed in specially formed microscopic structures, can have electromagnetic properties that are different from the properties of all substances of natural origin. In particular, these metamaterials can have a negative refractive index that means they refract the light in a totally different manner.

Skeptics asked, whether do not break the materials with the negative refractive index the fundamental laws of physics. If this were so, the whole research program would be called into question [1,2].

#### Application of metamaterials:

- the microwave technologies;
- radio applications (in particular the antenna technologies);
- the development of the microwave waveguide devices;
- to achieve a reduction of the visibility of objects, or creating a visual illusion of shape or size of the object etc.





### Conclusions.

Not many people know about metamaterials, but this is very interesting and important for development of physical science. The possibility of existence of negative refraction enabled or forced physicists to revise substantially the entire area of electromagnetism. When all the ideas are finally fully understood, basic optical phenomena such as refraction and diffraction-limited resolution are necessary to revise, considering their new opportunities associated with negative refraction metamaterials, that create it.

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УДК 538.945

## SUPERCONDUCTORS TODAY AND IN THE FUTURE

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**Abstract:** The article deals with the phenomenon of superconductivity in conductors and superconductors. The examples of the materials used as superconductors and temperatures required for this property to appear are given. The dependence of resistance in the materials under study and its correlation with temperature is considered at the examples of the experiments made. The application and the problem of

superconductor operation at low temperatures have been found as well as the problem of high temperature superconductor invention.

**Key words:** superconductor, resistance, compounds, superconductivity.

The **object-matter** is superconductors and their use in technology. The **subject-matter** is the phenomenon of superconductivity in materials. The **objective** is to conclude what problems occur during operations with superconductors. The **task** is to find possible solutions to the problem. The **materials** are scientific articles with the information available on the problem. The **methods** are analyze, observation and comparison.

The task of superconductors is to allow electric current to flow without resistance at long distances, keeping high velocities and low-voltage on the electric grids with no transmission. Magnetically levitated trains which are available now are based on superconductor properties. Ultra-high speed computers, motors and generators have been made possible due to superconductors. But there are some problems of using superconductors. The biggest one is to cool them down to the temperature required. Tin, for example must be cooled down to  $t=3,72\text{K}$  and lead to  $t=7,19\text{K}$ .

Experimental studies have shown the existence of several high temperature superconductors although the problem cannot be sorted out as even the hottest superconductor must be cooled down to 4K. For instance, when dealing with a Nuclium<sup>3</sup>Tin compound, we find this cooling process rather expensive. Currently, superconductor materials capable of showing their properties at high temperature are being looked for. In general, high temperatures are preferable because they are less expensive in production and further maintenance. We are going to describe two methods of cooling materials: the first one is by using liquid helium and the second one is by using liquid nitrogen. Liquid helium is at least ten times more expensive to produce, than the second one. The next reason for using liquid nitrogen is that liquid helium is a finite resource. Helium is extracted from natural gas wells and could be used up. It is formed as a product of radioactive decay and cannot decay at the atmosphere completely. It escapes the Earth's gravitational pull and ends up in space.

The rate of the reservoir replenishment of helium is insufficient to keep up with current rates of usage. No doubt, helium could be among the first of the non-renewable resources to run out! There is no real effective replacement for helium to produce low temperatures, so helium-cooled superconductivity on a large scale was always doomed.

First of all, it is necessary to understand more clearly what a superconductor is, where it can be used, how this discovery helps people, and discuss the pros and cons of using superconductors. Understanding what materials are superconductors and how resistance changes with the temperature is also important.

So, materials cannot be subdivided into conductors and insulators. All materials conduct electricity. Some of them conduct more easily than others, but the proper conditions must be created. If a metal conducts electricity well, it means that it offers little or no resistance when someone tries to make a current flow through the investigated metal. And if plastics, for example, insulate well, that means that these materials possess high resistance to electric current. Resistance seems to be a much more useful term than subdividing materials into "conductors" and "insulators".

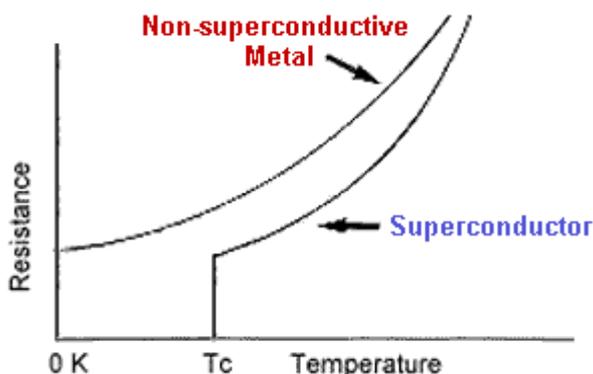


Fig. 1.1 shows the resistance - temperature correlation of superconductors and non-superconductive metals.

Several different mechanisms cause resistance and they become more important at different temperatures. Thus, the way it changes is a really interesting and important question. The answer is simple enough: suppose, we have a piece of gold wire in an electric circuit (gold is one of the best conductors). It shows very low resistance to electricity, because the resistivity of gold is  $2.20 \cdot 10^{-8}(\text{Ohm} \cdot \text{M})$ . To understand

that it is a really low resistance let us look at the resistivity of two other conductors: Nickel= $8.700 \times 10^{-8}$ (ohm\*m) and Tin  $12.000 \times 10^{-8}$ (ohm\*m). But increasing its temperature we get higher resistance. Generally speaking, the higher the temperature is, the more thermal vibrations inside the gold crystalline structure are and the more difficult it is for electrons to get through (the negatively charged particles inside the atoms that carry electric currents). Conversely, if one cools down gold, and reduces the vibrations it is made easier for electrons to flow. At low temperatures, for example, defects and impurities in the material cause most of the resistance. (A fairly complex mathematical equation called Mattheiessen's rule demonstrates the total resistance of a material at any given temperature by summing up various effects.)

In 1911, a Dutch physicist Heike Kamerling Onnes (1853-1926), a Nobel laureate, who worked at Leiden Laboratory, was the first to notice the phenomenon. He cooled a wire made of mercury to the toe-tingling temperature of (-269C, -452F,4K), Onnes found that its electrical resistance suddenly disappeared. Thus, he discovered superconductivity. But it was a fairly short-term effect. Onnes found out that if a strong magnetic field were applied to mercury, the superconductivity would vanish as quickly as it appeared. 20 years later, German physicists Karl Meissner and Robert Ochsenfeld observed one more thing about Magnetism. Superconductors are diamagnetic: they do not let magnetism penetrate inside them. If a superconductor is in a magnetic field, you will get an electric current flow through its surface. This current creates a magnetic field that cancels the original field trying to get inside the superconductor and repelling the magnetic field outside. It is known as the Meissner effect and it explains how you can make superconductor levitate in a magnetic field. Moreover, it can be easily demonstrated by a lab assistant at Karazin National University using a cobalt-samarium tablet cooled by liquid nitrogen and put onto a cylindrical molded magnet. (YBa(2)Cu(3)O(7) T=77.4K)

We consider the fact that not all materials can show superconductivity to be a serious problem. Mercury is an exception here. Besides mercury, 25 other elements (mostly metals, semimetals and semiconductors) are known to possess superconductivity. Moreover, thousands of compounds and alloys have been discovered to have it, too.

The superconducting cuprates (copper-oxides) have achieved astonishingly high Tc's when you consider that by 1985 known Tc's had only reached 23 Kelvin. To date, the highest Tc attained at ambient pressure for a material that will form stoichiometrically (by direct mixing) has been 147K. And the highest Tc overall is 187C for a material which does not form stoichiometrically (see below list). It is almost certain that other, more-synergistic compounds still await discovery among the high-temperature superconductors [Bakai, Raniuk, 1993:1].

Compounds:

Sn(10)SbTe(9)Ba2MnCu(21)O(42+) +187 C;

Sn(9)SbTe(3)Ba(2)MnCu(14)O(28+) +121 C and other.

Each material (compound or alloy) becomes a superconductor at different temperatures (known as its critical temperatures or Tc). The trouble with most of these materials is that they superconduct only within a few degrees below the absolute zero (the lowest theoretically possible temperature: -273.15C,-459,6F,0K)

[Muller, Ustinov 1988:2] Table 1.1

**Table 1.1. Critical temperatures and critical magnetic fields of superconducting elements [7]**

Element	T <sub>c</sub> /K	H <sub>cm</sub> (0) /Oe	Element	T <sub>c</sub> /K	H <sub>cm</sub> (0) /Oe
Al	1.175 ± 0.002	104.9 ± 0.03	Pa	1.4	
Be	0.026		Pb	7.196 ± 0.006	803 ± 1
Cd	0.517 ± 0.002	28 ± 1	Re	1.697 ± 0.006	200 ± 5
Ga	1.083 ± 0.001	59.2 ± 0.3	Ru	0.49 ± 0.015	69 ± 2
Hf	0.128		Sn	3.722 ± 0.001	305 ± 2
Hg (α)	4.154 ± 0.001	411 ± 2	Ta	4.47 ± 0.04	829 ± 6
Hg (β)	3.949	339	Tc	7.8 ± 0.01	1410
In	3.408 ± 0.001	281.5 ± 2	Th	1.38 ± 0.02	160 ± 3
Ir	0.1125 ± 0.001	16 ± 0.05	Ti	0.40 ± 0.04	56
La (α)	4.88 ± 0.02	800 ± 10	Tl	2.38 ± 0.04	178 ± 5
La (β)	6.0 ± 0.1	1096, 1600	V	5.40 ± 0.05	1408
Lu	0.1	< 400	W	0.0154 ± 0.0005	1.15 ± 0.03
Mo	0.915 ± 0.005	96 ± 3	Zn	0.850 ± 0.01	54 ± 0.3
Nb	9.25 ± 0.02	2060 ± 50	Zr	0.61 ± 0.15	47
Os	0.66 ± 0.03	70			

If we continue to review advantages and disadvantages from the point of view of the benefits we gain when there is no resistance, we are sure to see none of them because we will have to cool them down to their critical temperature. In fact, that explains why superconductors failed to be a beneficial discovery in spite of the fact that they were discovered 107 years ago. Therefore, we come back to the problem of high-temperature superconductors.

[Bozovic, He, Wu, Bollinger 2016 536, 309-311] More than 30 years ago, scientists discovered a high-temperature superconductivity in copper-oxide compounds which are called cuprates. They had been trying to understand how these materials can conduct electricity without resistance at temperatures hundreds of degrees above the ultra-chilled temperatures required by conventional superconductors. If the mechanism behind this exotic behavior is discovered, it could help to find the way of engineering materials that become superconducting at room temperature. These superconductors could enable lossless power grids, and what is more, affordable magnetically levitated transit systems.

Nowadays, physicists at the U.S. Department of Energy's Brookhaven National Laboratory provide an explanation why the temperature required for cuprates to become superconducting is so high. It is as follows: critical temperature is controlled by the density of electron pairs (the number of electron pairs per unit area). "This finding, described in a Nature paper published August 17, challenges the standard theory of superconductivity, which proposes that the critical temperature depends instead on the strength of the electron pairing interaction."

Ivan Bozovic, a senior physicist in Brookhaven Lab's Condensed Matter Physics and Materials Science Department, said that solving the enigma of high-temperature superconductivity had been the focus of condensed matter physics for more than 30 years. His experimental finding provides a basis for explaining the origin of high-temperature superconductivity in the cuprates.

The essence of his experiment lies in studying the characteristics of the grown samples of a cuprate known as LSCO for the four elements it contains (lanthanum, strontium, copper, and oxygen). Such characteristics include real-time information about the surface morphology, thickness, chemical composition, and crystal structure.

Chemically adding strontium atoms to the LSCO films, the scientists ensured the production of mobile electrons in the copper-oxide layers where superconductivity occurs. But as it turned out, the substance added in superfluous amounts caused decrease of electron pairs - the opposite of what would have been naturally expected. To investigate the discovery even further, Bozovic and his team measured the magnetic and electronic properties of the engineered LSCO films, using the mutual distance technique. (The technique determines the distance a magnetic field transmits through a superconductor, which indicates the density of electronic pairs.) These measurements established a precise linear relationship between the critical temperature and electron pair density. Both decrease steadily as the substance is added, down to a complete absence of electron pairs. The temperature at the same time drops to near-zero Kelvin. LSCO becomes more metallic the more it is 'overdoped'.

If Bozovic's team is correct, it is small, local pairs of electrons that are behind the high temperature at which cuprates gain superconductivity. The next step in solving the mystery of superconductivity would be understanding what interactions make these pairs so small.

But Bozovic's team isn't the only one in search for answers. [Cheuk, Nichols, Lawrence, Okan, Zhang, Khatami, Trivedi, Paiva, Rigol, Zwierlein 2016:1] Martin Zwierlein, professor of physics and principal investigator at the NSF Center for Ultracold Atoms and the Research Laboratory of Electronics at the Massachusetts Institute of Technology, and his team have made an important contribution. They have demonstrated that the mathematical model developed to understand real materials could plausibly recreate behaviors of the atoms within a certain temperature range (the Hubbard model). To be more specific, the atoms in the team's 2D experiments. (2D gas serves as a stand-in for electrons in a superconducting solid. Potassium atoms are trapped by lasers in the two-dimensional grid, interacting with each other and revealing the behaviors of superconducting electrons.) That particular experimental setup is likely to identify the ideal conditions for inducing superconductivity.

Because of strong interactions essential for high-temperature superconductivity, not even the most powerful computers in the world have been able to solve the Hubbard model at the temperatures at which electrons are superconducting. A challenge for physicists has therefore long been to come up with computational techniques that can solve the model at the lowest possible temperatures in the current supercomputers. Rigol and collaborators developed, however, one such technique.

The value of the team's work is that scientists will know for sure that high-temperature superconductivity can actually be produced, in case superconductivity is observed at lower experimental temperatures.

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### INSTABILITY OF THE DIELECTRIC LIQUID SURFACE IN THE PRESENCE OF THE UNIPOLAR VOLUME CURRENT

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**Abstract.** This article deals with the oil surface instability when it is subjected to the unipolar current from the needle, to which we apply high voltage. The resulting ion wind reaches oil layer, and the electric force acting on these ions in the oil lead to its vortex motion. We supply qualitative considerations by the quantitative estimation. It shows the dependence on the voltage, distance between the needle and the layer, current and the other parameters of the system. Experimental observations show the validity of such a mechanism of instability.

**Key words:** cell-structure, dielectric, instability, self-organization, unipolar current.

**Introduction:** A fast growth of the field of physics related to the systems far from thermodynamic equilibrium is due to their numerous technical applications and fundamental significance. These systems exchange with the environment with their energy and particles, and the second law of thermodynamics is not applicable to them. Experiment shows that spontaneous formation of ordered structures in such open systems may take place far from the equilibrium [Castagnino 2008, Mayer 2014]. This phenomenon called self-organization underlies many physical, biological, economic and social processes. The range of phenomena studied by synergetics is the formation of the dissipative structures under certain conditions in nonlinear systems [Chicon 2014, Ibrahim 2005].

The phenomenon of self-organization appears most clearly in hydrodynamics, it is the result of instability that can lead to other nonlinearities in the system and even the destruction of the system. The most famous example of such instability is the breakdown of capillary jets to drops. The waves on the surface along the jet obey the harmonic law, but the amplitude of these oscillations changes exponentially. Another important example is the Rayleigh-Taylor instability of boundary between two different media, such as the sugar and salt solutions. In this case the focus of investigation is the dispersion law of waves on the surface that have some wave number along the surface, but the amplitude of these waves grows with a certain increment in time. The result is the formation of characteristic mushroom structures which may induce toroidal vortex motion. These closed vortex solutions are interesting because, unlike the linear vortices (e.g. tornado, funnel in the bathroom, etc.), they have no beginning or end, and they possess the increased stability and particularly long lifetime. Examples of such instabilities and toroidal vortices include pop-up-bubbles of air, mushrooms of powerful explosion, smoke rings and even ball lightning. In this paper, we consider the instability close to the Rayleigh-Benard instability.

The parameter of self-organization that controls the behavior of the system, is the temperature gradient. The diffusion begins due to the inhomogeneity of density resulting from heating. Exceeding some critical gradient, the diffusion does not lead to a uniform temperature distribution. In a thin layer of liquid, the cells of hexagonal shape are formed, within each of these cells the liquid rises in the central part and goes down the periphery. An important problem of convection in a plane layer is the fact that following the Busineska approximation, it is possible to obtain an accurate analytical solution of the equations of hydrodynamics. However, a simple exact solution could be found in the abstract formulation of two free layers that are not

deformed, there are no practical realizations of these exact solutions. Nevertheless, the approximate methods based on the analytical exact solutions work well for the real systems.

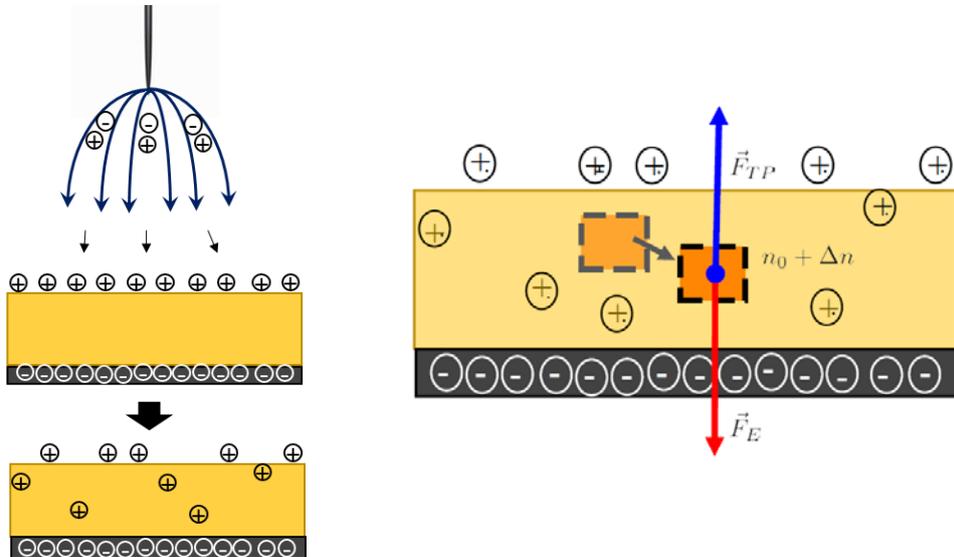
In this paper, we consider the instability of the oil layer placed in the inhomogeneous electric field and the unipolar current produced by the needle to which a high potential is applied. We reveal the mechanism behind this instability and consider different possible explanations to the loss of stability. Further we supply our qualitative explanation by the simple estimation of the characteristic size of the cell and show its growth with the voltage applied to the tip of the needle. We also illustrate the results by two examples of the systems obtained in the system.

**Discussion and Results.** Mechanism of structure formation. Consider the following experiment. A vertically oriented needle is mounted over the horizontally metal plate. The needle and the plate are connected to the poles of a low-power source of high voltage. The drop of the silicon or machine oil is placed on the plate, the needle is mounted above the center of the drop vertically at a distance of a few centimeters, and we gradually increase the voltage between the electrodes. This drop spreads over the surface of the plate and takes on the shape close to the planar layer bounded by the plastic border. At a certain voltage the liquid surface suddenly loses stability and the disturbances are clearly visible in reflected light [Cai 2008, Gutling 2008].

A small increase in pressure leads to an ordered structure consisting of more or less regular cells [Verweij 1998, Vega 2003]. Further increase of the voltage causes decrease in the size of cells that continuously appear and disappear, each time creating a structure. Increasing the voltage of the electric field near the positive electrode leads to ionization of the air, followed by formation of ions, then they move toward the negatively charged electrode sweeping a neutral air particle (see Fig.1).

The appearance of the structure on the oil surface can be associated with many phenomena: 1) the instability of the dielectric surface due to the electric field of uncompensated charges on oil surface; 2) instability of the surface as a consequence of surface tension forces; 3) the effect of an electric field on the charges formed near the tip and flowing to the surface of the oil; 4) the effect of an electric field on the charge carriers of unipolar current in the bulk of oil [Perez 1996].

**Fig.1** The scheme of ion wind in the system (left panel). The forces acting on the portion of liquid (right panel).



We believe that as a result of the ion wind formed in the vicinity of the needle tip, the unipolar current in the bulk of oil is formed. Charges that adhere to the surface of oil, do not stay there and continue their motion in the bulk of oil, sweeping liquid and as a result of instability in this system, the vortex fluid motion is induced.

Quantitative estimation of the cell structure size. Consider a small portion of some fluid. The concentration of ions increases slightly due to some fluctuations in the unipolar current. Then an additional force acting on the liquid from the external electric field leads to the acceleration of this portion of liquid and overtaking layers of surrounding liquid. As a result, electric force is compensated by the viscous force, and we obtain following estimation

$$e\Delta n\Delta V \frac{E}{\epsilon} \sim \eta S \frac{\Delta v}{a},$$

where  $e$  is the electron charge,  $\Delta n$  is the exceeding charge concentration in the volume  $\Delta V$ ,  $E$  is the electric field,  $\varepsilon$  is the dielectric constant of liquid,  $\eta$  is its viscosity,  $S$  is the surface area,  $a$  is its linear size,  $\Delta v$  is the velocity variation on the distances of order of  $a$ .

Further we consider the continuity of ion flow and compare the number of ions formed near the tip with the number of ions passing through the oil,

$$n_0 S v_0 \Delta t \sim \Delta N \frac{S}{r^2},$$

where  $r$  is the distance from the tip. We obtain the following estimation for the size of cells,

$$a \sim \sqrt{\frac{\eta \beta^2 \varepsilon U}{I}} r,$$

where  $U$  is the voltage between electrodes,  $I$  is the current in the system.



From this result, we see that the characteristic size of the cells is proportional to the root of the voltage applied to the needle and the distance between tip and surface of the oil. Figure 2 shows two characteristic examples of the structure obtained on two different distances.

**Fig.2** *Two examples of structures obtained in the system.*

**Conclusions.** Thus, in the paper we show that the instability in the oil layer is the result of the unipolar current flow in the bulk of the oil. The electric force acting on the ions in the liquid leads to the loss of the stability and toroidal vortices appear, where the electric force is equilibrated by the viscous friction force. Using this qualitative picture we derive a simple estimation for the size of the cell on the surface of the liquid. It explains a natural growth of the cell size with the increase of the voltage. The experimental observations of the structure are in agreement with our theoretical estimation.

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