



Slovak international scientific journal

№84, 2024

Slovak international scientific journal

The journal has a certificate of registration at the International Centre in Paris – ISSN 5782-5319.

The frequency of publication – 12 times per year.

Reception of articles in the journal – on the daily basis.

The output of journal is monthly scheduled.

Languages: all articles are published in the language of writing by the author.

The format of the journal is A4, coated paper, matte laminated cover.

Articles published in the journal have the status of international publication.

The Editorial Board of the journal:

Editor in chief – Boleslav Motko (Bratislava) Slovakia

The secretary of the journal – Milica Kovacova (Bratislava) Slovakia

- Lucia Janicka – (Bratislava) Slovakia
- Stanislav Čerňák – (Bratislava) Slovakia
- Miroslav Výtisk – (Nitra) Slovakia
- Dušan Igaz – (Nitra) Slovakia
- Terézia Mészáros – (Banská Bystrica) Slovakia
- Peter Masaryk – (Rzeszów) Poland
- Filip Kocisov – (Wrocław) Poland
- Andrej Bujalski – (Košice) Slovakia
- Jaroslav Kovac – (Tnava) Slovakia
- Paweł Miklo – (Bratislava) Slovakia
- Jozef Molnár – (Bratislava) Slovakia
- Tomajko Milaslavski – (Nitra) Slovakia
- Natália Jurková – (Bratislava) Slovakia
- Jan Adamczyk – (Prague) Czech Republic
- Boris Belier – (Bratislava) Slovakia
- Stefan Fišan – (Bratislava) Slovakia
- Terézia Majercakova – (Wien) Austria
- Ekaterina Semko (Kyiv) Ukraine

1000 copies

Slovak international scientific journal

Partizanska, 1248/2

Bratislava, Slovakia 811 03

email: info@sis-journal.com

site: <http://sis-journal.com>

CONTENT

BIOCHEMISTRY AND GENETICS OF ANIMALS

<i>Adesehinwa O.A., Boladuro B.A., Makanjuola B.A.M., Sorunke A.O., Bolaji A.A., Agbede J.O., Adesehinwa A.O.K.</i>	
GROWTH, HEALTH STATUS AND COST BENEFIT ANALYSIS OF WEANER PIGS FED DIET SUPPLEMENTED WITH MALTODEXTRIN.....	4

COMPUTER SCIENCES

<i>Episkoposian S., Grigoryan S.</i>		<i>Gurbanova N., Hajiyeve Z., Abdullayeva G.</i>	
STEP-BY-STEP GREEDY ALGORITHMS WITH RESPECT TO WALSH SYSTEM	11	MOBILE MEDICAL APPLICATIONS IN DIGITALIZATION OF HEALTHCARE	18
<i>Manafov E., Sardarova I.</i>		<i>Al-Ammori Ali, Ishchenko R., Klochan A., Shkurko O., Povoroznik D.</i>	
SMART HOME TECHNOLOGY AND TRENDS IN LIVING SPACE TRANSFORMATIONS	15	ANALYSIS AND ASSESSMENT OF INFORMATION THREATS IN THE TRANSPORT SECTOR	21

CONSTRUCTION AND ARCHITECTURE

<i>Ignatenko O.</i>		<i>Salimova A.</i>	
IMPROVEMENT OF TECHNOLOGICAL SOLUTIONS FOR ERECTION OF LARGE-SPAN COATINGS WITH LIFTING MODULES	28	REFLECTION OF ANCIENT CULTS IN AZERBAIJANI ART	35

ECONOMY

<i>Ayyubov M.</i>	
ECONOMETRIC MODEL OF THE CYCLICAL FUNCTIONING OF THE NATIONAL ECONOMY IN THE LONG-TERM PERSPEKTIVE (ON THE EXAMPLE OF THE NATIONAL ECONOMY OF AZERBAIJAN)	41

HISTORY

<i>Ismayilowa A., Abbasova S.</i>	
GENOCIDE CARRIED OUT IN WESTERN AZERBAIJAN IN 1918-1920	47

MATHEMATICS

<i>Antonov A.</i>		<i>Ramani J.V., Kumar Dinesh</i>	
IT FOLLOWS FROM THE SPECIAL THEORY OF RELATIVITY THAT INVISIBLE AFTERLIFE WORLD IS IN FACT PHYSICALLY REAL	52	A FINITE DIFFERENCE METHOD FOR THE SOLUTION OF THIRD ORDER BOUNDARY VALUE PROBLEMS IN ORDINARY DIFFERENTIAL EQUATIONS.....	59

NORMAL AND PATHOLOGICAL PHYSIOLOGY

<i>Bukach O., Ariichuk D., Babchenko V., Soha N., Stefurak M.</i>	
A CLINICAL CASE IN THE PRACTICE OF A RHEUMATOLOGIST: SYSTEMIC LUPUS ERYTHOMUS WITH INFLAMMATION OF ORGANS AND SYSTEMS..	63

PEDAGOGY

Abbasova S.

SETTING THE PROBLEM IN TEXTBOOKS AND
METHODICAL MATERIALS FOR TEACHERS 66

Kostadinov O.

MODEL OF PASSIVE AND ACTIVE FOREIGN LANGUAGE
VOCABULARY DYNAMICS 69

PHYSICS

Khalilov S.

INFLUENCE OF HEAT TREATMENT ON THERMAL AND
ELECTRICAL PROPERTIES OF POLYMER
SEMICONDUCTOR POLYHYDROCHYNONE 74

Robert Lloyd Jackson II

THE GENERATING FUNCTION TECHNIQUE
AMELIORATES EFFECTIVE AND STRING FIELD
THEORIES AND FORESHADOWS THEIR LINKAGE TO
QUANTUM INFORMATION THEORY 77

ZOOLOGY

Bely D., Niyazaliev K.,

Nurbaev K., Kopkova A., Sayakova Z.

SPECIES COMPOSITION AND NUMBER OF RODENT
CARRIERS OF THE PLAGUE PATHOGEN IN THE
(MOYINKUM DESERT PLAGUE FOCUS IN 2021 89

BIOCHEMISTRY AND GENETICS OF ANIMALS

GROWTH, HEALTH STATUS AND COST BENEFIT ANALYSIS OF WEANER PIGS FED DIET SUPPLEMENTED WITH MALTODEXTRIN

Adeshinwa O.A.,

Department of Animal Production and Health, Federal University of Technology, Akure

Boladuro B.A.,

Makanjuola B.A.M.,

Sorunke A.O.,

Bolaji A.A.,

Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan

Agbede J.O.,

Department of Animal Production and Health, Federal University of Technology, Akure

Adeshinwa A.O.K.

Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan

DOI: [10.5281/zenodo.11624284](https://doi.org/10.5281/zenodo.11624284)

Abstract

This study evaluated the influence of maltodextrin in the diet of weaned pigs on growth, backfat thickness, haematology, serum biochemical and cost benefit indices. A total of 54 weaned pigs which are largewhite $\times$ land-race crosses with average weight of 9.35 ± 2.36 kg were used for this study. They were randomly allotted to three dietary treatments (T1 - basal diet, T2 - 500g/tonne maltodextrin inclusion, T3 - 1kg/tonne maltodextrin inclusion) with three replicates each and six animals per replicate in a completely randomized design. The body weight gains of the pigs were not significantly ($P > 0.05$) affected by the dietary treatments. They were 23.65, 25.92 and 24.63 kg in T1, T2 and T3 respectively. At the 6th week of the study, the FCR was significant ($P < 0.05$) and were 3.62, 4.26 and 3.81 in T1, T2 and T3 respectively. However, the FCR at the 13th week was not significant ($P > 0.05$) among the treatments. The high density lipoprotein cholesterol were significantly higher in T2 (56.33 mg/dL) and T3 (52.00 mg/dL) than in T1 (46.00 mg/dL). The back fat thickness and all the haematological indices measured were not significantly ($P > 0.05$) influenced by the dietary treatment. The feed cost per weight gain improved with inclusion of maltodextrin from ₦1,213.03 in T1 to ₦1,153.77 in T2 and ₦1,120.75 in T3. The supplementation of maltodextrin in the diet of weaned pigs did not negatively influence the growth and the health status of the animals.

Keywords: Health Status, Maltodextrin, Postweaning performance, Feed utilization, Blood profile.

Introduction

Weaning is one of the most critical stages in pig's life because of the need to adjust to dietary and environmental changes. These changes could have adverse effect on the intestinal and immune systems resulting in impaired health and growth particularly during the first few weeks post-weaning. At weaning, the sows' milk is replaced by a dry and less digestible starch-based diet (Williams, 2003), resulting in significantly reduced energy intake for epithelial structure maintenance (Pluske *et al.*, 1996), reduced transmucosal resistance (Spreeuwenberg *et al.*, 2001, Boudry *et al.*, 2004), and increased secretory activity in the small intestine (Boudry *et al.*, 2004). With the underdeveloped innate and adaptive immune systems of the weaned pigs, damage to the epithelial layers also reduces the ability of nutrients to be digested and absorbed into the blood stream which increases the substrates available for pathogen proliferation (Pluske *et al.*, 2002). These biological changes have short and long-term effects on subsequent performance of pig in terms of growth and well being. As a result of this, it is important that swine producers use appropriate health, nutrition, and management strategies to minimize the adverse effects of weaning stress so as to improve productivity.

A nutritional strategy to promote an early feed consumption after weaning is the use of highly palatable and digestible ingredients in the post-weaning diet,

such as milk-derived products, or highly digestible cereal or animal origin protein sources (Solà-Oriol *et al.*, 2009). Apart from the main ingredients, non-nutritive feed additives, such as zinc oxide, acidifier, flavour and antibiotics are often incorporated to stimulate gut health and digestive capacity (Heo *et al.*, 2013). Hence, the need for an alternative non-conventional feed additive. Due to the adaptive nature of piglet's digestive system to milk components, post weaning diets have been formulated with lactose-rich ingredient that stimulate the intake of feed, help diet transitions (Berrocso *et al.*, 2012), and increase nutrient digestibility (O'Doherty *et al.*, 2005), thereby mitigating the decrease in post weaning performance. Studies by Mahan and Newton (1993) and Oliver *et al.* (2002) have shown that it is possible to use hydrolyzed corn starch (Maltodextrin) as replacement for lactose in diets of infants without adversely affecting performance.

Notably, one of the main sources of energy for an infant's development and growth comes from carbohydrates. Maltodextrins (MDs) are a class of carbohydrates (CHOs) industrially produced by enzymatic or acid hydrolysis of the starch, followed by purification and spray drying (Takeiti *et al.*, 2010). It has an energy value of approximately 4 kcal/g (Katouzian *et al.*, 2015). Studies have shown that maltose and maltodextrin are digested by a set of enzymes called maltases. These enzymes are responsible for about 70 and 20% of the hydrolysis of those carbohydrates, respectively.

Maltodextrin has the ability to lower the pH of the contents of the rectal cavity and has been implicated in lowering the total coliform and *E. coli* populations in the caecum thus, having a prebiotic effect (Pivetta *et al.*, 2014). Also, it has been reported to be effective in partially or totally (Augusto *et al.*, 2011; Pivetta *et al.*, 2014) substituting lactose in the feed of weaned piglets. Lactase activity has been reported to be lower than maltase activity in weaner pigs (Kidder, 1980), hence, maltodextrin supplementation in the diet of weaner pigs might induce the synthesis of maltase through the modulation of enzyme activity exerted by the substrate with improved performance. This study assessed the influence of supplementing the diet of weaned pigs with varying level of maltodextrin on the performance, back fat thickness, cost benefit and health status of the animals in a tropical environment.

Materials and methods

This study was carried out at AK Research Farms, Eleyele, Ibadan, Oyo State, Nigeria with daily temperature ranging between 25 - 35°C and annual rainfall of 1800mm (Victory *et al.*, 2022). The study lasted 91 days. Fifty-four weaned piglets (large white x landrace crosses) with mean weight of 9.35±2.36kg (±SE) were used for the experiment. They were administered 0.2 - 0.3 mg/kg of ivermectin injection sub-cutaneously against internal and external parasites before the commencement of the experiment.

The animals were housed in open sided cross ventilated pens with concrete floor under good management practices. The pens were equipped with concrete water trough and Big Dutchman's semi-automatic feeder. Water and Feed were supplied *ad libitum* throughout the experimental period. Daily routine practices carried out included feeding, watering, waste disposal, washing of pens and general observation of the animal's welfare.

The pigs were randomly allotted into 3 dietary treatments labeled T1, T2 and T3 in a completely randomized design (CRD). Each treatment was replicated 3 times with 6 animals per replicate. The diet of T1 (control/basal diet) was formulated to meet the nutrients requirements as recommended by the National Research Council (2012) for weaned pigs raised in tropical environment (Table 1). Pigs in T2 were fed basal diet with 500g/tonne maltodextrin while T3 contained the basal diet with an inclusion rate of 1kg/tonne maltodextrin.

The feed intake was estimated daily by subtracting the weight of the left over feed from that of the feed given. The body weight of the pigs were determined weekly using a walk-through digital measuring scale. The weight gain was calculated as the difference between the initial weight and the final weight. The feed conversion ratio (FCR) was determined as the ratio of feed intake to weight gain.

Table 1

Percentage Composition of Basal Diet	
Ingredients	Quantity %
Maize	40.00
Groundnut cake	25.00
Wheat offal	10.00
Corn bran	16.00
Fish meal	2.50
Limestone	2.00
Bone meal	2.00
Lysine	0.40
Methionine	0.325
Salt	0.40
Starter Premix	0.25
Toxin binder	0.05
Multi enzyme	0.05
Lavaricide	0.025
Palm oil	1.00
Total	100
Calculated Composition	
Metabolizable energy (Kcal/kg)	2650
Crude fiber (%)	5.73
Crude protein (%)	19.67

The proximate composition of the samples of the three diet were determined using the recommended procedures described by Association of Official Analytical Chemists (AOAC, 2010). The backfat thickness were measured across the treatment at the 12th week of the study using the ultrasonic probe technique described by Fortin *et al.* (1980) and modified by Jiang *et al.* (2014). The ultrasonic probe technique works on the principle of reflection of sound wave. The calibration of the instrument was based on the assumption that the ultrasonic sound waves travels through fatty tissue at a

velocity of 1480 m/s. The backfat thickness was taken off the midline over the last rib using ultrasound gel on the probe. This was done using the Dramiski ultrasound scanner.

At the end of the feeding trial, pigs were randomly selected from each treatment and sampled for blood through the jugular vein into clinical sample bottles for analysis using hypodermic syringe and needle. The blood sampled for serum biochemistry analysis were collected into sterile plain sample bottles without anti-coagulant while those for haematological analysis were

sampled into bottles with anti-coagulant (EDTA) to prevent the blood from clotting. The sampling was done in the morning before feeding. About 5mls of blood samples were collected from each animal and were stored in iced flask till it was delivered to the laboratory some minutes after collection. The blood sampled for haematology were analysed for packed cell volume (PCV), haemoglobin concentration, erythrocyte count, leucocyte count, platelets, lymphocytes, neutrophils, monocytes, eosinophils, mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH) and mean cell volume (MCV). For serum biochemical analysis, the sampled blood

were centrifuged for 20 - 30 min at 4000 rpm to separate the serum from the cells. The serum was analysed for total protein, albumin, aspartate aminotransferase (AST), alanine amino transferase (ALT), blood urea nitrogen, creatinine, glucose, total cholesterol, high density lipoprotein cholesterol and triglyceride. The globulin, albumin-globulin ratio (A:G) and low density lipoprotein cholesterol were estimated.

Data were subjected to analysis of variance (ANOVA) procedures using the General Linear Model procedures of SAS (2002). The means among variables that were significant were separated using the Duncan's Multiple Range (DMR) Test.

Table 2

Proximate Composition of Experimental Diet			
SAMPLE	T1	T2	T3
Crude Protein (%)	19.43	19.625	19.835
Ether Extract (%)	3.79	3.865	3.825
Crude Fibre (%)	3.595	3.555	3.52
Ash (%)	5.59	5.46	5.345
Moisture (%)	11.355	11.19	11.135
Gross Energy (Kcal/g)	4.0215	4.031	4.0395
Nitrogen free extract (%)	67.595	67.495	67.475

Results and Discussion

The performance of weaned pig fed different levels of maltodextrin till week 6 is as highlighted in Table 3. At week 6 no significant difference was observed in the body weight, feed intake and weight gain among the treatments. The weight gain were 8.68, 7.24 and 7.75 kg in T1, T2 and T3 respectively at week 6. However, the feed conversion ratio (FCR) significantly differs among the treatments. The group fed with diet containing 500g/tonne maltodextrin (T2) had the significantly ($P<0.05$) highest FCR (4.26) but was not significantly ($P>0.05$) different from group fed with 1kg/tonne maltodextrin, T3 (3.81). The FCR of T2 however, differ significantly ($P<0.05$) from that of T1 fed the control diet (3.62). The FCR of T1 and T3 were however not significantly ($P>0.05$) different. At the 13th week of the study, the result obtained is as indicated in Table 4 showed that the feeding of varying levels of maltodextrin to weaned pigs in this study did not significantly ($P>0.05$) influence all the growth indices measured. The final weights were 33.15, 35.20 and 33.89 kg in T1, T2 and T3 respectively. The average daily feed intake ranged from 1.11 kg in the group fed control diet (T1) and 1.21 kg in T2 fed 0.05 % maltodextrin inclusion in the diet. Pigs in T2 had the highest (4.23) feed conversion ratio (FCR), while the lowest was (4.11) recorded

in the group fed 0.1% maltodextrin inclusion (T3). This corroborates the findings of Hauptli *et al.* (2016) who reported no significant effect of feeding weaner pigs with maltodextrin. Pivetta *et al.* (2014) also reported that the inclusion of maltodextrin on the diet of weaned pigs did not compromise the performance of the pigs but depressed feed intake. The significant difference seen between the FCR of T1 and T2 at week 6 may suggest that feeding maltodextrin may only be useful for a short period postweaning. The reports of O'Doherty *et al.* (2010) and Kim *et al.*, (2010) suggest that maltodextrin improve the performance of weaned pigs from first week of inclusion and was identified to have similar effects with lactose. However, there may be need to ascertain the effect of feeding maltodextrin for longer periods on the performance of the pigs. The thickness of back fat in weaner pig is related to growth and reproductive indices (Roongsitthichai and Tummaruk, 2014). The backfat thickness of pigs fed varying levels of maltodextrin the diet is as shown in Figure 1. The backfat thickness of the weaner pigs were not significantly influence by the inclusion of maltodextrin in the diet. They were 8.50, 10.25 and 9.75 mm in T1, T2 and T3 respectively.

Table 3

Performance of Weaned Piglets Fed Different Levels of Maltodextrin at Week 6				
PARAMETERS	T1	T2	T3	SEM
Initial Weight (kg)	9.50	9.28	9.26	0.91
Final Weight (kg)	18.17	16.52	17.0	1.76
Weight Gain (kg)	8.68	7.24	7.75	0.91
Average Daily Gain (g)	206.60	172.36	184.47	21.6
Feed Intake (kg)	30.83	30.88	29.15	2.94
Average Daily				
Feed Intake (g)	734.10	735.23	721.16	69.97
Feed conversion Ratio	3.62 ^b	4.26 ^a	3.81 ^{ab}	0.10

^{a, b} Means with different superscript across the row are significantly different at $\alpha=0.05$

T1 - Control (Without maltodextrin)

T2 - 500g/tonne maltodextrin inclusion

T3 - 1kg/tonne maltodextrin inclusion

Table 4

Performance of Weaned Piglets Fed Different Levels of Maltodextrin at Week 13				
PARAMETERS	T1	T2	T3	SEM
Initial Weight (kg)	9.50	9.28	9.26	0.91
Final Weight (kg)	33.15	35.20	33.89	2.07
Weight Gain (kg)	23.65	25.30	24.63	1.29
Average Daily Gain (g)	0.26	0.28	0.27	0.02
Feed Intake (kg)	101.20	109.73	102.46	7.63
Average Daily Feed Intake (Kg)	1.11	1.21	1.13	0.08
Feed conversion Ratio	4.20	4.23	4.11	0.17

T1 - Control (Without maltodextrin)
T2 - 500g/tonne maltodextrin inclusion
T3 - 1kg/tonne maltodextrin inclusion

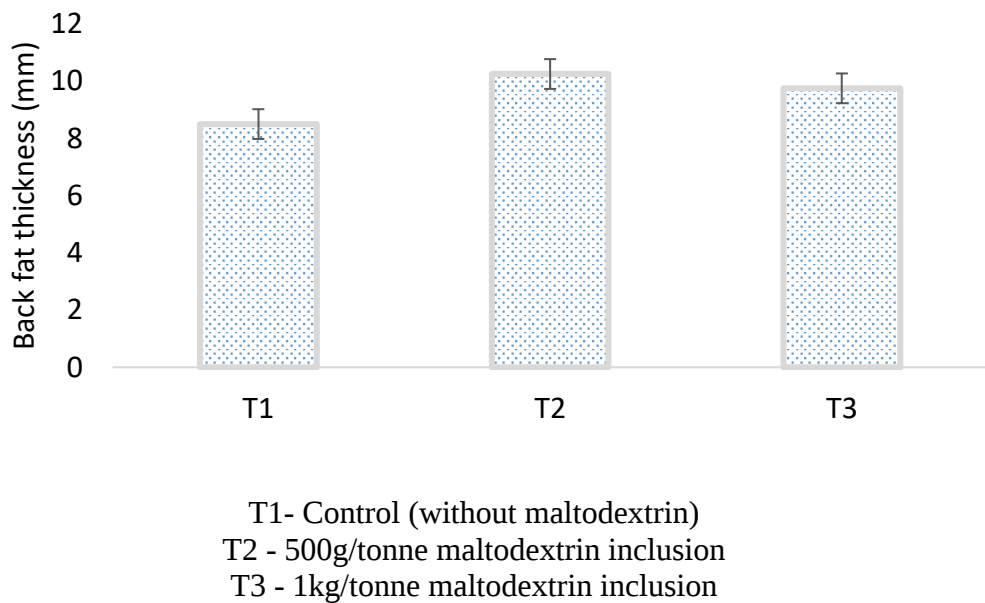


Fig 1: Back fat thickness (mm) of weaner pigs fed varying levels of maltodextrin in the diet.

Haematological and serum biochemical assays play crucial roles in assessing the physiological and health status of animals (Adenkola *et al.*, 2009; Etim, 2014; Koomkrong *et al.*, 2017). The haematology indices of weaner pigs fed varying levels of maltodextrin is as presented in Table 5. No significant ($P>0.05$) effect of the dietary treatments were seen on the haematological indices measured in this study. Similarly, Pivetta *et al.* (2014) that fed maltodextrin at inclusion rate above those in this study reported no significant interaction between diet with maltodextrin and that of fructooligosaccharides for all the haematological parameters measured. Although not significantly ($P>0.05$) notable, maltodextrin had lowering effect on the levels of haematological parameters measured in this study. The packed cell volume (PCV) was 38.00 % in the animals on the control diet (T1), 33.00 % in animals fed 0.5kg/tonne maltodextrin in the diet (T2) while those fed 1kg/tonne maltodextrin in the diet (T3) had 35.33 %.

Haemoglobin ranged from 10.67 to 12.40 g/dL in T2 and T1 respectively. The erythrocyte count also referred to as red blood cell (RBC) were 6.05, 5.23 and 5.80 μL in T1, T2 and T3 respectively. The eosinophils were 4.67, 3.33 and 2.33 % in T1, T2 and T3 respectively. Mean corpuscular haemoglobin concentration (MCHC) reduced from 32.64 g/dL in T1 to 32.32 g/dL in T2 and 31.90 g/dL in T3. Similarly, Mean haemoglobin concentration (MCH) reduced from 20.83 pg in T1 to 20.39 pg in T2 and 19.47 pg in T3. The reducing effect of maltodextrin on the haematological indices especially the packed cell volume, haemoglobin and red blood cells calls for a monitoring in the use of maltodextrin as a reduction below certain levels will suggest anaemia in the piglets. The values obtained for all the haematological indices in this study fall within the normal physiological range of a weaner pig (Merck Manual, 2012).

Table 5

Haematological parameters of weaner pigs fed varying levels of maltodextrin

Parameters	T1	T2	T3	SEM
Packed cell volume (%)	38.00	33.00	35.33	35.44
Haemoglobin (g/dL)	12.40	10.67	11.27	11.44
Erythrocytes Count (μ L)	6.05	5.23	5.80	5.69
Total Leucocytes (μ L)	4400.00	4433.33	4300.00	4377.78
Platelets (μ L)	169666.67	116333.33	103333.33	129777.78
Lymphocytes (%)	49.33	48.33	49.33	49.00
Neutrophils (%)	46.33	45.00	45.33	45.56
Monocytes (%)	3.00	3.33	2.33	2.89
Eosinophil (%)	4.67	3.33	4.33	4.11
MCHC (g/dL)	32.64	32.32	31.90	32.29
MCH (pg)	20.83	20.39	19.47	20.23
Mean cell volume (fL)	63.82	61.02	62.65	62.65

T1 - Control (Without maltodextrin)

T2 - 500g/tonne maltodextrin inclusion

T3 - 1kg/tonne maltodextrin inclusion

MCHC - Mean corpuscular haemoglobin concentration

MCH - Mean corpuscular haemoglobin

The serum biochemicals are important biomarkers which could be suggestive of the impact of external factors such as plane of nutrition on the functionality of tissues, organs and body systems as a whole (Adenkola *et al.*, 2009; Koomkrong *et al.*, 2017). The serum biochemical indices of piglets fed diet containing different inclusion levels of maltodextrin is highlighted in Table 6. The varying inclusion levels of maltodextrin in the diets presented to weaner pigs in this study did not significantly influence the serum biochemical indices assayed in this study except the High density lipoprotein (HDL) cholesterol. HDL was significantly ($P < 0.05$) highest (56.33mg/dL) in T2 fed diet containing 500g/tonne maltodextrin and different from 46.00 and 52.00 mg/dL recorded in T1 and T3 respectively. The level of HDL in the serum increased with inclusion of maltodextrin in this study. The maltodextrin had a hypolipidemic effect (Hassan *et al.*, 2014) on the pigs. This corroborate the report of Inglett and Grisamore (1991) who stated that the inclusion of maltodextrin in the diet has the potential to reduce bad fat (LDL) and increase good fat (HDL). This is made possible by the action of the beta-glucan component of maltodextrin which lowers total blood cholesterol by improving the HDL and lowering the LDL cholesterol (Inglett and Grisamore, 1991). This is beneficial to the health of the pig. The total protein were 7.00, 7.20 and 7.40 g/dl in T1, T2 and T3 respectively. The Alanine aminotransferase increased from 38.97 IU/l in T1 to 39.67 IU/l in

T2 and 40.50 IU/l in T3. The creatine was 0.77mg/dL in T1 and 0.80 mg/dL in both T2 and T3.

Feed cost takes a very huge proportion of the variable cost of production in most livestock enterprises, that is why farmers are always on the look out for cheaper and effective alternatives. Maltodextrin has been identified as cheaper alternative to other expensive carbohydrate sources especially in the diet of weaner pigs (Machado and Carvalho, 2015). The cost-benefit analysis of maltodextrin supplementation in the diet of weaner pigs is as presented in Table 7. The result showed no significant effect ($P > 0.05$) of maltodextrin supplementation on overall cost of feeding. The average cost of feed consumed per day were ₦270.63, ₦293.72 and 274.51 in T1, T2 and T3 respectively. The feed cost per weight gain decreased across the treatments with increasing level of maltodextrin in the diet. Feed cost per weight gain were ₦1,213.03 in diet fed 0 % maltodextrin (T1), ₦1,153.77 in T2 fed 0.05 % maltodextrin and ₦1,120.75 in T3 fed 0.1 % maltodextrin. The cost per weight gain which was estimated to be higher for the control diet (T1) than in the diets supplemented with maltodextrin (T2 and T3) implies that the cost of including maltodextrin in the diet of pigs is beneficial considering that less is spent on feeding to produce a kg of live weight. This is an indication that the inclusion of maltodextrin diet is beneficial cost and health wise.

Table 6

Serum Biochemical Parameters of Weaners Fed Varying Levels of Maltodextrin				
Parameters	T1	T2	T3	SEM
Total protein (g/dL)	7.00	7.20	7.40	0.11
Albumin (g/dL)	2.90	3.07	3.25	0.06
Globulin (g/dL)	4.10	4.13	4.15	0.06
RATIO	0.71	0.74	0.78	0.01
AST (IU/l)	44.00	47.00	47.00	2.58
ALT (IU/l)	38.67	39.67	40.50	1.95
Blood urea nitrogen (mg/dL)	8.43	8.83	8.80	0.12
Creatinine (mg/dL)	0.77	0.80	0.80	0.01
Glucose (mg/dL)	78.33	82.00	84.50	1.52
Total cholesterol (mg/dL)	91.00	93.67	96.50	1.78
High density lipoprotein (mg/dl)	46.00 ^c	56.33 ^a	52.00 ^b	1.14
Triglyceride (mg/dL)	79.00	84.00	81.50	0.87
Low density lipoprotein (mg/dL)	29.20	20.53	28.20	1.57

^{a, b, c} Means with different superscript across the row are significantly different at $\alpha=0.05$

T1 - Control (without maltodextrin)

T2 - 500g/tonne maltodextrin inclusion

T3 - 1kg/tonne maltodextrin inclusion

AST - Aspartate transaminase

ALT - Alanine aminotransferase

Table 7

Cost-Benefit Analysis of Maltodextrin Supplementation in Diet of Weaner Pigs				
Parameters	T1	T2	T3	SEM
Cost of feed per kg (₦/Kg)	243.36	243.58	243.8	0.06
Total cost of feeding (₦)	24626.95	24626.96	24980.82	1857.51
Average Daily Feed Intake (Kg)	1.11	1.21	1.13	0.08
Average cost of feed/day (₦)	270.63	293.72	274.51	20.41
Feed conversion Ratio	4.20	4.23	4.11	0.17
Feed Cost/Weight Gain (₦/Kg)	1021.30	1029.53	1001.75	40.82

T1 - Control (Without maltodextrin)

T2 - 500g/tonne maltodextrin inclusion

T3 - 1kg/tonne maltodextrin inclusion

Dollar to Naira- \$1 = ₦403

Conclusion

The inclusion of maltodextrin in the diet of weaned pigs did not negatively influence the growth, back fat thickness and health status of the pigs. Maltodextrin had a hypolipidism effect on the pigs by increasing the high density lipoprotein (HDL) and reducing the low density (LDL). Its inclusion also improved the cost per weight of the gain of the pigs. Thus, maltodextrin can be added up to 0.1% in the diet of pigs in the tropics.

Acknowledgement: The authors appreciate the management and staff of AK Research Farm, Eleyele, Ibadan, Nigeria for their assistance and contributions to this research work.

References

1. A.O.A.C. (2010). Official Methods of Analysis. 18th edition (W. Horwitz Editor). Association of Official Analytical Chemists. Washington, DC. pp 1094.
2. Adenkola, A. Y., Ayo, J. O., Sackey, A. K. B. and Adelaiye, A. B. (2009). Haematological and serum biochemical changes in pigs administered with ascorbic acid and transported by road for four hours during the harmattan season. J. Cell Anim. Biol, 3(2), 21-28
3. Augusto, R. M. N., Berto, D. A., Lo Tierzo, V., Mello, G., Hauptli, L. and Lucchesi, L. (2011). Maltodextrina em rações de leitões desmamados com diferentes pesos: desempenho e morfometria intestinal. Acta Scientiarum: Animal Sciences, Maringá, 33(1): 41-46.
4. Berrocoso, J. D., Serrano, M. P., Cámara, L., Rebollar, P. G., and Mateos, G. G. (2012). Influence of diet complexity on productive performance and nutrient digestibility of weanling pigs. Animal Feed Science and Technology, Amsterdam, v. 171, n. 2-4, p. 214-222.
5. Boudry, G., Péron, V., Le Huerou-Luron, I., Lalles, J. P., and Seve, B. (2004). Weaning induces both transient and long-lasting modifications of absorptive, secretory, and barrier properties of piglet intestine. The Journal of nutrition, 134(9), 2256-2262.
6. Etim, N. N., Williams, M. E., Akpabio, U., and Offiong, E. E. (2014). Haematological parameters and factors affecting their values. Agricultural Science, 2(1), 37-47.
7. Fortin, A., Sim, D. W., & Talbot, S. (1980). Ultrasonic measurements of backfat thickness at different locations and positions on the warm pork carcass and comparisons of ruler and ultrasonic procedures. Canadian journal of Animal Science, 60(3), 635-641.

8. Hauptli, L., Berto, D. A., Lo Tierzo, V., Augusto, R. M., Saleh, M. D., & Trindade Neto, M. A. D. (2016). Maltodextrine and oil in the diet of weaned piglets. *Bol. Ind. Anim, Nova Odessa* 73(4), 339-346.
9. Hassan, A. M., Khalil, M. M., El-Gammal, R. E. and El Sherbini, Y. I. (2014). Chemical, physical and biological characteristics of low fat beef burger with maltodextrin. *Journal of Food and Dairy Sciences*, 5(11), 795-811.
10. Heo, J. M., Opapeju, F. O., Pluske, J. R., Kim, J. C., Hampson, D. J., and Nyachoti, C. M. (2013). Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhoea without using in-feed antimicrobial compounds. *Journal of animal physiology and animal nutrition*, 97(2), 207-237.
11. Inglett, G. E. and Grisamore, S. B. (1991). Maltodextrin fat substitute lowers cholesterol. *Food technology (USA)*.
12. Jiang XiaoBing, J. X., Zhang Liang, Z. L., Chen SiQing, C. S., Wang KeTian, W. K., Chen ZhuPing, C. Z., Chen Lei, C. L., Wang JinYong, W. J. and Zhu Li, Z. L. (2014). Ultrasound measurement of backfat thickness and longissimus muscle area in live swine: effects of equipment, personnel and pigs pose.: *Journal of Animal and Veterinary Advances*, 13(8). 506-513
13. Katouzian, I. Motamedzadegan, A. and Dane-shi, M. (2015) The effect of adding sucralose and maltodextrin on the rheological, physical, chemical and sensory properties of pastry cream. *Journal of food processing and preservation* 8(1): 23 - 40 .
14. Kidder, D. E., and Manners, M. J. (1980). The level and distribution of carbohydrases in the small intestine mucosa of pigs from 3 weeks of age to maturity. *British journal of nutrition*, 43(1), 141-153.
15. Kim, J. S., Shinde, P. L., Yang, Y. X., Yun, K., Choi, J. Y., Lohakare, J. D., and Chae, B. J. (2010). Effects of dietary lactose levels during different starter phases on the performance of weaning pigs. *Livestock Science*, 131(2-3), 175-182.
16. Koomkron, N., Boonkaewwan, C., Laenoi, W. and Kayan, A. (2017). Blood haematology, muscle pH and serum cortisol changes in pigs with different levels of drip loss. *Asian-Australasian journal of animal sciences*, 30(12), 1751.
17. Machado, C. A., and Carvalho, L. S. S. (2015). Maltodextrin in animal feed. *Revista Portuguesa de Ciências Veterinárias*, 110(593/594), 14-16.
18. Mahan, D. C., and Newton, E. A. (1993). Evaluation of feed grains with dried skim milk and added carbohydrate sources on weanling pig performance. *Journal of Animal Science*, 71(12), 3376-3382.
19. Merck Manual (2012). Haematologic reference ranges. *Mareck Veterinary Manual*. Retrieved from <http://www.merckmanuals.com/>
20. National Research Council. (2012). *Nutrient requirements of swine*, 11th edn. Washington, DC, USA: National Academies Press.
21. O'Doherty, J. V., Dillon, S., Figat, S., Callan, J. J., and Sweeney, T. (2010). The effects of lactose inclusion and seaweed extract derived from *Laminaria* spp. on performance, digestibility of diet components and microbial populations in newly weaned pigs. *Animal feed science and technology*, 157(3-4), 173-180.
22. O'Doherty, J. V., Nolan, C. S., and McCarthy, P. C. (2005). Interaction between lactose levels and antimicrobial growth promoters on growth performance of weanling pigs. *Journal of the Science of Food and Agriculture*, 85(3), 371-380.
23. Oliver, W. T., Mathews, S. A., Phillips, O., Jones, E. E., Odle, J., and Harrel, R. J. (2002). Efficacy of partially hydrolyzed corn syrup solids as a replacement for lactose in manufactured liquid diets for neonatal pigs. *Journal of Animal Science*, Champaign, v. 80, n. 1, p.143-153.
24. Pivetta, M. R., Berto, D. A., Amorim, A. B., Saleh, M. A. D., Pinheiro, D. F., Paulino, M. D. L. M. V., and Gonçalves, H. C. (2014). Use of maltodextrin and a prebiotic in the feed of weaned piglets. *Semina: Ciências Agrárias*, 35(4), 2129-2145.
25. Pluske, J. R., Pethick, D. W., Hopwood, D. E., & Hampson, D. J. (2002). Nutritional influences on some major enteric bacterial diseases of pig. *Nutrition research reviews*, 15(2), 333-371.
26. Pluske, J., Le Didovich, J. and Verstegen, M. (2003). Introduction. In *Weaning the pig – concepts and consequences*, Wageningen Academic Publishers, The Netherlands. pp. 15–16.
27. Roongsitthichai, A. and Tummaruk, P., (2014). Importance of backfat thickness to reproductive performance in female pigs. *The Thai Journal of Veterinary Medicine*, 44(2), pp.171-178
28. SAS, 2002. *Statistical Analysis software*, Version 9.0. SAS Institute Incorporation, Cary, NC, USA.
29. Solà-Oriol, D., Roura, E., and Torrallardona, D. (2009). Feed preference in pigs: Effect of cereal sources at different inclusion rates. *Journal of Animal Science*, 87(2), 562-570.
30. Spreeuwenberg, M. A. M., Verdonk, J. M. A. J., Gaskins, H. R., and Verstegen, M. W. A. (2001). Small intestine epithelial barrier function is compromised in pigs with low feed intake at weaning. *The Journal of nutrition*, 131(5), 1520-1527.
31. Takeiti, C. Y., Kieckbusch, T. G., and Colares-Queiroz, F. P. (2010). Morphological and physicochemical characterization of commercial maltodextrins with different degrees of dextrose-equivalent. *International Journal of Food Properties*, 13(2), 411-425.
32. Victory, G. O., Oyewole, A. L., and Olaitan, A. A. (2022). Climate-Smart Agricultural Practices at Oyo State-Nigeria. *South Asian Journal of Social Review (ISSN: 2958-2490)*, 1(1), 1-7.
33. Williams, I. H. (2003). *Growth of the weaned pig. Weaning the pig: concepts and consequences*, Wageningen Academic Publishers, The Netherlands. pp. 17–31.

COMPUTER SCIENCES

STEP-BY-STEP GREEDY ALGORITHMS WITH RESPECT TO WALSH SYSTEM

Episkoposian S.,

*Faculty of Applied Mathematics and Physics,
National Polytechnic University of Armenia*

Grigoryan S.

*Faculty of Applied Mathematics and Physics,
National Polytechnic University of Armenia*

DOI: [10.5281/zenodo.11624303](https://doi.org/10.5281/zenodo.11624303)

Abstract

This paper proposes a modified step-by-step "greedy" algorithm for approximating functions with respect to Walsh system. This algorithm works iteratively, adding the next largest coefficient at each step and evaluating the approximation error. The paper describes the algorithm, its Python implementation, and examples of its application to test functions.

Keywords: greedy algorithm, Walsh system, Walsh-Fourier coefficients.

1. Introduction

The expansion of functions in systems of basis functions is a fundamental problem in various areas of mathematics and its applications. One widely used basis is the Walsh-Fourier system, based on Rademacher functions and their products. Efficient function expansions in the Walsh basis have important applications in signal processing, data compression, approximation theory, and other fields.

The classic method for constructing function approximations is the Fourier series truncation method, where the first N terms of the expansion are kept. However, this approach is not always optimal, as achieving good approximation accuracy may require a significant number of expansion terms. An alternative approach is the so-called "greedy" algorithms, which select the expansion terms not in the order of their appearance, but in the order of decreasing their weights (coefficients). This method often provides faster convergence for the same number of series terms.

This paper proposes a modified step-by-step "greedy" algorithm for approximating functions in the Walsh-Fourier system [1,2]. The classical "greedy" algorithm selects a fixed number n of the largest absolute Walsh-Fourier coefficients to approximate the function. However, this approach is not always optimal in terms of accuracy for a given number of series terms. The proposed algorithm works iteratively, adding the next largest coefficient at each step and evaluating the approximation error. The process stops once the error becomes less than a specified threshold ε . This allows achieving the required accuracy with a minimal number of series terms. The paper describes the algorithm, its Python implementation, and examples of its application to test functions. The results demonstrate that the modified "greedy" algorithm can provide more efficient approximations compared to the classical method and partial Fourier approximation when reaching the required level of accuracy.

2. Step-by-step "greedy" algorithm with respect to Walsh system

To define the Walsh function, it is necessary to define the Rademacher function [1].

Definition 1. The Rademacher system is defined as

$$r_0(x) = \begin{cases} 1, & x \in \left[0, \frac{1}{2}\right), \\ -1, & x \in \left[\frac{1}{2}, 1\right], \end{cases}$$

$$r_0(x+1) = r_0(x), r_k(x) = r_0(2^k x), k = 1, 2, \dots,$$

i.e. to find the r_k Rademacher function, the interval $[0; 1)$ is split 2^{k+1} of equal subintervals, on each of which the $r_k(x)$ function takes $+1$ and -1 values successively.

The Walsh system is defined as all possible finite products of Rademacher functions. More precisely, we define the Walsh system by Paley numbering as follows [2,3]:

Definition 2. $W_0(x) \equiv 1$. Let n be any natural number, represented as $n = \sum_{s=1}^k 2^{m_s}$, $m_1 > m_2 > \dots > m_s$. The n -th Walsh function will be defined as follows:

$$W_n(x) = \prod_{s=1}^n r_{m_s}(x).$$

The function $f(x)$ is given. Let us denote its Fourier-Walsh n -th partial sum as follows:

$$S_n(x) = \sum_{k=0}^{n-1} C_k(f) W_k(x),$$

where $C_k(f) = \int_0^1 f(t) W_k(x) dx$ are the Fourier-Walsh coefficients of the function $f(x)$.

The greedy algorithms ([4]) with respect to Walsh system defined the following way.

Let's arrange the coefficients $\{C_k(f)\}$ in descending order of their absolute values, as follows:

$$|C_{\sigma(0)}(f)| > |C_{\sigma(1)}(f)| > \dots > |C_{\sigma(n)}(f)|$$

and consider the greedy approximant of the function $f(x)$. Let's designate it as follows:

$$G_n(x) = \sum_{k=0}^{n-1} C_{\sigma(k)}(f) W_{\sigma(k)}(x):$$

It's known that the greedy algorithm, for example, for the Walsh system, is not always optimal ([5,6]).

In particular, we have shown that for example $f(x) = x^5$,

$$A = |f(x) - S_{50}(x)| = 0.0410837068979848,$$

and

$$B = |f(x) - G_6(x)| = 0.0530793301723754.$$

Thus, we find that $A < B$.

Now let's modify the algorithm by implementing a "greedy" approach with sequential steps. Our objective is to develop a "greedy" algorithm with incremental steps of arbitrary precision.

First, we fix an arbitrary number $\varepsilon > 0$. If $|f(x) - G_n(x)| < \varepsilon$, then the process halts, and the value of ε should be decreased.

We select from the sequence $\{C_k(f)W_k(f)\}$ the term $C_{\sigma(0)}(f)W_{\sigma(0)}(x)$ for which

$$|C_{\sigma(0)}(f)| = \max_{0 \leq k \leq n} |C_k(f)|,$$

and we estimate

$$|f(x) - C_{\sigma(0)}(f)W_{\sigma(0)}(x)|.$$

We verify the following condition:

$$|f(x) - C_{\sigma(0)}(f)W_{\sigma(0)}(x)| < \varepsilon \quad (1)$$

If the condition (1) is satisfied, then we compute the difference

$$|f(x) - G_n(x)| - |f(x) - C_{\sigma(0)}(f)W_{\sigma(0)}(x)|,$$

and the process halts.

If condition (1) is not met, then we define

$$f_1(x) = f(x) - C_{\sigma(0)}(f)W_{\sigma(0)}(x).$$

Now we select $C_{\sigma(1)}(f)W_{\sigma(1)}(x)$ and create the difference

$$|f_1(x) - C_{\sigma(1)}(f)W_{\sigma(1)}(x)|.$$

Let's reevaluate:

$$\begin{aligned} &|f_1(x) - C_{\sigma(1)}(f)W_{\sigma(1)}(x)| \\ &= |f(x) \\ &\quad - C_{\sigma(0)}(f)W_{\sigma(0)}(x) \\ &\quad - C_{\sigma(1)}(f)W_{\sigma(1)}(x)| \\ &< \varepsilon \end{aligned} \quad (2)$$

Again, if condition (2) is fulfilled, the process halts, and we calculate:

$$|f(x) - G_n(x)| - |f_1(x) - C_{\sigma(1)}(f)W_{\sigma(1)}(x)|:$$

And if condition (2) does not occur, then we continue the process for the function:

$$f_2(x) = f_1(x) - C_{\sigma(1)}(f)W_{\sigma(1)}(x)$$

We continue this process until it stops at any step, meaning we will have

$$|f_k(x) - C_{\sigma(k)}(f)W_{\sigma(k)}(x)| < \varepsilon,$$

and then calculate the difference

$$|f(x) - G_n(x)| - |f_k(x) - C_{\sigma(k)}(f)W_{\sigma(k)}(x)|.$$

And if the process continues until reaching n , then we conclude that the outcome of the "greedy" algorithm with successive steps is equivalent to the outcome of the complete "greedy" algorithm.

The algorithm was implemented using a Python program. It takes inputs such as M (for the partial Fourier-Walsh sum calculation), n (for the complete "greedy" algorithm calculation), ε (precision level), and $f(x)$ (the function under consideration) data.

3. Code in Python

```
from scipy.linalg import hadamard
import sympy as sp
```

```
# Symbolic variable
```

```
x = sp.symbols('x')
```

```
M=int(input("Enter M number: "))
```

```
n = int(input("Enter n number for Greedy: "))
```

```
E=float(input("Enter epsilon: "))
```

```
# User input for the expression
```

```
user_input = input("Enter a mathematical expres-
sion in terms of 'x': ")
```

```
# Parse the user input into a SymPy expression
```

```
expr = sp.sympify(user_input) #function
```

```
def generate_x_values(M):
```

```
    return [k/M for k in range(M+1)]
```

```
x_values = generate_x_values(M)
```

```
#define Walsh
```

```
c_index=M # initial index
```

```
N = 1
```

```
N_check = 0
```

```
binary_length = 0
```

```
d_bool = False
```

```
while N_check < M:
```

```
    N = N * 2
```

```
    binary_length += 1
```

```
    if M > 0 and (M & (M - 1)) == 0:
```

```
        d_bool = True
```

```
        M += 1
```

```
    if M == 1:
```

```
        d_bool = False
```

```
    N_check = N
```

```
step_size = 1 / N
```

```
step_sizes = [i * step_size for i in range(N + 1)]
```

```
hadamard_matrix = [hm for hm in hadamard(N)]
```

```
def index_convert(N, l):
```

```
    walsh_index = []
```

```
    for i in range(N):
```

```
        decimal_number = i
```

```
        desired_length = l
```

```
        binary_number = format(decimal_number,
f"0{desired_length}b")
```

```
        reversed_code = binary_number[::-1]
```

```
        walsh_index.append(int(reversed_code, 2))
```

```
    return walsh_index
```

```
walsh_index = index_convert(N, binary_length)
```

```
walsh_function = [hadamard_matrix[i] for i in
walsh_index]
```

```
M=c_index
```

```
def calculate_coefficients(integrated_expr,
step_sizes, walsh_function, c_index):
```

```
    differences = []
```

```
    for interval_start, interval_end in
zip(step_sizes[:-1], step_sizes[1:]):
```

```
        integrated_value_start = inte-
grated_expr.subs(x, interval_start)
```

```
        integrated_value_end = inte-
grated_expr.subs(x, interval_end)
```

```

        difference = float(integrated_value_end - integrated_value_start)
        differences.append(difference)

        coefficients = []
        for c in range(c_index + 1):
            c_list = [diff * walsh for diff, walsh in zip(differences, walsh_function[c])]
            coefficient = sum(c_list)
            coefficients.append(coefficient)

        return coefficients

    integrated_expr = sp.integrate(expr, x)
    coefficients = calculate_coefficients(integrated_expr, step_sizes, walsh_function, c_index)
    sorted_c=sorted(coefficients,key=lambda x: abs(x), reverse=True)#decreasing order

    def get_f_for_x(x_values, step_sizes, w):
        w_x = []
        for i, x in enumerate(x_values):
            for j in range(len(step_sizes) - 1):
                if step_sizes[j] <= x < step_sizes[j + 1]:
                    w_x.append(w[j])
                    break
            else:
                w_x.append(w[-1])
        return w_x

    f_x=[]
    for j in range(M+1):
        expr_value = expr.subs(x, x_values[j])
        f_x.append(expr_value)

    def calculate_cw(coefficients, walsh_function, M, N):
        c_w = []
        for j in range(M+1):
            c_w_values = []
            for i in range(N):
                c_w_values.append(coefficients[j] * walsh_function[j][i])
            c_w.append(c_w_values)
        return c_w

    c_w = calculate_cw(coefficients, walsh_function, M, N)
    sorted_cw=calculate_cw(sorted_c,walsh_function,M,N)

    c_w = []
    walsh_values_in_x = []
    sorted_c_w_in_x=[]
    for i in range(M+1):
        w_x = get_f_for_x(x_values, step_sizes, walsh_function[i]) #Values of w_i(x)
        cw_x=get_f_for_x(x_values,step_sizes,sorted_cw[i])
        walsh_values_in_x.append(w_x)
        sorted_c_w_in_x.append(cw_x)
    transposed_sorted_cw_x = [[row[i] for row in sorted_c_w_in_x] for i in range(N)]

```

```

    range(len(sorted_c_w_in_x[0]))] # cw(0),...cw(1), cw(1)

    sigma = []
    s=[] #for fourier M
    for row in transposed_sorted_cw_x:
        row_sum = sum(row[:n+1])
        sum_fourier=sum(row[:M+1])
        sigma.append(row_sum)
        s.append(sum_fourier)

    #greedy normal
    a=[]
    for i in range (M+1):
        fs=abs(f_x[i]-sigma[i])
        a.append(fs)
        B=sum(a)/len(a)

    #Fourier
    fourier=[]
    for i in range (M+1):
        four=abs(f_x[i]-s[i])
        fourier.append(four)
        A=sum(fourier)/len(fourier)

    #greedy step by step
    b=[]
    b_without_abs=[]
    f_k=[]
    greedy_step=0
    t=False
    while t==False:
        while t==False:
            for i in range(n+1):
                for j in range(M+1):
                    b_i_without_abs=f_x[j]-sorted_c_w_in_x[i][j]
                    b_i=abs(f_x[j]-sorted_c_w_in_x[i][j])
                    b.append(b_i)
                    b_without_abs.append(b_i_without_abs)

            greedy_step+=1
            GS=sum(b)/len(b)

            if b_i<E:
                t=True
                break
            else:
                f_x=b_without_abs
                b=[]
                b_without_abs=[]
                t=False

        break

    print("Greedy Normal Form=",B)
    print("Greedy step by step=",GS)
    print("Fourier approximation=",A)
    print("steps=",greedy_step)
    The results of the algorithm are then presented in the following format:

```

Example 1.

$$M = 50,$$

$$n = 20,$$

$$\varepsilon = 0.13,$$

$$f(x) = x$$

$$\text{Greedy Normal Form} = 0.0702512254901961$$

$$\text{Greedy step by step} = 0.0638235294117647$$

$$\text{Fourier approximation} = 0.0702512254901961$$

step=3, where 'step' indicates in which steps the algorithm performed the approximation with the accuracy ε .

Example 2.

$$M = 80,$$

$$n = 60,$$

$$\varepsilon = 0.1,$$

$$f(x) = x^8$$

$$\text{Greedy Normal Form} = 0.0451854271375904$$

$$\text{Greedy step by step} = 0.0451854271375904$$

$$\text{Fourier approximation} = 0.0453110690028777$$

In this example, the values of Greedy Normal Form and Greedy step by step are identical, which means that the "greedy" algorithm with successive steps continued the calculations until completion, reaching n , and as a result matched the outcome of the full "greedy" algorithm.

Conclusion

In this paper, we proposed a modified step-by-step "greedy" algorithm for approximating functions in the

Walsh basis with arbitrary precision. The classical "greedy" algorithm fixes the number of expansion terms, which is not always optimal in terms of approximation accuracy. The proposed algorithm works iteratively, adding terms until the required accuracy is achieved. The Python implementation and examples demonstrate that this approach can provide more efficient approximations compared to classical methods when reaching a given accuracy level. Future work will investigate the convergence and error estimates for the modified algorithm.

References

1. Rademacher H., Einige Sätze über Reihen von allgemeinen Orthogonalfunktionen, Math. Ann., 1922, v. 87, no. 1–2, p. 112 – 138.
2. Walsh J., A Closed Set of Normal Orthogonal Functions, Amer. J. Math., 1923., v. 45. p. 5 – 24.
3. Paley R., A Remarkable Series of Orthogonal Functions, Proc. Lond. Math. Soc. 1932, v. 34, p. 241 – 279.
4. Temlyakov, V.N., Greedy approximations, Cambridge University Press, 2011
5. Episkoposian S.A., On the divergence of Greedy algorithms with respect to Walsh subsystems in L^1 , Nonlinear Analysis: Theory, Methods & Applications, v. 66, n. 8, 2007, p. 1782-1787.

SMART HOME TECHNOLOGY AND TRENDS IN LIVING SPACE TRANSFORMATIONS

Manafov E.,*Doctoral student***Sardarova I.***Academic supervisor, PhD, Assoc. Prof.**Department of Electronics and automation,**Azerbaijan State Oil and Industry University**Baku, Azerbaijan*DOI: [10.5281/zenodo.11624311](https://doi.org/10.5281/zenodo.11624311)**Abstract**

The improvement of management systems has opened the gate for complex automation of processes. Nowadays, technologies are developing. Similar results are also used in the smart control systems applied in houses and other buildings. In recent years, innovations in the technologies, the development process in automation systems allow to use devices faster and more productive and flexible.

Modernization of management systems in our time has led to complex mechanization and automation of production processes. By applying new and modern progressive methods, the intensification of production is ensured, thus, the quality indicator of the produced product is improved. Such achievements are also used in intelligent management systems applied in buildings. Today, technology is constantly developing. Of course, the development of technologies plays a big role in people's lives. We are living in such a time that before, "This cannot be realized, it is impossible to do." Projects using sentences like these are very easy to implement nowadays. Innovations that have happened in the field of technology in recent years, of course, have an impact on us. The development process in mechatronic systems makes it possible to use devices with faster and larger capacities. Technologies are evolving today. The results of technological development are also used in smart control systems applied in homes and other buildings. In recent years, innovations in technologies, the development process in automation systems allow using devices faster, more productively and flexibly.

The level of development in smart homes did not happen by itself. All innovations first take place within society and are shaped by the influence of trends within society. Also, with the use of special technologies to increase the value of smart homes, it is also aimed at improving the smart home environment.

A smart home is a home equipped with technological solutions designed to provide services that meet people's needs. The purpose of this article is to systematically evaluate the latest smart home literature and review research and developments in the living space and smart technologies transformations. In addition to providing an overview of the development and performance of current smart home systems and this paper provides detailed information on the latest equipment and systems.

Keywords: smart systems, sensors, electronic systems, automation, smart transformation.

The Smart Home - technology of the century. It integrates many new technologies through home networks to improve the quality of human life. Smart home commerce has attracted the attention of researchers for over a decade. Smart home technology is a combination of networks and services. In recent years, the term "smart" has become synonymous with any technology that has some level of artificial intelligence. The ability to collect information from the environment and react accordingly is a critical feature of smart technologies. Smart technology has become the main driver of innovative ideas such as the smart home system. With the development of smart products and services, the world has witnessed an increase in device interaction and data sharing, which has influenced the rapid development of smart home technologies worldwide. Due to the advantages provided by smart technologies and the possible large global market, interest in smart home technologies among researchers has increased dramatically.

In the field of home automation and control, the smart home has become a very promising sector. The term "smart home" is not limited to human residences. Rather, it has broader technological implications, including smart housing and living.

A smart home is a home equipped with technological solutions designed to provide services that meet people's needs. The purpose of this article is to systematically evaluate the latest smart home literature and review research and developments in the sensors types and security systems field. In addition to providing an overview of the development and performance of current smart home systems and this paper provides detailed information on the latest equipment and systems. Details of the by smart home management system components provided and its advantages pointed in the article.

Smart technologies are currently developing rapidly. We understand a certain concept of a computer network that connects various devices into a network; these devices interact and are able to exchange information offline without human intervention or with minimal participation. Now Smart technologies used in the industrial sector, the so-called B2B (business to business) technologies, and in the B2C (business to consumer) consumer sector. One of the striking examples of the use of technology in the space of everyday practices can be the concept of a "smart home" - a house within which the technology of interconnected "smart" things is used, which are part of the internal and exter-

nal home spaces. Such a “smart home” is a self-regulating system containing a number of subsystems: microclimate subsystems, subsystems for lighting and regulation of the operation of electronic devices; within the framework of a “smart home” a “smart refrigerator” can operate, equipped with devices with artificial intelligence, which can analyze the consumption of certain products, their stock and consumption dynamics. You can also include a security system here. It must be said that the concept of a “smart home” presupposes, on the one hand, devices that can operate autonomously in a systemic unity, on the other hand, a “house”, which is, as a rule, a separate building, they are conveniently and rationally designed, taking into account the possibility of using smart technologies. The purpose of this work is to highlight and consider some trends in the transformation of living space within the framework of smart home technology.

After analyzing some changings home space in relation to smart home technology, some trends are visible as follows:

The first trend is the increasing functionality of the home and home spaces. Configuration of living space reflects social realities is an opportunity for customized home design, taking into account both design and aesthetic imperatives, which can be unique, and functional and technological solutions. Of course, it is worth saying that we are talking about the premium segment of houses and corresponding solutions which are not available to all segments of the population, even if we take into account residents of large cities. Researchers note that only laying the necessary cables and sensors is comparable in the cost of purchasing a good class car. The popularity of individual design solutions, loft design (mainly in urban environments), regarding interior design of space is increasing. Some producing companies even say that such design correlates with the lifestyle of single people and married couples without children, as opposed to traditional design and architectural solutions of the industrial era, designed for the traditional family. As a rule, loft design involves technological equipment. It is logical to assume that smart home technologies will focus on this kind of solutions, although a traditional house, without large internal “empty spaces,” is also relevant for the implementation of the smart home technologies. The individualized design of a modern home, which applies to both the premium segment and more budget options, represents the trend of customizing a home, and many areas of life of a modern person. By customization we mean a certain trend which appeared as part of marketing strategies, it is associated with the development of personalized products and services aimed at specific customers.

Customization may imply the opportunity for the consumers themselves to participate in the creation of a product in terms of developing its features, design in a broad sense, or personalized service. It is clear that solutions in the field of the Internet of Things, such as “multi-home” technologies, require customization, since it is impossible to unify the needs and features of a home (especially when it comes to the premium segment and a separate house). In addition, customization will also concern the ability to create interior elements,

furniture and, probably, integrate them with devices within the “smart home” system (sensors, drives and other elements can already be purchased). Moreover, it is even possible to print building elements for a house and create the house itself using a 3D printer (here, of course, questions arise about the reliability of parts and their technical characteristics, compliance with building codes and regulations). It is possible that such a practice, focused on functionality and decentralized customized production, will seriously change the contours of the socio-economic system, and the very attitude towards consumption throughout society.

So, highlighted aspects of increasing the importance of the functional component of the space of the house, customization and the possibility of autonomous creation of elements of the home space.

As for the trend towards autonomy, it also applies to the devices themselves within the framework of the “smart home” concept. For example, there are already sensor networks that implement “smart dust” technology. “Smart dust” is a collection of miniature sensors with computing and wireless communication capabilities, in addition, these elements have memory for data storage and special sensitive elements for environmental analysis. These elements are comparable in size to sand grains. Each element, or “mote” (speck of dust), can have its own sensors, power supply, communication and computing node. Such motes can group together and create flexible and mobile networks, consuming a small amount of energy. “Smart dust” can be used in climate control systems and multimedia environments in the “smart home” space.

Conclusion

So, trends are identified in autonomization and increased functionality in various aspects of smart home technology. These trends echo the general vector of development of the technical and information universe in which modern people live. As information technologies develop, these trends will intensify—customization of various spheres and practices, strengthening of their functional potential, at the same time as “smarter”, autonomization at various levels. All this will concern the development of the home environment of the “smart home”, which can turn into something different compared to the current home space (if we understand the home space as a set of everyday practices). It is possible that the very principle of autonomy and autonomization of the elements of the house in its correlation with the expansion of the “computational potential” of things and objects will give rise to some new contours of human living space.

References

1. Arduino Smart Home Automation by Alan Trevennor was published in 2013. It was officially published by Apress and has the ISBN: 1430257709.
2. The Smart Smart Home Handbook: Control Your Home with Your Voice by Adam Juniper (2018) It was officially published by Ilex Press and has the ISBN: 1781575800.
3. Smart home Complete Self-Assessment Guide by Gerardus Blokdyk was published in 20180105. It

was officially published by Emereo and has the ISBN: 1489195637.

4. Harper, R. (2003). Inside the Smart Home. London: Springer.

5. Burkhard, S., & Bouée, C.-E. (2013). Home Automation Solutions

6. Stefen Robs, Programmable Logic Controller (PLC) Tutorial, Siemens Simatic S7-200, 2007

7. Madhuchhanda Mitra, Industrial Automation an Introduction, 2005

8. Con Veb. Principles and Applications, 1988

9. Stefen Tub, (PLC) Tutorial: Circuits and Programs, 2005

10. Harry Enderson, PLC Programming Using RSLogix 500: Basic Concepts of Ladder Logic, 2015

11. Khaled Kamel, Industrial Controllers, 2013

МОБИЛЬНЫЕ МЕДИЦИНСКИЕ ПРИЛОЖЕНИЯ В ЦИФРОВИЗАЦИИ ЗДРАВООХРАНЕНИЯ**Курбанова Н.Г.***Кандидат технических наук,
доцент кафедры медицинской и биологической физики
Азербайджанский Медицинский Университет***Гаджиев З.А.***Кандидат технических наук,
ассистент кафедры медицинской и биологической физики
Азербайджанский Медицинский Университет***Абдуллаева Г.А.***Кандидат технических наук,
ассистент кафедры медицинской и биологической физики
Азербайджанский Медицинский Университет***MOBILE MEDICAL APPLICATIONS IN DIGITALIZATION OF HEALTHCARE****Gurbanova N.,***Ph.D, assistant of professor, department "Medical and biological physics",
Azerbaijan Medical University***Hajiyev Z.,***Ph.D, assistant, department "Medical and biological physics",
Azerbaijan Medical University***Abdullayeva G.***Ph.D, assistant, department "Medical and biological physics",
Azerbaijan Medical University*DOI: [10.5281/zenodo.11624332](https://doi.org/10.5281/zenodo.11624332)**Аннотация**

В современном мире многие люди активно пользуются мобильными приложениями. За последние годы разработки в сфере здравоохранения внесли большой вклад в рост мобильных приложений. Многие из которых работают в режиме оффлайна и позволяют пользователям отслеживать свое здоровье, физическую активность, сон, пульс, артериальное давление, уровень сахара в крови и другие параметры. Цифровизация здравоохранения требует от медицинских мобильных приложений стать частью единой медицинской экосистемы.

Abstract

In the modern world, many people actively use mobile applications. Developments in the healthcare sector have contributed greatly to the growth of mobile apps in recent years. Many of which work offline and allow users to track their health, physical activity, sleep, pulse, blood pressure, blood sugar and other parameters. Digitalization of healthcare requires medical mobile applications to become part of a unified healthcare ecosystem.

Ключевые слова: мобильные медицинские приложения, электронный рецепт, цифровизация здравоохранения, медицинская экосистема.

Keywords: mobile medical applications, electronic prescription, digitalization of healthcare, healthcare ecosystem.

Цифровизация сферы здравоохранения жизненная необходимость современности, которая направлена на повышение эффективности и ответственности оказания медицинской помощи за счет применения инновационных подходов. Целью цифрового здравоохранения является объединение медицинских данных в рамках единой цифровой платформы, анализ которых позволит обеспечить высокий уровень качества медицинских услуг и заботу о здоровье населения. Анализ медицинских данных граждан, накапливаемых в течение всего жизненного цикла, позволяет лучше понять причину заболевания, поставить точный диагноз и обеспечить наиболее правильное лечение. Например, в сфере радиологии данные и алгоритмы искусственного интеллекта являются незаменимым инструментом диагностирования заболеваний на

самой ранней стадии. Анализ больших данных позволяет выстраивать модели оптимизации процессов, предотвращения распространения пандемий и улучшения качества здоровья и продолжительности жизни [4, 5].

В стратегии цифрового здравоохранения основной задачей является формирование единой экосистемы медицинских данных, объединяющей все медицинские учреждения страны и обеспечение непрерывного доступа к этим данным со стороны медицинского персонала. Что позволит им в принятии решений в процессе диагностирования заболеваний и назначении наиболее эффективных методов лечения. Основным источником данных будет реестр под названием «Медицинский цифровой двойник гражданина», в котором будет отражена вся информация о здоровье - медицинские истории,

диагнозы, методы лечения, результаты анализов и радиологии, назначения рецептов, анамнестическая история о генетической предрасположенности к заболеваниям с момента идентификации факта беременности во время обращения матери в медицинское учреждение до момента трансплантологии органов, в случае если гражданин дал согласие стать донором после смерти. Накапливаемые медицинские данные станут основой для макроанализа состояния здоровья населения в масштабах всей страны, понимания востребованности и удовлетворенности качеством медицинских услуг, планирования развития необходимой инфраструктуры, применения эффективных экономических моделей, включая страхование, развития кадрового потенциала и соответственно гибкого планирования развития отрасли и реализации приоритетных для государства задач в здравоохранении [3].

На сегодняшний день в Единой информационной системе Министерства здравоохранения Азербайджана функционирует 20 электронных систем, включающих более 70 программных модулей, некоторые из них также функционируют в качестве мобильного приложения.

В современном мире мобильные медицинские приложения становятся все более популярными, меняющим парадигмы здравоохранения. С развитием мобильных технологий и доступности смартфонов, мобильные медицинские приложения предлагают широкий спектр возможностей для улучшения здоровья, диагностики, мониторинга и управления медицинскими состояниями.

Центром Общественного Здравоохранения и Реформ Министерства здравоохранения Азербайджана разработаны некоторые **мобильные приложения** [1]:

1. Приложение "Здоровое питание" поможет составить правильный рацион питания и рассчитать калории. Приложение также работает в режиме OFFLINE и не требует подключения к Интернету. Оно состоит из 5 основных функций: 1) Калькулятор калорий,

2) Калькулятор массы тела, 3) Калькулятор полезности пищи, 4) Ежедневный калькулятор калорий и 5) Статьи с информацией о полезном питании

2. Основной целью создания мобильного приложения "Сахарный диабет" является информирование населения о профилактике, лечении и контроле уровня сахара при диабете. Программу могут использовать как больные сахарным диабетом, так и люди, уделяющие внимание питанию и углеводному обмену. Мобильное приложение предоставляет отделение памяти для своевременного приема лекарств, калькулятор единиц хлеба и полезную информацию о диабете (типы, диабет, осложнения, использование инсулина и т. д.).

3. С помощью мобильного приложения "Защити свое сердце" вы можете постоянно контролировать здоровье своего сердца, можете ознакомиться с основными факторами риска сердечно-сосудистых заболеваний, с методами борьбы со стрессом и другими полезными материалами. Раз-

делы «Назначение времени приема лекарств», «Измерение артериального давления и пульса» в приложении напоминают о своевременном приеме назначенных лекарств. Вы можете мгновенно записывать информацию о вашем здоровье (артериальное давление и пульс) и отправлять в виде таблицы на адрес электронной почты своего врача с помощью мобильного устройства в течение дня или недели.

4. Мобильное приложение "Паллиативная помощь". Паллиативная помощь – это междисциплинарная медицинская специальность, направленная на уменьшение страданий и поддержание максимально возможного качества жизни пациентов в критическом состоянии и их семей. Основная цель мобильного приложения предоставить пациентам, членам их семей, а также медицинскому персоналу подробную информацию о паллиативной помощи, помочь найти ответы на вопросы, которые могут возникнуть.

Помимо характеристик паллиативной помощи, в мобильном приложении описаны меры, направленные на уменьшение симптомов, оказание психологической и социальной поддержки, снижение страха или тревоги потери близкого человека в семье. Также в него включен национальный и международный опыт паллиативной помощи, организации, занимающиеся паллиативной помощью в Азербайджане, и новости об их деятельности.

5. Мобильное приложение «Бурла Хатун». Каждая беременная женщина хочет знать и следить за тем, как растет ее будущий ребенок в утробе матери и за его здоровьем. Мобильное приложение «Бурла Хатун» обеспечивает быстрый и удобный доступ к информации о вашей беременности, развитии ребенка и важным рекомендациям для беременных, а также простым языком объясняет самые важные моменты по уходу за новорожденными и младенцами после рождения.

6. Приложение "Первая помощь" помогает реагировать на повседневные чрезвычайные ситуации и дает советы, что делать в случае неотложной медицинской помощи. Приложение предоставляет доступ к тематическим видеороликам и простым пошаговым инструкциям по выполнению мер первой помощи или помощи в мерах, принимаемых при необходимости или по указанию служб скорой медицинской помощи или других экстренных служб.

7. Приложение "ВидеоДоктор", это телемедицинские услуги, предоставляемые лицензированными врачами, работающими в группе независимых специализированных практик, известных под общим названием VideoDoktor Professionals. Эти специалисты оказывают услуги через телемедицинскую платформу «ВидеоДоктор» ежедневно и в любом месте. Очные видео сеансы могут проводиться по запросу или в заранее оговоренное время, днем и ночью, включая праздничные дни. Получите качественную медицинскую помощь в безопасности вашего дома.

8. Приложение “Электронный рецепт” является мобильным применением системы «Электронный рецепт», который является единым реестром регистрации и управления рецептами по медицинским препаратам, выписанным гражданам в государственных и частных медицинских учреждениях Азербайджана. Воспользоваться системой «Электронный рецепт» могут все граждане, получающие услуги по обязательному медицинскому страхованию, граждане, относящиеся к льготной категории, а также граждане, получающие услуги по частному медицинскому страхованию, а также незастрахованные граждане [2].

Мобильные приложения здравоохранения отражают уровень цифровизации этой отрасли. По изменению уровня мобильных приложений можно сделать вывод об сегодняшних успехах в цифровизации здравоохранения в республике. Как видно, из описанных выше приложений первые из них предоставляли информацию даже в режиме оффлайна. Обмен информацией можно было выполнить в виде отправления СМС сообщений, или специализированных видео-чатов. А **приложение “Электронный рецепт”** является уже мобильным применением системы «Электронный рецепт» анонсированном в 2023 году, в котором, пользователь должен иметь уже идентификационный код, т.е. регистрацию в государственном реестре. Что является новым этапом цифровизации здравоохранения с использованием централизованной государственной базы. Предлагается формировать единое информационное пространство при помощи системы электронного рецепта, которая будет охватывать поликлиники, стационары и сети аптек страны. В

будущем интеграция системы с реестром контроля за движением лекарственных средств, позволит усилить контроль за операциями реализации медикаментов, включая предотвращение распространения незарегистрированных препаратов. Также через это мобильное приложение можно будет удобно вести поиск аптеки для приобретения нужного препарата или заказывать его заранее. Считаем, что мобильное приложение электронного рецепта особенно будет необходимым для пациентов с хроническими заболеваниями. Им больше не придется отсиживать очередь к врачу для выписки необходимого препарата. Когда система полностью заработает, то продлевать рецепт они смогут удаленно по согласованию с доктором. А приходить к врачу на прием необходимо будет уже только на обязательные осмотры.

Список литературы

1. <https://isim.az/ru/pages/46>
2. <https://reseptim.az>
3. Зуенкова Ю.А. Опыт и перспективы применения цифровых двойников в общественном здравоохранении // Менеджер здравоохранения, 2022, № 6, с. 69-77
4. Кудратиллаев М.Б. Мобильные медицинские приложения: значение в жизни человека и их особенности, обзор существующих приложений // "Science and Education" Scientific Journal, May 2023, Volume 4 Issue 5, p.803-811
5. Kernebeck S., Busse T., Böttcher M. et al. Impact of mobile health and medical applications on clinical practice in gastroenterology // World J Gastroenterol., 2020, 26 (29), p. 4182–4197

АНАЛІЗ ТА ОЦІНКА ІНФОРМАЦІЙНИХ ЗАГРОЗ ТРАНСПОРТНОГО СЕКТОРУ**Аль-Амморі Алі***д.т.н., професор,**завідувач кафедри інформаційно-аналітичної діяльності та інформаційної безпеки,
Національний транспортний університет, Київ, Україна***Іщенко Р.М.***к.ф.-м.н., доцент, доцент кафедри інформаційно-аналітичної діяльності та інформаційної безпеки,
Національний транспортний університет, Київ, Україна***Клочан А.Є.***PhD, асистент кафедри інформаційно-аналітичної діяльності та інформаційної безпеки,
Національний транспортний університет, Київ, Україна***Шкурко О.П.***к.соц.ком., доцент кафедри інформаційно-аналітичної діяльності та інформаційної безпеки,
Національний транспортний університет, Київ, Україна***Поворознік Д.Є.***студент кафедри інформаційно-аналітичної діяльності та інформаційної безпеки,
Національний транспортний університет, Київ, Україна***ANALYSIS AND ASSESSMENT OF INFORMATION THREATS IN THE TRANSPORT SECTOR****Al-Ammori Ali,***Doctor of Technical Sciences, Full Professor, head of the Department of Information Analysis and Information Security,
National Transport University, Kyiv, Ukraine***Ishchenko R.,***Candidate of Physical and Mathematical Sciences (Ph.D), Docent, Associate Professor of the Department of Information Analysis and Information Security,
National Transport University, Kyiv, Ukraine***Klochan A.,***PhD, Assistant Lecturer of the Department of Information Analysis and Information Security,
National Transport University, Kyiv, Ukraine***Shkurko O.,***Candidate of Sciences in Social Communications (PhD), Associate Professor of the Department of Information Analysis and Information Security,
National Transport University, Kyiv, Ukraine***Povoroznik D.***student of the Department of Information Analysis and Information Security,
National Transport University, Kyiv, Ukraine*DOI: [10.5281/zenodo.11624349](https://doi.org/10.5281/zenodo.11624349)**Анотація**

Останніми роками транспортний сектор України зазнав цифрової трансформації, що значно вплинуло як на ефективність його роботи, так і на комфорт пасажирів. Однак, зростаюча залежність від інформаційно-комунікаційних технологій призвела до того, що зазначена галузь стала достатньо вразливою через вплив різноманітних кіберзагроз, які можуть завдати суттєвої шкоди підприємству транспортної галузі. Відповідно, визначення та аналіз існуючих інформаційних загроз, що виникають під час роботи транспортних підприємств та оперативне реагування на них з метою запобігання катастроф є актуальною науково-технічною задачею.

Abstract

In recent years, the transport sector of Ukraine has undergone a digital transformation, which significantly affected both the efficiency of its work and the comfort of passengers. However, the growing dependence on information and communication technologies has led to the fact that the mentioned industry has become quite vulnerable due to the impact of various cyber threats that can cause significant damage to the transport industry enterprise. Accordingly, the identification and analysis of existing information threats arising during the operation of transport enterprises and prompt response to them in order to prevent disasters is an urgent scientific and technical task.

Ключові слова: транспортний сектор, інформаційна безпека, інформаційна технологія, інформаційні загрози, DDoS-атаки, кібератака.

Keywords: transport sector, information security, information technology, information threats, DDoS attacks, cyber attack.

Вступ. Інформаційна безпека відіграє важливу роль у забезпеченні ефективного функціонування підприємств транспортного сектору [1]. В науково-технічній літературі існує достатньо робіт, присвячених аналізу інформаційних загроз, що можуть виникати в різних галузях транспортного комплексу країни. Зокрема, в роботі [4] розглянуто сукупність методів і практик захисту від атак зловмисників для забезпечення безперебійної роботи комп'ютерів, електронних систем, мереж та даних на автомобільному транспорті. В роботі [2] проаналізовано існуючі проблеми інформаційної безпеки авіаційного транспорту. Автором роботи [3] запропоновано розглядати інформаційну безпеку як елемент підвищення ефективності комплексного контролю на підприємствах водного транспорту. У роботі [5] досліджено питання організації, впровадження та забезпечення інформаційної безпеки на водному транспорті, зокрема, на морських суднах. Деякі проблеми впровадження стандартів кібербезпеки на

морському транспорті розглянуто авторами роботи [6].

Однак, для ефективного забезпечення інформаційної безпеки підприємств транспортного сектору необхідно провести комплексний аналіз інформаційних загроз, які завдають найбільшої шкоди зазначеній галузі. Останнє дозволить визначити вразливі місця, розробити план реагування, впровадити усі необхідні заходи безпеки та підготувати персонал для успішного розпізнавання та реагування на кібератаки.

Таким чином, **метою** даної роботи є проведення комплексного аналізу інформаційних загроз, що виникають під час функціонування підприємств транспортного сектору.

Основна частина. Визначимо, яка частка кібератак припадає на транспортний сектор. Для цього використаємо річний звіт компанії Microsoft за 2022 рік [9]. На діаграмі (рис. 1) продемонстровано сектори економіки, що найчастіше піддавались нападам кіберзлочинців.

Галузі, що зазнали кібератак в світі

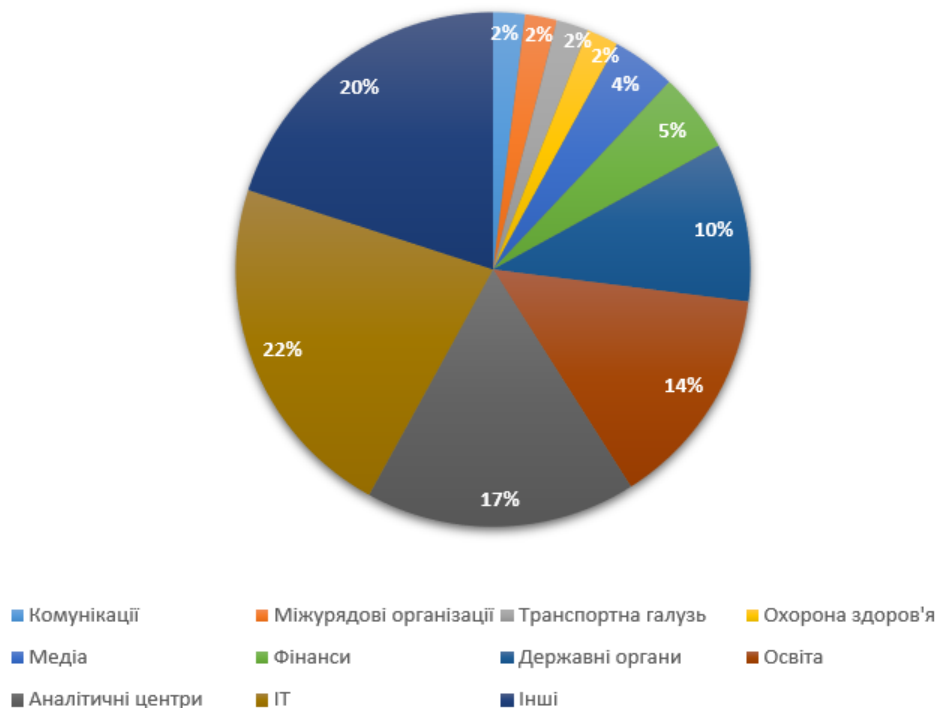


Рисунок 1 – Галузі, що зазнали кібератак в усьому світі на 2022 рік

В цьому ж звіті була подана інформація про галузі в Україні, що найбільше підпали під удар після вторгнення. Результати дослідження зображені на наступній діаграмі (рис. 2).

Галузі, що зазнали кібератак в Україні

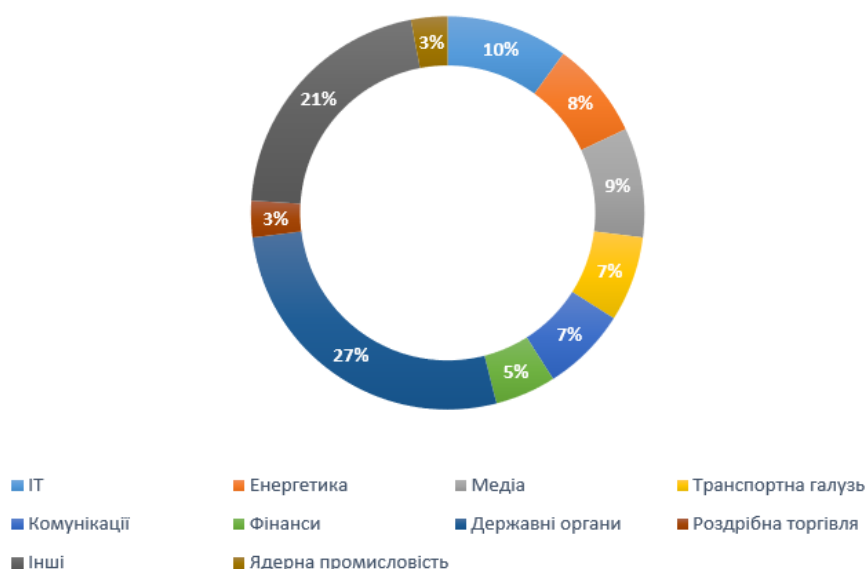


Рисунок 2 – Галузі в Україні, що зазнали кібератак на 2022 рік

Проаналізувавши діаграми, можна помітити, що сектори економіки в світі, що найчастіше піддаються кібератакам, значною мірою відрізняються від тих, що зазнали кібератак в Україні. Також це помітно й для транспортної інфраструктури, де кібератаки на Україну становлять 7% (на відміну від тих, що стосуються світу – 2%). Велику роль в цих змінах відіграє вторгнення ворога в нашу країну.

Цілеспрямовані обстріли транспорту становлять загрозу для сфери, що має вирішальне значення для громадян України, які намагаються вижити в умовах війни. Згідно з опитуванням, проведеним за підтримки ЮНІСЕФ у травні 2022 року, респонденти в постраждалих від конфлікту міських районах були найбільше занепокоєні проблемами транспорту і палива, перебоями в постачанні, безпекою та обмеженим доступом до продуктів харчування, медичних і фінансових послуг.

Для визначення безпосередніх загроз, що мають найбільший прояв у транспортному секторі, скористаємось ще одним звітом. Європейське агентство з

мережевої та інформаційної безпеки (ENISA) вперше провело аналіз по ландшафту кіберзагроз у транспортному секторі ЄС [8]. Звіт має на меті надати нове розуміння реальності транспортного сектору шляхом картографування та вивчення кіберінцидентів з січня 2021 року по жовтень 2022 року. Він визначає основні загрози, суб'єкти та тенденції на основі аналізу кібератак, спрямованих на авіаційний, морський, залізничний та автомобільний транспорт за майже 2 роки.

Розглянемо статистику інцидентів на різні транспортні сектори. За звітний період проаналізовано 27 інцидентів, спрямованих на авіаційний транспорт (28%), 18 інцидентів, спрямованих на морський транспорт (18%), 21 інцидент, спрямований на залізничний транспорт (21%) і 24 інциденти, спрямовані на автомобільний транспорт (25%). Також було включено 8 інцидентів (8%), які стосувалися транспортного сектору в цілому, або інциденти, спрямовані проти транспортних міністерств.



Рисунок 3 – Загрози транспортним секторам за звітний період

Протягом звітнього періоду спостерігалися наступні види загроз (рис. 4) для транспортної галузі. В даному випадку, інцидент можна віднести до кількох категорій загроз, який означає, що загальний відсоток загроз, показаних на рис. 4, перевищує 100%. Наприклад, вектор атаки для початкового до-

ступу може включати фішингову кампанію, яка потім супроводжується компрометацією за допомогою програми-вимагача. Подібним чином, інциденти, які включали атаку на постачальника, класифікувалися як атаки на ланцюг постачання, так і як тип атаки, використаний для компрометації.



Рисунок 4 – Основні загрози транспортному сектору (січень 2021 – жовтень 2022)

Розглянемо основні загрози транспортному сектору.

Програми-вимагачі. Програмне забезпечення-вимагач визначається як тип атаки, під час якого зловмисники захоплюють контроль над активами та вимагають викуп в обмін на повернення доступності активу. Інциденти з програмами-вимагачами представлені окремо від шкідливих програм, оскільки вони становлять значну частину виявлених інцидентів (38%) протягом звітнього періоду, з кількома резонансними інцидентами, які отримали широкий розголос.

Загрози, що пов'язані з даними. Джерела даних стають об'єктами атак з метою несанкціонованого доступу та розголошення, а також маніпулювання даними для втручання в поведінку систем. Ці загрози є основою для багатьох інших загроз, які також розглядаються. Наприклад, програми-вимагачі, або DDoS-атаки, мають на меті відмовити в доступі до даних і, можливо, вимагати плату за відновлення цього доступу. З технічної точки зору, загрози для даних в основному можна класифікувати як витоки та порушення даних. Порушення даних – це навмисна атака, здійснена кіберзлочинцем з метою отримання несанкціонованого доступу та витоку чутливих, конфіденційних або захищених даних. Витік даних – це подія, яка може призвести до ненавмисного витоку чутливих, конфіденційних або захищених даних через, наприклад, неправильні конфігурації, вразливості або людські помилки. У звітньому періоді близько 30% спостережуваних інцидентів були формою загрози для даних транспортних організацій.

Шкідливе програмне забезпечення. Шкідливе програмне забезпечення – це загальний термін, який використовується для опису будь-якого програмного забезпечення або мікропрограми, призначеної для виконання несанкціонованих процесів, що негативно впливають на конфіденційність, цілісність або доступність системи. Традиційно прикладами шкідливого коду є віруси, хробаки, троянські програми, шпигунські програми, рекламні програми та інші кодові об'єкти, які вражають комп'ютер. Протягом звітнього періоду 17% інцидентів, спрямованих на транспортний сектор, були пов'язані зі зловмисним програмним забезпеченням.

Відмова в обслуговуванні. Доступність є об'єктом безлічі загроз і атак, серед яких виділяється DDoS-атака. DDoS-атаки націлені на доступність систем і даних і, хоча не є новою загрозою, відіграють значну роль у ландшафті загроз кібербезпеки транспортного сектору. Атаки відбуваються, коли користувачі системи або сервісу не можуть отримати доступ до відповідних даних, послуг або інших ресурсів. Це може бути досягнуто шляхом виснаження сервісу та його ресурсів або перевантаження компонентів мережевої інфраструктури. Протягом звітнього періоду геополітичні події та активність хактивістів збільшили кількість DDoS-атак на транспортні організації, досягнувши 16% від загальної кількості інцидентів.

Використання вразливостей. Експлуатація вразливостей – це використання відомих вразливостей або вразливостей нульового дня.

Соціальна інженерія. Соціальна інженерія охоплює широкий спектр діяльності, яка намагається використати людську помилку або поведінку людини з метою отримання доступу до інформації або послуг. Вона використовує різні форми маніпуляцій, щоб змусити жертв припуститися помилки або передати конфіденційну чи секретну інформацію. У сфері кібербезпеки соціальна інженерія заманює користувачів відкривати документи, файли або електронні листи, відвідувати веб-сайти або надавати неавторизованим особам доступ до систем або послуг. Ця канва загроз складається переважно з таких векторів: фішинг, спам-фішинг, «китобій», «смішинг», «вішинг», компрометація ділової електронної пошти, шахрайство, видавання себе за іншу особу та підrobка документів. У цьому звітному періоді спостерігались переважно фішингові атаки, спрямовані на користувачів транспорту (10%), а також інциденти, пов'язані з шахрайством, видаванням себе за іншу особу та підrobкою документів (6%).

Атаки на постачальників і ланцюги поставок. Атака на ланцюг постачання спрямована на відносини між організаціями та їхніми постачальниками. У цьому звіті використовується визначення, наведене в ландшафті загроз ENISA для ланцюга поставок, де атака вважається такою, що містить компонент ланцюга постачання, якщо вона складається з комбінації принаймні двох атак. Щоб атаку можна було класифікувати як атаку на ланцюг поставок, цілями мають бути як постачальник, так і клієнт. Схоже, що зловмисники продовжують користуватись цим джерелом, щоб проводити свої операції та закріплюватися в організаціях, намагаючись отримати вигоду від широкого впливу та потужної бази жертв таких атак. У звіті спостерігались як атаки на ланцюг постачання, як визначено вище, так і атаки на постачальників, які призвели до збоїв або збитків суб'єктам у транспо-

ртному секторі (10% від загальної кількості інцидентів). Цей вплив не обов'язково був наслідком вторинної атаки.

Порушення/вторгнення. Порушення/вторгнення – це інциденти, коли атака на систему була підтверджена або оприлюднена, і зловмисники отримали доступ до системи, але деталі того, як відбулося порушення або вторгнення, не були розкриті.

Інші загрози включають поодинокі випадки збору облікових даних і підrobку геолокації в морському секторі.

Нарешті, є невеликий відсоток інцидентів, коли навіть якщо відбулася кібератака, недостатньо інформації, щоб дозволити класифікувати інцидент. Загалом це становить 7% інцидентів (невідомих).

Дані про інциденти, зібрані до жовтня 2022 року, свідчать про збільшення кількості повідомлень про атаки з використанням програм-вимагачів протягом 2022 року (рис. 5). Кількість повідомлень про ці атаки у транспортному секторі майже подвоїлася, збільшившись до 25% у 2022 році з 13% у 2021 році. На відміну від програм-вимагачів, у 2022 році спостерігалось зниження кількості інцидентів, пов'язаних зі шкідливим програмним забезпеченням, порівняно з 2021 роком (з 11% до 6%) [7].

Загрози, пов'язані з даними (зломи, витоки), зменшилися порівняно з програмами-вимагачами, але залишаються значними. Атаки, що спостерігались у 2021 та 2022 роках, були спрямовані на облікові дані, персональні дані співробітників та пасажирів, корпоративні дані та інтелектуальну власність.

У 2022 році спостерігалось збільшення кількості DDoS-атак, що здебільшого пов'язано з нещодавною активністю хактивістів. Частота цих атак зосереджена на конкретних регіонах і залежить від поточної геополітичної напруженості.

Основні загрози транспортному сектору: 2021 проти 2022

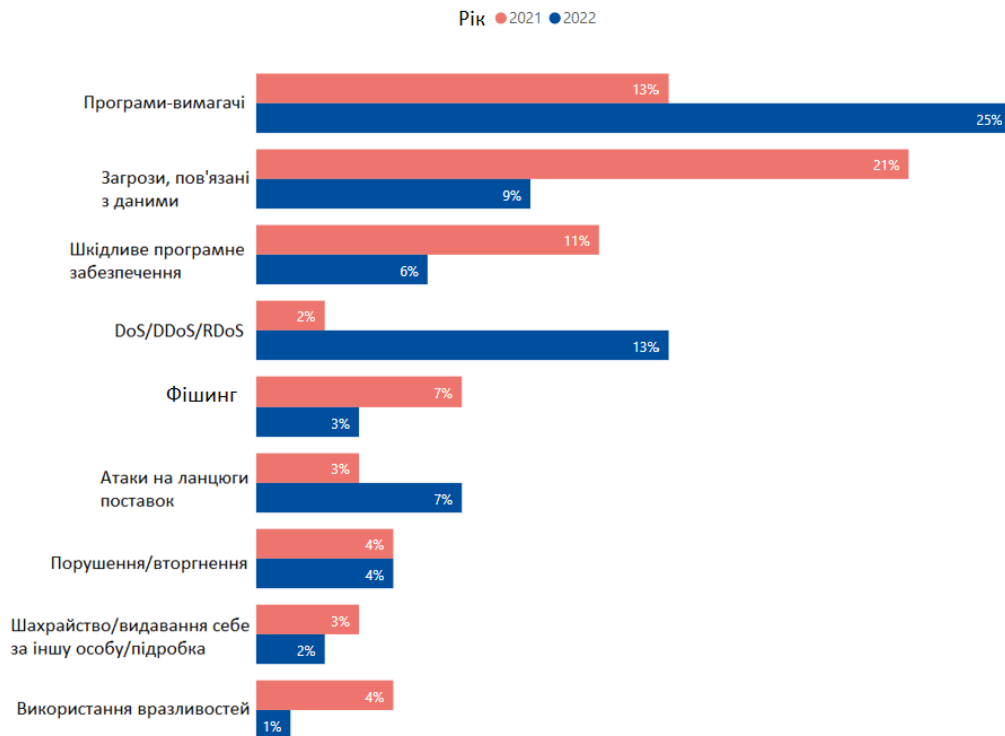


Рисунок 5 – Порівняння частоти загроз для транспортного сектору

Далі розглянемо мотиви, якими керуються зловмисники при здійсненні кібератак на транспортні підприємства (рис. 6). Можливими мотивами є наступні:

- шпигунство, коли метою атаки є збір інформації (інтелектуальної власності або інформації державного значення);

- фінансова вигода, коли за атакою є чітка грошова вимога, наприклад, вимагання, продаж викрадених даних тощо;
- ідеологічні, коли атака пов'язана з хактивістською діяльністю і є чіткі декларації про мету атаки з боку суб'єкта;
- порушення роботи, коли атака спрямована на порушення роботи сервісів, на відміну від випадків, коли це є побічним ефектом атаки.

Мотиви порушників

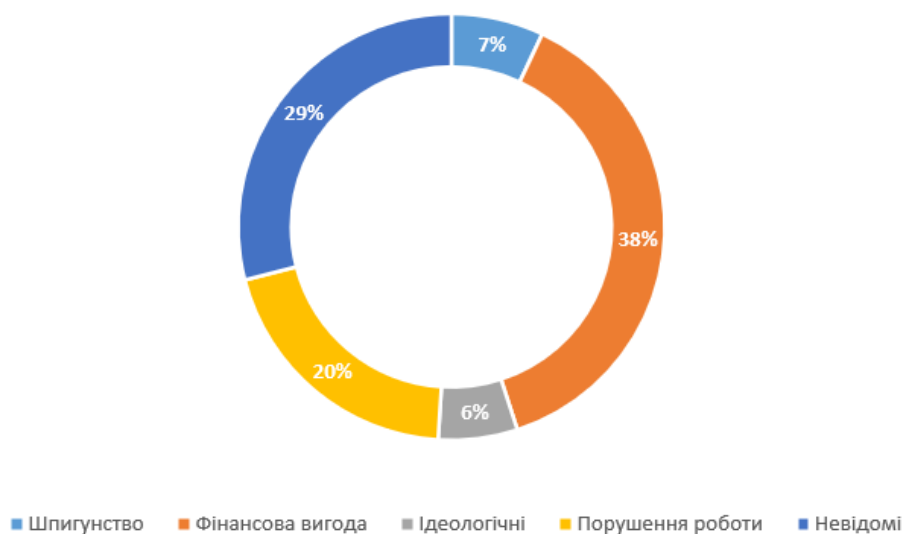


Рисунок 6 – Мотиви атак на транспортні підприємства

Більше половини інцидентів, зафіксованих у звітному періоді, були пов'язані з кіберзлочинцями (55%). Це також пов'язано з мотивацією цих атак, яка переважно полягає у фінансовій вигоді (38%).

Транспортний сектор вважається прибутковим бізнесом для кіберзлочинців, оскільки дані клієнтів розглядаються як товар, а при атаках на транспортні ланцюги поставок – як дуже цінна інформація, що становить комерційну таємницю. Чверть атак пов'язана з хактивістськими групами (23%), мотивація яких зазвичай пов'язана з геополітичною ситуацією і спрямована на порушення роботи (20%) або з ідеологічними мотивами (6%).

Висновки. Таким чином, транспортний сектор є життєво важливим для економіки та суспільства в цілому. Кібератака може порушити нормальне функціонування міста, регіону чи цілої країни, одночасно завдаючи шкоди багатьом галузям промисловості.

Транспортний комплекс входить до списку секторів, що найчастіше піддаються кібератакам злочинців. В Україні відсоток кібератак на транспортну інфраструктуру ще більший, ніж у світі (2% у світі, 7% в Україні). Зростання загрози значною мірою пов'язано з подіями останніх років.

Аналіз загроз інформаційної безпеки з січня 2021 року по жовтень 2022 року показав, що найчастіше транспортний сектор зіштовхується з наступними видами загроз: програми-вимагачі; загрози, пов'язані з даними; шкідливе програмне забезпечення; відмова в обслуговуванні; атаки на ланцюги поставок; порушення/вторгнення; шахрайство; використання вразливостей. При цьому основними мотивами порушників є шпигунство, фінансова вигода, ідеологічні мотиви та порушення роботи сервісів.

Список літератури

1. Аль-Амморі А.Н., Дехтяр М.М., Іщенко Р.М., Клочан А.Є. Методи та засоби захисту інформації. Системи управління, навігації та зв'язку. Збірник наукових праць. 2024. № 1. С. 38-44.

2. Бугайко Д., Харазішвілі Ю., Ляшенко В., Квілінський О. Системний підхід до визначення рівня розвитку авіаційного транспорту: індикатори, рівень, загрози. Журнал європейської економіки. 2021. Том 20, № 1(76). С. 152-190.

3. Євтушевська О.А. Інформаційна безпека як елемент підвищення ефективності комплексного контролю підприємств водного транспорту. Зовнішня торгівля: економіка, фінанси, право. Науковий журнал. Серія: Економічні науки. 2015. № 5-6 (82-83). С. 157-162.

4. Колодяжний В.М., Левтеров А.І., Малащук Є.В. Кібербезпека автомобілів: історія цифровізації автомобілів, поточний стан проблеми, цілі сталого розвитку та стандарти. Вісник ХНАДУ. 2022. Випуск 96. С. 59-65.

5. Мельник О.М., Волошин А.О., Онищенко О.А., Щербина О.В., Васалатій Н.В., Нікітюк П.В. Організація забезпечення інформаційної безпеки морського судна. Збірник наукових праць Українського державного університету залізничного транспорту. 2022. Випуск 201. С. 69-78.

6. Трофименко А.О., Майданевич С.Б., Войченко Т.О., Дорофєєва З.Я. Деякі проблеми питання впровадження стандартів кібербезпеки на морському транспорті. Водний транспорт. 2023. № 1 (37). С. 179-188.

7. Cyberthreats in the transportation industry [Електронний ресурс] – Режим доступу до ресурсу: <https://www.ptsecurity.com/ww-en/analytics/cyber-threats-in-the-transport-sector-2023/>.

8. ENISA Transport Threat Landscape [Електронний ресурс] – Режим доступу до ресурсу: <https://www.enisa.europa.eu/publications/enisa-transport-threat-landscape>.

9. Microsoft Digital Defense Report 2022 [Електронний ресурс] – Режим доступу до ресурсу: <https://www.microsoft.com/en-us/security/business/microsoft-digital-defense-report-2022#tabx9128d5321b074ae784b8e940d6d5fd4ei>.

CONSTRUCTION AND ARCHITECTURE

ВДОСКОНАЛЕННЯ ТЕХНОЛОГІЧНИХ РІШЕНЬ ЗВЕДЕННЯ ВЕЛИКОПРОГОНОВИХ ПОКРИТТІВ ПІДЙОМНИМИ МОДУЛЯМИ

Ігнатенко О.О.

*Кандидат технічних наук, докторант каф. Будівельних технологій
Київського національного університету будівництва і архітектури,
Україна*

<https://orcid.org/0009-0009-7691-884X>

IMPROVEMENT OF TECHNOLOGICAL SOLUTIONS FOR ERECTION OF LARGE-SPAN COATINGS WITH LIFTING MODULES

Ignatenko O.

*Candidate of Technical Sciences, doctoral student of the Department of
Construction Technologies of Kyiv National University of Construction and
Architecture, Ukraine*

<https://orcid.org/0009-0009-7691-884X>

DOI: [10.5281/zenodo.11624363](https://doi.org/10.5281/zenodo.11624363)

Анотація

В статті описане нове технологічне рішення по зведенню великопрогонових покриттів підйомними модулями. Опорні ригелі покриття в процесі укрупнення на фундаментах розміщуються в просторі між спареними колонами несучого каркасу. Переміщення ригелів покриттів на проектну висоту виконують зі спиранням на стовпи підйомних модулів, які підрошуються в міжколонному просторі. Нове рішення дозволяє суттєво скоротити об'єми висотних монтажних робіт та загальні строки підйомних робіт.

Abstract

The article describes a new technological solution for erection of large-span coatings by lifting modules. Support crossbars of coating in process of enlargement on foundations are placed in space between paired columns of bearing frame. Movement of cross-bars of coatings to design height is performed with resting on trunks of lifting modules, which are grown in inter-column space. The new solution allows to significantly reduce the volume of high-altitude installation work and the overall time of lifting work.

Ключові слова: зведення великопрогонових покриттів, підйомні модулі

Keywords: erection of large-span coatings, lifting modules

Актуальність проблеми

Сучасні технології зведення великопрогонових покриттів промислових та цивільних об'єктів передбачають попереднє укрупнення блоків покриттів на низьких ригельних методах вільного підйому з використанням самохідних стрілових кранів [1, с.80 – 62] та наступне примусове переміщення покриттів на проектну висоту методами підтягування або виштовхування [2, с.12-14]. Переваги відомих рішень примусового підйому покриттів акцептуються при розробці нових технологій підйому з використанням підйомних модулів. Зменшення об'ємів монтажних висотних робіт та скорочення загальних строків підйомних робіт з використанням підйомних модулів, є актуальним напрямком вдосконалення технологічних рішень зведення великопрогонових покриттів.

Аналіз публікацій

Результати вивчення організаційно-технологічних варіантів зведення великопрогонових залізобетонних та металевих покриттів відображені в наукових працях українських та закордонних вчених. Серед українських вчених найбільший вклад в розробку технологій по зведенню конструктивно-технологічних блоків покриттів з використанням під-

йомних модулів зробили Колесник Л. А. [3], Назаренко В.Ф. [4], Ніжніковський Г.С. [1], Осипов О.Ф. [2], Ситнік Н.П.[4], Собко Ю.Т. [5], Тонкачєв Г.М. [2], Федоренко П.П.[6], Черненко В.К. [2], Шкромда А.А.[6]. Серед закордонних вчених великий внесок в розробку науково-теоретичних рішень по зведенню великопрогонових покриттів промислових та громадянських об'єктів зробили Fliger K. [7], Rowinski L. [7], Kühn E. [8], Rühle H. [8], Orlik G. [9], Ziólko J. [9].

Мета роботи

На закладі аналізу переваг і недоліків відомих варіантів зведення великопрогонових покриттів методами підтягування або виштовхування, необхідно розробити рішення з використанням механізованого технологічного обладнання, представленого підйомними модулями. Згідно з розробленою технологією, підрошувальні стовпи підйомних модулів виштовхують опорні ригелі конструкцій покриттів в просторі між спареними колонами несучого каркасу. Підрошування секцій стовпів підйомних модулів виконують гідравлічні домкрати, розташовані на фундаментах між спареними колонами. Навантаження від ригелів покриття, що піднімається, по чергово сприймають підйомні пло-

щадки, з'єднанні зі штоками гідравлічних домкратів підйомних модулів та ригелів фіксаторів підйому, змонтовані на зовнішніх сторонах спарених колон. Використання розроблених підйомних модулів дозволяє оптимізувати монтажні процеси по зведенню покриттів за рахунок суттєвого зменшення кількості монтажних операцій та скорочення тривалості підйому покриттів на проектну висоту.

Виклад основного матеріалу досліджень

Підйом великопрогонового металевого конструктивно-технологічного блоку покриття методом підтягування був використаний при зведенні покриття цехів авіаційного заводу. Покриття складалось з блоків розмірами 96 x 48м та 96 x 54м і масою 1100 – 1200 т [6, с.74 - 76]. Процес підйому покриття методом підтягування та вузол фіксації ригеля піднімаемого покриття показані на Рис.1.

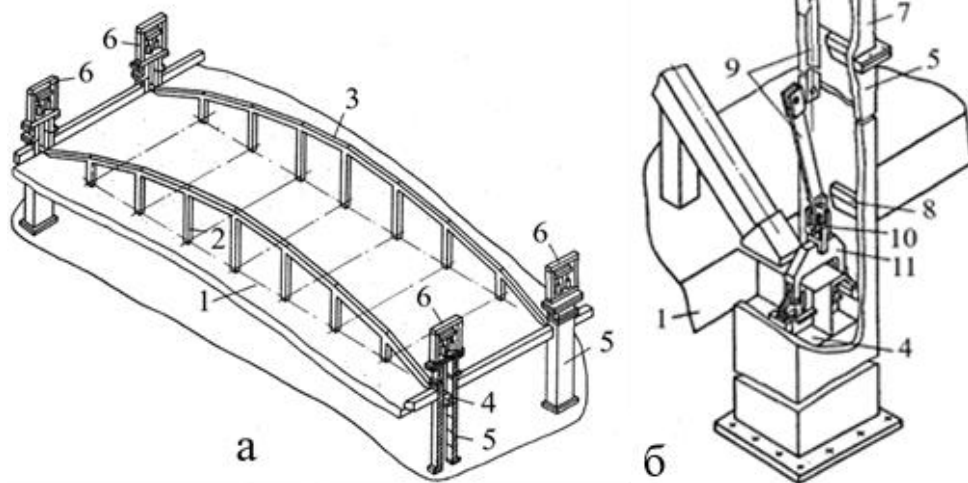


Рис.1 Підйом великопрогонового покриття методом підтягування: а – покриття в процесі підйому, б – вузол фіксації опорного ригеля піднімаемого покриття, 1- блок покриття, 2- стійка ферми покриття, 3 – верхній пояс ферми покриття, 4 – опорний ригель покриття, 5 – колона несучого каркасу, 6 – підйомник ПШ-330, 7 – опора підйомника, 8 – проміжний підйомний упор, 9 – тягова стрічка, 10 – перехідна ланка тягової стрічки, 11 – стропувальна траверса.

Підйом покриття на висоту 34м тривав 10 змін. Гідропідйомники ПШ-330 були розташовані на оголовках проектних колон і виконували циклічне підтягування блоків покриттів за допомогою шарнірно-ланцюгової тягової стрічки. Гідропідйомник тягучого типу ПШ – 330 складався з двох гідравлічних домкратів ГД – 170 (вантажопідйомність по 170 тон кожний, довжина робочого ходу штоку домкрата 1120мм), двох страхувальних гвинтів, піддомкратної і наддомкратної балок, цільнозвареної челочної стрічки (довжина 12м), яка з'єднана нижнім кінцем з тяговою стрічкою (в перерізі 600x40мм). Тягова стрічка складалась з шарнірно з'єднаних ланок довжиною 6м. Тягова стрічка була шарнірно прикріплена до балки піднімаемого покриття. В якості опорних конструкцій для гідропідйомника використовувались колони несучого каркасу з проміжними столиками для тимчасового спирання блоку покриття в процесі переміщення на проектну висоту. Підйом двох покрівельних блоків (загальна площа 40000 м² на висоту 34 м був виконаний за 10 змін. [4]. Процес підйому кожного блоку складався з шістьох повторних циклів. До кожного циклу входили два послідовних етапи – підйом блоку покриття на 6м та проміжне спирання покриття на опорні столики колон. В кожному циклі підйому покриття шість разів підтягувалось до гори на висоту 1м, яка була відповідна ходу штоків домкратів та кроку отворів в тяговій стрічці. Під час підйому покриття в колонах за допомогою ручної

лебідки в міжколонному просторі демонтувались елементи решітки на ділянці висотою 6м з подальшим монтажем решіток після підйому ригеля покриття. До недоліків справжнього методу монтажу можна віднести складний монтаж і демонтаж підйомного обладнання на значній висоті з утворенням висотних опорних площадок для підйомників (додатковий розхід опорних металоконструкцій склав 160т), складне і небезпечне обслуговування підйомника на висоті 34 м, необхідність утворення великої кількості проміжних висотних площадок для демонтажу ланцюгів тягової стрічки по мірі підйому покриття. До переваг аналізованого рішення можна віднести утворення жорсткого поперечного каркасу з несучих колон та міжколонних балок, контроль вертикальності підйомного процесу покриття, який забезпечувався переміщенням опорних ригелів блоку покриття між спареними несучими колонами.

Характерним прикладом використання методу виштовхування зі спиранням ригелів покриття, що піднімається, на оголовки підросувальних стволів підйомників, є зведення покриття цеху авіазаводу розмірами 144 x 275м. Покриття площею 39600 м² і масою 1100т піднімалось на висоту 24 м за 12 змін. В підросуванні стволів підйомників були задіяні гідропідйомники ПГ-300 [5]. Варіант підйому покриття методом виштовхування зі спиранням на оголовки підросувальних стволів підйомників показаний на Рис.2.

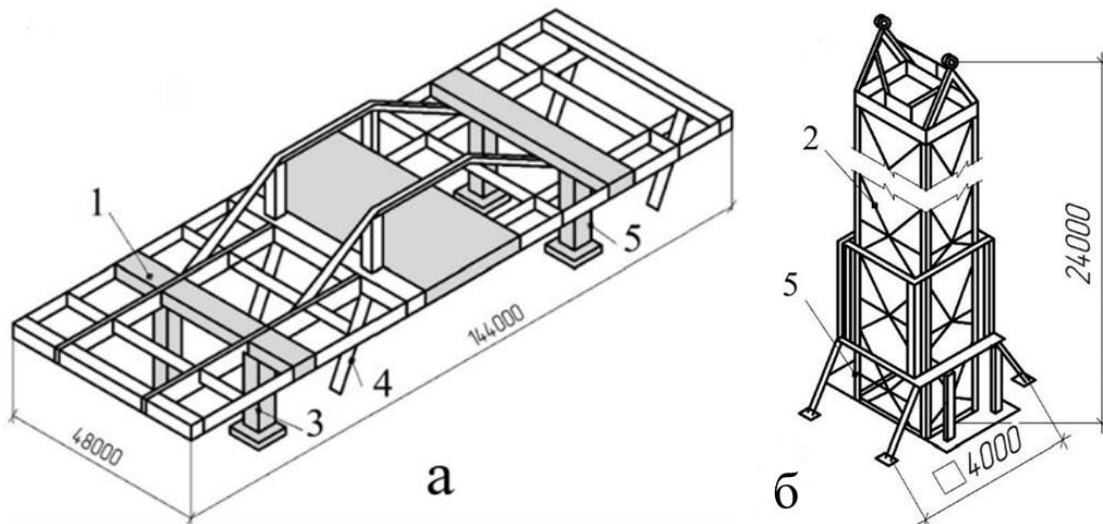


Рис. 2 Підйом покриття методом виштовхування зі спіранням ригелів покриття на оголовки підрозумувальних стовпів підйомників: (а) – великопрольотне покриття в процесі підйому, (б) – підйомний модуль ПГ-300, 1 – покриття, 2 – сегменти ствола підйомника, 3 – підрозумувальний ствол підйомника, 4 – цілісна проектна колона, 5 – гідравлічні домкрати.

В процесі вертикального переміщення несучі ригелі покриття спирались на оголовки підрозумувальних стовпів підйомників. Суцільні проектні колони буди прикріплені до нижньої поверхні несучих ригелів покриття в період укрупнення великопрольотного блоку покриття на низьких риштуваннях (висота 2,0 м). По мірі підрозумування стовпів підйомників, проектні колони змінювали положення з нахилоного до вертикального. На завершальній фазі підрозумування стовпів підйомників проектні колони закріплювались в вертикальному положенні в фундаментних стаканах. На наступному етапі монтажних робіт на оголовки проектних колон передавалось навантаження від опорних ригелів покриття. Після цього стовпи підйомників демонтувались. Враховуючи те, що в процесі підйому покриття методом підрозумування проектні колони не були задіяні, можна класифікувати підрозумуванні стовпи підйомників як «підрозумувальні монтажні колони». Для остаточної посадки блоків покриття на проектній висоті багаторазово виконувати цикли «підйом-опускання» в висотних межах 200 – 300 мм з постійним регулюванням місць стикування ригелів окремих блоків покриття. До недоліків технології, що розглядається, можна віднести складність посадки блоків покриття на оголовки проектних колон та значна працесмість монтажних процесів на висоті 24м, пов'язаних зі стиковкою між собою ригелів піднятих блоків покриття. До переваг розглянутого варіанту підйому покриття можна віднести відсутність проміжних висотних монтажних площадок в процесі вертикального

переміщення ригелів покриття. Весь процес підйому покриття був сконцентрований на фундаментах. В роботах на висоті 24м монтажники були задіяні тільки на завершальній фазі при фіксації оголовків проектних колон на нижніх гранях ригелів покриття та остаточному скріпленні між собою окремих сегментів покрівельної конструкції.

З урахуванням переваг варіанту підйому покриття методом підтягування, коли проектні спарені колони, які разом з міжколонними балками та зв'язками створювали поперечний каркас жорсткості та виконували функцію направляючих для переміщення в міжколонному просторі спарених колон опорних ригелів конструкції покриття та методу виштовхування, коли до переліку верхозазначених робіт відносились тільки монтажні роботи по остаточній фіксації опорних ригелів покриття на оголовках колон несучого каркасу та концентрація всіх процесів підрозумування колон в зоні фундаментів, була розроблена нова технологія зведення великопрогонових покриттів з використанням підйомних модулів.

Згідно з розробленою технологією, переміщення опорних ригелів покриття з рівня укрупнення на риштуваннях (висота до 2м) до рівня проектної висоти виконувалось в просторі між спареними колонами несучого каркасу зі спіранням на оголовки підрозумувальних стовпів підйомних модулів. Фази циклу підрозумування секцій стовпів підйомного модуля показані на Рис.3.

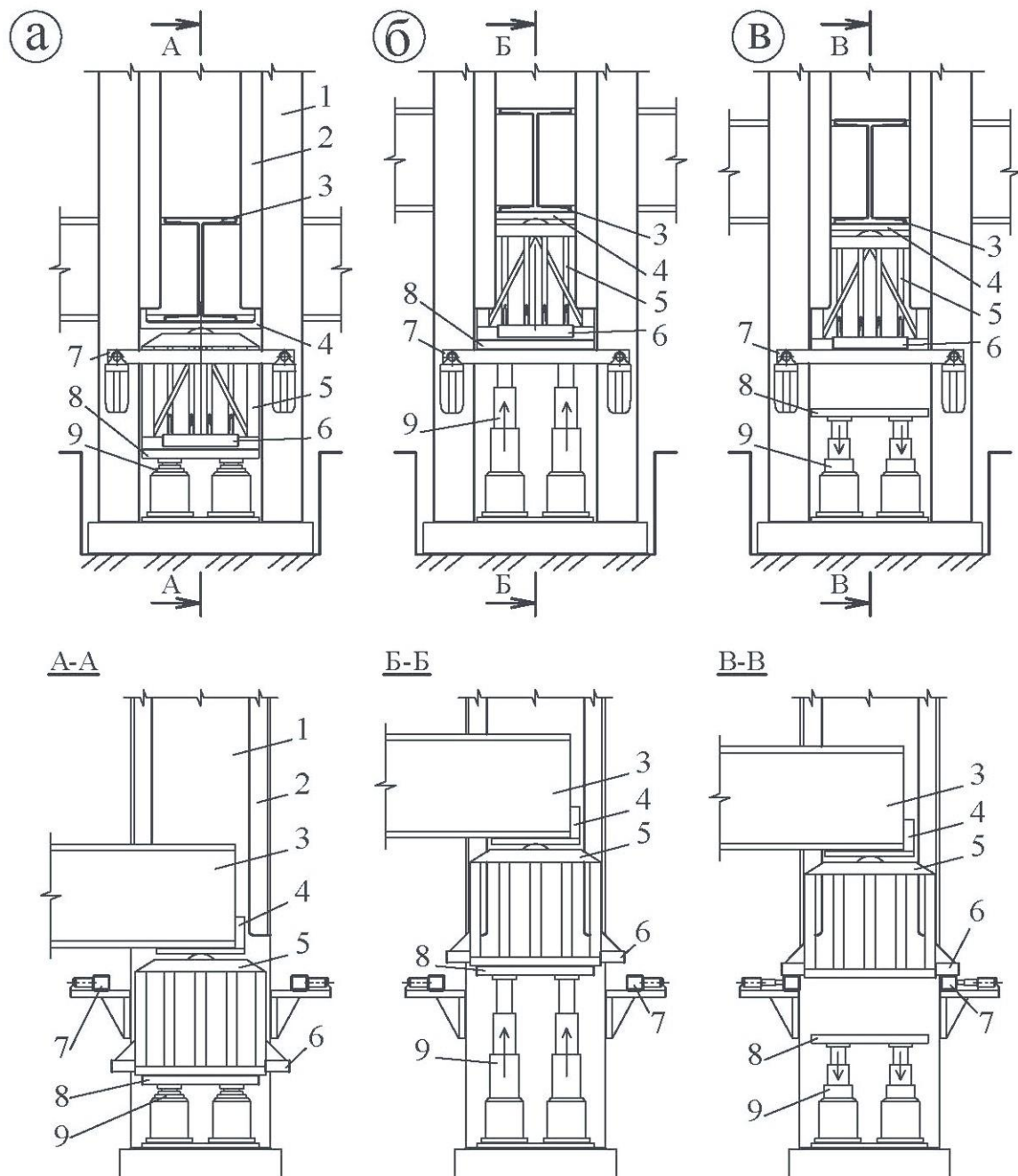


Рис.3 Фази циклу підйому покриття зі спиранням на підрошуванні стовли підйомних модулів:
 а – сприйняття навантаження від покриття підрошувальним стовлом підйомного модуля,
 б – виштовхування покриття стовлом підйомного модуля, в – передача навантаження від покриття на
 фіксатори підйому, 1 – колона каркасу, 2 – напрямний профіль, 3 – ригель покриття, 4 – опорна рама
 покриття, 5 – верхня секція ствола підйомника, 6 – консольний виступ секції ствола підйомника,
 7 – опорна рама, 8 – ригель фіксатора підйому, 9 – риштування.

Послідовність зведення блоку покриття зі спиранням несучих ригелів покриття на підрошувальні стовли підйомних модулів показана на Рис. 4.

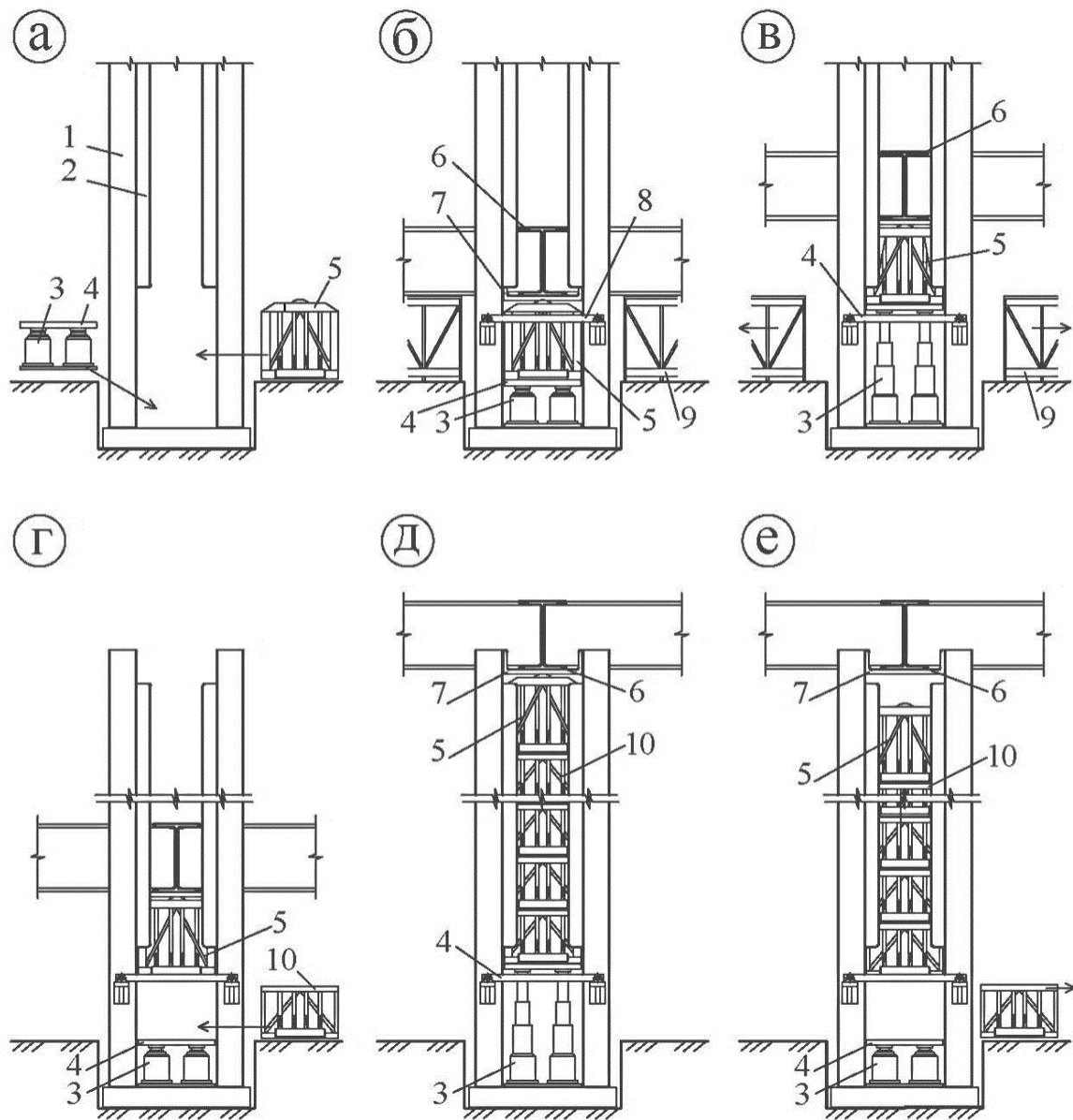


Рис.4 Послідовність зведення блоку покриття зі спиранням несучих ригелів покриття на підрошувальні стовпи підйомних модулів: а, б – передпідйомний етап, в, г, д – підйомний етап, е – післяпідйомний етап, 1 – колона каркасу, 2 – напрямний профіль, 3 – гідропідйомник, 4 – опорна площадка модуля, 5 – верхня секція ствола підйомника, 6 – ригель покриття, 7 – опорна рама, 8 – ригель фіксатора підйому, 9 – риштування.

Процес зведення великопрогонових покриття зі спиранням на оголовки підрошувальних стовпів підйомних модулів складався з трьох етапів. - *Передпідйомний етап*. З використанням самохідних стрілових кранів встановлюють на фундаменти спарені колони несучого каркасу, на внутрішніх поверхнях колон закріплюють вертикальні напрямні профілі, в міжколонному просторі на фундаментах розміщують гідропідйомники та опорні площадки підйомного модуля, на опорні площадки подають оголовки підрошувального ствола підйомного модуля. На торцевих поверхнях колон на висотній відмітці, нижчій ніж висотна відмітка верхньої поверхні оголовків стовпів підйомників, закріплюють ригелі фіксатору підйому. На низьких риштування (висота до 2м) виконують монтаж конструкцій блоку покриття. Несучі ригелі покриття, при цьому,

монтують в міжколонному просторі над верхніми секціями ствола підйомника. Між верхніми секціями стовпів підйомників та несучими ригелями покриття розміщують опорні рами. Виконують весь комплекс робіт по монтажу технологічного обладнання в покрівельному просторі, по утворенню всіх паро-, тепло, гідро та зовнішніх фінішних покрівельних прошарків., Зібраний на фундаментах великопрогоновий блок покриття 100% готовності може бути переміщений на проектну висоту.

- *Підйомний етап*. Подають робочу рідину в корпуси гідропідйомників підйомного модуля. Штоки гідропідйомників переміщують верхню секцію ствола підйомного модуля, опорну раму та несучий ригель покриття до рівня вищого, ніж рівень закріплення ригелів фіксатору підйому. В нижній

частині двох бокових поверхонь оголовка підрозувального ствола підйомного модуля і у всіх подальших секціях підрозувального ствола підйомника передбачені опорні консольні виступи. Ригелі фіксатору підйому розміщені на горизонтальних опорних площадках з можливістю переміщення в горизонтальній площині. Горизонтальне переміщення ригелів фіксатору підйому забезпечують гідроциліндри, закріплені в торцях площадок. При виштовхуванні оголовків ствола підйомника, ригелі фіксатору підйому знаходяться в початковому положенні, при якому опорні консольні виступи оголовків стволів підйомників безперешкодно піднімаються вище рівня розміщення ригелів фіксатору підйому. Після підйому консольних виступів оголовків ствола підйомника вище рівня ригелів фіксатору підйому, виконують горизонтальне переміщення ригелів фіксатору підйому до моменту, поки ригелі фіксатору підйому не опиняться під консольними виступами оголовків ствола підйомника.

Наступний крок – опускання оголовків ствола підйомника до моменту спирання консольних виступів оголовків ствола підйомника на ригелі фіксатору підйому. Після передачі навантаження від піднімаемого покриття на ригелі фіксатору підйому, опорні площадки підйомного модуля переміщують в початкове положення.

На опорні площадки підйомного модуля подають другу секцію підрозувального ствола. Переміщення другої секції ствола підйомного модуля опорною площадкою підйомника між вертикальними напрямними профілями виконують до моменту дотику верхньої поверхнею другої секції ствола підйомника нижньої поверхні оголовка ствола підйомника. При подальшому вертикальному переміщенні опорних площадок підйомника, навантаження від піднімаемого покриття передається на підрозувальний ствол підйомного модуля. Звільнені від навантаження, ригелі фіксатору підйому можуть бути переміщені в початкове положення. Таким чином забезпечується безперешкодний підйом консольних виступів другої секції підрозувального ствола підйомника вище рівня розташування ригелів фіксатору підйому. Надалі, після горизонтального переміщення ригелів фіксатору підйому під консольні виступи другої секції ствола підйомника, виконують опускання консольних виступів другої секції ствола підйомників на ригелі фіксатору підйому. Звільнена від навантаження, опорна площадка підйомного модуля може бути переміщена в початкове положення для підрозування наступних секцій ствола підйомника.

Процес почергової передачі навантаження від піднімаемого покриття на підрозувальний ствол підйомника та ригелі фіксатору підйому продовжують до моменту досягнення покриттям проектної висоти. На завершальній фазі підйому остаточне висотне положення опорних рам покриттів для закріплення на оголовках колон забезпечується, дистанційно керованим, мінімальним «підніманням-опусканням» оголовка підрозуваного ствола підйомного модуля. - *Післяпідйомний етап*. Після закріплення опорних рам покриття на оголовках колон

виконують демонтаж секцій ствола підйомного модуля. В процесі опускання секцій ствола підйомного модуля навантаження від демонтуємих секцій почергово сприймають ригелі фіксатору підйому та опорні площадки підйомних модулів.

При використанні пропонуємого підйомного модуля процеси підрозування секцій стволів підйомників сконцентровані на рівні фундаментів, навантаження від ригелів покриття, що піднімається, передається на фундаментну плиту через гідропідйомники або через колони, на яких в нижньому висотному рівні закріплені горизонтальні площадки ригелів фіксаторів підйому. Всі процеси по підрозуванню секцій стволів підйомників виконуються в автоматичному режимі. Керування процесами підйому виконують оператори, командний пункт яких розташований за межами зони монтажних робіт.

Висновки

- на закладі аналізу відомих варіантів підйому великопрогонових покриттів методами виштовхування та підтягування був визначений напрямок вдосконалення організаційно-технологічних і конструктивно-технічних рішень, а саме, утворення несучого каркасу в одному монтажно-технологічному етапі з укрупненням покриттів в конструктивно-технологічний блок на низьких ристуваннях (висота до 2м), забезпечення вертикальності підйому покриття за рахунок переміщення опорних покрівельних ригелів між спареними несучими колонами зі спиранням на оголовки підрозувальних стволів підйомних модулів, вертикальність переміщення підрозувальних секцій стволів підйомників забезпечується напрямними вертикальними профілями, закріпленими на внутрішніх поверхнях спарених колон;

- зменшення процесів, в яких задіяні монтажники під час підйому конструктивно-технологічного блоку покриття, до операцій по фіксації опорних ригелів покриття на оголовках проектних колон на завершальній фазі підйому;

Список літератури

1. Нижниковский Г.С., Гуревич Э.И., Ланда С.Л. и др. Крупноблочный монтаж промышленных зданий и сооружений: Киев, Будівельник, 1979, 256с.
2. Черненко В.К., Осипов О.Ф., Тонкачев Г.М., Назаренко І.І. Технологія монтажу будівельних конструкцій. За редакцією Черненко В.К., Київ, Будівельник, 2011, 374 с.
3. Колесник Л. А., Шнайдер А. И., Черненко В.К. и др. Крупноблочный монтаж строительных конструкций: Киев, Будівельник, 1990, 320 с.
4. Назаренко В.Ф., Сытник Н.П., Николаев В.В., Гидроподъемные установки на монтаже большепролетных конструкций: Киев, Монтажные и специальные работы в строительстве. Научно-практический журнал. 1986, №5, С.15-20.
5. Черненко В.К., Собко Ю.Т. Дослідження основних технологічних показників, що впливають на

безкранові методи піднімання структурних покриттів: Київ, Нові технології в будівництві. Науково-технічний журнал. 2016, №36, С.50 – 55.

6. Федоренко П.П., Шкромада А.А. Индустриальные методы строительства промышленных предприятий: Киев, Будівельник, 1988, 200 с.

7. Fligier, K., Rowinski, L. (1977). Montaz zintegrowanych konstrukcji budowlanych. Warszawa: Pansnwowe wydawnictwo naukowe, 128.

8. Rühle, H., Kühn, E., Weissbach, K. (1978). Priestorové strešné konštrukcie. Bratislava: Vydavateľstvo ALFA, 328.

9. Ziólko, J., Orlik, G. (1980). Montaż konstrukcji stalowych. Warszawa: Arcady

Salimova A.T.

fəlsəfə doktoru, dosent AzMİU (Azərbaycan)

REFLECTION OF ANCIENT CULTS IN AZERBAIJANI ART

Salimova A.

PhD, Dosent, AzUAC (Azerbaijan)

DOI: [10.5281/zenodo.11624380](https://doi.org/10.5281/zenodo.11624380)**Xülasə**

Əcdadlarımızın təfəkküründə bizdən gizlənən arxetipin məntiqi ən bariz şəkildə dekorativ-tətbiqi sənətdə və memarlıqda özünü göstərirdi. Cənnət və Yer rəmzləri mədəniyyət aləminə üzvi şəkildə toxunmuşdur - insan səmaya baxmaqla məkanı və vaxtı ölçməyi öyrənmişdir. Əvvəlcə həndəsi simvolizmdə ifadə olunan mənəvi prosesin mahiyyəti və məqsədi simvolik və tətbiqi funksiyaları yerinə yetirən çoxsaylı variasiyalara səbəb olmuşdur.

Abstract

The concealed logic of archetypal thought among our ancestors is most vividly manifested in decorative arts and architecture. Symbols of the Sky and Earth are organically woven into the cultural world—by observing the sky, humanity learned to measure space and time. The essence and purpose of the spiritual process, initially expressed through geometric symbolism, gave rise to numerous variations that serve both symbolic and practical functions.

Açar sözlər: Azərbaycan, Göy Tanrı, "babil" işarəsi, kult, kainatın üç hissəli şəkli.

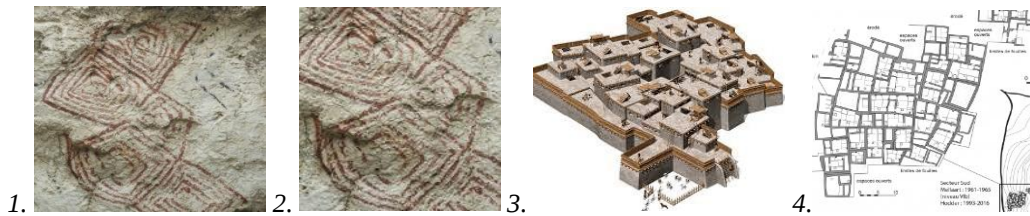
Keywords: Azerbaijan, Gok Tanry, "Babylon" symbol, cult, tripartite cosmology.

Bu günə qədər gəlib çatmış ayin və mərasimlər bəşər mədəniyyətinin nadir təbəqəsini təmsil edir. Son onilliklərdə əcdadlarımızın müqəddəs həyatı mövzusu xüsusi aktualıq qazanmışdır. Bu, əsasən yeni arxeoloji materialların və tədqiqatların ortaya çıxması ilə bağlıdır. Göy Tanrıya inam göylə yerin birliyi haqqında qədim fikirlərdən qaynaqlanır. Qədim insanın dünya mənzərəsi kainatla sıx qarşılıqlı əlaqədən formalaşmışdır. Belə ki, onu əhatə edən mikrokosmosda makrokosmik münasibətləri təqlid edən strukturları yenedən yaratması təəcəbblü deyil. İncəsənət əvvəlcə sinestetik xüsusiyyətlərə malik idi - onun növlərinin hər biri sinesteziya ilə xarakterizə olunur. Sinesteziya sayəsində incəsənətdə vahid bədii məkan anlayışının universallığını və qarşılıqlı təsir göstərən sənətlərin problemini izah etmək mümkündür.

Hər bir fərdi sənət forması özünəməxsus xüsusiyyətlərə malik olan öz sinestetik bütövlüyünü formalaşdırır. Belə simvolik elementlərə "Babil" işarəsi - bir-birinin içərisində çəkilmiş bir neçə düzbucaqlı təsviri daxildir. Kiçik Asiyada neolit dövründə belə bir simvol Yer in əlaməti idi: "onun mərkəzini təcəssüm etdirən müqəddəs bir dağın timsalında" [12, s. 131]. "Babil" təsviri Azərbaycan, Türkiyə, İran, Şimali Qafqaz, Dağıstan, Bolqarıstan ərazisində tapılıb. O, ziqqurat və ya piramida planına bənzəyir [12, s. 131]. Mifoloji olaraq Kainat üç mərtəbə ilə təmsil olunurdu - Cənnət, Yer, Cəhənnəm, bir-birlərinə mərkəzi ox ilə bağlıdılar. Üç kosmik sferanın vəhdətini və əlaqəsini ifadə edən simvolizm çox mürəkkəb və ziddiyyətlidir ki, bu da onun min illər ərzində dəyişdirilməsi və zaman keçdikcə sonrakı kosmik simvolizmlərə

çevrilməsi ilə izah olunur. H.Heyrman hesab edir ki, sinesteziya sənətin bütün növlərində özünü biruzə verir, çünki sinesteziya "mənanın psixoloji vahidi" vasitəsilə sənəti birləşdirən vasitədir. Sinesteziya ümumi cəhətlərə və analogiyalara, eləcə də metaforalara işarə edə bilər [34]. K.Yunqun fikrincə, ilkin mifoloji obrazlar - arxetiplər düşünülmədən yaradılırdı, mənaca bənzər idi, bir-biri ilə əlaqəsi olmayan mifologiyalarda rast gəlinirdi, bu da, onların bir-birindən köçürülməsi izahını inkar edir. [20, s.110]. Qeyd etmək lazımdır ki, Almaniyada "Babil" dedikdə Ağ dəniz bölgəsinin labirintləri daş halqalı kurqanlar nəzərdə tutulur. [12, s.131]. Azərbaycan, Dağıstan və Şərqi Avropadakı "Babil"lərin təsvirlərini müqayisə edən Ariel Qolanın fikrincə, Qobustan variantı ən qədimdir. [12, s.131]. Bundan əlavə, Qala (Abşeron) kəndində mərkəzi altı çəkilmiş üç kvadratin təsviri aşkar edilmişdir (daş üzərində Yekəxana kəndində, Göyçay rayonu) və s. Həmçinin Muğla (Türkiyə) ərazisində qayalarda, Batmandan (Türkiyə) qəbir daşlarında, Çara Təpə (İran) qayalarında da rast gəlinir.

Gəmiqaya (Naxçıvan, Azərbaycan) petroqlifləri arasında araba, yaşayış tikililəri, Babilin təsvirləri kimi şərh edilə bilən düzbucaqlı təsvirlər vardır. Ən maraqlısı Gəmiqaya 498 daşı üzərində üç həkk olunmuş düzbucaqlının təsviridir (ümumiyyətlə, burada xronoloji diapazon eramızdan əvvəl IV minilliyin sonu - I minilliyin əvvəlləri daxil olmaqla - Tunc və Erkən Dəmir dövrlərini əhatə edir). Oxşar təsvirlər Çatal Höyükda var və yaşayış binaların planına bənzəyir [26, s.35].



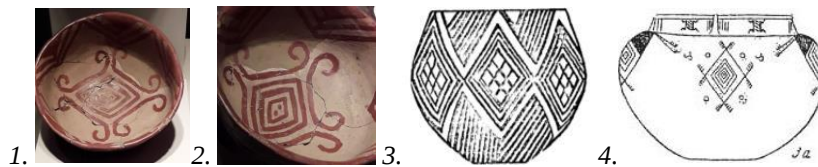
1-4. Çatal Höyük

Bəzi tədqiqatçılar "Babillər" təsvirlərinin labirintlərlə əlaqəli olduğunu düşünürlər [7, s. 21-23]. Tamamilə mümkündür ki, "Babil" semantik cəhətdən Azərbaycanın və Dağıstanın maddi mədəniyyət abidələrində təsvirinə tez-tez rast gəlinən labirintlə bağlıdır. Həm "labirint", həm də "Babil" simvolunun "yeraltı dünya tanrısı" qala evinin təsviri olduğuna dair bir fikir var. [12, s. 132]. Başqa bir versiyaya görə,

Babillər – qədim memarların binaları işarələmək üçün istifadə etdikləri cizgilərdir. Beləliklə, Rıbakovun fikrinə, "Babillər" in həndəsi quruluşu qızıl bölgünün ahəngdar hissələrini ehtiva edir və yaqin ki, tikinti işləri zamanı mütənasiblik aləti kimi istifadə edilmişdir. Eyni fikrə Bolqarıstan memarlığının tədqiqatçıları G.M. Davletşin və F.Ş. Xuzin də gəlmişlər [13, 26, s. 34].



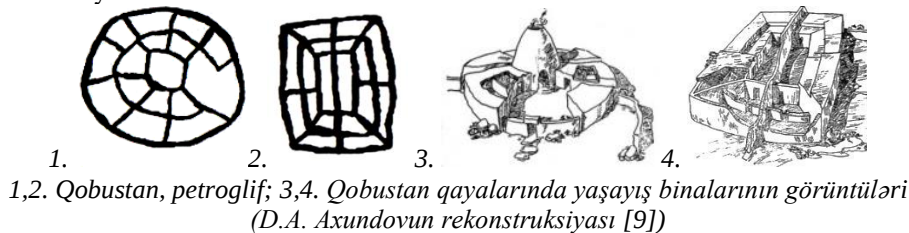
Petroqliflər. 1. Qobustan. Böyükdaş. Daş-23 (İ.Cəfərzadə, 1973-cü il); 2. Abşeron, Qala kəndi; 3. daş, Yekyaxana kəndi, Göyçay rayonu; 4. Xəlil Baba məqbərəsi, Siyəzən rayonu [26, s. 34]



1-3. Boşqablar, Hacılar kəndi.e.ə. 6000-ci il, Anadolu Sivilizasiyası Muzeyi, Ankara (Türkiyə); 4. Xanlar, Azərbaycan, Tunc dövrü

Dunay Bolqarıstanında məşhur zadəgan Mostişin (X əsrin ortaları) qəbir daşında və Pliskada qədim daşlardan birində "Babil" kvadratı (7-ci əsrin sonu-IX əsrlər) təsvir edilmişdir [13]. Dağıstanda "babillər" qayalarda və yaşayış binalarında olur, hətta cüzi dəyişikliklə onlar oyunlar üçün istifadə olunur; [5]. Şolde-Teyada (Tıva, Rusiya) yerin səthində cığırqlarla hissələrə bölünmüş şaquli yerləşdirilmiş kiçik daşlardan ibarət müntəzəm düzbucaqlı aşkar edilmişdir. Onun şimal-şərqdəki xəttinin ucu dairə-"ruhlar evi" kimi təsvir edilir [18, s. 46; 19, 77-109; 14, s. 32]. Muğur-Sarqol və Aldı-Mozaqada (Tuva, Rusiya) daxili xətlərlə bir neçə hissəyə bölünmüş düzbucaqlılar şəklində çoxsaylı həndəsi fiqurlar məlumdur [19, s. 77-109]. Bu təsvirləri nəzərdən keçirən M.Kilunovskaya onları ev kimi təəvvür edir:

"yaşayış yeri" və ya "ruhların məskənləri": Orta Asiyada Son Tunc dövründə geniş yayılmış daş tikililər kontekstində olan "Yaşayış yerləri"-içərisi xətlərlə və ya, nöqtələrlə doldurulmuş düzbucaqlı həndəsi fiqurlardır. [18, s. 46]. Eramızdan əvvəl 6-cı minillikdən 1-ci minilliyə qədər inkişaf edən əkinçilik və heyvandarlıq dövrünün qədim yaşayış məskənlərinin memarlığına xüsusi diqqət yetirmək istərdim. Azərbaycan ərazisində tapılan bu dövrə xas (Kül-təpə, e.ə. V-IV min, Naxçıvan; Şomu-təpə, e.ə. VI - V min, Qazax vilayəti) [8, s.14] təsvirlər Qobustan və Gəmiqaya petroqliflərindəki təsvirlərə bənzəyir. D.A.Axundov Qobustan qayalarındakı təsvirlərin qədim kəndlərin (Şomu-təpə, Toyra-təpə) plan həllərilə oxşarlığını da vurğulayıb. [8, s. 15-30].



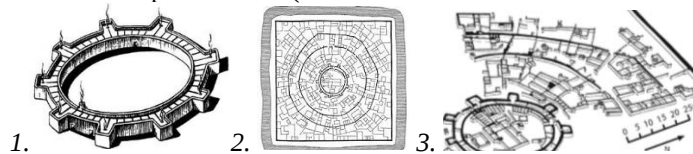
1,2. Qobustan, petroqlif; 3,4. Qobustan qayalarında yaşayış binalarının görüntüləri (D.A. Axundovun rekonstruksiyası [9])



1. Muğla. Türk gaya resimleri 2. Alıçlı. Batman Kozluk mahalı; 3-4. Qəbir daşı. Meşkin. Ərdəbil (İran Azərbaycanı)

Qeyd etmək lazımdır ki, “Babillər”in təsvirləri əsasən ziqquratın planı ilə eynidir. Mesopotamiyada ziqqurat dünyanın mərkəzində dayanan müqəddəs dağın reproduksiyası idi, yəni “yerin göbəyi”. Ziqqurat göylə yer arasında əlaqə idi [24]. Ziqquratlar İraqda (Borsippa, Babil, Dur-Şarrukində - e.ə. I minillik) və İranda (Çoqa-Zənbil, 2-ci minillik) qorunub saxlanılmışdır. Maraqlı təsvirləri Təpə-Sialkdan (e.ə.

3000-ci il; Kaşan, İran) tapılmış polixrom keramika üzərində də görmək olar. Fars mifologiyasında Varanın səhabələrinin məskəni kvadrat formasındadır; bu təsvir əsasən zahirində xaos və ölümlə dolu olan bir dünya ilə ziddiyyət təşkil edən daxili kvadrat ideyasını əks etdirir. Bu kompozisiyaya ən çox Şirvan-Quba məktəbinin xalçalarında rast gəlinir.



1. 2. 3. Dashly-3. e.ə. XVII əsr. Əfqanıstan [36]

Daşlı-3 xüsusi diqqətə layiqdir. e.ə e. Arxeoloqlar arasında onun məqsədi ilə bağlı fikir birliyi yoxdur. Daşlı-3 yaşayış məskəni bir neçə əsrlər boyu mövcud olub, 600 nəfərə qədər yerləşə bilən 130 x 150 m ərazini tutub. Maraqlı faktlar, məsələn: dairəvi plan, dolama dəhliz, binanın xarici perimetri boyunca doqquz “qüllə”-nin təşkili, adətən məbədlərə xas olan bir kult fokusunun olması.

Bəzi təsvirlərin simvolu digər bir semantik paraleli xatırladır - mandala simvollarını. Burada Azərbaycan xalça sənətinin ornament xüsusiyyətlərini nəzərə alaraq, əsas semantik elementi - “gölləri” qeyd etmək olar ki, bu da, Orta Asiya və Türkiyə xalçalarına aiddir. Türk xalçalarının göllərində dərin kosmik mənalar var. Azərbaycan incəsənəti abidələrinin həndəsi bəzəyində də göllər şərh edilmişdir. Qeyd edək ki,

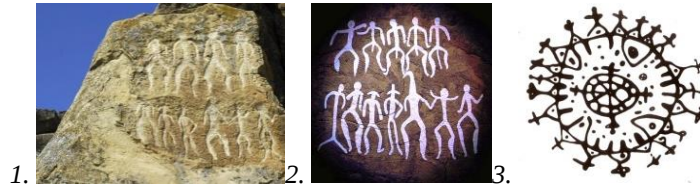
Quba (Azərbaycan) toxucuları medalyonları – orta ölçülü gölləri “çarhovuz” (hovuz), onun üzərində yerləşən elementləri “ördək” adlandırırlar. [17]. Bu təəccüblü deyil, çünki mifoloji Göy Tanrısının iradəsi ilə “insan oğullarının” məskunlaşdığı yerin -Orta Tenqri dünyasının əsas tanrısı “Müqəddəs Torpaq-Su” hesab olunurdu. [10]. Həmçinin Azərbaycanda tunc dövründən qalmış məşhur zərgərlik məmulatları - Ayın təsviri ilə bağlı iç-içə üç dairəvi elementi olan həmayil-boyunbağı və ya, çevrələr - mərkəzi aydın şəkildə görünərək üç dairə ilə əhatə olunmuş təsvirlər də maraqlıdır. Oxşar bəzəklər Sarmato-Alanda da geniş yayılmışdır. Qədim iranlılar arasında yeri üç dəfə genişləndirən günəş qəhrəmanı Yımanın əfsanəsinə uyğun olaraq müqəddəs məkanı təşkil etmək üçün üç konsentrik dairədən istifadə edilirdi.



1,2,3. Dekorativ boyunbaqlar [30]. Nərgizava (Azərbaycan); 4-5. Qəbir daşı, Kəngəmiran kəndi, Azərbaycan (Lerik rayonu)

Bənzər bir kompozisiyanı Arkaimin memarlığında (Orta Tunc III-II min e.ə.) görürük. [6]. **Göbəkli - Təpə də (Türkiyə)** demək olar ki, eyni plana malikdir. Oxşar ənənə Kiçik Asiya mənşəli Etrusk məbədində də var - müqəddəs məkanın bütün hissələrinin ibadətəgahın üfqi müstəviyə proyeksiyası kimi qəbul edilən və Kainatın şaquli oxu ilə birləşdirilmiş üç dairəvi pillədən - göy, yer və yeraltı dünyadan ibarət ideal məbəd. [11, s. 58]. Oxşar kompozisiya quruluşu tarixi İslam şəhərlərinin təməlində dayanır, harada ki, inkişaf müqəddəs mərkəzdən periferiyaya – ibadətəgah mərkəzi olan qala, yaxud içəri şəhərdən xaricə doğru gedirdi. Belə bir kompozisiyanın kökləri həm də mənəvi dünyanın üçlüyünü əks etdirən Göy Tanrı anlayışının

ifadəsi sayıla bilər. Tenqrizm eyni zamanda Kainatın üç zonasına vurğu ilə xarakterizə olunur: səmavi, yerüstü və yeraltı [31]. Səmavi dünya “üç, doqquz və ya, daha çox üfqi pillələrdən ibarət idi, onların hər biri bir tanrının məskəni idi; sonuncu pillə Səmanın Böyük Ruhuna - Göy Tanrısına aid idi” [31]. Səmada atlara minən insanlara qarşı yüngül və xeyirxah tanrılar və ruhlər var idi, buna görə də atlar onlara qurban verildirdi. [31]. Heyvandarlıqla bağlı iş, təbiətin ilahiləşdirilmiş qüvvələrinə sitayiş və əcdadların ayinləri ilə əlaqəsi olan təbii ritmlərdən asılı (vaxt, fəsillərin ardıcıl dəyişməsi və səma cisimlərinin hərəkəti) bütün rituallar, mərasimlər, bayramlar birbaşa və ya, dolayısı yolla həyatın uzadılmasına yönəldilmişdi [31].



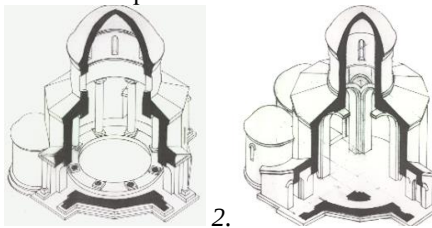
1,2. Yallı. Qobustan petroqlifi (Apşeron, Azərbaycan); 3. Zərövşən. Tacikistan. Tunc dövrü

Bir çox qədim xalqlar arxaik "dairəvi rəqsləri" - qoruyub saxlayıblar: deyə bilərik ki, onlar meditasiyanın xüsusi formalarına əsaslanır. Bütün dünyada ibtidai ritualların əsasında səmavi simvolizm və səmavi gücə inam dayanır: odun, qurbangah və ya büt ətrafında dairəvi rəqslər və yurdların, çadırların dairəvi formaları; fırlanan şamanlar; meqalitik işarə və strukturların dairəvi quruluşu. Şübhəsiz ki, "dairəvi rəqslər" ilə göy cisimlərinin Günəş ətrafında hərəkəti ilə səma tanrısına – "Göy Tanrı"ya pərəstiş arasında əlaqə var. Bu cür "sirlər" ali dini biliklərin mövcudluğunu, eləcə də vəcd halında yenilənməni – bir tərəfdən paklaşmanı, kəffarə qurbanlarını nəzərdə tuturdu; yürüşlər, mahnılar, rəqslər və ekstazın müxtəlif təzahürləri isə simvolizm və allegoriya elementləri ilə sirlərin əsas məzmununu təşkil edirdi. Qədim Yunanıstanın bir çox müəmmaları hələ də öz sirlərini qoruyub saxlayır. Qədim yunanlar yay gündönümündə bir sıra rəqqasların ilan kimi qıvrıldığı "od" rəqsi ifa edirdilər. [12, s. 31]. Qurbangahın ətrafında dairəvi ritual hərəkətlər də zərdüştilərin ənənəvi rituallarına daxil idi [4, s. 56-57]. Svan mədəniyyətində üç pilləli dairəvi rəqs var: "on iki rəqs edən adamdan ibarət dairədən formalaşmış, hər biri iştirakçını qabaqda kəmərdən tutur; dairəvi rəqsin ikinci pilləsi birincinin çiynlərinə, üçüncü pilləsi ikincinin çiynlərinə söykənir. [29, s. 101]. Bir çox xalqların mədəniyyətində qorunub saxlanılan arxaik dairəvi rəqslər indi də şənliklər zamanı keçirilir. Xüsusi qrupa türk xalqlarının kollektiv rəqsləri daxil edilməlidir - bunlara Orta Asiya, Sibir və Anadolu xalqları daxildir. Bu gün də geniş yayılan Azərbaycan milli rəqsi "Yallı"nın tarixi çoxəsrlik tarixə malikdir. Qobustanda mezolit dövrünə (e.ə. 8-ci minillik) aid olan, rəqs edən insanları təsvir edən petroqliflər buna sübutdur. Gəmiqayanın (Kəlbəcər rayonu, Azərbaycan) görüntüləri arasında kollektiv rəqs səhnələri də qeydə alınıb [3, s. 175]. Maraqlıdır ki, Naxçıvandan götürülmüş tunc dövrü keramika məmulatlarında da rəqs edən insanları təsvir edən kompozisiyalara rast gəlinir. [3, s. 35]. A.Ələkbərova "yallı"nın ritual hesab edir, rəqsin bütün hərəkət və ritmləri öz orijinal formasında qorunub saxlanılıb, burada əsas qüvvə

ritmdədir. [2, s. 10-11]. Bir qayda olaraq, Azərbaycan rəqsi üç hissədən ibarətdir: birinci hissə dairəvi hərəkət, ikinci hissə yerində lirik dönmə (süzmə) və üçüncü hissədə yenidən dairəvi hərəkət, lakin daha sürətli və daha çox təntənəli şəkildə.

Dairəvi ritual rəqslər səs ritmi ilə müşayiət olunur - bura əl çalmaq, ayaqları şamplamaq, insan səsi, həmçinin müxtəlif zərb alətlərindən istifadə daxildir. Musiqi müşayiəti çox ritmikdir, getdikcə daha sürətli olur. Yallı rəqsi sürətli temp və ritmlə səciyyələnir: yavaş ritmlə başlayır və temp tədricən artır. Qobustanlılar ayınların rəqsi zamanı Qobustan ərazisində Cingirdağ dağının ətəyində və Böyükdaş dağında yerləşən "qavaldaş" daşından istifadə edirdilər. Xalq arasında Cingir-baba adlanan Cingirdağ dağı 19-cu əsrin əvvəllərinə qədər ziyarətə gələn idi. Alimlərin fikrincə, qavaldaş insanlara yuxarı paleolitdən məlumdur. Qaval daşı nəhəng əhəng daşındır - onu ritmik vurmaqla aydın motivli mahnılar çalmaqla olur. Zərbənin vurulduğu sahədən asılı olaraq üç rezonansda müxtəlif yüksəklikli səs yaranır [1, s. 33].

Dairəvi rəqslər dünya dirləri yaranandan sonra da öz simvolikasını saxlamışdır. Belə ki, sufilərin ritual rəqsi ulduzların hərəkətini təkrarlayır, Kainatın simvolik quruluşuna əsaslanır və "Allahı dərk etmək yolunu" təmsil edir. [4, s. 56-57]. Sufi dərvişlərinin rəqsi öz oxu ətrafında fırlananların özlərini Allaha yaxınlaşdırdıqları düşüncədir. Yəni də rəqs nağara, fleyta və qavalın müşayiəti ilə təmsil olunur. Onu da qeyd etmək lazımdır ki, bu mənəvi təcrübənin bütün bədənə sağlamlığına müsbət təsiri vardır. Ritual dairəvi rəqsləri öyrənərkən, rəqs hərəkətinin gedişatına diqqət yetirə bilərsiniz - burada konsentrik və spiralvari elementlərdən istifadə edilir. Bu, həm bir nöqtə (rəqqas), həm də vahid mərkəz ətrafında hərəkətin sintezində özünü göstərir. Prosesin qurulması prinsipi cisimlərin dairəvi hərəkətilə təcəssüm olunan atəşə qarşı ayınlərlə bağlı arxetipik obrazları özündə əks etdirən dinamikadadır - əsas parametrlərə görə onlar "təsəvvüf" və "şiə"liyin yeddi pilləli" ucaltma ritualları ilə üst-üstə düşür [29, s. 78].



1. Qafqaz Albaniyasının mərkəzi günbəzli kilsələri. Kilsədəğ (II - III əsrlər, Kabala rayonu) və Mamrux məbədləri (III - IV əsrlər, Kutkaşenski rayonu)

Kainatın mənzərəsini çoxmərhələli quruluş şəklində nəzərə alan əcdadlarımız öz dini-memorial strukturlarını pilləli formalarda yaratmışlar. Şərq

memarlığını təhlil etdikdə, bu ideyaya mütənasib kromlekləri, Sasani İranının dörd sütunlu od məbədlərini, son antik Şərq və erkən xristian

memarlığının memorial sallaxlarını, eləcə də Şimali və Cənubi Azərbaycanın müqəddəs atəşə ehtiram edilən çoxsaylı mərkəzi ibadətqahlarını qeyd etmək olar. Onların tərkibi çoxpilləli qüllə quruluşuna malikdir, çox vaxt günbəzlə vurğulanıb. Kainat sisteminin məkan qavrayışı məbəd məkanlarının şaquli inkişafına və üfüqi dərinliyinə təsir etdi. Qafqaz Albaniyasındakı (Azərbaycan) mərkəzi günbəzli, pilləli Xristian kilsələrini təhlil edərkən – burada aşağı səthinin dairəvi yerləşmiş oyuqlardan, yuxarı səthinin isə binanın mərkəzinə doğru yüksələn və zirvəsində günbəz qoyulmuşdur konstruksiyasına rast gəlirik [27, s. 12-14]. Onları şaquli bölgü kompozisiyalarındakı zamanın müntəzəm cəhətini əks etdirən vahid mərkəzə doğru yönəlmiş “zaman və məkan quruluşu ideyası” əsasında bərpə etmək olar.

Bu cür mərkəzlilik, konsentriklik və ritmiklik sistemi ən qədim arxaik musiqi forması sayılan – muğamatda (dəstgah) da özünü göstərir. Azərbaycan muğamı öz quruluşunda özünəməxsus dramaturgiyaya malik bütöv bir kompozisiyadır - giriş, işlənmiş süjet xətti, kulminasiya nöqtəsi və yekun [29, s. 13]. Muğamın quruluşu ilkin səs tonlarınadönüş edərək, getdikcə səs axınının yuxarıya doğru dairəvi hərəkətini xatırladır [29, s. 42]. Tədqiqatçıların fikrincə: “Muğam-dəstgah kompozisiyasında konstantlıq “yeddi pillə”nin ritmik formuluna və modallıq prinsipinə çevrilən daxili prosesin dinamikası ilə ifadə olunur” [29, s. 52]. Azərbaycan muğamı türk taksimləri, İran dəstgahları, uyğur muğamları, özbək-tacik şaşmaqamları, ərəb maqomları, hind raqaları və s. kimi şərq musiqi ənənələri ilə ümumi kompozisiya xüsusiyyətlərinə malikdir. Kosmik ayin hərəkətləri təkamül nəticəsində muğamı ritmik piramidal

konsepsiyaya çatdırmışdır. Məhz mənəvi yüksəlişin ritmik təşkilatında - ucalığa doğru gedişatında ritual təcrübə, ayin formaları, miflərin, əfsanələrin, bir sözlə, nəsilərdən miras qalan bütün mənəvi sərvətlərin zaman keçdikcə muğam-dəstgahında saflaşaraq təməlli formaya çevrilməsi məsələsi durur [29, s. 74]. Azərbaycan xalq musiqisinin əsasını təşkil edən ladlar beş növ tetrakordun birləşməsindən formalaşmışdır. [32, s. 15-17]. Fərhadova S.M. hesab edir ki, “Muğam, ilk növbədə, mənəvi prosesdir, xalqın təfəkkürünü formalaşdırıb, dinamikasını qoruyan aparıcı bir qüvvədir” [29, s. 16]; musiqi vasitəsilə düşüncə prosesinin universallığının və konseptuallığının təzahürüdür [29, s. 17]. R.Zöhrabovun fikrincə: Azərbaycan “muğamları maddi-mənəvi mədəniyyətimizin ən qiymətli abidəsidir” [16, s. 69].

Kompozisiyanın mərkəzdən çiçəklənməsinin universal prinsipini muğamın bütün səviyyələrində tək seqmentdən - ritm-intonasiyasından tutmuş bütövlükdə formaya qədər izləmək olar [29, s. 52]. Dairə içində dairə, kvadrat içində kvadrat, açılan spiral kimi həndəsi şəkildə ifadə edilən mənəvi prosesin simvolik obrazları xalqımızın mədəniyyətində özünü göstərən vahid semantik nüvənin böyüməsi konsepsiyasını ehtiva edir və gördüyümüz kimi, mədəniyyətimiz dünya nizamının kosmik qavrayışı olan “dairələr nəzəriyyəsi”nə əsaslanır. Ritmik dairələr nəzəriyyəsi orta əsrlər musiqi elminin əsasını təşkil edir. Nəzəriyyəçi və bəstəkar Səfiəddin Urməvi (təxminən 1217-1294) “Kitab-ül-ədvər” əsərində də musiqinin ilk növbədə ritmik şəkildə təşkil olunmuş kosmik proses olduğunu qeyd etmişdir: “Uca Allah göyləri yaradaraq, fırlanmalarını əmr etdi. Səslər onların fırlanmasından yaranır və bu səslərə “mənəvi melodiyalar” deyilir [29, s. 63].



1.2. Şəbəkə və ornament, Şəki Xan sarayı, Azərbaycan . 3.4. Urməvi, Güney Azərbaycan, 5, 6 . Şirvan xalçası, Azərbaycan; 7. Quba Xalçası (Azərbaycan)

Qobustanda təsvir olunan "Babil" işarəsi ən qədim hesab olunur. Qədim yaşayış məskənlərinin (Kül-tepe, Şomu-tepe, Azərbaycan) memarlığı Qobustan (Azərbaycan) və Gəmiqaya (Azərbaycan) petroqliflərindəki təsvirlərə bənzəyir [26, s. 36]. Tunc dövrünün mənəvi aləminin üçqatlığını əks etdirən maraqlı zərgərlik əşyaları var. "Babil" simvolu, konsentrik dairələr kult memarlığında və şəhərsəlmada, həmçinin qəbir daşları və ornament şəklində tapılır. Övvəlcə həndəsi simvolizmdə ifadə olunan ruhani prosesin mahiyyəti və məqsədi (bir cadugərin və ya şamanın şəxsinə enerji mərkəzi ilə ritual dairəvi rəqsi, eləcə də bir şamanın qavalı kimi) yalnız simvolik deyil, həm də tətbiq olunan funksiyaları yerinə yetirən çoxsaylı dəyişikliklərə səbəb oldu [26, s. 36] “Babil” simvolu və konsentrik dairələrə dini memarlıqda və şəhərsəlmada, qəbir daşları üzərində və ornamental sənətdə rast gəlinir. Bu simvollar müxtəlif ərazilərdə eyni dövrdə yaranmış və nəsilərin

yaddaşında müxtəlif assosiasiyalar şəklində - dekorativ ornamentlər (xalçalar, rəngli vitrajlar – şüşə şəbəkə, daş şəbəkə), oyunlar və s. kimi qorunub saxlanılmışdır. Aparılan təhlil tam əminliklə təsdiq etməyə imkan verir ki, Azərbaycan ta qədimdən dünya kosmoloji təfəkkürünün formalaşma prosesinin vahid bir hissəsi olub. Burada Göy Tanrıya inam ən mərkəzi yeri tuturdu. İşarə komplekslərinin simvolikasının bərpası və dünyanın realizasiya edilmiş müxtəlif modelləri arasındakı semantik əlaqə əcdadlarımızın dini, kosmoqonik ənənələrinin əsaslarını üzə çıxarır. İbtidai sənətkarlıqda sinesteziya daha çox ibtidai cəmiyyətdə təbiətinə görə vəhdət təşkil edən dini səviyyədə ideyaların əlaqəsidir. İbtidai dövrün simvolik kosmoloji konsepsiyalarının spesifik kateqoriyaları məkan, zaman və hərəkətin vəhdəti haqqında ümumi fəlsəfi fikirləri əks etdirir. Biz dünya nizamının yenidən qurulması prosesində bütün sənət növlərinin icmasının

sinesteziyasını görürük. Rəsmlərin təhlili göstərir ki, maddi mədəniyyət abidələrinin dekorativ-tətbiqi bəzəyi Azərbaycan xalqının bütün həyatına sirayət etmiş, şifahi xalq yaradıcılığında, adət-ənənələrdə, dekorativ-tətbiqi sənətdə öz əksini tapmış ibtidai ayin və əfsanələrlə bağlı dəyişməz obrazlar çevrəsini ehtiva edir.

References

1. Abdullaeva, S.A. Folk musical instruments of Azerbaijan (musicological-organological research). - Baku: Elm, 2000. - 486 p. (in russian)
2. Alekperova, A. Round dances of the yalla of the Nakhichevan zone. -Baku, 1994. (in russian)
3. Aliev, V.G. Culture of the Middle Bronze Age of Azerbaijan. -Baku, Elm, 1991 (in russian)
4. Alieva, K.M. Sufi ideas and their reflections in carpet patterns. -Baku, 2001 (in russian)
5. Alimov, M. New version of the purpose of the "Babylons" discovered in Dagestan. <http://www.lezghins.com/>
6. Arkaim is an ancient city with a surprisingly high level of organization and developed culture. <http://gorodkazan.info/arkaim-drevnij-gorod-s-udivitelno-vy/>
7. Artamonov M.I. Medieval settlements on the Lower Don. -SPb, 1935 (in russian)
8. Akhundov D.A. Architecture of ancient and early medieval Azerbaijan. -Baku, 1986 (in russian)
9. Akhundov D.A. Temple lights in Azerbaijan./ Magazine "Mitra", 2004 (in russian)
10. Bisenbaev A.K. Myths of the ancient Turks. - Almaty, 2008 (in russian)
11. Boyko Yu.N. Temple of the city of Gelon. "Soviet Archaeology", No. 3. -M., 1990 (in russian)
12. Golan A. Myth and symbol. M., 1994 (in russian)
13. Davletshin G.M., Khuzin F.Sh. Bulgar civilization on the Volga. -Kazan, 2011 (in russian)
14. Devlet M.A. Stone "compass" in the Sayan Canyon of the Yenisei. -M., 2004 (in russian)
15. Devlet M.A. Petroglyphs at the bottom of the Sayan Sea. -M., 1998 (in russian)
16. Zohrabov, R. Mugam. (in Azerbaijani, Zöhrabov R.F. Muğam). -Baku, 1991 (in azerbaijani lang.)
17. Kerimov, L. Azerbaijani carpet. In 3 vols. Vol. 2. -Baku, 1983 (in russian)
18. Kilunovskaya, M. E. Chariots of the Bronze Age in the rock art of Tuva. On Sat. "Rock art in modern times. society." Vol. VIII. Volume 2. -Kemerovo, 2011 (in russian)
19. Kilunovskaya, M. E. Drawings on the rocks of Tuva. Sat. scientific works in honor of the 60th anniversary of A. V. Vinogradov. -SPb., 2007 (in russian)
20. Myths of the peoples of the world [in 2 volumes]. -M., 1991, vol. 1 (in russian)
21. Museibli, N. Gemigaya. -Baku, 2004 (in azerbaijani lang.)
22. Museibli, N.. Rock art of Gamigaya. "IRS" ("Heritage"), No. 7. - Baku, 2003 (in russian)
23. Neymatova, M.S. Memorial monuments of Azerbaijan (XII-XIX centuries). -Baku, 1981 (in russian)
24. Oparin, A.A. Religions of the world and the Bible. <http://nauka.bible.com.ua>
25. Rybakov, B.A. Architectural mathematics of ancient Russian architects. "Soviet Archeology" No. 1. -M., 1957 (in russian)
26. Salimova, A.T. "Babylon" sign in Azerbaijan // VII International Scientific and Practical Conference «World science priorities», November 23–24, 2023. - Vienna. Austria. -163 p. -pp.33-36 (in russian)
27. Salimova, A.T. Altars-sanctuaries of the Mother Goddess in Azerbaijan // "The scientific heritage" No. 125 (125). - Budapest, Hungary. - pp.12-14 (in russian)
28. Stepanov, A.V., Ivanova I.I., Nechaev A.A. Architecture and psychology. -M., 1993 (in russian).
29. Farkhadova, S.M. Historical roots of the Azerbaijani mugham-dasgah. -Baku, 2018. -224 p.
30. Artistic metal of Shirvan. -Baku. 2012 (in russian)
31. Shaidullina, L.D. Religious and cultural codes of the Turks of northern Eurasia and their continuity. <http://forum.turan.info>
32. Shikhaliev, I. Modal theory of Azerbaijani music. -Baku, 2005 (in russian)
33. Ebrahim Karimi Mobarakabadi. Rock Art of the Howz-Māhy Region in Central Iran. <https://www.researchgate.net/publication/298788369>
34. Heyrman, H. Art and Synesthesia: in Search of the Synesthetic Experience. Lecture on Art and Synesthesia. URL - <http://www.doctorhugo.org/synaesthesia/>
35. Shestak, I.Yu. Trance states in the mysteries of the ancient world. <https://russculture.ru/2020/09>
36. <http://architectureguru.ru/kruglyj-xram-nadashly-3/>

ECONOMY

ECONOMETRIC MODEL OF THE CYCLICAL FUNCTIONING OF THE NATIONAL ECONOMY IN THE LONG-TERM PERSPEKTIVE (ON THE EXAMPLE OF THE NATIONAL ECONOMY OF AZERBAIJAN)

Ayyubov M.

*Leading research fellow, Institute of Economics
Ministry of Science and Education of the Republic of Azerbaijan
<https://orcid.org/0000-0002-2255-1706>
DOI: [10.5281/zenodo.11624382](https://doi.org/10.5281/zenodo.11624382)*

Abstract

The article discusses the methodological foundations for the development of a “conjunctural-structural” macro-econometric model of the cyclical functioning of the country’s national economy. It argued that, along with various processes that are cyclical in the country’s economy, the country’s economy as a whole at the macro level operates in a cyclical mode. One cycle of functioning consists of the stages of development and decline in the rate of development, crisis, decline and stabilization. At the stage of development of the country’s economy, an intra-system economic threat to the state structure does not arise. Intra-system economic threats to the state structure manifest themselves at the stages of declining growth rates of economic development and crisis. Therefore, it is necessary to have tools with the help of which one could determine the time of formation of stages of declining growth rates and the manifestation of crisis situation in the country’s economy. We believe that by developing a “conjunctural-structural” macro-econometric model of the cyclical functioning of the country’s national economy, it is possible to determine the possible time of onset of economic threats to the state structure and prepare a program for eliminating threats beforehand.

Keywords: cyclical economic process; econometric model; cyclical functioning of the country's national economy; “conjunctural-structural” macro econometric model; economic threats to the state structure.

Methodology. The research methodology is a systems approach, the basic principles of the general theory of dynamic systems. To compile a “conjunctural-structural” equation for a macro-econometric model of the cyclical functioning of the country’s national economy, the author of the article has developed a methodology based on statistical-economic, calculation-constructive, econometric methods of cognition.

Based on the research methodology developed by the author of the article, an algorithm for performing calculations to compile a “conjunctural-structural” equation of a macro-econometric model of the cyclical functioning of the country’s national economy constructed.

Introduction. Since the mid-19th century, many scientific works published explaining the essence and content of cyclical processes of various durations in the country's economy. The American economist, representative of the neoclassical economic school E.H. Hansen in the 30s of the last century systematized ideas about the economic cycles occurring in the national economy of the country [1]. In modern macroeconomic theory, related to investments directed into the national economy of the country, the following cycles are distinguished:

1. The role of growth and decline in investment volume.
2. Analysis of the dynamics of factors determining the volume of investment: graph of the limits of investment efficiency suitable for interest rates.
3. Dynamics of technical, natural resource, territorial factors, as well as population growth factors that determine the volume of investments and their impact on the cyclical nature of the functioning of the country’s economy.

4. Chain characteristics of investments related to the development of innovations, scientific, and technological progress (Schumpeter);

5. Long-term production of elements of fixed assets, the impact of the durability of fixed capital on economic systems.

6. Initial impulses that create economic processes caused by economic growth, which have an oscillatory, cyclical nature.

Also, in economic theory, there are several types of macroeconomic cycles, differing in the duration of the periods. Modern concepts of macroeconomic cycles of various durations can be grouped as follows.

1. Short-term cycles with a period of 3-5 years. 3-5-year short-term cycles include: the life cycle of manufactured products (service life of product types) Schumpeter, associated with innovation; K. Kitchen’s cycles associated with world gold reserves and vital material reserves; cycles of K. Marx and E. Hansen of uneven reproduction of working capital in the country’s economy.

2. Medium-term 8-12 year cycles associated with fixed production assets. These types of cycles include the cycles of K. Marx on the massive renewal of fixed assets of production, as well as the cycles of K. Juglar on the influence of monetary factors associated with the activities of banks on the period of change in fixed capital.

3. Long-term 15-25-year cycles of the American economist, Nobel Prize winner S. Kuznets, related to the demographic situation in the country, migration, construction, including the renewal of infrastructure facilities.

4. Long-term (more than 40 years) oscillatory cycles of N. Kondratiev, associated with the economic situation, that is, with the situation and with the state of social reproduction. N. Kondratiev, based on statistical data from European countries (period 1800-1920), having studied the functioning of national economies, concluded that national economies in the long term (40-60 years), depending on the situation, have an oscillatory nature.

Discussion. Conjuncture factors include factors that influence the elements of the reproduction process, consisting of the stages of production, exchange, income distribution and consumption.

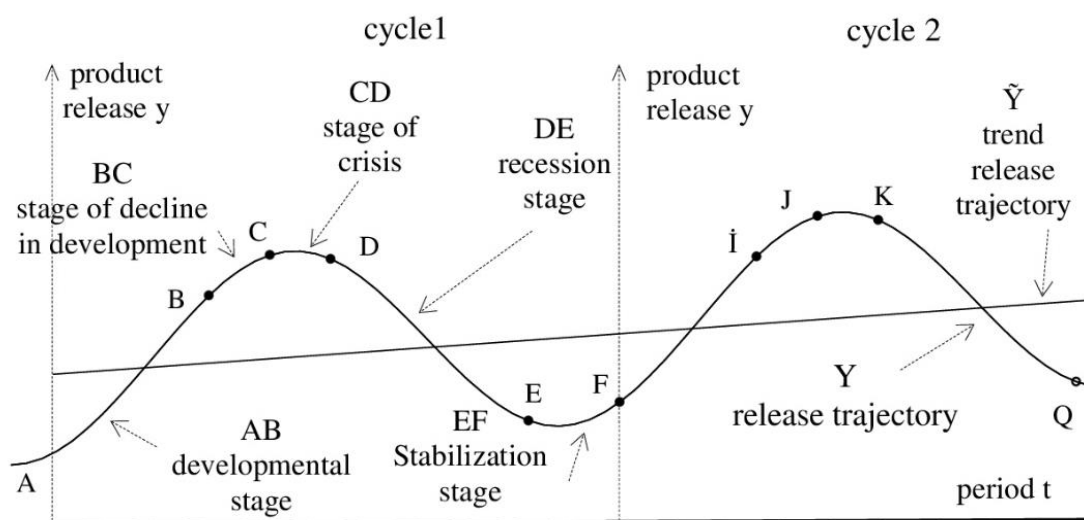
According to N. Kondratiev and followers of Kondratiev's theory, due to the fact that the functioning of national economies, as well as large regional economic systems over a long period (40-60 years) is of an oscillatory nature. These vibrations have a "long-wave" characteristic [203]. However, neither Kondratiev nor

his followers proposed an econometric model assessing the "long-wave" oscillatory activity of the national economy.

In studies of the functioning of the national economy of different countries, the American economist R.G. Hawtry [400] concluded that macroeconomic fluctuations in the functioning of the national economy do not depend on technological progress, capital accumulation or population growth. Macroeconomic fluctuations are a secondary indicator of development, and they are just fluctuations. In reality, the country's economy has the character of development, and indicators characterizing fluctuations are secondary indicators and are not important.

We believe that, along with cycles of economic processes of different nature and duration, in the longer term (more than 30 years) the country's national economy operates in a cyclical mode.

Diagram 1: schematic model of the functioning of the country's national economy in the long-term (more than 30 years) period.



In the mid-20th century, US economists A. Burns and W. K. Mitchell [398] proposed a concept that explains the essence of the cyclical functioning of the country's economy over 25-30 years.

According to the authors, business activity in the national economy of the country, that is, the production of material products and the provision of services, flows along a straight line, characterized by long-term development along the Y curve, which rises and falls around the trend $\tilde{Y}$ (diagram). However, the authors believed that in the long term, the development of the country's economy has a direct trend of constant growth $\tilde{Y}$, and the factors shaping the production of material products and the provision of services Y have virtually no effect on the direct trend $\tilde{Y}$.

In our opinion, the American economists A. Burns and W. K. Mitchell, in their studies of the cyclical nature of the functioning of the country's economy in the long term, came to the wrong conclusion.

So firstly, in classical and neoclassical economic theories it believed to be that the functioning of national economic systems has a cyclical nature, consisting of

stages: development $\rightarrow$ slowdown development $\rightarrow$ crisis $\rightarrow$ decline $\rightarrow$ stabilization (Diagram.1).

Secondly, the indicator of production and provision of services Y, expressing the result of the functioning of the national economy, depends on changes in fixed capital, working capital, labor, money supply, as well as from the multiplier effect of investments and the effect of acceleration of production volumes, provision of services.

Thirdly, in the long term, the dependence of the trend parameter of the country's economic development $\tilde{y}$ on the actual parameter of production of goods and provision of services y, is measured by a linear function

$$\tilde{y} = a_0 + a_1 \cdot y$$

As can be seen from the function, provided that parameters a_0 and a_1 remain constant, large values of the parameter y correspond to large values of the parameter $\tilde{y}$, and small values of the parameter y correspond to small values of the parameter $\tilde{y}$.

Conclusions. We believe that, along with cyclical economic processes that differ in essence and duration, in the longer term (more than 30 years) the country's national economy operates in a cyclical mode. (Diagram 1).

In contrast to the opinion of the American economist R.G. Hawtry, we believe that the country's economy has the character of development at a certain stage. The indicators characterizing fluctuations are the primary indicators that form the growth rate of development.

In addition, in contrast to the opinion of American economists A. Burns and W. K. Mitchell, we believe that in the long term, the development of the country's economy has a direct trend of constant growth $\tilde{Y}$, and the factors that shape the production of products and the provision of services Y shape the development trend.

$$f(x) = a_0/2 + \sum_{k=1}^m (a_k \cdot \cos kt + b_k \cdot \sin kt), \quad k = 1, 2, 3, \dots, m, \quad (2)$$

That is:

$$\tilde{y}^S = \tilde{y} + f(x) = (c_0 + c_1 \cdot t) + f(t), \quad (3)$$

Or,

$$\tilde{y}^S = (c_0 + a/2 + c_1 \cdot t) + \sum_{k=1}^m (a_k \cdot \cos kt + b_k \cdot \sin kt), \quad k = 1, 2, 3, \dots, m, \quad (4)$$

In this case, the parameters $\tilde{y}^S$ of the cyclic process are expressed by the trigonometric Fourier function with a period of 2π . Dividing the parameter of an empirical series of a cyclic process into trigonometric Fourier series is considered a Problem of harmonic analysis [264, pp. 165-169; 129, pp. 418-419; 344, p. 427-463].

We believe that the function expressing the dynamics of the indicator of total output $\tilde{y}^S$ for the period T

$$\tilde{y}^S = (c_0 + a/2 + c_1 \cdot t) + \sum_{k=1}^m (a_k \cdot \cos kt + b_k \cdot \sin kt), \quad k = 1, 2, 3, \dots, m, \quad (4)$$

is a “conjunctural-structural” function, expressing a change in the structure of gross output, depending on the conjuncture of the functioning of the national economy in the long term.

According to the method we proposed, when expressing the parameters of the $\tilde{y}^S$ of a periodic process using the trigonometric Fourier function, harmonic series are calculated that approximate a given empirical series, and a function with a correlation coefficient of the highest harmonic order is selected.

When expressing the parameters of a periodic series using the trigonometric Fourier function, the parameters of the Fourier series are determined using the following system of equations:

$$\left. \begin{aligned} a_0 &= 2 \cdot \Sigma(y - \tilde{y}) / n \\ a_k &= 2 \cdot [\Sigma(y - \tilde{y}) \cdot \cos kt] / n \\ b_k &= 2 \cdot [\Sigma(y - \tilde{y}) \cdot \sin kt] / n \end{aligned} \right\} \quad (5)$$

In the system of equations (5): y is an indicator of the dynamics of the empirical series, $\tilde{y}$ is an indicator of the dynamics of the aligned empirical series; n is the number of years of the empirical series; t – expression of time sequence (T) in radians:

We believe that in the long term, the development of the country's economy has a constantly increasing $\tilde{Y}$ -direct trend. However, the factors that shape the Y row have a direct impact on the trend line $\tilde{Y}$ (diagram 1).

Methodology for developing an econometric model of the cyclical functioning of the national economy in the long-term (more than 30 years) period.

The parameter $\tilde{y}^S$, characterizing the periodic process, can be expressed as the algebraic sum of the reduced parameter $\tilde{y}$ of the empirical series y for time t :

$$\tilde{y} = (c_0 + c_1 \cdot t), \quad (1)$$

And the parameter of the empirical series y , expanded into a trigonometric Fourier series $f(x)$:

$t = (0.2\pi/n, 2 \cdot 2\pi/n, 3 \cdot 2\pi/n, \dots, (n-1) \cdot 2\pi/n, 2\pi)$;
 k - the number of harmonics that bring the Fourier series closer to the empirical series.

Algorithm for compiling a macroeconomic model of the cyclical functioning of the country's national economy

We believe that the macroeconomic model of the cyclical functioning of the national economy in the long-term (more than 30 years) period must be compiled according to the equations we proposed (1), (2), (3), (4), (5).

The macroeconomic “conjunctural-structural” model of the cyclical functioning of the national economy in the long term (more than 30 years) is compiled in the following sequence.

1. At the first stage, the dynamics of the empirical indicator of total output over the past (more than 30 years) period in the country's national economy is examined. If the graph of the dynamics of the empirical indicator of total output y for the period under study shows signs of cyclicity, begin the study.

2. Dynamics of the aggregate output volume parameter y levels off in a straight line

$$\tilde{Y} = (c_0 + c_1 \cdot T), \quad (1)$$

3. The indicator $\sum u$ is calculated as the sum of the differences between the empirical series of total production output y and the calculated indicator $\tilde{y}$:

$$\sum u = \sum (y - \tilde{y}), \quad (5)$$

4. The expression of moments of the time period T , in t radians, for the purpose of decomposing the empirical series of the total volume of output of goods and services Y into the trigonometric Fourier series is calculated by the formula

$$t = 2\pi \cdot T/n, \quad (6)$$

In formula (6): n is an indicator of the number of moments in the time period T , measured in years. In calculations when expressing the time period T in terms of t radians, the initial year of the time period T is assumed to be zero. For example, if the time period T covers 30 years, then the expression for n moments of period T in t radians is calculated as:

$$t = (0; 1 \cdot 2\pi/30; 2 \cdot 2\pi/30; 3 \cdot 2\pi/30; \dots; 29 \cdot 2\pi/30), \quad (7)$$

5. The harmony of the first row $\tilde{Y}^S I$ at values $k = 1$ is calculated in the following sequence.

5.1. The trigonometric functions $\cos t$ and $\sin t$ are calculated in radians;

5.2. Parameters $\sum(u \cdot \cos t)$ and $\sum(u \cdot \sin t)$ are calculated;

$$k = 2, \cos 2t \text{ и } \sin 2t, \sum(u \cdot \cos 2t) \text{ и } \sum(u \cdot \sin 2t), a_2 = (2/n) \cdot \sum(u \cdot \cos 2t); b_2 = (2/n) \cdot \sum(u \cdot \sin 2t), \quad (11)$$

$$\tilde{Y}^S_{II} = (c_0 + a_0/2) + c_1 \cdot T + a_1 \cdot \cos t + b_1 \cdot \sin t + a_2 \cdot \cos 2t + b_2 \cdot \sin 2t, \quad (12)$$

2) Third harmony $\tilde{Y}^S_{III}$, with values:

$$k = 3, \cos 3t \text{ и } \sin 3t, \sum(u \cdot \cos 3t) \text{ и } \sum(u \cdot \sin 3t), a_3 = (2/n) \cdot \sum(u \cdot \cos 3t); b_3 = (2/n) \cdot \sum(u \cdot \sin 3t), \quad (13)$$

$$\tilde{Y}^S_{III} = (c_0 + a_0/2) + c_1 \cdot T + a_1 \cdot \cos t + b_1 \cdot \sin t + a_2 \cdot \cos 2t + b_2 \cdot \sin 2t + a_3 \cdot \cos 3t + b_3 \cdot \sin 3t \quad (12)$$

And so on.

Calculations continue until the maximum value r_{MAX} obtained.

Thus, we believe that, based on the methodology we propose, it is possible to form a “conjunctural-structural” econometric model of the cyclical functioning of the country’s national economy in the distant future. By calculating the normative forecasts for the indicator of total output in the national economy, as well as socio-economic indicators arising from the indicator of total output, it is possible to assess the possible state of the country’s national economy in the distant future.

Compilation of an econometric model of the cyclical functioning of the national economy of Azerbaijan in 1965-2000.

The national economy of the Republic of Azerbaijan until 1992 of the 20th century functioned as part of the national economic system of the USSR. As result of the collapse of the national economic system of the USSR state, in the 90s of the last century, the national economy of the Republic of Azerbaijan transformed from a structure based on a social formation into a new structure of a market economy.

During the study, we believed that the essence of the theoretical provisions of the mechanism of production and provision of services in the period 1965-1992 and in the period 1992-2000 in the national economy of Azerbaijan has not changed.

5.3. The parameters a_0, a_1, b_1 of the trigonometric Fourier series are calculated using the formulas:

$$a_0 = (2/n) \cdot \sum u; a_1 = (2/n) \cdot \sum(u \cdot \cos t); b_1 = (2/n) \cdot \sum(u \cdot \sin t), \quad (8)$$

5.4. Based on the calculated parameters a_0, a_1, b_1 , the Fourier trigonometric series $f(x)$ is calculated:

$$f(t)_I = a_0/2 + a_1 \cdot \cos t + b_1 \cdot \sin t, \quad (9)$$

Thus, with the cyclical functioning of the national economy of the country, the calculation equation of the “conjuncture-structural” model - the dynamics of gross output in the long term in the first harmony is expressed by the function:

$$\tilde{Y}^S_I = (c_0 + a_0/2) + c_1 \cdot T + a_1 \cdot \cos t + b_1 \cdot \sin t, \quad (10)$$

The correlation coefficient calculated between the empirical series of gross output Y and the series of dynamics of gross output $\tilde{Y}^S_I$ in the first harmony.

If the calculated value of the correlation coefficient RI is between the values of $0.950 \leq r \leq 1.000$, then it considered there is a high relationship between the calculated first harmonic series $\tilde{Y}^S_I$ and the empirical series of total output Y the relationship is high.

5.5. The equation of the “conjunctural-structural” model is calculated:

1) Second harmony $\tilde{Y}^S_{II}$, with values:

Based on information from the State Committee for Statistics of Azerbaijan, we have compiled statistical data on the indicator of the total output of products and services in Azerbaijan for the period 1965-2020.

Research has shown that the period of one full cycle of functioning of the national economy of Azerbaijan is 35-36 years. It was determined that the national economy of Azerbaijan: in the period 1965-1984 functioned at the stage of development; in the period 1984-1990 at the stage slowdown and crisis; in the period 1990-1995 during the recession; and in the period 1995-2000 at the stage of stabilization.

The compilation of the “conjunctural-structural” econometric model was carried out in the following sequence.

1. Dynamics of Y volumes of gross output of the national economy of Azerbaijan during the study period 1965-2000, in 2000 prices, aligned by linear function

$$\tilde{Y} = 0,0036 \cdot T + 0,5048.$$

In the resulting linear function: T – time points for 1965-2000; 0.0036 – average annual increase in the dynamics of total output of products and services in 2000 prices; the value 0.5048 represents the initial value of the aligned time series of total output at 2000 prices.

2. The indicator ($\sum u$) calculated.

3. Moments of the time period T are expressed in t radians:

$$t = (0; 1 \frac{2\pi}{30}; 2 \frac{2\pi}{30}; 3 \frac{2\pi}{30}...; 35 \frac{2\pi}{30}).$$

4. Calculated by:

$$\cos t, \cos 2t, \cos 3t \text{ v} \sin t, \sin 2t, \sin 3t$$

5. Calculated by:

$$\sum(u \cdot \cos t), \sum(u \cdot \cos 2t), \sum(u \cdot \cos 3t), \sum(u \cdot \sin t), \sum(u \cdot \sin 2t), \sum(u \cdot \sin 3t).$$

6. The functions $\tilde{Y}_{I}^S, \tilde{Y}_{II}^S, \tilde{Y}_{III}^S$ of the harmonic series $k = (1, 2, 3)$ of gross output are compiled.

Calculations showed that in the period 1965-2000 the "conjunctural-structural" equation of the full cycle functioning of the national economy of Azerbaijan in third harmony ($k=3$), at $r = 0.977$ is expressed as:

$$\begin{aligned} \tilde{Y}_{III}^S = & 0,5041 + 0,0036 \cdot T - 0,318 \cdot \cos t - 0,016 \cdot \sin t + 0,052 \cdot \cos 2t + 0,095 \cdot \sin 2t + \\ & + 0,036 \cdot \cos 3t - 0,021 \cdot \sin 3t. \end{aligned}$$

Thus, based on our research, we came to the conclusion that:

- 1) the national economy of Azerbaijan operates in a cyclical mode in the long-term period;
- 2) the period of one complete cycle is 35-36 years.
- 3) it was determined that in the twentieth century, in the period 1894-2000, the national economy of Azerbaijan functioned in three complete cycles;
- 4) from the beginning of the new 21st century, from 2001, the national economy of Azerbaijan began to function in a new 35-36 flight cycle;

Based on statistical data from the State Statistics Committee of the Republic, it was established that the economy of Azerbaijan from 2001 to 2014 functioned at the stage of development. And starting from 2015, the pace of economic development began to decline. So, it was established that, if the average annual rate of total output of products and provision of services at the development stage was 20.5%, after 2014, the average annual growth rate of total output of products and provision of services tended to decrease and amounted to (-0.1)%.

We believe that using our proposed methodology for compiling a "conjunctural-structural" macro-econometric model of the cyclical functioning of the country's national economy, it is possible to draw conclusions about the history of the functioning of the country's economy in the distant past, and based on the forecasts compiled, conclusions can be drawn about the state of the country's national economy in the long-term future period.

References

1. Hansen E.X. The theory of economic cycles / Classics of Keynesianism: in 2. Volume II Economic cycles and national income, Part III-IV / E. Hansen - M.: OJSC Publishing House "Economy" 1997, pp. 5-298. ISBN – 5-282-01823-342 (in Russian).
2. Klinov V.G. Economic conditions. Factors and mechanisms of formation, M.: Economics, 2005, p.19 (in Russian).
3. Kondratyev N.D. Large cycles conjectures and theory of foresight. Selected works / Ed. coll.: Abalkin L.I. (prev) and others - M.: ZAO Publishing House "Economy", 2002. - 767 p. ISBN 5-282-02181-1 (in Russian).
4. Hawtrey R.G. Readings in Business Cycle Theory, 1944. // The Quarterly Journal of Economics Vol. 66, No.1 (Feb. 1952), pp. 25-42. URL: <https://www.jstor.org>.
5. Burrows A.F. and Mitchell W.C. Measuring Business Cycles // Journal of Political Economy Vol. 55, No. 4 (Aug., 1947), pp. 281-298 (18 pages) Published By: The University of Chicago Press. URL: <https://www.jstor.org>.
6. Eyyubov M.R. Cyclical functioning of the economic system of Azerbaijan and forecasting the future period / Caucasus and Central Asia in the process of globalization. Economic and international relations. II international conference. Caucasus University. Baku, May 2007. Book II. pp. 693-701 (in Azerbaijani).
7. General theory of statistics. M., Publishing house Mosk. University 1977. – 327 p. 264, pp. 165-169 (in Russian).
8. Bronshtein I.N., Semendyaev K.A. Handbook on mathematics for engineers and college students. 13th ed., Moscow, ed. Science, chief ed. physics and mathematics lit. 1986 pp. 129, 418-419 (in Russian).
9. Fikhtengolts G.M. Course of differential and integral calculus. Volume III / Expansion of functions in Fourier series. M., 1969, pp. 344, 427-463 (in Russian).
10. Ayubov M.R. Features of the cyclical functioning of the Azerbaijani economy // News of the National Academy of Sciences of Azerbaijan. Series "Economics", No. 3, 2013. ISBN-0321-1630, pp. 11-22 (in Azerbaijani).
11. Ayyubov M.R. Macroeconomic model of safe functioning of the national economy of Azerbaijan in the longterm period / Upravlenie, 7 (2), pp. 71-86. doi: 10.26425/2309-3633-2019-2-71-86 (in Russian).
12. Ayyubov Mazaddin R., ECONOMIC CONCEPTUAL BASIC PROVISIONS OF "AZERBAIJAN-2030: THE STATE PROGRAM OF SUSTAINABLE DEVELOPMENT STRATEGY" International Journal of Economics and Society March 2016, Issue 5, pp122-127.
13. National economy of the Azerbaijan SSR in 1970. CSB under the Council of Ministers of the Azerbaijan SSR. Statistical Yearbook. Baku 1972. p.25 (in Russian).
14. National economy of the Azerbaijan SSR in 1987. CSB under the Council of Ministers of the Azerbaijan SSR. Statistical Yearbook. Baku 1988. pp.8-9 (in Russian).

15. National economy of the Azerbaijan SSR in 1988. CSB under the Council of Ministers of the Azerbaijan SSR. Statistical Yearbook. Baku 1990. p.7 (in Russian).

16. State Statistics Committee of Azerbaijan. Azerbaijan in numbers. Brief statistical collection. Baku-1995 il, pp. 12-13;

17. State Statistical Committee of the Republic of Azerbaijan. NATIONAL ACCOUNTS OF AZERBAIJAN 2003. Official publication. Statistical yearbook. Baku-2004.

18. State Statistical Committee of the Republic of Azerbaijan. NATIONAL ACCOUNTS OF

AZERBAIJAN 2010. Official publication. Statistical yearbook. Baku-2011.

19. State Statistical Committee of the Republic of Azerbaijan. NATIONAL ACCOUNTS OF AZERBAIJAN 2016. Official publication. Statistical yearbook. Baku-2017.

20. State Statistical Committee of the Republic of Azerbaijan. NATIONAL ACCOUNTS OF AZERBAIJAN 2020. Official publication. Statistical yearbook. Baku-2021.

21. State Statistical Committee of the Republic of Azerbaijan. NATIONAL ACCOUNTS OF AZERBAIJAN 2023. Official publication. Statistical yearbook. Baku-2024.

HISTORY

GENOCIDE CARRIED OUT IN WESTERN AZERBAIJAN IN 1918-1920

Ismayilova A.

Phd Student of Baku State University, lecturer of Baku Eurasian University

Abbasova S.

Phd Student of Baku State University, lecturer of Azerbaijan University Languages

<https://orcid.org/0000-0003-4507-994X>

DOI: [10.5281/zenodo.11624403](https://doi.org/10.5281/zenodo.11624403)

Abstract

Four times in the 20th century (1905-1906, 1918-1920, 1948-1953, 1988-1991) Azerbaijanis were deported from the territory of present-day Armenia - their historical-ethnic land - with massacres. Armenians fighting for "Turkless Armenia" and their ideologues, as well as their patrons from near and far abroad, completed the ethnic cleansing operation in the 90s of the 20th century. The last settlement of Azerbaijanis in Armenia - the village of Nuvedi was subjected to genocide by the Armenians and the indigenous inhabitants of the village - Azerbaijanis - were deported from their historical and ethnic lands. Thus, not a single Azerbaijani remained in Western Azerbaijan, which is now called Armenia. This article talks about the genocides carried out by Armenians against the Azerbaijani people in Western Azerbaijan in 1918-1920. Valuable documents proving these genocides are today in the documents of the Extraordinary Investigation Commission preserved in the National Archives of the Republic of Azerbaijan, the "General Staff Military History and Strategic Studies Archive", the "Başbakanlık Ottoman Archive" of the Republic of Turkey and the "Political Archive of the German Ministry of Foreign Affairs" in Berlin, Germany "(Politischen Archiv den Auswärtigen)" are preserved in the funds of the First World War and the War of Independence. The actual materials in those archival documents prove that from 1917 to 1920, Armenians mercilessly killed tens of thousands of peaceful, unarmed Turkish-Muslim population in Zangazur district of Azerbaijan due to their ethnicity. Historical facts are shown in the article referring to these sources.

Keywords: Western Azerbaijan, Yerevan, Zangazur, genocide, Turkish-Muslim, Armenians.

This work was supported by the Azerbaijan Science Foundation – Grant № AEF-GAT-7-2023-2(44)-10/10/5-M-10

Introduction

At the beginning of the 20th century, Armenians purposefully implemented the policy of genocide in the territory of Azerbaijan. Taking advantage of the political situation after the February revolution and the October coup in 1917, the Armenians colluded with the Bolsheviks and committed genocide against the Turkish-Muslim population. The main goal was to weaken the social base of "Musavat", which won the elections to the Baku Soviet. The Armenian-Bolshevik forces led by S. Shaumyan started from Baku and from March 31 continued in Shamakhi, Lankaran, Zangezur, Iravan, as well as in Urmiya, Khoy and Maku. This is not the first murder committed by Armenians against the local population. Armenians tried to implement their plans by abusing the disruption of historical and political stability. Thus, trying to benefit from the revolution that took place in Tsarist Russia in 1905-1907, Armenians committed genocide against the Turkish-Muslim population. Unthinkable crimes were committed against the peaceful, innocent population during these events, which are recorded in history as the Armenian-Muslim conflict. There is enough information about this in historical sources. In the works "Bloody Years" by Mammad Said Ordubadi and "Armenian-Muslim conflict in 1905-1906" by Mir Mohsen Nawab, important facts related to the atrocities committed against Azerbaijanis in 1905-1906 were found. In the 1905-1906 editions of the "Kaspi" newspaper printed in Baku in Russian, as well as in the book "Armenian-Turkish

clashes in the Caucasus (1905-1906)" by A. Don, published in Armenian in 1907, with the events that took place during that period related information can be found [1, 36]. However, Azerbaijanis did not learn from this, even after these events, they wrote works promoting humanism and coexistence. However, such works by Armenians do not exist.

At that time, they covered up this genocide, which was organized by the Dashnak military forces, in a different way. Thus, the Armenian Bolsheviks, led by Stepan Shaumyan, tried to paint it as a civil war and thereby cover up the real historical truth. The ugly, criminal acts of Armenians who committed genocide in Azerbaijan are known from archival materials and witness statements. However, despite this, after the establishment of the Soviet government in Azerbaijan, this issue was not objectively investigated in a scientific direction, and in historiography, the genocide committed against the Azerbaijani people was characterized as "civil war", "Musavat massacre", and "March Uprising". However, after the fall of the USSR, the opportunity to objectively investigate the historical truths was obtained. It was possible to express and analyze historical documents and sources as they are. This is a direct blow to the plans of the Armenians and their patrons, who are trying to falsify and hide their actions.

Genocide in Zangezur

In 1918-1920, Zangezur district was one of the territories of Azerbaijan that suffered the genocide of Armenians. Armenian gangs led by Andranik and Nijde attacked the territories of Azerbaijan, threatened the

population, and called for submission to the Armenian government. Those who did not submit to the Armenian government had to leave the city or become victims of Andranik's brutal crimes. It should be noted that in the 19th century, as a result of the Russo-Qajar and Russo-Turkish wars, Armenians from both Ottoman and Qajar empires and other regions of Tsarist Russia were moved to this area with the agreements concluded between the parties. As a result of the resettlement, the Armenians who settled in the historical lands of Azerbaijan carried out a policy of ethnic cleansing against the local population. It is no coincidence that the Armenian population living here played an active role in the genocide carried out in the 20th century. When Andranik's and others' gangs attacked, the Armenians living in these areas also supported the implementation of the genocide, since they were resettled here in the 19th century, they knew the region better, which allowed them to help the attacking gangs and strike from within against the Azerbaijanis who were trying to defend themselves.

On July 15, 1918, the government of the Azerbaijan Democratic Republic established an Extraordinary Commission of Inquiry to investigate the genocide against Azerbaijanis in 1918 [13, 27]. The massacres that took place through this institution were investigated, witness statements and information obtained from those involved in the investigation once again confirm that the Armenian-Bolshevik forces committed genocide on purpose. Two of the 36 volumes of investigative materials examined by this institution refer to the events that took place in Zangezur. It is known from the documents of the Extraordinary Investigation Commission that 115 villages of Zangezur district were destroyed by Armenians. The names of those villages are mentioned in these documents. [6 p. 127]. 3257 men, 2276 women, 2196 children were killed from 115 villages. In addition, it should be noted that 10,068 Azerbaijanis were killed by Armenians and maimed as a result of serious injuries before the report of the Extraordinary Investigation Commission was prepared. The chaotic and unstable situation during the events of the genocide did not allow identifying all of the victims of Armenian atrocities [3, 166].

The events that took place in Zangezur accident are proof of Armenian atrocities. Armenians killed the population mercilessly. This can be seen from the facts and examples known from the investigation. Children's corpses found on the streets of Sheki village, divided into two parts, nursing babies who were bayoneted in Irmishli village, families burned alive along with their houses, people whose hands, feet, and various organs were cut off and put in a terrible condition show the scale and horror of the murders committed by Armenians [9, 47]. With this, they tried to create fear among the population and drive the survivors out of their places once and for all with such "examples". Armenians did not ignore the religion and customs of the population and did not hesitate to damage the holy places. Thus, in the village of Vagudu of Zangezur district, more than 400 people, who assumed that the Armenians would not touch the mosque, hid there and tried to

protect themselves in the mosque. However, the Armenians threw a bomb into the mosque, set it on fire and burned it together with the people inside it [6, 128]. It should be noted that the damage done to holy places and historical monuments does not end there. The genocides committed by Armenians against the people of Azerbaijan and the policy of ethnic cleansing do not consist only of the events that took place in 1918-20. From the end of the 20th century, starting from the 80s, they began to occupy the territories of Azerbaijan. As a result, they have damaged the monuments and material-cultural examples here. It is enough to show that animals were kept in mosques.

The attacks, which started in 1918, intensified in November 1919. Armenians organized more extensive attacks and carried out heavy operations in the villages of Zangezur such as Okchu, Atgiz, and Shabadan. Since 1920, it was the Republic of Ararat that organized the intensification of these massacres [4]. The main purpose of this was to cleanse Zangezur of Azerbaijanis and completely armenize it, and after capturing Zangezur, it was permanently captured by the main states that participated in the Paris peace conference and legitimized it. It is no coincidence that the official armed forces of Ararat state participated in the process of ethnic cleansing.

From January 1920, letters were sent to the Parliament of Azerbaijan and political circles about the deterioration of the situation in Zangezur, mass massacres committed by Armenians, and they asked for help to prevent Armenian atrocities. Among such telegrams addressed to the government of Azerbaijan, it is possible to mention the ones sent by Jalil Sultanov, a member of the Azerbaijani parliament who visited Zangezur, and Huseyn Akhundzade, a teacher from Jabrayl. From the telegrams sent on January 21 and 23, 1920, it is once again clear that the Armenians were mercilessly oppressing the Azerbaijani people and trying to seize these territories by committing genocide against the population. As stated in the telegram sent by Jalil Sultanov on January 23, 1920, the goal of the Armenians was to completely capture the territories of Karabakh, Nakhchivan, Iravan, and Zangezur, to remove the local population from here and to armenize them: completely destroyed. The number of regular Armenian army that participated in the battle reaches ten thousand. According to the information we received, an attack on Jabrayil district will be launched tomorrow from the Zangezur side. The goal of the Armenians is to completely cut off the connection with Nakhchivan, thus solving the issue of both Karabakh and Nakhchivan once and for all. The time has come to put an end to the protests on paper, to reveal to the world the treacherous Armenians who led to the destruction of the over two hundred thousand Zangezur Muslim population. Please take immediate action so that at least Shusha and Gabriel can be saved. Every minute is precious. Being late is equal to crime and treason in front of the people and the country" [6, 130].

It should be noted that what was written in the book "Garagin Nizhde i eqo ucheniya («Гарагин Нижде и его учения») published in Armenia in 2004 about the genocide in Zangezur is proof of the actions

committed by Armenians. It is written here that more Azerbaijanis were killed, and that 200 villages inhabited by Turks and Tatars were "returned" to Armenians. This should be considered as an acknowledgment of the actions committed by Armenians [16, 8]

Genocide in Irevan

With the collapse of empires at the end of the First World War, peoples had the opportunity to determine their own destiny. As a result, with the collapse of Tsarist Russia, the peoples of the Caucasus managed to declare their independence. The Republic of Azerbaijan, Armenia (Ararat) and Georgia were formed in the South Caucasus. There were problems in determining the borders of the states. Thus, Armenians trying to realize the dream of "Great Armenia" wanted to set the borders according to the borders of this desired "state". According to the unfounded claims of Armenians, the Armenian state should have included the territories of the Ottoman Empire, Azerbaijan and Georgia. They tried to realize these plans in the following years [10, 49]. Territorial disputes with Azerbaijan and Georgia are also the result of this policy of the Armenians, who are trying to appropriate the ancient and eternal lands of the peoples in order to build the "Great Armenia", which never existed and is only a dream. In order to realize their plans, the Armenians, who tried to seize foreign lands, and for this purpose, tried to expel the local, aboriginal population from their homeland by committing murders and exiles, although they could not build the "Great Armenia" of their dreams, they managed to create the currently existing Republic of Armenia.

On May 29, 1918, in order to end the massacres committed by the Armenians against Azerbaijan, the groundless territorial claims, the government of Azerbaijan was forced to give its historical lands, Iravan, to the Armenians as the capital. The main condition for the concession of Yerevan to the Armenians was that the Armenians renounced their claims to other territories. One of the factors that created conditions for this was the transfer of Gyumri (Alexandropol) territories, which the Armenians envisioned as the capital, to the control of the Ottomans [8, 136]. According to the information stored in the Russian archives, it is clear that the Provisional government, which was established after the February revolution of 1917, also used Armenians for its own purposes. For this purpose, he adopted the concept of "Turkey Armenia" [15, 356-357]. To weaken and defeat the Ottomans, the Russian, British and other forces used the Armenians living here, giving them promises and making concessions to create a state. The goal was to strengthen in these areas and to use the Armenians as a political tool for this. The fact that both the newly formed government, the successor of Tsarist Russia, and Soviet Russia drew Armenians to their side served this purpose. They tried to create a state for them by applying the concept of "Turkey-Armenia". However, as is known from history, the plan to create a state for Armenians was transferred to the Caucasus because the Ottoman state later liberated those territories. With this, the Armenian state was estab-

lished in the historical lands of Azerbaijan in the territory of the South Caucasus - in the lands of Western Azerbaijan [12, 249]

Iravan was one of the territories of Azerbaijan where Armenians committed genocide. Back in November 1917, after the October coup in Russia, Armenians who seized the weapons of the Russian troops retreating from Eastern Anatolia and the Caucasus front committed genocides against Turks and Azerbaijanis. Thus, on December 5, 1917, an agreement was signed in Erzincan between the South Caucasian Commissariat and the Ottoman government. After that, the Armenians, who took advantage of the retreat of the Russian troops from Eastern Anatolia, seized the weapons and started slaughtering the Turkish-Muslim population [14, 21]. In this regard, information is also provided in the documents kept in the political archive of the German Ministry of Foreign Affairs. At that time, the German representative in the South Caucasus, Bernstroff, sent to the German Ministry of Foreign Affairs on February 27, 1918, it was written: "Atrocities committed by Armenian volunteer groups in Erzincan should be considered very important. The population in the villages was completely destroyed" [11, 41].

From the beginning of 1918, Armenian armed groups started to commit mass massacres against Azerbaijanis in Iravan province. Until March 1918, Armenian armed groups destroyed 198 villages, including 32 villages in Iravan District, 84 in Echmiadzin District, 7 in Yeni-Beyazid District, and 75 in Surmali District of Iravan Governorate. In those districts, approximately 135,000 Azerbaijanis were subjected to genocide [6, 133].

Until September 1919, except for some village of Zangibasara, all the villages of Iravan district and also of Vedibasara were destroyed, their inhabitants were mercilessly killed, and the survivors were removed from their native lands. In 1920, the "Azerbaijan" newspaper published information about this in April: "There are no more Muslims left in Goycha district. Currently, 84 Muslim villages have been destroyed in Yeni Beyazid district, 22 of them were destroyed in April alone. Tashkent, Goshabulaq, Sariyagub, Bash Shorja, Ashagi Shorja, Sogangulu-Agali, Agkilsa, Zoda, Gulu, Agali, B. Garagoyunlu, K. Garagoyunlu, Zarzibil, Adli, Inakdag, Garaiman, Kaseman, Bashkend, Bala Marza, Shishgaya, Bash The population of Haji and Garibgaya villages with more than 15,000 houses fled, leaving behind all their property and the state. All this wealth is now left to Armenians, the looted property is worth several millions or even billions" [6, 135]. The information published in this newspaper is once again a proof that Armenians have taken possession of someone else's land by force and committed genocide, displacing the local population. Also, if you pay attention to the etymology of the listed village names, it shows that each of them belongs to Azerbaijan. However, later Armenians changed the names of the native lands of Azerbaijan in order to Armenianize them by implementing a genocidal policy against toponyms. With this, they are trying to deny that these territories historically belong to Azerbaijan and falsify history. However, the names

mentioned in sources and historical documents and their origin also expose Armenian lies.

There is also information about the subsequent resettlement of Armenians to these areas in English documents kept in the archives of Great Britain. Of these, the memorandum prepared by the political intelligence department of the British Foreign Ministry on October 28, 1918 states: "When solving the Armenian question, it should be taken into account that its center of gravity is not in the Caucasus, but in the south of Asia Minor. Armenians came to the Caucasus from Turkey mainly as refugees during the last decades during the Russian rule. The Russian government used them here to incite disputes between Georgians and Tatars" [2, 110]. Important facts related to the genocides committed by Armenians in Azerbaijan were also reflected in the documents of the British government stored in the British archives. Among them, the letters sent by the high commissioner for the South Caucasus appointed by the British government, General O. Wardrop, to his government, the information contained in his correspondence can be cited as an example. In his report sent to London on October 2, 1919, he informed: "Recently, the Armenians destroyed 60 Muslim villages in Yeni Beyazid, Alexandropol and Iravan regions" [5, 30].

In the letters sent by O. Wardrop in December 1919, it was mentioned that the Armenians killed the civilian population - the Muslim population, including women and children, in the mosque, and the Muslims of Zangezur are in a state of panic. It should be noted that in addition to O. Wardrop's information, the Azerbaijani government also sent a letter to the British Prime Minister Lord Curzon, informed about the genocide committed by the Armenians in Zangezur, and the British government officially recognized these territories as Azerbaijani territory. [5, 31].

It is known from the British documents that the British government tried to use the Armenians against the Ottomans, and even for this purpose Andranik was provided with weapons and financial support for the resistance against the Turks. Genocides committed by Armenians in Azerbaijan were evaluated as damage to British plans. In this regard, it is stated in official documents and correspondence that if the Armenians do not stop the massacres, the aid to them will be stopped. O. Wardrop wrote about this in document No. 52 sent on January 28, 1920: "The main purpose of my visit to Yerevan was to put pressure on the Armenian Prime Minister to withdraw the regular troops from Zangezur and punish the culprits. I have already sent a telegram to his relatives that if the Armenian government does not stop the aggression, I will advise His Majesty's government not to help them" [5, 34] Each of these facts confirms that Armenians committed genocide against the people of Azerbaijan. In matters related to the genocide, it is once again proven that the events were committed by the political line of the Armenians and the state of Ararat.

The genocides carried out by Armenians in the territory of Iravan governorate in 1918-1920 were also reflected in the Ottoman archival documents. In these documents, it was also mentioned that he asked for help

from the Ottoman 15th regular army command to defend against Armenian oppression and atrocities committed by Armenians against the population. Among the documents of this period, there are also maps describing the territories where the Armenians committed genocide, which are historical sources of great importance in terms of specifying the territory covered by the massacres. One such map was drawn on July 3, 1919. The map called "Description of the places where Armenians committed atrocities against the population of Goyja" shows the areas where the Armenians committed genocide - Agbulag, Shoreyel, Gamarli and other areas. Another map drawn up in the same month shows regions affected by genocide such as Iravan, Big Vedi, Karalar, Shirazli, Khalisa, Sadarak, Alisar [11, 43].

In Ottoman archival documents from 1920, it is possible to find information about atrocities committed by Armenians, killing the population in an inhuman manner. An example of this is the documents where 50 children and teenagers were chopped with axes by Armenians in 1920 in Gizilkilsa village of Yerevan, their eyes were removed with red skewers, and people were burned in cauldrons and destroyed by torture. The documents belonging to the Ottoman archives once again prove that in 1918-1920, Armenians committed genocide against Azerbaijanis, invaded Azerbaijani territories by committing brutal murders, and as a result of all this, created a state for themselves in the historical lands of Azerbaijan.

The result

The territory of Western Azerbaijan, which is now the territory of the state called Armenia, is the historical land of Azerbaijan. There are historical sources, toponyms, and monuments that prove this place belongs to Turkish culture. However, Armenians living with the dreams of "Great Armenia" displaced the aboriginal population of this place from their native lands through genocide and deportation. When we look at history, we see that the current historical and political conditions are effective for Armenians in this regard. During Tsarist Russia and later during the USSR, Armenians used the opportunity for their own plans. The genocides carried out by the Armenians in 1918-1920 were a continuation of the massacres committed in 1905-1906 and the same policy they pursued. However, the policy of genocide and ethnic cleansing against Azerbaijan and Azerbaijanis did not end there. V. I. In December 1920, Zangezur was given to Armenia unconditionally as a result of the new colonial policy implemented in this region by the dictates of the Armenian and Georgian Bolsheviks, who had great influence in the ruling circles of Soviet Russia headed by Lenin. Armenians, who felt that this issue was completely resolved for their own benefit, did not object to the return of the Azerbaijani population expelled from Zangezur to their homes in order to create temporary calm, but in the following years, they again displaced the Azerbaijanis from their native places. Azerbaijanis were deported from the Armenian SSR from 1948-53 by the hands of the Soviet regime. Armenians were settled in their houses, native and historical territories. The Armenians used all the means and every opportunity to expel the Azerbaijanis

from this area. Starting from the late 1980s, they managed to completely expel Azerbaijanis from Western Azerbaijan using the current political situation in the USSR. These facts once again prove that the actions of Armenians are against humanity and international law norms. The rights of the displaced Azerbaijani population must be restored. This is the historical and legal right of the expelled population.

References

1. Arzumanlı V., Həbiboglu V., Muxtarov K.. 1918-ci il qırğınları. Tarixi araşdırmalar Bakı, "Öyrətmən". 1995. 90 səh.
2. Azerbaijan Democratic Republic: Great Britain's Archive documents, Baku, 2008, 576 p.
3. Bayranov İ. M. Qərbi Azərbaycan: Tarixi həqiqətlər və ya Ermənistanın etnik təmizləmə siyasəti, Bakı: 2011, 288 səh.
4. Əmrahov M. Ermənilərin Cənubi Qafqaza köçürülərək Qərbi Azərbaycan torpaqlarına ərazi iddiaları üçün zəmin yaradılması. "Qərbi Azərbaycanın tarixi və mədəniyyəti" konfransının materialları, Bakı, 2023 // https://www.researchgate.net/publication/375998391_Ermnilerin_Cnubi_Qafqaza_kocurulrk_Qrbi_Azrbaycan_torpaqlarina_razi_iddialari_ucun_zmin_yaradilmasi
5. Gözəlova N. Azərbaycanın türk-müsəlman əhləsinin soyqırımı: Britaniya kitabxanasının arxiv sənədlərində (1918-1920). Bakı, 2017, 76 s.
6. İsgəndərli A. C. Azərbaycan həqiqətləri: 1917-1920. Bakı, "Elm və təhsil", 2012, 228 s.
7. İsmayılov K. Zəngəzur bölgəsində azərbaycanlıların soyqırımı. "Azərbaycan".-2015.-3 aprel.-N 68.-S.7.
8. Qasımlı M. "Erməni məsələsi"ndən "erməni soyqırımı"na: gerçək tarix axtarışında (1724-1920) / M.Qasımlı. – Bakı: "Mütərcim", 2014.
9. Mustafa N. Ermənilərin İrəvan quberniyasında və Zəngəzur qəzasında törətdikləri terror və qırğınlar (1905-1906), Bakı, 2022
10. Musayev İ. Azərbaycanın Naxçıvan və Zəngəzur bölgələrində siyasi vəziyyət və xarici dövlətlərin siyasəti 1917-1921, Bakı, 384 s.
11. Nəcəfli G. Şərqi Anadolu, Naxçıvan və İrəvan bölgəsində ermənilərin türk-müsəlman əhaliyə qarşı törətdikləri soyqırımlar (1918-1920). Bakı, 2017, 248s.
12. Paşayev A. Açılmamış səhifələrin izi ilə. Bakı, 2001, səh. 240-253)
13. Tariximizin faciəli səhifələri: soyqırımı. Bakı, 2000, 186 s.
14. Tayfur A., Erol A., Şahin A., Kaya B. Azərbaycan belgelerinde ermeni sorunu (1918-1920). Ankara, 2001, 706 s.
15. Архив новейшей истории России. Журналы заседаний Временного Правительства. т.1, М., 2001
16. Гарагин Нижде и его учения. Ереван, 2004, 42с.

MATHEMATICS

IT FOLLOWS FROM THE SPECIAL THEORY OF RELATIVITY THAT INVISIBLE AFTERLIFE WORLD IS IN FACT PHYSICALLY REAL¹

Antonov A.

PhD, HonDSc, H.Prof.Sci

Independent researcher, Kiev, Ukraine

DOI: [10.5281/zenodo.11624422](https://doi.org/10.5281/zenodo.11624422)

Abstract

The article proves that the generally accepted version of special theory relativity (SRT), which states that imaginary numbers are physically unreal, is incorrect. Experimental evidence is given of the general scientific principle of the physical reality of imaginary numbers, with the use of which a corrected version of the SRT was created. She argues that in addition to our visible universe, there are many other mutually invisible universes in nature. And they form the actually physically existing afterlife invisible world, predicted by all religions.

Keywords: imaginary numbers, special theory of relativity, invisible universes, invisible afterlife world.

1. Introduction

Imaginary numbers, discovered about 500 years ago by Scipione Del Ferro, Niccolò Fontana Tartaglia, Gerolamo Cardano, Lodovico Ferrari and Raphael Bombelli [1], are known to everyone and are currently used in all exact sciences. They are even studied in school mathematics courses. But unlike other numbers that are understandable to everyone - integers and fractions, positive and negative, scalar and vector, etc. - their physical essence has not yet been explained. Indeed, what 2 kg., 3 m., 4 sec. is clear to everyone, but what is 2i kg., 3i m., 4i sec., where $i = \sqrt{-1}$, no one can explain. Nevertheless, no one cared about this, just as, for example, now no one can explain. Nevertheless, no one cared about this, just as, for example, now no one cares that the phenomenon of ball lightning is not explained.

But at the beginning of the 20th century Joseph Larmor [2], Nobel Prize winner Hendrik Anton Lorenz [3], Jules Henri Poincaré [4], Nobel Prize winner Albert Einstein [5] and other outstanding scientists created the special theory of relativity, which rightly accepted to be considered an outstanding scientific achievement of physics of the 20th century, because it proposed the principle of relativity. And which is therefore now studied in all physics textbooks used in the educational process even at the most prestigious universities. However, in this theory, calculations using relativistic formulas, which were the final result of all reasoning, in some

cases led to a result measured by imaginary numbers. And this result already needed to be explained. After all, no one would need a theory that even its creators could not explain. But the authors of SRT did not know how to do this. And the fate of the service station hung in the balance. But it was saved by the fact that an additional postulate was introduced into the SRT, called the principle of not exceeding the speed of light, from which it followed that quantities measured by imaginary numbers do not exist in nature. And therefore, there is no need to explain them.

This is the form in which SRT is still taught.

2. The physical reality of imaginary numbers.

But besides STR there are other sciences. Including the theory of electrical circuits, which is used in radio engineering, electrical engineering and computer science. Fundamental to this theory is Ohm's law [6], [7], discovered in 1826 for DC electrical circuits, which is now studied even in school physics textbooks. And in 1893, Charles Proteus Steinmetz proposed its interpretation of Ohm's law for alternating current electrical circuits [8], which is now used daily by millions of engineers around the world in their work. In this theory of electrical circuits, the imaginary resistances of capacitors and inductors, which can be measured by instruments, were recognized as actually physically existing. And if these imaginary resistances were recognized as physically unreal, as follows from SRT, then neither radio engineering, nor electrical engineering, nor computers, nor radio measuring instruments should exist.

¹ This is reprint of the article "Antonov A. A. From the physical reality of imaginary numbers it follows that the invisible afterlife world predicted by all religions actually exists. Norwegian Journal of development of the International Science. 130. 36-41. <https://doi.org/10.5281/zenodo.10975059>".

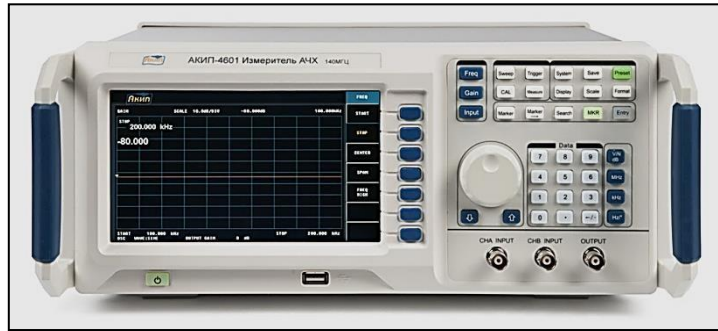


Fig. 1. In any radio-technical laboratory there are devices called frequency response meters, which prove the physical reality of imaginary and complex numbers by their mere existence

But they do exist. And thereby they prove the physical reality of imaginary numbers [9]-[33]. Consequently, by the existence of radio- and electrical engineering, the generally accepted version of SRT was refuted even before its creation. Other proofs of the physical reality of imaginary numbers have been published in [34]-[46]. Therefore, the logical conclusion is that the version of SRT currently presented in all physics textbooks is incorrect [47]-[66]

3. Physical reality of invisible parallel universes

In the existing generally recognized version of SRT from its relativistic formulas and the principle of non-exceeding the speed of light also follows that in nature there is only our visible universe in which everything is measured only by real numbers. However, in the corrected version of SRT [67]-[74], from its relativistic formulas it follows that in our Multiverse [75]-[85], in addition to our visible universe, there are also about twenty other mutually invisible parallel universes

And one can be convinced of their existence [86]-[91]. as a result of astronomical observations of the starry sky in portals [92]-[94], since the constellations in them will differ - and the further into the portal one penetrates, the greater the differences will be - from the constellations observed at the same time in the same region outside the portals. And since there are a lot of anomalous zones [95]-[98] on Earth, such anomalous zones. Like, for example, the main astronomical observatory of the National Academy of Sciences of Ukraine, located in Goloseyevsky forest 12 km from the center of Kyiv. Therefore, in order to verify the existence of neighboring invisible universes adjacent to our visible universe, it is enough to compare on a computer the observations of this observatory with the observations of neighboring observatories located outside the anomalous zones.

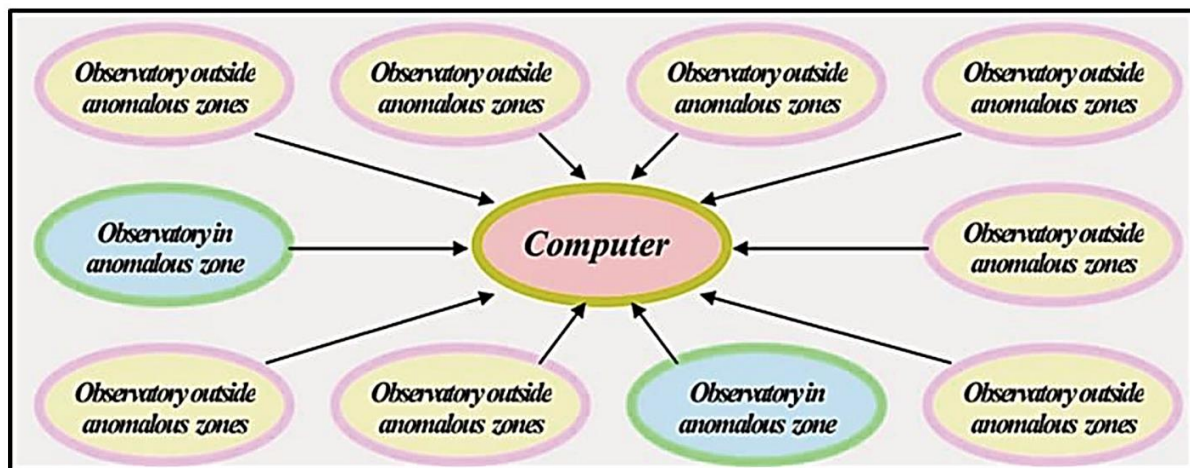


Fig. 2. Scheme of an astronomical experiment to detect invisible universes

4. Why, despite all the refutations of the generally accepted version of SRT, set out in all physics textbooks, it continues to be taught.

But this simple and low-cost experiment, which in the most indisputable way will allow us to answer the question of whether there are invisible universes neighboring our visible universe, no one has done or is going to do. Obviously, because physicists do not need such an answer, since it will refute the version of SRT studied in textbooks.

The corrected version of SRT states that imaginary numbers are physically real and invisible universes ex-

ist. Therefore, having become convinced of the existence of invisible universes, we will have to admit that the corrected version of SRT is correct and once again be convinced that imaginary numbers actually physically exist. And then it will inevitably be necessary to explain their physical meaning of imaginary numbers. And it is obvious - in addition to our visible world, there is an invisible world.

5. The existence of a physically real invisible world

However, the usefulness for science of the above experimental evidence of the physical reality of imaginary numbers goes beyond problems of correcting the

version of STR given in physics textbooks. From experimentally proven principle of the physical reality of imaginary numbers, one will inevitably have to conclude that the results of all studies described by imaginary numbers in all other exact sciences also are physically real.

Then many difficult questions will arise. For example, what exists in the looking glass when we see ourselves in the mirror? And therefore, in the end, we will have to admit that in addition to our visible world, there is also a huge (most likely even much larger than our visible world) invisible world [99]-[107]. Indeed, in addition to the room in which we are now and which we see, there are a large number of other invisible to us rooms in other apartments, houses, cities and countries. The same situation is in space – in addition to our visible universe, in other dimensions there are about twenty other parallel universes of the hidden Multiverse that are invisible to us. And outside of our hidden Multiverse in the Hyperverses, there are many other Multiverses.

And the existence of such a world invisible to us, in which Gods and the souls of the dead live, was long predicted by all world religions. Consequently, what these religions say about the world order, about the afterlife, is true. And therefore, all of us, the inhabitants of planet Earth, will now have to believe in this.

6. Conclusion

The author hopes that the information presented in the article will be an incentive to unite the efforts of science and religions in their activities for the benefit of people.

Acknowledgments

The author is cordially grateful for the understanding, comments and help of his wife Olga Ilyinichna Antonova.

References

- Weinstein E.W. (2005). The CRC Concise Encyclopedia of Mathematics. 3-rd ed. CRS Press. Boca Raton. FL.
- Ohm G. S. (2014). Die galvanische Kette. Verlag Der Wissenschaften. Göttingen.
- Ohm G. S. (2015). Gesammelte Abhandlungen. Severus Verlag, Hamburg.
- Steinmetz C. P. (2010). Theory and Calculation of Electric Circuit. Nabu Press. Charlstone.
- Larmor J.J. (1897). A Dynamical Theory of the Electric and Luminiferous Medium. Part III. Relations with Material Media. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences. 190, 205-300.
- Lorentz H.A. (1899). Simplified Theory of Electrical and Optical Phenomena in Moving Systems. Proceedings of the Netherlands Academy of Arts and Science. Amsterdam. 1, 427-442.
- Poincaré H. (1905). On the Dynamics of the Electron. Comptes Rendus. 140. 1504-1508.
- Einstein A. (1905). Zur Elektrodynamik bewegter Körper. Annals of Physic. 17. 891-921.
- Antonov A. A. (2021). The version of STR stated in physics textbooks is incorrect because it denies the existence of radio engineering. 82nd International Scientific Conference of the Eurasian Scientific Association "Scientific result in theory and practice". Moscow. ESA. 11-15. <https://esa-conference.ru/sborniki/?y=2021>
- Antonov A. A. (2022). The version of STR presented in physics textbooks is incorrect, since it follows from it that radio engineering should not exist. European Journal of Applied Sciences. Services for Science and Education. UK. 10(1). 440-445. DOI://doi.org/10.14738/aivp.101.2022
- Antonov A. A. (2022). The existence of radio engineering refutes the physics text-books version of STR. The scientific heritage. (Budapest, Hungary). 83(1). 19-22. DOI: 10.24412/9215-0365-2022-83-1-19-22
- Antonov A.A. (2022). The fundamental Ohm's law in radio engineering as interpreted by Steinmetz, which proves the physical reality on imaginary capacitive and inductive reactances, refuted the version of the STR presented in physics textbooks even before its creation. German International Journal of Modern Science. 26. 50-53. DOI: 10.24412/2701-8369-2022-26-50-63
- Antonov A.A. (2022). The version of STR stated in physics textbooks is refuted by the existence of radio engineering. Danish Scientific Journal. 56. 56-59. <http://www.danish-journal.com>
- Antonov A.A. (2022). The version of STR presented in physics textbooks is in correct because it denies the possibility of the existence of Ohm's law as interpreted by Steinmetz and, consequently, the existence of radio engineering. Annali d'Italia. 28(1), 43-47. <https://www.anditalia.com/>
- Antonov A.A. (2022). The version of STR stated in physics textbooks is refuted by the existence of radio engineering. Norwegian Journal of development of the International Science. 78(1). 63-67. DOI: 10.24412/3453-9875-2022-78-63-66.
- Antonov A.A. (2022). If the physics textbook version of STR were true, then Ohm's law should not exist in nature, and therefore all radio engineering would not exist. International independent scientific journal. 36. 16-19. <http://www.iis-journal.com>
- Antonov A.A. (2022). If the version of STR in physics textbooks were true, then there would be no radar, no television, no radio navigation, no telecommunication and many other things. Journal of science. Lyon. 28. 76-79. <https://www.joslyon.com/>
- Antonov A.A. (2022). The version of STR set out in physics textbooks is incorrect because it states that Ohm's law as interpreted by Steinmetz does not really exist, and therefore radio engineering does not exist either. Sciences of Europe (Praha, Czech Republic). 87(1). 54-57. DOI: 10.24412/3162-2364-2022-1-54-57
- Antonov A.A. (2022). Why the physics textbooks teach an incorrect version of the special theory of relativity which denies the existence of radio- and electrical engineering. III international scientific conference "Challenges and problems of modern science". London. Great Britain. 78-86. DOI: <https://doi.org/10.528/zenodo.7486814>

20. Antonov A. A. (2023). Why is the incorrect version of the special theory of relativity being studied in physics textbooks, refuted the existence of radio- and electrical engineering even before its creation? The scientific heritage. (Budapest, Hungary). 105. 83-89. DOI: 10.5281/zenodo.7560145
21. Antonov A.A. (2023). Why is an incorrect version of the special theory of relativity that denies the possibility of the existence radio and electrical engineering being studied in physics textbooks? German International Journal of Modern Science. 48. 23-29. DOI: <https://doi.org/10.5281/zenodo.7541137>
22. Antonov A.A. (2023). Who needs the incorrect version of special relativity taught in physics textbooks despite all its experimental refutations? Annali d'Italia. 39, 64-70. DOI: 10.5281/zenodo.7568916
23. Antonov A.A. (2023). Why is incorrect version of the special theory of relativity that denies the possibility of the existence of radio and electrical engineering being studied in textbooks of physics? Norwegian Journal of development of the International Science. 100. 27-33. <https://doi.org/10.5281/zenodo.7528512>
24. Antonov A.A. (2023). Why is incorrect version of the special theory of relativity, refuted by the existence of radio and electrical engineering, is still studies in all university physics textbooks? Danish Scientific Journal. 69. 66-72. <https://doi.org/10.5281/zenodo.7692053>
25. Antonov A.A. (2023). Why is incorrect version of the special relativity still being studied in physics textbooks, which denies Ohm's law for alternating current used worldwide by millions of radio- and electrical engineers? International independent scientific journal. 46. 38-44. <https://doi.org/10.5281/zenodo.7525751>.
26. Antonov A.A. (2023). Why is the generally accepted version of STR, which denies the possibility of the existence of radio engineering and electrical engineering, tsunamis and bell ringing, the physical phenomenon of resonance and Ohm's physical law for alternating current, music created by the piano and even swing swings on the playground, nevertheless is still considered correct and studied in physics textbooks? Sciences of Europe (Praha, Czech Republic). 112. 44-50. DOI: 10.5281/zenodo.7708515
27. Antonov A.A. (2023). Why is the incorrect version of the special theory of relativity still being studied in physics textbooks, despite all its experimental refutations. European Journal of Applied Sciences. Services for Science and Education. UK. 11(2). 61-71. DOI: <https://doi.org/10.14738/aivp.112.14128>
28. Antonov A.A. (2023). Why the incorrect version of the special theory of relativity, which denies the possibility of the existence of radio engineering and electrical engineering, has not yet been refuted. Journal of science. Lyon. 40. 19-25. <https://doi.org/10.5281/zenodo.7704392>
29. Antonov A. A. (2008). Physical Reality of Resonance on Complex Frequencies. European Journal of Scientific Research. 21(4). 627-641. <http://www.eurojournals.com/ejsr.htm>
30. Antonov A. A. (2009). Resonance on Real and Complex Frequencies. European Journal of Scientific Research. 28(2). 193-204. <http://www.eurojournals.com/ejsr.htm>
31. Antonov A. A. (2010). New Interpretation of Resonance. International Journal of Pure and Applied Sciences and Technology. 1(2). 1-12. http://doi.org/10.17686/sced_rusnauka_2010-888
32. Antonov A. A. (2010). Oscillation processes as a tool of physics cognition. American Journal of Scientific and Industrial Research. 1(2). 342-349. doi:10.5251/ajsir.2010.1.2.342.349
33. Antonov A. A. (2010). Solution of algebraic quadratic equations taking into account transitional processes in oscillation systems. General Mathematics Notes. 1(9). 11-16. http://doi.org/10.17686/sced_rusnauka_2010-887
34. Antonov A. A. (2013). Physical Reality of Complex Numbers. International Journal of Management, IT and Engineering. 3(4). 219-230 http://doi.org/10.17686/sced_rusnauka_2013-898
35. Antonov A. A. (2014). Correction of the special theory of relativity: physical reality and nature of imaginary and complex numbers. American Journal of Scientific and Industrial Research. 5(2). 40-52. doi:10.5251/ajsir.2014.5.2.40.52
36. Antonov A. A. (2015). Physical reality of complex numbers is proved by research of resonance. General Mathematics Notes. 31(2). 34-53. http://www.emis.de/journals/GMN/yahoo_site_admin/asets/docs/4_GMN9212-V31N2.129701.pdf
37. Antonov A.A. (2015). Principle of physical reality of imaginary and complex numbers in modern cosmology: the nature of dark matter and dark energy. Journal of the Russian physico-chemical society. 87(1). 328-355. (In Russian). http://doi.org/10.17686/sced_rusnauka_2015-1119
38. Antonov A. A. (2016). Physical Reality and Nature of Imaginary, Complex and Hypercomplex Numbers. General Mathematics Notes. 35(2). 40-63. http://www.geman.in/yahoo_site_admin/asets/docs/4_GMN-10932-V35N2.31895146.pdf
39. Antonov A. A. (2015). Ohm's law explains astrophysical phenomenon of dark matter and dark energy. Global Journal of Physics. 2(2). 145-149. http://gpcpublishing.com/index.php?journal=gjp&page=article&op=view&path%5B%5D=294&path%5B%5D=pdf_14
40. Antonov A. A. (2015). Adjustment of the special theory of relativity according to the Ohm's law. American Journal of Electrical and Electronics Engineering. 3(5). 124-129. doi: 10.12691/ajeec-3-5-3
41. Antonov A. A. (2016). Ohm's Law is the general law of exact sciences. PONTE. 72(7) 131-142. doi: 10.21506/j.ponte.2016.7/9
42. Antonov A. A. (2016). Ohm's Law explains phenomenon of dark matter and dark energy. International Review of Physics. 10(2). 31-35. <https://www.praiseworthyprize.org/jsm/index.php?journal=irephy&page=article&op=view&path%5B%5D=18615>

43. Antonov A. A. (2016). Ohm's law refutes current version of the special theory of relativity. *Journal of Modern Physics*. 7. 2299-2313. <http://dx.doi.org/10.4236/jmp.2016.716198>
44. Antonov A.A. (2021). The special theory of relativity stated in physics textbooks is incorrect. 77th International Scientific Conference of the Eurasian Scientific Association "Theoretical and practical issues of modern science". Moscow. ESA. 11-15
45. Antonov A. A. (2021). Version of the special theory of relativity that is studied in all physics textbooks is incorrect. *Österreichisches Multiscience Journal* (Innsbruck, Austria). 43(1). 17-22. <http://osterr-science.com>
46. Antonov A. A. (2021). Generally accepted version of the special theory of relativity contained in physics textbooks is incorrect. *The scientific heritage*. (Budapest, Hungary). 73(2). 39-43. DOI: 19.24412/9215-0365-2021-73-2-39-43
47. Antonov A. A. (2021). Special theory of relativity, which is studied in physics text-books, is incorrect. *German International Journal of Modern Science*. 16, 49-53. DOI: 10.24412/2701-8369-2021-16-49-53
48. Antonov A. A. (2021). Special theory of relativity, which is studied in all physics textbooks, is incorrect. *Danish Scientific Journal*. 51(1). 31-35. <http://www.danish-journal.com>
49. Antonov A. A. (2021). Special theory of relativity taught in all physics textbooks is incorrect. *Annali d'Italia*. 22(1). 39-44. <https://www.anditalia.com/>
50. Antonov A. A. (2021). Special theory of relativity presented in physics textbooks is wrong. *Norwegian Journal of development of the International Science* 68(1). 3-7. DOI: 10.24412/3453-9875-2021-68-3-7.
51. Antonov A. A. (2021). In all physics textbooks an erroneous version of special theory of relativity is given. *International independent scientific journal*. 31.34-39. <http://www.iis-journal.com>
52. Antonov A. A. (2021). Special theory of relativity taught in physics textbooks is wrong. *Journal of science*. Lyon. 23. 47-52. <https://www.joslyon.com/>
53. Antonov A. A. (2021). All physics textbooks study incorrect special theory of relativity. *Sciences of Europe*. (Praha, Czech Republic) 79(1). 30-35. DOI: 10/24412/3162-2364-2021-79-30-35
54. Antonov A. A. (2021). Experimental proofs of infidelity of the version of the special theory of relativity studied in physics textbooks and the truth of its alternative version. 80th International Scientific Conference of the Eurasian Scientific Association "Development of science and education in the conditions of global instability". Moscow. ESA. 8-17. <https://esa-conference.ru/sborniki/?y=2021>
55. Antonov A. A. (2021). The fallacy of the STR version studied in physics text- books proved experimentally. *Österreichisches Multiscience Journal* (Innsbruck, Austria). 45(1). 17-26. <http://osterr-science.com>
56. Antonov A. A. (2021). Experimental evidences for the fallacy of the STR version in the physics textbooks. *European Journal of Applied Sciences. Services for Science and Education*. UK. 9(6). 349-364. DOI:10.14738/aivp.96.11304.
57. Antonov A. A. (2021). If the STR version in physics textbooks were true, we would never have heard the music of the piano and the bell ringing, there would be no television, no cellular telephony, no radar or GPS navigation, we would not even be aware of the existence of resonance and Ohm's law as interpreted by Steinmetz, and our children could not swing on the swings. *The scientific heritage* (Budapest, Hungary). 78(2). 41-50. DOI: 10.24412/9215-0365-2021-78-2-41-50
58. Antonov A. A. (2021). Experimental refutations of the STR version contained in physics textbooks and confirmations of the truth of its alternative version. *German International Journal of Modern Science*. 22. 52-61. DOI: 10.24412/2701-8369-2021-22-52-61
59. Antonov A. A. (2021). The STR version in physics textbooks must be corrected, be-cause if it were true, there would be no tsunamis or indian summer in nature, we would be never have heard piano music, engineers would be not have been able to create television, cell phones, GPS trackers, and even children would not be able to swing on swings. *Danish Scientific Journal*. 54(1). 29-38. <http://www.danish-journal.com>
60. Antonov A. A. (2021). Experimental evidence of the incorrectness of the STR version studied in physics textbooks. *Annali d'Italia*. 25(1). 32-41. <https://www.anditalia.com/>
61. Antonov A. A. (2021). The incorrectness of the STR version presented in physics textbooks proven experimentally. *Norwegian Journal of development of the International Science*. 74(1). 3-7. DOI: 10.24412/2453-9875-2021-74-53-62.
62. Antonov A. A. (2021). Experimental refutations of the generally accepted version of the SRT studied in physics textbooks. *International independent scientific journal*. 34(1). 23-32. <http://www.iis-journal.com>
63. Antonov A. A. (2021). Experimental refutations of the SRT version in the physics textbooks. *Journal of science*. Lyon. 26(1). 29-37. <https://www.joslyon.com/>
64. Antonov A. A. (2021). Experimental evidences for the fallacy of the STR version in physics textbooks. *Sciences of Europe* (Praha, Czech Republic). 82(2). 19-28. DOI: 10.24412/3162-2364-2021-82-2-19-28
65. Antonov A.A. (2023). The Corrected Version of the Special Theory of Relativity. *European Journal of Applied Sciences. Services for Science and Education*. UK. 11(5). 68-83. DOI:10.14738/aivp.115.15474
66. Antonov A. A. (2023). Corrected special theory of relativity. *Journal of science*. Lyon. 48. 27-36. <https://doi.org/10.5281/zenodo.10277156>
67. Antonov A. A. (2023). Corrected special theory of relativity. *Annali d'Italia*. 49, 25-35. DOI: 10.5281/zenodo.10214679
68. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. *The scientific heritage*. (Budapest, Hungary). 123. 72-81,
69. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. *Norwegian Journal of development of the International Science*. 118. 40-49. <https://doi.org/10.5281/zenodo.10009500>

70. Antonov A. A. (2023). Alternative Version of the Special Theory of Relativity. Sciences of Europe. (Praha, Czech Republic). 128. 62-71.
71. Antonov A. A. (2023). Special Theory of Relativity. German International Journal of Modern Science. 67. 64-73. DOI: 10.5281/zenodo.10966458
72. Antonov A. A. (2023). Corrected Version of the Special Theory of Relativity. Danish Scientific Journal. 77. 88-97. <https://doi.org/10.5281/zenodo.10054677>
73. Antonov A. A. (2011). Structure of the Multiverse. British Journal of Science. 2(2). 51-60. http://doi.org/10.17686/sced_rusnauka_2011892
74. Antonov A. A. (2012). Multiverse. Time Travels. International Journal of Pure and Applied Sciences and Technology. 12(2). 43-56. http://doi.org/10.17686/sced_rusnauka_2012-896
75. Antonov A. A. (2012). Discovery of the real multiverse. Encyclopedia of Russian thought, Reports to the Russian Physical Society. 16(3). 3-20. (In Russian). http://doi.org/10.17686/sced_rusnauka_2012-1115
76. Antonov A. A. (2013). Cognition of the multiverse as a factor in accelerating the development of human civilization. Journal of Russian physical thought. 1-12, 6-77. (In Russian). http://doi.org/10.17686/sced_rusnauka_2011-1117
77. Antonov A. A. (2015). Hidden Multiverse. International Journal of Advanced Research in Physical Science. 2(1). 25-32. http://doi.org/10.17686/sced_rusnauka_2015-903
78. Antonov A.A. (2015). The astrophysical phenomenon of dark matter and dark energy proves the existence of the hidden Multiverse. American Journal of Modern Physics. 4(4). 180-188. DOI: 10.11648/j.jamp.20150404.14
79. Antonov A. A. (2015). Hidden Multiverse: explanation of dark matter and dark energy phenomena. International Journal of Physics. 3(2). 84-87. doi:10.12691/ijp-3-2-6
80. Antonov A. A. (2015). Principles and structure of the real Multiverse: explanation of dark matter and dark energy phenomena. American Journal of Modern Physics. 4(1). 1-9. doi: 10.11648/j.ajmp.20150401.11
81. Antonov A. A. (2016). Hypothesis of the Hidden Multiverse: Explains Dark Matter and Dark Energy. Journal of Modern Physics. 7(10), 1228- 1246. doi: 10.4236/jmp.2016.710111
82. Antonov A. A. (2015). Quaternion structure of the hidden Multiverse: explanation of dark matter and dark energy. Global Journal of Science. Frontier Research A: Physics and Space Science. 15(8). 8-15. https://globaljournals.org/GJSFR_Volume15/2-Quaternion-Structure-of-the-Hidden.pdf
83. Antonov A. A. (2016). Verifiable Multiverse. Global Journal of Science Frontier Research: A Physics and Space Science. 16(4) 4-12. doi: 10.17406/GJSFR
84. Antonov A. A. (2020). How to See Invisible Universes. Journal of Modern Physics. 11(05), 593-607. DOI: 10.4236/jmp.2020.115039
85. Antonov A. A. (2020). Can invisible universes be seen? International independent scientific journal. 21(2). 51-60. <http://www.iis-journal.com>
86. Antonov A. A. (2020). How to discover invisible universes. Norwegian Journal of development of the International Science. 42(1). 36-48. <http://www.njd-iscience.com>
87. Antonov A. A. (2020). Universes Being Invisible on Earth outside the Portals Are Visible in Portals. Natural Science. 12(8). 569-587. <https://doi.org/10.4236/ns.2020.128044>
88. Antonov A. A. (2020). Invisible universes can be seen in anomalous zones. Danish Scientific Journal. 43(1). 9-24. <http://www.danish-journal.com>
89. Antonov A. A. (2021). Invisible universes can be seen in anomalous zones. International independent scientific journal. 23(1). 28-44.
90. Antonov A. A. (2012). Earth, portals, parallel universes. American Journal of Scientific and Industrial Research. 3(6). 464-473. doi:10.5251/ajsir.2012.3.6.464.473
91. Antonov A. A. (13 January 2016). How Portals of the Invisible Multiverse Operate. Science PG Frontiers. <http://www.sciencepublishinggroup.com/news/sciencepgfrontiersinfo?articleid=7>
92. Antonov, A. A. (2016). Star gates of the hidden multiverse. Philosophy and cosmology. 6. 11-27. (In Russian). <http://ispcjournal.org/journals/2016-16/Antonov16.pdf>
93. Chernobrov, V. (2000). Encyclopedia of mysterious places of the Earth. Veche Publishing House. Moscow. (In Russian).
94. Chernobrov, V. (2004). Encyclopedia of mysterious places of Russia. Veche Publishing House. Moscow. (In Russian).
95. Chernobrov, V. (2007). Encyclopedia of mysterious places of the Earth and space. Veche Publishing House. Moscow. (In Russian).
96. Chernobrov, V. (2009). Encyclopedia of mysterious places of Moscow and Moscow region. Helios ARV Publishing House. Moscow. (In Russian).
97. Antonov A. A. (2017). The physical reality and essence of imaginary numbers. Norwegian Journal of development of the International Science. 6. 50-63. <http://www.njd-iscience.com>
98. Antonov A. A. (2018). Physical Reality and Essence of Imaginary Numbers in Astrophysics: Dark Matter, Dark Energy, Dark Space. Natural Science. 10(1). 11-30. doi:10.4236/ns.2018.101002
99. Antonov A. A. (2023). Proving physical reality and explaining the physical essence of imaginary numbers. Norwegian Journal of development of the International Science. 123. 26-36. <https://doi.org/10.5281/zenodo.10451085>
100. Antonov A. A. (2024). Physical reality of imaginary numbers and their physical essence. Danish Scientific Journal. 80. 25-35/ <https://doi.org/10.5281/zenodo.10594282>
101. Antonov A. A. (2024). Proof of physical reality of imaginary numbers and explanation of their physical essence. German International Journal of Modern Science. 72. 17-27.
102. Antonov A. A. (2024). Physical reality of imaginary numbers and their physical essence. Sciences of Europe. (Praha, Czech Republic). 133(1). 79-90. DOI: 10.5281/zenodo.10575590

103. Antonov A. A. (2024). Physical reality of imaginary numbers and their physical essence. The scientific heritage. (Budapest, Hungary). 129. 43-53. DOI: 10.5281/zenodo.10558263

104. Antonov A. A. (2024). Proving Physical Reality and Explaining Physical Essence of Imaginary Numbers. Journal of science. Lyon. 50. 25-35. <https://doi.org/10.5281/zenodo.10609816>

105. Antonov A. A. (2024). Physical reality of complex numbers and their physical essence. International independent scientific journal. 58. 3-13. <https://doi.org/10.5281/zenodo.10491923>

106. Antonov A. A. (2024). Proof of physical reality of imaginary numbers and explanation of their physical essence. Annali d'Italia. 51, 25-35. DOI: 10.5281/zenodo.10573831

A FINITE DIFFERENCE METHOD FOR THE SOLUTION OF THIRD ORDER BOUNDARY VALUE PROBLEMS IN ORDINARY DIFFERENTIAL EQUATIONS

Ramani J.V.,

*Department of Mathematics, Dyal Singh College (University of Delhi),
Lodhi Road, New Delhi, India*

Kumar Dinesh

*Department of Mathematics, Dyal Singh College (University of Delhi),
Lodhi Road, New Delhi, India*

DOI: [10.5281/zenodo.11624443](https://doi.org/10.5281/zenodo.11624443)

Abstract

In this paper, we propose an efficient finite difference method to solve third order boundary value problems. Analysis proves that the proposed method have at least quadratic convergence. Numerical results confirm the accuracy and efficiency of the proposed method.

Keywords: Boundary Value Problems, Finite Difference, Taylor series, Row Sum Norm, Maximum Error.

1. Introduction

Third-order differential equations arise in many modelling problems like aeroelasticity, beam deflection theory, electromagnetic waves, theory of thin film flow.

In this paper, we study an effective numerical technique based on finite differences to solve third order boundary value problems(BVPs) of the following type:

$$u''' = f(x, u), a \leq x \leq b \quad (1.1)$$

subject to the boundary conditions

$$u''(a) = \alpha, u(b) = \beta, u'(b) = \gamma \quad (1.2)$$

where the α , β and γ are arbitrary constants.

The discussion on the existence, uniqueness and convergence of the solution of problem 1.1 can be found in the literature [1], [12], [3], [6]. We wont mention the conditions on the existence and uniqueness of the solution to problem 1.1.

We assume the existence and uniqueness of the solution to problem 1.1. We also assume that problem 1.1 is well posed.

This article is arranged in the following order. In section 2, we propose the finite difference method. In section 3, we discuss the convergence of the proposed method. In section 4, we illustrate the method with examples and finally in section 5 we present the performance of our proposed method.

2. The Difference method

To find an approximation to the solution of the problem 1.1, we discretize the domain $[a, b]$ into N equal subintervals each of size $h = \frac{b-a}{N}$:

$$a = x_0 < x_1 < x_2 < \dots x_{N-1} < x_N = b \quad (2.1)$$

where the nodes are given by $x_i = a + ih, i = 0, 1, \dots, N$.

We want to determine the numerical approximation of the true solution $u(x)$ of the problem 1.1 at the nodal point

$$x_i, i = 1, 2, \dots, N.$$

Let u_i and f_i denote the numerical approximations of $u(x)$ and $f(x, u(x))$ at $x = x_i, i = 0, 1, 2, \dots, N$ which allows us to write the boundary value problem 1.1 at node $x = x_i$ as written as

$$u_i''' = f_i, a \leq x_i \leq b \quad (2.2)$$

subject to the boundary conditions

$$u_0'' = \alpha, u_N = \beta, u_N' = \gamma.$$

We define the nodes as

$$x_{i \pm \frac{1}{2}} = x_i \pm \frac{h}{2}, i = 1, 2, \dots, N-1$$

and denote the solution of the problem 2.2 at $x_{i \pm \frac{1}{2}}$ by

$$u_{i \pm \frac{1}{2}}.$$

Using the method of undetermined coefficients and Taylor's series expansion [7, 8, 9], we get the following scheme:

$$\begin{aligned} u_{i-\frac{1}{2}} - 2u_{i+\frac{1}{2}} + u_{i+\frac{3}{2}} &= h^2 u_{i-1}'' + \frac{h^3}{24} (25u_{i-\frac{1}{2}}''' + 11u_{i+\frac{1}{2}}''') + T_i, i = 1 \\ -u_{i-\frac{3}{2}} + 3u_{i-\frac{1}{2}} - 3u_{i+\frac{1}{2}} + u_{i+\frac{3}{2}} &= \frac{h^3}{2} (u_{i-\frac{1}{2}}''' + u_{i+\frac{1}{2}}''') + T_i, 2 \leq i \leq N-2 \\ u_{i-\frac{3}{2}} - 3u_{i-\frac{1}{2}} + 2u_{i+\frac{1}{2}} &= hu_{i+1}' + \frac{h^3}{48} (21u_{i-\frac{3}{2}}''' - 67u_{i-\frac{1}{2}}''') + T_i, i = N-1 \\ -2u_{i-\frac{5}{2}} + 5u_{i-\frac{3}{2}} + 5u_{i-\frac{1}{2}} &= 8u_i - 5hu_i' + \frac{h^3}{24} (25u_{i-\frac{3}{2}}''' + 30u_{i-\frac{1}{2}}''') + T_i, i = N \end{aligned} \quad (2.3)$$

where

$$T_i, i = 1, 2, \dots, N$$

is the truncation error.

After neglecting the truncation errors T_i at the nodes $x_{i-\frac{1}{2}}, i = 1, 2, \dots, N$, in 2.3, we obtain a system of $N \times N$ equations in the unknowns $u_{i-\frac{1}{2}}$, which may be linear or non-linear according as $f(x, u)$ is linear or non-linear.

Using the values $u_{i-\frac{1}{2}}$, we compute the values $u_i, i = 0, 1, \dots, N$ according to the second-order approximation

$$u_i = \begin{cases} \frac{1}{2} \left(3u_{i+\frac{3}{2}} - u_{i+\frac{1}{2}} \right) & \text{if } i = 0 \\ \frac{1}{2} \left(u_{i-\frac{1}{2}} + u_{i+\frac{1}{2}} \right) & \text{if } 1 \leq i \leq N-1 \end{cases} \quad (2.4)$$

3. Convergence Analysis

Let $U_{i-\frac{1}{2}}, i = 1, \dots, N$, denote the true solution of the problem 1.1 at the $x_{i-\frac{1}{2}}, i = 1, \dots, N$ and let $\mathbf{U}$ be the column vector

$$\mathbf{U} = [U_{i-\frac{1}{2}}] \quad (3.1)$$

Also let, $\mathbf{u}$ be the column vector consisting of the approximations $u_{i-\frac{1}{2}}$ at the nodes $x_{i-\frac{1}{2}}, i = 1, \dots, N$,

$$\mathbf{u} = [u_{i-\frac{1}{2}}] \quad (3.2)$$

and the errors at the nodes $x_{i-\frac{1}{2}}, i = 1, \dots, N$ be denoted by

$$\epsilon_{i-\frac{1}{2}} = U_{i-\frac{1}{2}} - u_{i-\frac{1}{2}}, i = 1, \dots, N \quad (3.3)$$

and the error vector in column form be denoted by

$$\mathbf{e} = [\epsilon_{i-\frac{1}{2}}] = [U_{i-\frac{1}{2}} - u_{i-\frac{1}{2}}] \quad (3.4)$$

Then, we have the following equations

$$\mathbf{AU} = \mathbf{b} + \mathbf{t} \quad (3.5)$$

$$\mathbf{Au} = \mathbf{b} \quad (3.6)$$

where the $N \times N$ matrix $\mathbf{A}$ and column vectors $\mathbf{b}$ and $\mathbf{t}$ are given by

$$\mathbf{A} = \begin{bmatrix} 1 & -2 & 1 & 0 & \dots & & & & & 0 \\ -1 & 3 & -3 & 1 & 0 & \dots & & & & \\ 0 & -1 & 3 & -3 & 1 & 0 & \dots & & & \\ 0 & 0 & -1 & 3 & -3 & 1 & 0 & \dots & & \\ 0 & 0 & 0 & -1 & 3 & -3 & 1 & 0 & \dots & \\ 0 & 0 & 0 & \ddots & \ddots & \ddots & \ddots & \ddots & \dots & \\ \vdots & & & & \ddots & \ddots & \ddots & \ddots & \dots & \\ & & & & & -1 & 3 & -3 & 1 & 0 \\ & & & & & \dots & 0 & 0 & 1 & -3 & 2 \\ 0 & & & & & \dots & 0 & 0 & -2 & 5 & 5 \end{bmatrix}_{N \times N} \quad (3.7)$$

$$\mathbf{b} = [b_i] \quad (3.8)$$

$$\mathbf{t} = [T_i] \quad (3.9)$$

and the b_i 's and T_i 's are given by

$$b_i = \begin{cases} h^2 \alpha + \frac{h^3}{24} \left(25f_{i-\frac{1}{2}} + 11f_{i+\frac{1}{2}} \right) + T_i, i = 1 \\ \frac{h^3}{2} \left(f_{i-\frac{1}{2}} + f_{i+\frac{1}{2}} \right) + T_i, 2 \leq i \leq N-2 \\ h\gamma + \frac{h^3}{48} \left(21f_{i-\frac{3}{2}} - 67f_{i-\frac{1}{2}} \right) + T_i, i = N-1 \\ 8\beta - 5h\gamma + \frac{h^3}{24} \left(25f_{i-\frac{3}{2}} + 30f_{i-\frac{1}{2}} \right) + T_i, i = N \end{cases} \quad (3.10)$$

and

$$T_i = \begin{cases} \frac{1}{24} h^5 u_{i-\frac{1}{2}}^{(5)} \text{ if } i = 1, \\ \frac{1}{240} h^7 u_{i-\frac{1}{2}}^{(7)} \text{ if } 2 \leq i \leq N-2, \\ -\frac{809}{1920} h^5 u_{i-\frac{1}{2}}^{(5)} \text{ if } i = N-1, \\ -\frac{7}{384} h^5 u_{i-\frac{1}{2}}^{(5)} \text{ if } i = N \end{cases} \quad (3.11)$$

The matrix $\mathbf{A}$ is nonsingular [4, 5] and its inverse $\mathbf{A}^{-1} = \mathbf{B} = [b_{ij}]$ is given by

$$b_{ij} = \begin{cases} \frac{1}{8} & \text{if } i = N, j = 1, \dots, N \\ \frac{1}{8} & \text{if } i = 1, \dots, N-1, j = N \\ \frac{(2(N-i)+1)^2}{8} & \text{if } i = 1, \dots, N-2, j \leq i \\ \frac{(2(N-i)+1)^2}{8} & \text{if } i = N-1, N, j = 1, \dots, N-2 \\ \vdots & \end{cases} \quad (3.12)$$

and

$$\|\mathbf{A}^{-1}\| = \frac{8N^3 - 16N^2 + 15N - 6}{24} \quad (3.13)$$

Here $\|\mathbf{A}^{-1}\|$ denotes the maximum row sum norm of $\mathbf{A}^{-1}$.

Now,

$$\|\mathbf{A}^{-1}\| \leq \frac{N^3}{3} \quad (3.14)$$

From equations 3.5 and 3.6, we have

$$\mathbf{A}\mathbf{e} = \mathbf{t} \quad (3.15)$$

which gives

$$\mathbf{e} = \mathbf{A}^{-1}\mathbf{t} \quad (3.16)$$

Therefore,

$$\|\mathbf{e}\| \leq \|\mathbf{A}^{-1}\| \|\mathbf{t}\| \quad (3.17)$$

where $\|\mathbf{t}\|$ is the maximum norm of $\mathbf{t}$.

If we let,

$$M = \max_{a \leq x \leq b} |u^{(5)}(x)| \quad (3.18)$$

Then

$$\|\mathbf{t}\| \leq Mh^5 \quad (3.19)$$

Hence

$$\|\mathbf{e}\| \leq \frac{N^3 M h^5}{3} = \frac{(b-a)^3 M h^5}{3h^3} = \frac{M(b-a)^3}{3} h^2 \quad (3.20)$$

which shows that the our proposed scheme 2.3, 2.4 has second order convergence.

4. Numerical Examples

The following problems illustrate the performance of our method. We compute the maximum absolute error MAE in the true solution $u(x)$, namely:

$$\text{MAE} = \max_{0 \leq i \leq N} |u(x_i) - u_i|$$

All the computations were performed on Ubuntu 20.04.4 LTS GNU linux operating system with IDLE 3.8.10 running Python version 3.8.10 on Intel® Core™ i5-9400 CPU @ 2.90GHz × 6 PC.

Example 4.1. Consider the linear model problem in [10] given by:

$$u''' - xu(x) = (x^3 - 2x^2 - 5x - 3) \exp(x), 0 \leq x \leq 1 \quad (4.1)$$

with the boundary conditions

$$u''(0) = 0, u(1) = 0, u'(1) = -\exp(1) \quad (4.2)$$

with the exact solution

$$u(x) = x(1-x)\exp(x) \quad (4.3)$$

The MAE computed by method 2.3 for different values of N are given below

N	MAE
128	8.150736478892279e-05
256	2.0557217413813555e-05
512	5.161967603378552e-06
1024	1.2933322996243161e-06
2048	3.2368860043946283e-07
4096	8.096661511538226e-08

Example 4.2. Consider the linear model problem in [11] given by:

$$u''' + u(x) = (x^2 - 6x - 1) \sin(x) + (7 - x^2) \cos x, 0 \leq x \leq 1, \quad (4.4)$$

with the boundary conditions

$$u''(0) = 0, u(1) = 0, u'(1) = 2\sin(1) \quad (4.5)$$

with the exact solution

$$u(x) = (x^2 - 1) \sin(x) \quad (4.6)$$

The MAE computed by method 2.3 for different values of N are given below:

N	MAE
128	3.0204368352604316e-05
256	7.55068418839544e-06
512	1.8876175097159997e-06
1024	4.71897596415749e-07
2048	1.1797358473453201e-07
4096	2.9493265135682734e-08

Example 4.3. Consider the nonlinear model problem in [12] given by:

$$u''' + 2\exp(-3u(x)) = 4(1+x)^{-3}, 0 \leq x \leq 1, \quad (4.7)$$

with the boundary conditions

$$u''(0) = -1, u(1) = \ln(2), u'(1) = \frac{1}{2} \quad (4.8)$$

with the exact solution

$$u(x) = \ln(1+x) \quad (4.9)$$

The MAE computed by method 2.3 for different values of N are given below:

N	MAE
128	2.2417700782846953e-05
256	5.662842074857788e-06
512	1.4230859950213962e-06
1024	3.5669952002108547e-07
2048	8.92905674886816e-08
4096	2.2330040715915107e-08

5. Conclusion

In this paper we have proposed a numerical method to solve third order boundary value problems having quadratic convergence. We have estimated the error involved. We have also given several numerical examples which confirms our claim.

References

1. Ravi P. Agarwal, Boundary value problems for higher order differential equations, World-Scientific, Singapore, (1986).
2. Gregus M., Third order linear differential equations, Series: Mathematics and its Applications, Springer Netherlands, Vol. 22, (1987).
3. Gupta C. P. and Lakshmikantham V., Existence and uniqueness theorems for a third-order threepoint boundary value problem, Nonlinear Analysis: Theory, Methods and Applications, Vol. 16, No. 11, pp.949–957, (1991).
4. M. K. Jain, Numerical Solution of Differential Equations, New Age International, (2018).
5. Horn, R. A. and Johnson C. R., Matrix Analysis, Cambridge University Press, New York, NY 10011, USA, (1990).
6. Murty, K.N. and Rao, Y.S., A theory for existence and uniqueness of solutions to three-point boundary value problems, Journal of Mathematical Analysis and Applications, Vol. 167, No. 1, 43–48, (1992).
7. P. K. Pandey, The numerical solution of third order differential equation containing the first derivative, Neural Parallel and Scientific Comp., Vol. 13, 297–304, (2005).
8. P. K. Pandey, An efficient numerical method for the solution of third order boundary value problem in ordinary differential equations, Int. J. Computing Science and Mathematics, Vol.9, No. 2, 171-180, (2018).
9. P. K. Pandey, The Numerical Solution of Three Point Third Order Boundary Value Problems in Odes, Journal of Science and Arts, Year 20, No. 3(52), 529-536, (2020).
10. Calgar, H. N., Calgar, S. H. and Twizell, E. H., The Numerical Solution of Third-Order Boundary-Value Problems with Fourth-Degree B-Spline Functions, Intern. J. Computer Math., Vol. 71, 373-381 (1999).
11. El-Danaf, T. S., Quartic Nonpolynomial Spline Solutions for Third Order Two-Point Boundary Value Problem, World Academy of Science, Engineering and Technology, International Journal of Mathematical, Computational, Physical, Electrical and Computer Engineering 2(9), 637-640 (2008).
12. Ghazala, A., Muhammad, T., Shahid, S. S. and Hamood, U. R., Solution of a Linear Third order Multi-Point Boundary Value Problem using RKM, British Journal of Mathematics and Computer Science 3(2): 180-194 (2013).

NORMAL AND PATHOLOGICAL PHYSIOLOGY

A CLINICAL CASE IN THE PRACTICE OF A RHEUMATOLOGIST: SYSTEMIC LUPUS ERYTHOMUS WITH INFLAMMATION OF ORGANS AND SYSTEMS

Bukach O.,

assistant of the department of internal medicine

Ariichuk D.,

Babchenko V.,

Soha N.,

Stefurak M.

Bukovyna State Medical University

DOI: [10.5281/zenodo.11624463](https://doi.org/10.5281/zenodo.11624463)

Abstract

Systemic lupus erythematosus (SLE) is one of the most serious systemic connective tissue diseases that develops more often in young women and girls, although it can occur at any age. Patients with SLE still have a high risk of death (3 times higher than in the general population). Early diagnosis, intensification of basic therapy and minimization of the dose of glucocorticoids (GC), assessment of cardiovascular risk and treatment of cardiovascular diseases are considered to be the basis for improving the prognosis in SLE.

Keywords: systemic lupus erythematosus, facial erythema, polyarthritis, pneumosclerosis, myocardiofibrosis.

Introduction

Rheumatology is one of the most diagnostically complex medical disciplines, which is at the intersection of many specialties. A rheumatologist needs a high level of professional skills, because he often has to diagnose conditions that can hide under the mask of rheumatological symptoms. One of the most difficult groups of rheumatological diseases to differentiate is systemic lupus erythematosus.

Systemic lupus erythematosus (SLE) is a systemic autoimmune polyetiological disease characterized by hyperproduction of autoantibodies to various components of the cell nucleus with the development of immunoinflammatory damage to tissues and internal organs [1, 7]. In all age groups, the incidence is higher among women, especially those of reproductive age, when the ratio of the incidence of women to men is 8:1–15:1, while this pattern is least pronounced in prepubertal age — 4:3 [2, 11]. According to over the past 60 years, the 5-year survival of patients with SLE has increased from 50 to 91–97% [16, 18]. Such an improvement is primarily associated with timely diagnosis, and therefore early initiation of therapy, and management of patients based on the principle of "treatment until the goal is achieved" — stable clinical and laboratory remission [12].

SLE is accompanied by multiple organ damage and the development of various complications, including both typical and rare ones. In particular, one of the main reasons for the unfavorable prognosis of the disease is kidney damage [5]. Despite progress in the diagnosis and treatment of this pathology, kidney damage remains the leading cause of death in patients with SLE. Many such patients develop chronic kidney disease (CKD), as well as complications, concomitant diseases and conditions that are a consequence of immunosuppressive therapy: infections, osteoporosis, damage to the cardiovascular and reproductive systems, etc. [3, 4]. Regarding methods of treatment of lupus nephritis in SLE, many studies are being conducted, new promising

drugs are appearing [9, 15]. CKD is also associated with the development of vitamin D deficiency, systemic osteoporosis, and secondary hyperparathyroidism [6].

According to the literature, there are 5 main types of soft tissue calcification: dystrophic, metastatic, idiopathic, iatrogenic, and calciphylaxis [10, 17]. Most often, in systemic connective tissue diseases, a dystrophic process is noted, which consists in secondary tissue damage and the formation of calcifications [8]. It is generally accepted that soft tissue calcifications are detected in dermatomyositis, systemic scleroderma, CREST syndrome, overlap syndrome, but they are rare in SLE [13, 14].

We bring to your attention a clinical case of the development of myocardial cardiomyopathy, pneumosclerosis, polyarthritis and dyscirculatory encephalopathy in a patient with SLE.

Purpose: to describe a clinical case of the development of damage to all organs and systems in a patient with SLE and to prescribe combined treatment depending on the damage to the relevant body systems.

Materials and methods

Patient V., 50 years old, complains of difficulty in self-care, pain and stiffness in the joints of the hands and feet, periodic aching pain in the area of the heart, palpitations, rapid fatigue, coldness of the hands, suffocation during physical exertion.

She considers herself a patient for 11 years. He is periodically treated as an inpatient. Systematically takes GC (diprosan, medrol). In connection with deterioration of well-being and strengthening of the above-mentioned symptoms, she was sent for inpatient treatment in the rheumatology department of the OKL.

Objectively upon admission: the general condition of the patient is of moderate severity. Normosthenic. Swelling of the feet. Body temperature is 37.1°C. Pulse 82 per minute, satisfactory properties. Blood pressure 140/90 mm Hg. The rhythm of cardiac activity is correct, the ratio of tones is preserved. In the

lungs, percussion is clear pulmonary sound, auscultation – vesicular breathing, basally weakened. Respiratory rate - 22 per minute. The tongue is wet, covered with a white coating. The abdomen is soft, sensitive in the epigastric region, in the left hypochondrium, the edge of the liver is sensitive to palpation. Symptom Pasternacki is negative on both sides. Limitation of movements in the radiocarpal joints: right - dorsiflexion 0°, palmar flexion - 25°, left - dorsiflexion 0°, palmar - 25°. Left shoulder joint: flexion 90°, abduction 90°. Knee joints: right flexion 40°, extension 180°, left flexion 45°, extension 175°. Ankle-foot joints: right dorsiflexion - 30°, plantar flexion - 10°, left dorsiflexion 30°, plantar 10°. Contractures of both radiocarpal joints. Contracture of the left shoulder joint. Extensor contracture of the right knee joint with impaired function. Flexion-extension contracture of the left knee joint without impaired locomotor function. Contractures of both ankle-foot joints with impaired function. Pain along the paravertebral points of the thoracic spine.

Conducted examination:

PRS from 06.22.23 - negative. Blood group B(III), Rh-positive

General blood test from June 21, 2023 - erythrocytes- $3.4 \times 10^{12}/l$, Hb - 106 g/l, k.p. - 0.9, platelets- 216×10^9 , leukocytes- $5.1 \times 10^9/l$, eosinophils - 2%, rod nuclear - 2%, segment nuclear- 70%, lymphocytes - 25%, monocytes - 1%; erythrocyte sedimentation rate - 34 mm/h.

Biochemical analysis of blood from July 1, 2023. protein 76.0 g/l, urea - 6.8 mmol/l, total bilirubin - 11.0 $\mu\text{mol/l}$, blood glucose - 3.6 mmol/l.

Biochemical analysis of blood from July 9, 2023. protein 77.0 g/l, urea - 6.7 mmol/l, total bilirubin - 18.0 $\mu\text{mol/l}$, blood glucose - 5.1 mmol/l, AsAT - 0.2 $\mu\text{mol/l}$, AlAT - 0.41 $\mu\text{mol/l}$, thymol test - 1.0 units, urea - 6.6 mmol/l l, cholesterol - 4.2 mmol/l.

Blood glucose as of March 7, 2023 - 6.4 mmol/l.

Rheumatic tests from June 23, 2023 - ASLO - 200; CRP - 42 mg/ml, sialic test - 328 units, sulfur mucoid - 280 units.

General urine tests from 01.07.23 - 100 ml, light yellow, transparent, specific weight- 1012, weakly acidic, single transitional epithelium, single leukocytes, single bacteria, protein, glucose - not found.

Daily glucosuria 06/21/23 1.00 l

Fecal analysis from June 21, 2023 - no helminth eggs were found.

Fluorography of the chest organs from June 29, 2023 - lungs and heart within normal limits.

Electrocardiography from July 1, 2023 - sinus rhythm, regular, heart rate 87 beats per minute. Changes in the myocardium of the back wall of the left ventricle, hypertrophy of the myocardium of the left ventricle.

Ultrasound diagnostics of the abdominal cavity from June 24, 2023 - vertical size of the right lobe of the liver - 152 mm, increased echogenicity. The gallbladder is oval in shape, contains echogenic bile, the walls are compacted. Pancreas of increased echogenicity. Spleen 110x41mm, homogeneous. The right kidney is moderately lowered, N sizes. In both kidneys,

the calyces are compacted, casts of salts, the parenchyma is preserved. Signs of chronic cholecysto-pancreatitis.

Ultrasound diagnostics of the thyroid gland (thyroid gland) - both lobes of the thyroid gland are of normal size, the tissue of the thyroid gland is homogeneously heterogeneous, more on the right. Signs of diffuse goiter.

Consultation of a gynecologist on November 6, 2023, she is healthy.

Consultation of an endocrinologist - Diffuse non-toxic goiter II st. Autoimmune thyroiditis.

The diagnosis was made: Systemic lupus erythematosus, chronic course, activity of the 1 degree, with lesions of the skin (erythema of the face, décolletage, reticular liver), heart (myocarditic myocardiofibrosis, arrhythmic variant of Heart failure IIA, functional class II), lungs (pneumosclerosis Pulmonary failure I), joints (Polyarthritis Ro II stage, Joint functional insufficiency II stage, contractures of carpal, knee, ankle-foot joints), nervous system (dyscirculatory encephalopathy), RES (lymphoadenopathy).

And the treatment carried out: diet No. 10, medrol, dexamethasone, panangin, renalgan, corvitin, tivortin, reosorbilact, metamax, thiotriazoline, neocardil, aspecard, megafen, calcium-D3 nicomed. Passed health school No. 6.

On July 6, 2023, she was discharged home to continue outpatient treatment.

RECOMMENDED in the future for the patient:

1. "D" registration with a rheumatologist, endocrinologist, gastroenterologist at the place of residence.
2. Methylprednisolone 20 mg (according to the scheme).
3. Plaquenil 1 tablet at night- 6 months
4. Calcium - D3 Nikomed 1 tablet x 2 r per day - during the period of taking GC.
5. Pantapazole 40 mg 1 tablet x 1 per day - during the period of GC reception.
6. Curantyl 1 tablet x 2 times (2 weeks).
7. Panangin 1 tablet x 3 times a day - the entire period of taking GCS
8. Sedative therapy (barboval, motherwort, sedative herbal preparation).
9. Observe the regime of work and rest.

CONCLUSION

A large number of pathological conditions unrelated to rheumatology can be hidden under the mask of rheumatological symptoms. Systemic lupus erythematosus, which is characterized by polymorphism of manifestations, requires special attention. The presence of comorbid pathology in patients with systemic lupus erythematosus creates problems for verifying the diagnosis of this disease and conducting high-quality multi-symptom treatment.

References

1. Achebe I., Mbachi C., Asotibe J.C. Paintsil I. (2020) Dystrophic Calcinosis Cutis in Systemic Lupus Erythematosus. *Cureus*. 2020;12(6):e8727. doi.org/10.7759/cureus.8727.

2. Almaani S., Meara A., Rovin B.H. Update on Lupus Nephritis. *Clinical journal of the American Society of Nephrology: CJASN*. 2017;12(5):825–835. doi.org/10.2215/CJN.05780616.
3. Anders H.J., Saxena R., Zhao M.H. et al. Lupus nephritis. *Nature reviews. Disease primers*. 2020;6(1):7. doi.org/10.1038/s41572–019–0141–9.
4. Andrews J., Psaltis P.J., Bayturan O. et al. Warfarin use is associated with progressive coronary arterial calcification: insights from serial intravascular ultrasound. *JACC: Cardiovascular Imaging*. 2018;11(9):1315–1323.
5. Aringer M., Costenbader K., Daikh D. et al. European League Against Rheumatism/American College of Rheumatology classification criteria for systemic lupus erythematosus. *Annals of the Rheumatic Diseases*. 2019;78:1151–1159.
6. Chandran M., Wong J. (2019) Secondary and Tertiary Hyperparathyroidism in Chronic Kidney Disease: An Endocrine and Renal Perspective. *Indian journal of endocrinology and metabolism*. 2019;23(4):391–399. doi.org/10.4103/ijem.IJEM_292_19.
7. Dima A., Balanescu P., Baicus C. (2014) Pharmacological treatment in calcinosis cutis associated with connective-tissue diseases. *Romanian journal of internal medicine = Revue roumaine de medecine interne*. 2014;52(2):55–67.
8. Freire V., Moser T.P., Lepage-Saucier M. Radiological identification and analysis of soft tissue musculoskeletal calcifications. *Insights into imaging*. 2018; 9(4): 477–492. doi.org/10.1007/s13244-018-0619-0.
9. Imran T.F., Yick F., Verma S. et al. Lupus nephritis: an update. *Clinical and experimental nephrology*. 2016;20(1):1–13. doi.org/10.1007/s10157-015-1179-y.
10. Jimenez-Gallo D., Ossorio-Garcia L., Linares-Barrios M. Calcinosis cutis and calciphylaxis. *Actas Dermosifiliogr*. 2015;106(10):785–794.
11. Le C., Bedocs P.M. Updated. *Treasure Island, FL: StatPearls Publishing. Calcinosis Cutis*. 2020.
12. Lederhandler M., Valins W., Zoghbi Z., Grossman M.E. Leg ulcers in systemic lupus erythematosus associated with underlying dystrophic calcinosis and bone infarcts in the absence of antiphospholipid antibodies. *JAAD case reports*. 2016;2(2):164–167. doi.org/10.1016/j.jdc.2016.02.009.
13. Lopez A.T., Grossman M.E. Facial calcinosis cutis in a patient with systemic lupus erythematosus: A case report of tissue injury owing to photosensitivity as the cause of dystrophic calcification. *JAAD case reports*. 2017;3(5):460–463. doi.org/10.1016/j.jdc.2017.06.018.
14. Muñoz C., Isenberg D.A. Review of major endocrine abnormalities in patients with systemic lupus erythematosus. *Clinical and experimental rheumatology*. 2019;37(5):791–796.
15. Rattazzi M., Faggini E., Bertacco E. et al. Warfarin, but not rivaroxaban, promotes the calcification of the aortic valve in ApoE^{-/-} mice. *Cardiovascular therapeutics*. 2018;36(4):e12438. doi.org/10.1111/1755–5922.12438.
16. Soudet S., Delaporte E., Hatron P.Y. Diffuse calcinosis cutis in systemic lupus erythematosus: an exceptional complication. *Lupus*. 2016;25(9):1064–1065. doi.org/10.1177/0961203316630819.
17. Traineau H., Aggarwal R., Monfort J.B. et al. Treatment of calcinosis cutis in systemic sclerosis and dermatomyositis: A review of the literature. *Journal of the American Academy of Dermatology*. 2020;82(2):317–325. doi.org/10.1016/j.jaad.2019.07.006.
18. Zaremba Ye.Kh, Virna M.M, Shykh L.B, Bukovetska I.V, Kobzarenko O.A. Systemnyi chervonyi vovchak (klinichniy vypadok). *Praktykuiuchyi likar*. 2017;6(4):39–41.

PEDAGOGY

SETTING THE PROBLEM IN TEXTBOOKS AND METHODOLOGICAL MATERIALS FOR TEACHERS

Abbasova S.

Candidate of pedagogical sciences, docent

DOI: [10.5281/zenodo.11624493](https://doi.org/10.5281/zenodo.11624493)

Abstract

The situation of teaching includes the existence of a problem (contradiction) and the way to solve it. That is, the teacher should put a problem in front of the children, deeply understand the nature of the question, and also imagine how the children can answer. He should always be ready to help students not get confused in the formulation of problems and discussions. Creating a learning situation is a process of conducting problem-based learning.

Keywords: Active training, cognitive activity, methodological tools, types of work, reproductive.

The teaching situation ensures creative assimilation of knowledge by students through dialogue with the teacher. This method allows to develop cognition and communication skills, provides effective development of high-quality knowledge, intelligence and creative abilities, education of an active personality.

By creating a learning situation, the teaching method is aimed at:

- 1) identification of the problem (difficulties);
- 2) choosing a solution to the problem;
- 3) ability to work with information;
- 4) listening and understanding other people;
- 5) ability to work in a group.

Teacher's duty:

- creating learning situations (determining the pedagogical task (developing writing skills);
- choose the teaching material;
- to determine the way of organizing the learning situation (how to start, what to do for everyone);
- predict possible actions of children;
- turning training tasks into learning situations (not only with the learning task, but also its "regulation" - putting this task in conditions that encourage children to be active, create motivation for learning).

Types of learning situations:

1. Selection. A number of ready-made solutions are provided, including incorrect ones. You need to choose the right one.
2. Uncertainty. Uncertain decisions due to lack of information.
3. Surprise. It causes surprising unusualness, paradoxically.
4. Conflict. A situation that thinks otherwise.
5. Incompatibility. It does not "fit" existing practices and ideas. [3, p.13-14]

The requirements for carrying out the study are:

- that students have basic knowledge and skills in subjects (have program material);
- ability to work independently;
- the value of the expected training results;
- the ability to change the way of thinking.

In the lesson of learning new material, two connections should be worked out: the formulation of an educational problem and the search for its solution. The formation of the educational problem and the search for a solution are carried out by students during a specially structured dialogue.

Dialogue is at the heart of any learning situation, and dialogue is essential to resolving this situation.

Methods of creating a learning situation with problem formulation and solving occur in three stages of lessons:

- 1) updating knowledge.
- 2) statement of the problem.
- 3) "discovery" of new knowledge by children.

"Discovery" of new knowledge by children is based on some mental operations, so tasks that teach this mental operation should be included in the stage of updating knowledge. Thought must be put into "form". Therefore, in the actualization of knowledge, it is necessary to include tasks of this type: find the excess, divide into groups, compare and show the difference, tasks for the development of variant thinking, attention, memory, etc. In the final task, "complexity" is planned. Completion of the stage of updating knowledge is associated with the identification of "difficulties" in the activity. [2, p.101]

To create a learning situation means to present students with a sense of surprise or any contradiction that arises in relation to difficulties. For example: it is enough to look at the methods of creating educational situations in the lessons of the special course "Prevention of spelling errors".

Methodical material for Azerbaijani language lessons is prepared according to demand. At the heart of the outline plans is a modern approach to learning.

Various innovative techniques, methods and forms were used during the development of lessons. The realities of modern life require students to develop a creative approach to learning, so it is rational to apply group work to lessons in order to understand the importance of teamwork, develop research skills, deepen, systematize and summarize the material.

Lessons in groups assume the presence of children with a high, sufficient, medium and low level of knowledge in each group. Groups can be permanent or changing (depending on their deep goals and tasks, the degree of complexity, the level of mastery of the material, the wishes of the students). Improving speech culture is one of the main goals of learning at this stage, so it is appropriate to include elements of literature in Azerbaijani language classes. It also helps students to have a coherent understanding of the texts.

In the methodical materials presented for class V, a sufficient amount of different materials have been selected for all these types of work, so that each teacher can choose the necessary option, focusing on his class. [7, p.13] The presented textbook set consists of two books: a textbook and a teacher. funds for (MMV). According to this set, it is planned to teach the Azerbaijani language in 6 sections. In the 5th grade, the subject of the Azerbaijani language is taught for 5 hours a week for 34 weeks (170 hours).

A small summative assessment (KSQ) is carried out no earlier than 4 weeks and no later than 6 weeks, and each educational stage covering this period corresponds to a certain section (topic) reflected in the textbook. A major summative assessment (BSQ) is conducted at the end of each semester. The number of hours allocated for each section includes 1 hour for KSQ. Hours intended for BSQ are not reflected in the schedule. The reading and listening materials, as well as the speaking and writing activities presented in each unit, are related to the topic of that unit.

Materials related to language rules are divided into sections as follows: Section I – the sound and letter composition of the word (phonetics); Section II – semantic features of the word (lexicon); Section III – word composition and formation methods (word creation); Section IV – words denoting name, sign, action (morphology); Section V – spelling of compound words. Section VI - types of sentences according to purpose and intonation, punctuation in dialogue. At the end of each section, the textbook provides materials for repeated lessons on the language rules taught in the corresponding section. [8, p. 4]

Tasks of various levels of complexity combine knowledge of theoretical material in practice, allowing not only to perform training exercises of a reproductive nature, but also to use the creative component that contributes to the further development of the individual, the manifestation of activity, and also increases interest in the subject.

The manual will help novice teachers to acquire the first methodical skills, and will give experienced teachers the opportunity to diversify the methodical techniques used in the lesson. Plans are designed taking into account the age characteristics of students and contain not only educational material, but also game tasks that develop the creative activity of schoolchildren, take them to the interesting country of the Azerbaijani language and help them to remember easily. The proposed coursework will provide practical help in choosing the types of training and control work that are fully presented and meet the requirements of the National Curriculum for the Azerbaijani language for grades V-XI.

Methodical resources are designed for creative use by diversifying the methods of presenting the material. Training can be effective if there is a qualitative change in training methods, and attention is paid to the active inclusion of thinking in the process of cognition and knowledge acquisition. The concept of "active learning method" characterizes learning based on active cognitive activity in the process of cooperation with other

participants of the educational process. Often, the concept of "interactive teaching methods" is used as a synonym of this concept.

Active learning is a set of ways of organizing and managing teaching and cognitive activity, which are characterized by the following: creation of a cognitive problem situation by the teacher; stimulating the active research position of students in the process of solving the problem situation; creating conditions for independent discovery, assimilation and assimilation of new knowledge for students. The essence of this approach to teaching is that training is not based on enriching students' memory with new knowledge, but on the systematic development of thinking and skills for self-assimilation and assimilation of knowledge. [2, p. 114]

The main condition for learning in this case is the need for the child to consciously isolate the educational task as a cognitive task: what to learn, why to learn, how to learn and what results it will lead to. The teacher's position is that of a "facilitator". The main function that determines the role of the teacher in active learning as a guide on the way to knowledge is called facilitation (creating favorable conditions). It is a new type of teacher leadership, based on the joint activity of students and teachers, aimed at achieving a common educational goal. At the same time, the teacher does not rule the classroom as an undisputed authority and does not stand outside of it.

He cooperates with him in a systematic and purposeful way: he organizes problematic situations, helps students formulate research problems, provides methodical assistance in solving them, directs and shows the way to acquire knowledge. The task of the teacher-facilitator is to teach learning, that is, to help the child: master the main components of the learning activity; to master in practice the set of mental methods and methods necessary for the acquisition and application of knowledge. This curriculum has an action quality and is designed to help each student become a competent, independent researcher, independently acquire the necessary knowledge, and become a lifelong learner.

However, in order to implement such a training scheme, the teacher should not only understand the role of a guide in the path of acquiring knowledge, but also know its specific functions and be able to apply them in practice. For this, first of all, it is necessary to understand the facilitation process itself: facilitation as a process is the process of organizing the discussion, activating the students by effectively using guiding, guiding questions, leading to the discovery of new knowledge; the main feature of facilitation is that new knowledge is acquired not by the teacher, but by the students; the position of the facilitator, whose main function is to encourage thinking and guide it in the right direction. The main goal of the facilitation approach is to fully satisfy cognitive and creative needs and create opportunities for students' self-realization.

Since active learning methods are based on conducting research for the purpose of discovering new knowledge, active teaching itself is based on the laws of conducting research.

References

1. Abdullayev N.A. Spelling and orthography training issues. Baku, 1983, 90 p.
2. Abdullayev A.S., Karimov Y.Sh. Methodology of mother tongue teaching in primary classes. Baku, Maarif, 1968, 316 p.
3. Abdullayev A.S. Methodology of teaching Azerbaijani language in secondary school. Baku, Maarif, 1978, 279 p.
4. Spelling dictionary of the Azerbaijani language, Baku, Lider publishing house, 2004, 723 p.
5. Explanatory dictionary of the Azerbaijani language. Baku, East-West Publishing House, Volume IV, 2011, 709 p.
6. Efendizade A. Scientific basis of correct writing training. Baku, 1975, 173 p.

MODEL OF PASSIVE AND ACTIVE FOREIGN LANGUAGE VOCABULARY DYNAMICS**Kostadinov O.***Ph.D., Guest Lecturer**Nikola Vaptsarov Naval Academy**Varna, Bulgaria**ORCID ID: 0000-0002-9183-5243**DOI: [10.5281/zenodo.11624502](https://doi.org/10.5281/zenodo.11624502)***Abstract**

Learning a foreign language requires the perception and assimilation of foreign language knowledge to memorize and use it later. The process of remembering is accompanied by forgetting. Memorizing foreign words happens gradually and in stages, which is why foreign language vocabulary is divided into two categories: passive and active vocabulary. For these reasons, we have different degrees of mastery of foreign words. These features of the process of acquiring foreign language knowledge make it dynamic. Between passive and active vocabulary, there is constant movement of vocabulary in both directions. Repetition of foreign words from the passive vocabulary leads to their passage into the active vocabulary and vice versa – when a given foreign word is not actively used, it returns to the passive vocabulary. The dynamics of learning the foreign language determines the result. Knowledge of this dynamic is important for the correct construction of teaching methods and conducting the process of learning a foreign language.

Keywords: Passive Vocabulary; Memorization; Repetition; Language Dynamics; Contextual Memory; Foreign Language Acquisition.

1. Dynamics of Passive and Active Vocabulary in Foreign Language Acquisition

It is natural for foreign language learners to understand some words during conversation or reading, but when it comes time to speak or write, these words disappear. This phenomenon is known as passive and active vocabulary and is crucial for foreign language learning. Our ability to differentiate between these types of vocabulary is very important for anyone trying to acquire or improve their foreign language proficiency.

Passive and active foreign language vocabulary, as well as the dynamics between them, are essential elements of foreign language learning and acquisition. There are two main factors that determine the outcome of foreign language acquisition. On the one hand, these are the motivation and attention of the learner, and on the other hand, an important factor is the process of forgetting. Learning the vocabulary and grammar of a foreign language is a prolonged process that goes through several stages concerning each lexical or grammatical unit.

Each foreign word must first be perceived aurally or read, after which its meaning must be understood. Memorizing foreign words and their active use takes time, during which the studied vocabulary is reviewed repeatedly. The very act of memorizing vocabulary is conditional and variable. In human memory, there are two main sectors where foreign language information is stored: short-term and long-term memory. Information stored in short-term memory needs to be further developed, and information stored in long-term memory must be maintained to avoid being lost.

Knowing foreign vocabulary is a broader concept that includes foreign words whose meanings can be understood only in context, but a word read or heard outside of context can also be understood. On the other hand, there are foreign words that are only understood

but not actively used in speaking or writing. In this regard, the main characteristic of foreign language acquisition can be noted as its dynamic nature.

One of the key tasks in foreign language acquisition is converting passive vocabulary into active vocabulary. This requires constant practice and use of new words in various contexts. Regular review and practice help reinforce vocabulary and prevent forgetting. Additionally, using different learning methods such as listening, reading, writing, and speaking is essential for effective foreign language acquisition.

In conclusion, the dynamics between passive and active vocabulary are crucial for successful foreign language acquisition. Understanding these processes and using appropriate learning methods can significantly improve language skills and facilitate the transition from passive knowledge to active use of the foreign language.

2. Analysis of Passive and Active Foreign Language Vocabulary

2.1. Passive Vocabulary

Laufer, B., (1998). The passive vocabulary includes words that we recognize and understand when we hear or read them but do not use actively. These can be words encountered in books, movies, or conversations but not fully integrated into our own language use. The passive vocabulary is divided into two categories. In the first category are words that are understood only in context, without being understood out of context. This part of memory is called Contextual Passive Memory. The second category includes words that are understood out of context but not used actively, meaning their level of familiarity is higher than words that can only be understood in context. This part of memory is called Non-contextual Passive Memory. [1]

The passive vocabulary is divided into two categories:

- **Contextual Passive Memory:**
 - Words and expressions understood only within a specific context.
 - Maintained through passive repetition (listening and reading).
- **Non-contextual Passive Memory:**
 - Words and expressions understood even outside a specific context.
 - Maintained through active repetition (active learning, translation).
- **Characteristics of Passive Vocabulary:**
 - Recognition: Words are recognized when seen or heard.
 - Limited Use: Rarely used in active speech or writing.
 - Activation: May require effort to recall and use effectively.

Primary Conclusion:

Passive memory is divided into two categories:

- Contextual Passive Memory: Words and expressions understood only in context, maintained through passive repetition (listening and reading).
- Non-contextual Passive Memory: Words and expressions understood outside context, maintained through active repetition (active learning, translation).

2.2. Active Vocabulary

Laufer, B., (1998). The active vocabulary consists of foreign language words that are frequently and confidently used in daily communication. These are the words that come naturally, without us having to think, when we speak or write. The active vocabulary is a fundamental tool for any foreign language; it is always available and ready for use without the need for a dictionary or reference.

Active vocabulary is a measure of language proficiency and overall fluency. It is dynamic and ever-

changing. Words and expressions that are not used frequently decrease in their level of familiarity within the foreign language vocabulary of the speaker, resulting in their return to one of the previous levels of mastery found in the passive vocabulary. This process of words shifting between active and passive memory highlights the importance of regular usage for maintaining language skills. [1]

• Characteristics of Active Vocabulary:

- Frequent Use: Regularly employed in both spoken and written communication.
- Confident and Accurate Use: Words are understood and used correctly, with a high level of confidence.
- Quick and Automatic Recall: Words come to mind effortlessly, without the need for pauses or deep thinking.
- Spontaneity: Ability to use words naturally and spontaneously in various contexts.

Primary Conclusion:

Laufer, B., (1998). Active memory is created after the assimilation of words and expressions. These words are easily accessible and can be used spontaneously and effectively. The dynamic nature of active vocabulary underscores the need for consistent practice and engagement with the language to ensure that words remain readily available for use. Regular interaction with the language, through speaking, writing, and other forms of communication, is essential for maintaining and expanding one's active vocabulary.

3. Analysis of Kostadinov's Model of Passive and Active Foreign Language Vocabulary Dynamics

Ognyan Kostadinov's model for the dynamics of passive and active foreign language vocabulary is presented in a table that examines the different stages and processes related to the acquisition and use of foreign words (Table 1).

Table 1

KOSTADINOV'S MODEL OF PASSIVE AND ACTIVE FOREIGN LANGUAGE VOCABULARY DYNAMICS							
LISTENING			PASSIVE	ACTIVE	ACTIVE	ACTIVATION	SPEAKING
RECEPTION	INTERPRETATION		CONTEXTUAL	NON-CONTEXTUAL		→	ACTIVE
FOREIGN	COMPREHENSION	MEMORIZATION	PASSIVE	PASSIVE	ASSIMILATION	DYNAMICS	
WORDS	TRANSLATION		MEMORY	MEMORY		←	MEMORY
READING			REPETITION	REPETITION	PRACTICE	FADING	WRITING

Author: Ognyan Kostadinov,

ORCID ID: 0000-0002-9183-5243

The analysis of this model can be described as follows:

- **Reception of Foreign Words (INPUT Info):**
 - Listening and Reading are the primary methods for receiving new information. These activities include:
- **Understanding of meaning by:**
 - Interpretation: Understanding the meaning of words in the context of the sentence.
 - Comprehension: Fully grasping the meaning of the text.
 - Translation: Translating words or text into the native language.

• Passive Memory:

- This stage includes ****Memorization**** and ****Contextual Passive Memory****. Words are memorized in the context in which they are encountered, aiding better retention.

• Active Memory:

- Non-Contextual Passive Memory^{**}: Words are memorized without connection to a specific context.
- Repetition: Repeating words helps retain them longer and transition them to active memory.

• Active Usage:

- Assimilation: Integrating new words into active vocabulary through **Practice** and **Activation**, leading to dynamic use in speech and writing.

- Dynamics: Transition of words between active and passive memory depending on frequency of use.

- **Speaking and Writing (OUTPUT Info):**

- These activities represent the ultimate goals of the model—the active use of foreign words in speech and written texts.

This model emphasizes the importance of both passive and active learning strategies, highlighting the dynamic nature of vocabulary acquisition and retention. It illustrates the process from passive to active memory through practical application and repetition, underscoring the necessity of frequent use for maintaining an active vocabulary.

- **Key points of the model include:**

- The importance of practice and repetition for retention and activation of foreign words.
- The significance of context for effective memorization and understanding.
- The process of fading, where infrequent use leads to words transitioning from active to passive memory.

4. Basic Stages of Foreign Word Acquisition and Knowledge Transition from Passive to Active Vocabulary

Via listening to, reading, and writing texts, as well as via the use of visual dictionaries that offer each word in textual form together with a picture, we can acquaint with foreign vocabulary. The use of word cards and the repetition of reading phrases from dictionaries are also standard practices. It is also beneficial to make use of all the available ways to learn foreign words, as this will ensure effective and long-lasting memory. One of the most important factors in keeping new language is consistent exposure and practice. In addition, participating in discussions and using language that is applicable to real-world situations strengthens both memory and comprehension.

4.1. Listening to Unfamiliar Words:

The first stage is to get comfortable with foreign words by listening to them several times without being aware of what they signify in one's home language. The listener is supposed to adjust their ears to the sounds to achieve the aim. Hearing a foreign word several times helps in its memory, which in turn causes the listener to view the word as being familiar each time they hear it. The first step in being comfortable with a foreign term is to get familiar with it. This stage assists the student in becoming used to the phonetic structure of the new language he or she is learning.

4.2. Using Expressions with Unfamiliar Words:

When there are phrases that include words that are not easily understood in a foreign language, it is important to learn them in the appropriate manner. For students who are learning a foreign language, it is of utmost importance to comprehend the meaning of new

terms in the context in which they are used. However, the degree of difficulty of these expressions must correspond with the amount of knowledge that they possess; otherwise, relying on a dictionary, which may be distracting, is not the most effective method. New words are easier to recall when they are associated with previously learned ideas, which is accomplished via contextual learning.

4.3. Repetition of Foreign Words and Building Passive Vocabulary:

Passive vocabulary consists of two distinct categories: contextual and non-contextual words. These represent separate groups within the realm of passive vocabulary. The transition of words from contextual to non-contextual occurs through continuous exposure to a variety of texts, whether through listening or reading. This process exemplifies a dynamic interaction within passive vocabulary, where the acquisition and assimilation of words undergo transformative phases.

4.4. Utilizing Dictionaries and Digital Tools for Vocabulary Enhancement:

In the later stages of learning, students should employ dictionaries to delve into unfamiliar words, comprehending their fundamental meanings and broader applications. Additionally, numerous digital dictionaries offer audio features, enabling users to listen to the pronunciation of the word. Moreover, these dictionaries often provide contextual sentence examples, significantly aiding in grasping the accurate meaning of the word and facilitating its retention. This phase represents the mastery stage in enhancing one's familiarity with words. By utilizing sentence examples, learners can better grasp the proper usage and nuances of the word.

4.5. Mastering Memory: The Art of Effective Retention and Repetition

Memorization is not a single act, and to memorize information effectively, it is important to repeat what we have learned a great number of times.

Marousis, A., (2023). According to Harman Ebbinghaus's forgetting curve, the retention rate of information decreases over time:

- After 1 hour about 50% of the information is retained.
- After 1 day about 30% of the information is retained.
- After 1 week about 10% of the information is retained.[2]

Jaap, M., Murre, J., Dros, J. (2015). These values are approximate and may vary depending on various factors such as methods and individual differences. The Ebbinghaus Forgetting Curve (fig. 1) shows how quickly new information can be retained if it is not used or practiced regularly.

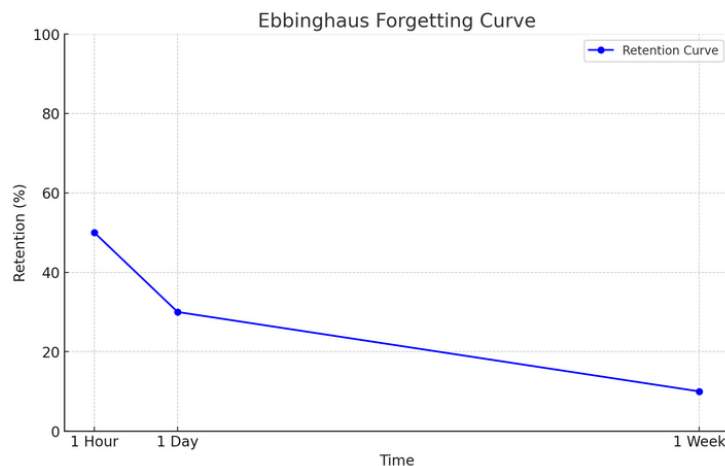


Figure 1

The repetitions should be planned out and spaced out over a period of one month to assist the learner's passive memory in absorbing the knowledge. To boost retention, this strategy makes use of the spacing effect, which involves extending the amount of time that passes between review sessions. Reviewing the content on a regular basis helps to reinforce the knowledge, which in turn increases the probability that it will be retained in long-term memory.

According to Harman Ebbinghaus, the forgetting curve (fig. 2) with periodic negotiation of what has

been learned every 12 hours illustrates how regular repetition of information significantly improves its retention in memory:

- 1 hour after learning about 50% of the information is retained.
- 12 hours after the first repetition the retention increases to 70%.
- 24 hours after learning (after the second repetition) retention is around 60%.
- After each subsequent iteration, the retention rate increases or stabilizes at high levels.

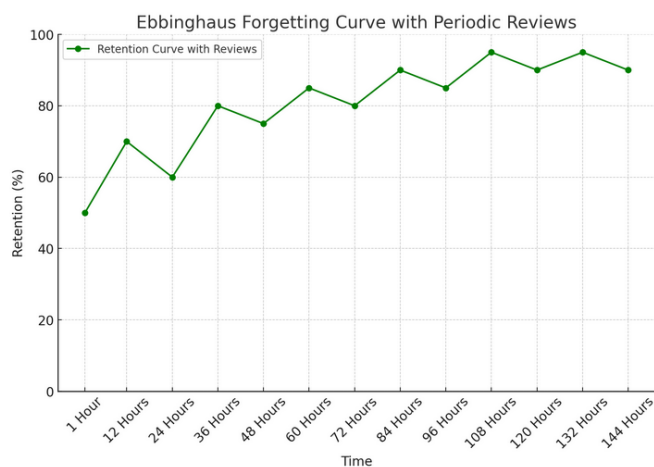


Figure 2

Regular repetition helps consolidate knowledge in long-term memory and significantly minimizes the pace at which information is forgotten. This may be accomplished using the most efficient means possible, which include the comprehension of relevant educational information by reading and comprehension. One example of this would be viewing films or television shows that are captivating and that pique the learner's interest and curiosity. It is possible that we may refer to this task as the third stage of learning foreign words since it is a job that will never be finished. Within the context of building passive vocabulary in a foreign language, this stage acts as a transitional stage leading to the fourth step. [3]

4.6. Transition from Passive to Active Memory:

Passive memory is often where a foreign word is stored after it has been mastered. When the words are spoken or heard often, they have the potential to enter active memory. As a rule, we need to take into consideration the fact that passive foreign language study, which includes listening to comprehension and reading comprehension, often only results in the improvement of passive memory. Only a small number of passive words can make their way into active memory without conscious effort. It is necessary to participate in active use, such as speaking or writing, to develop one's active vocabulary. This is because active usage helps to reinforce the words that are learnt via practical application. This is the fourth step of creating an active vocabulary inside a foreign language, often known as the process

of acquiring foreign words. Active use of the foreign language, which involves conversation as well as verbal and written translation from the native language into the foreign language, is the most effective method for accomplishing this goal.

4.7. Building Active Vocabulary:

Active foreign language vocabulary building is the last stage of memorization. It necessitates the active use of foreign words. This could be accomplished through dialog, oral, or written translations from a native language into a foreign language. The active foreign language vocabulary is based on passive vocabulary. Only after repeated use of passive words and their active use in speaking and writing can we expect to enhance active vocabulary. Practical usage solidifies the transition of words from passive to active memory. The level of fluency and proficiency in a foreign language measures the permanent process of building an active vocabulary.

Active vocabulary building is the final stage of memorization for acquiring foreign words. It requires actively using these words in various contexts. Dialogue, oral practice, or written translations from one's native language into the foreign language can achieve this active utilization of foreign words. A language builds its active vocabulary on its passive vocabulary. Mastery of words, initially encountered passively, only comes after repeated use in speaking and writing. Practical application further solidifies the transition of words from passive to active memory, reinforcing language acquisition. "The development of active vocabulary is an ongoing process in foreign language acquisition, measured by one's fluency and proficiency in the language.

4.8. Maintaining Vocabulary:

There is a possibility that some words may return to their passive form if we do not make consistent use

of them in our active vocabulary. When it comes to keeping an active vocabulary, regular practice and use are very necessary. It is helpful to keep words active and prevent them from reverting to passive memory by reviewing them and utilizing them in a variety of settings. Active and passive language usage on a regular basis may assist in the maintenance of vocabulary in a foreign language.

Conclusion:

The study outlines a model of passive and active foreign language vocabulary dynamics, emphasizing the importance of memorization and forgetting in language learning. It differentiates between passive vocabulary (words recognized and understood but not actively used) and active vocabulary (words frequently and confidently used in daily communication). The dynamic nature of vocabulary acquisition involves a continuous movement of words between passive and active states. Regular practice and repetition are crucial for maintaining and expanding active vocabulary. Understanding these dynamics is essential for developing effective teaching methods and enhancing language learning outcomes.

References

1. Laufer, B., (1998). The Development of Passive and Active Vocabulary in a Second Language: Same or Different? *Applied Linguistics*, DOI: 10.1093/applin/19.2.255
2. Marousis, A., (2023). What is the Ebbinghaus forgetting curve? Examples and strategies for overcoming it. *Talencards*, Available on: <https://www.talencards.com/blog/ebbinghaus-forgetting-curve/>
3. Jaap, M., Murre, J., Dros, J. (2015). Replication and Analysis of Ebbinghaus' Forgetting Curve, *PLOS / one*, DOI:10.1371/journal.pone.0120644

PHYSICS

ВЛИЯНИЕ ТЕРМООБРАБОТКИ НА ТЕПЛОВЫЕ И ЭЛЕКТРИЧЕСКИЕ СВОЙСТВА ПОЛИМЕРНОГО ПОЛУПРОВОДНИКА ПОЛИГИДРОХИНОНА

Халилов С.Х.

Кандидат физико-математических наук, доцент кафедры «Инженерная физика и электроника»
Азербайджанского Технического Университета

INFLUENCE OF HEAT TREATMENT ON THERMAL AND ELECTRICAL PROPERTIES OF POLYMER SEMICONDUCTOR POLYHYDROCHYNONE

Khalilov S.

Candidate of Physical and Mathematical Science,
Associate Professor of the Department of Engineering Physics and Electronics,
Azerbaijan Technical University
DOI: [10.5281/zenodo.11624509](https://doi.org/10.5281/zenodo.11624509)

Аннотация

Исследование показало, что более высокая температура термообработки полимерного полупроводника полигидрохинона, обеспечивает более плотную упаковку макромолекул, изменяет межмолекулярные расстояния и условия контакта между молекулами. Это приводит к увеличению длины эффективного сопряжения, благодаря улучшению при процессе термообработки условий для осуществления компланарности макромолекул.

Abstract

The study showed that a higher heat treatment temperature provides a more dense packing of macromolecules, changing the intermolecular distances and contact conditions between molecules. This leads to an increase in the effective conjugation length, due to the improvement in the heat treatment process of conditions for the coplanarity of macromolecules.

Ключевые слова: Электропроводность, теплопроводность, термообработка, компланарность.

Keywords: Electrical conductivity, thermal conductivity, heat treatment, coplanarity.

Еще 2018 году ученые из MIT и Аргоннской национальной лаборатории предположили, что потенциальными кандидатами на роль теплопроводящих полимеров могут стать макромолекулы с сопряженными связями в главной цепи. Система сопряжения связей в полимерах возникает либо за счет чередования двойных и одинарных связей, либо за счет чередования соединенных одинарными связями ароматических фрагментов, либо за счет сочетания этих случаев. [1,2]

Существующие литературные данные [3,4,5] показывают, что в полимерных полупроводниках области полясопряжения разделены менее структурированными прослойками и эти прослойки можно рассматривать как потенциальные барьеры для дрейфа носителей тока, высота которых определяет энергию активации проводимости постоянном токе.

С целью выяснения связи между электропроводностью с теплопроводностью, а также влияния термообработки на высоту потенциального барьера, который существует в объеме полимерного полупроводника полигидрохинона, была исследована температурная зависимость удельной электропроводности σ и коэффициента теплопроводности λ .

Измерение теплопроводности и электропроводности проводилась на прессованных образцах, приготовленных в виде таблеток. Для уменьшения доли общего теплового потока, идущего на излучение, применялись плоские образцы сечения $0,3 \div 0,4 \text{ см}^2$ и высотой $0,1 \div 0,2 \text{ см}$. Принятые меры позволили обеспечить измерение абсолютной величины λ в интервале

$80 \div 420^\circ\text{K}$ с точностью не менее $\sim 5\%$. Температура размягчения полигидрохинона $T > 430^\circ\text{K}$. Методика измерения описана в работе [6]. Исследование проводилось в вакууме 10^{-5} Торр ($133,322 \text{ Па}$)

На рис. 1 и 2 представлены температурные зависимости удельной электропроводности σ и коэффициенты теплопроводности λ и полимерного полупроводника полигидрохинона. Результаты измерения зависимости $\sigma(T)$ и $\lambda(T)$ воспроизводимы для каждой температуры термообработки. Из рис. 1 видно, что каждое повышение температуры термообработки приводит к увеличению электропроводности, следовательно уменьшается энергия активации (ΔE), определяемой по наклону прямой $\sigma(T)$ высокотемпературной области, которая характеризует потенциальный барьер в полигидрохиноне.

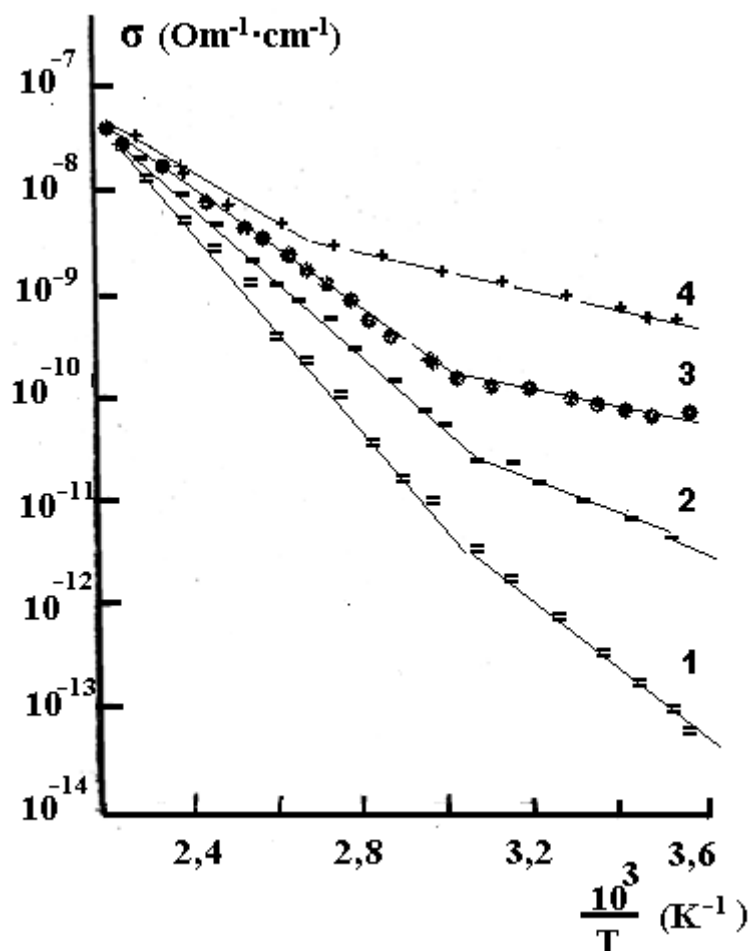


Рис.1. Температурные зависимости удельной электропроводности при разных температурах термообработки.

1. $T = 373^{\circ}\text{K}$ 2. $T = 383^{\circ}\text{K}$ 3. $T = 393^{\circ}\text{K}$ 4. $T = 413^{\circ}\text{K}$

Повышение температуры термообработки незначительно увеличивает величину теплопроводности (рис.2.)

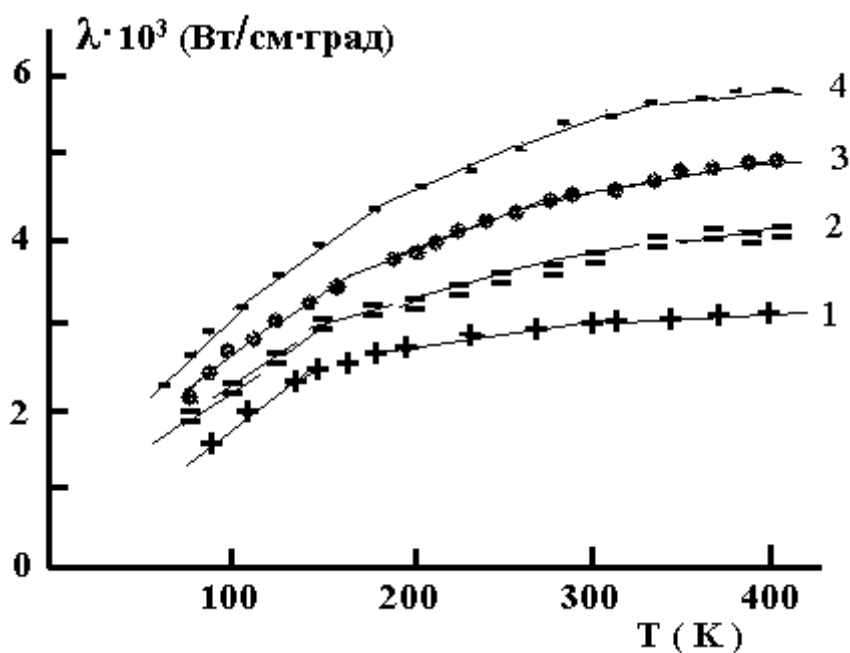


Рис.2.

Температурные зависимости удельной теплопроводности при разных температурах термообработки.

1. $T = 373^{\circ}\text{K}$ 2. $T = 383^{\circ}\text{K}$ 3. $T = 393^{\circ}\text{K}$ 4. $T = 413^{\circ}\text{K}$

В таблице приведены значения σ , λ и ΔE при температуре 293°K для каждой температуры термообработки.

Температура термообработки Т (К)	σ $\text{Ом}^{-1}\text{см}^{-1}$	λ Вт/Ом.град.	ΔE eV.
373	$1 \cdot 10^{-14}$	$3,1 \cdot 10^{-3}$	1,3
383	$1,2 \cdot 10^{-13}$	$4,0 \cdot 10^{-3}$	1,1
396	$9 \cdot 10^{-13}$	$4,8 \cdot 10^{-3}$	0,96
413	$8 \cdot 10^{-12}$	$5,8 \cdot 10^{-3}$	0,82

Как видно, значение λ достаточно низко, поэтому электронная теплопроводность рассчитанная на соотношений Видемана-Франца, а также за счет биполярной диффузии оказывается несущественным. Низкие значения коэффициента инфракрасного поглощения, также позволяет предположить, что измеренная на опыте λ является теплопроводностью фонов во всем исследованном интервале температуры.

Особенности λ могут быть связаны двумя обстоятельствами. Во-первых: тем, макромолекула содержит большое число атомов порядка 1000 Во-вторых: существенным является, по-видимому, большое различие взаимодействия внутри молекул и молекулярного взаимодействия. Внутримолекулярные связи являются ковалентными. Межмолекулярное взаимодействие существенно более слабое. Взаимодействие между линейными цепями этого полимера обусловлено межмолекулярной связью радикалов ОН [6]. Непрерывный рост λ с повышением температуры связано с характером фононного спектра. Фононный спектр делится на две части: первая низкочастотная часть спектра, которая связана с колебаниями целой молекулы. Вторая часть спектра – это внутримолекулярные колебательные и вращательные движение отдельных атомов и групп атомов. Эти колебания возбуждаются уже при $T < 100^\circ\text{K}$ и могут участвовать в переносе тепла. Таким образом, более высокая температура термообработки, видимо обеспечивает более плот-

ную упаковку макромолекул, изменяет межмолекулярные расстояния и условия контакта между молекулами. Это приводит к увеличению длины эффективного сопряжения, благодаря улучшению при процессе термообработки условий для осуществления компланарности макромолекул.

Вышеуказанное предположение согласуется с существующей теорией о структуре и свойствах полимерных полупроводников [7].

Список литературы

1. Yanfei Xu, Xiaoxue Wang, Jiawei Zhou, Bai Song, Zhang Jiang, Elizabeth M. Y. Lee, Samuel Huberman, Karen K. Gleason, Gang Chen. Molecular engineered conjugated polymer with high thermal conductivity, Science Advances. 2018.
2. Гагарин В.Г., Пастушков П.П. Изменение во времени теплопроводности газонаполненных полимерных теплоизоляционных материалов, Строительные материалы. 2017. № 6. С. 28–31.
3. Бах Н.А., Ванников А.В., Гришина А.Д., Нижний С.В., Усп. Химии, 35, 1733, 1965.
4. Богуславский Л.Н., Стельбанс, Докл. АН СССР, 147, 1114, 1968.
5. Халилов С.Х. Исследование центры захвата в полигидрохиноне, IV Республиканская межвузовская конференция по физике., стр.22., 1978, Баку.
6. Основы физики и химии полимеров. Изд. Высшая школа, М., 1976
7. Органические полупроводники., Изд. Наука, 1968.

THE GENERATING FUNCTION TECHNIQUE AMELIORATES EFFECTIVE AND STRING FIELD THEORIES AND FORESHADOWS THEIR LINKAGE TO QUANTUM INFORMATION THEORY

Robert Lloyd Jackson II

M.D.

Stilwell, KS

DOI: [10.5281/zenodo.11624536](https://doi.org/10.5281/zenodo.11624536)

Abstract

Many scientists are trying to develop a theory of everything or a supposition to explain all aspects of the physical universe. This paper explores a set of theories called effective and string field theory or *EFT* and *SFT*, respectively. These suppositions can be utilized in both old and possibly new physics. Typically, *EFT* and *SFT* have a mathematical method for solving problems called the perturbation theory (*PT*); the generating function technique or *GFT* can substitute this means of problem-solving. The latter method is used to solve several examples of physical problems, such as determining the cause of muon $g-2$ experimental deviations, the means for the calculation of glueballs via meson decay, the ascertainment of tetraquark mass from their decay products, and the analysis of binary black hole mergers. Ultimately, *GFT*, instead of traditional *PT* methods, is a potent tool for improving our understanding of concepts in contemporary physics, such as in *EFT* and *SFT*. Also, *GFT* shows the existence of a triality between *EFT*, *SFT*, and Quantum Information theory (*QIT*).

Keywords: generating function technique, effective, quantum, and string field theory.

1.) Introduction

An appropriate theory of everything or *ToE* should adequately combine general relativity and quantum mechanics [2,57,61,62]. Physics significantly grew after Sir Isaac Newton discovered gravity [1,38]. Then, Albert Einstein radically updated humanity's current understanding of gravity with his General Theory of Relativity [13,19,29,37,38,46,91]. General relativity heralded another revolution in physics [1]. Quantum mechanics, the study of quanta or particles, underwent a revolution a little after the world recognized general relativity as being virtually true [18,25,59]. Even though many physicists developed putative mathematical frameworks, there was no provable strong theory combining general relativity and quantum mechanics to date.

Two basic systems of ideas that attempted to explain aspects of the universe involved fields. *EFT* and *SFT* implemented physical body (i.e., particle) and string fields to describe the behavior of facets of classical and quantum physics [21,26,52]. Hypothetically, both theories served as a basis for a new *ToE*.

Calculus was the field of mathematics heavily entrenched in physics; thus, methods for solving such problems incorporating differential equations were essential. Since the inception of calculus, individuals have established various techniques (i.e., perturbation theory or *PT*) for deriving the solutions to differential equations [20]. The latest method for solving physics problems, *GFT*, which this author discovered, involved using several truncated Laurent series of formal power series or generating functions to solve problems known to old physics (i.e., Boussinesq equation, Navier-Stokes problems, etc.) [3,63]. This novel method of accruing solutions to differential equations has a broad reach and is considered capable of solving a wide range of problems in mathematical physics [88].

This paper discusses *EFT* and *SFT* via *PT* as practical *ToEs*. This study is divided into several sections: section 2 provides concepts in perturbation, effective, and string field theories; the next section shows how *GFT* serves as a template for solving problems linked

to *EFT* and *SFT*; Section 4 shows how *EFT* and *SFT* via *GFT* can be used in deriving solutions to four issues alluding to old and new physics; finally, the last section gives a quick review of *EFT* and *SFT* that shows *GFT* is a highly effective means for solving problems related to the two suppositions. In addition, the *GFT* claims at least two significant links are apparent between the two field theories and *QIT* in the last section.

2.) Basics of *EFT* and *SFT* after the consideration of *PT*, then *GFT*

2.1.) *PT* synopsis

In *PT*, an individual finds an approximate solution to a more straightforward defined problem [64]. The solution becomes more accurate as the approximate solution gains terms with decreasing parameters [64,89]. Ultimately, the approximate solution asymptotically approaches the exact solution as the number of terms added to the perturbation series approaches infinity [64]. In other words, the perturbation series becomes a formal power series over time [64].

2.2.) *EFT* synopsis

EFT encompasses an extensive array of fields in physics [21]. Therefore, *EFT* covers quantum, classical, and cosmological fields [21]. In this study, we will focus on quantum field theory, or *QFT*, and the cosmological aspects of *EFT*.

QFT combines quantum mechanics, classical field theory, and special relativity [4,24,28,47,60]. It is commonly applied to particle physics and, thus, essential in forming models within subatomic and condensed matter physics [4,24,28,47,60,92]. Since its advent in the 1920s and rebirth in the 1970s, *QFT* has had a prominent role in describing contemporary physics.

QFT was divided into at least three branches: quantum electrodynamics (*QED*), quantum flavor-dynamics (*QFD*), and quantum chromodynamics (*QCD*). *QED* was primarily developed by Dirac in 1927 and was built upon canonical quantization [9,32,40,44]. Also, it dealt with the interaction of fermionic and electromagnetic fields. *QFD* studied electroweak nuclear force, such as bosons Z^0 and $W^\pm$ activities, while *QCD* involved nuclear solid interactions, generally mediated

gluon fields [12,23,47]. It is expected to find situations where certain branches, like *QED* and *QCD*, cross over or encroach on each other.

PT can be used to solve many problems in *QFT* [47,60,92]. The interaction between particle fields is treated as small perturbations in a free field. Finally, the integration of *PT* with *QFT* is called perturbative quantum field theory or *pQFT*.

EFT can also be applied to cosmology [14,15,29]. Cosmology is the study of the universe and its evolution. This realm of study includes the observations of large-scale structures (*LSS*) and the laws that dictate their behavior [95]. *PT* plays an active role in solving problems associated with cosmology: The combination of *PT* and this area of study is called cosmological perturbation theory [14,15,29]. The practical field theory of large-scale structures or *EFToLSS* is used to enhance the derivation of solutions in this area of science via novel *PT* methodologies [96].

2.3.) *SFT* synopsis

This supposition involves reformulating relativistic strings to *QFT* [12,24,28,60,92]. Unlike *QFT*, which treats an individual field of particles in excited states or quanta, string theory converts point-like particles into one-dimensional entities, referred to as strings. Thus, string field theory uses these one-dimensional strings to define excited particle fields.

Second quantization dictates the type of *SFT* to be considered, such as open and closed string fields [97]. In the standard model of particle physics, some open string fields are represented by gauge (gluons, photons, *W* and *Z* bosons) and quark or lepton fermions [90]. Fields that describe the scattering of open or closed strings are called open or closed *SFT*, respectively. However, if a field contains a combination of both open and closed strings, it is referred to as an open-closed *SFT*.

SFT possesses advantages over regular string theory. For instance, it permits the calculation of “off-shell” amplitudes and thus provides information about string scattering [52]. In addition to giving an individual the means to calculate the masses of particle systems that obey classical equations of motion, it can be used to determine particle systems that do the contrary. This process is called “off the mass shell” or off-shell of the mass hyperboloid via perturbation methods [52]. In other words, *SFT* can be used to define attributes of particles that do not follow the equations of motion in a classical sense (i.e., virtual particles, dark sector quanta, etc.) due to its innate ability to depict particles as string fields.

2.4.) Mathematical descriptions of effective and string fields via *GFT*

In *EFT*, an elementary field γ is a formal power series of a function f . A physical body, such as a particle, can be designated as an exponential function f , assuming the auxiliary/characteristic equation is of the first order, takes the following form:

$$f(\xi) = c_1 e^{-\xi},$$

where c_1 is an arbitrary constant, and ξ is the ansatz transform variable. (Note: For *GFT* purposes, the auxiliary function is generally designated by the Greek

letter ϕ . However, this study will designate the auxiliary function with the alphanumeric letter f due to particle physicists' conventional use of ϕ for bosons.) The ansatz transformed variable ξ for a (3+1) system was defined as

$$\xi = \alpha t + \beta_1 x + \beta_2 y + \beta_3 z.$$

On the other hand, the expression of a “brane,” which can be designated by a sinusoidal wave function f , Assuming the auxiliary/characteristic equation is of the second order and is expressed as

$$f(\xi) = c_1 \cos(\xi) + c_2 \sin(\xi)$$

or

$$f(\xi) = c_1 \cosh(\eta) + i c_2 \sinh(\eta)$$

where η is the **imaginary** ansatz transform variable, where $\eta = i\xi$, and c_2 is another arbitrary constant.

The physical body and wave function f leads to *EFT* and *SFT*, respectively.

Thus, the elementary physical body or string field γ can be defined as

$$\gamma(\xi) = \sum_{k=0}^{\infty} p_k f(\xi)^k,$$

where p_k is the k -th parameter/coefficient of the formal power series γ . On the contrary, its conjugate elementary qubit gate γ^* is the following expression:

$$\gamma^*(\xi) = -\sum_{k=0}^{\infty} p_k f(-\xi)^k.$$

The formal power series g and g^* are also elementary effective or string fields. It is important to state an elementary string field is an object with an infinite number of branes; one of the branes acts as the “string” while the other branes serve as the “bulk” space or compactified dimensions of the universe [82,87]. Finally, a truncated Laurent series of the elementary effective or string field g or g^* raised by some power j forms a transformed compound effective or string field U if p_k is combinatorial or trigonometric:

$$U(\xi) = \sum_{j=-n}^n q_j \gamma(\xi)^j$$

or

$$U'(\xi) = -\sum_{j=-n}^n q_j \gamma'(-\xi)^j,$$

where n is the absolute integer value of the truncated power and q_j is the j -th parameter/coefficient and power. Regarding string field theory, n is equal to the supersymmetry level N . Ultimately, the difference between *PT* and *GFT* is that one method builds upon an approximate solution while the other narrows the general solution to derive the exact solution. The former method would require many steps to achieve its objective due to adding higher-order terms. At the same time, the latter only needs a few steps, like solving the parameter/coefficient and arbitrary constants.

3.) *GFT* as a new mathematical basis for garnering solutions in *EFT* or *SFT*

3.1.) *GFT* and general solutions to particles

GFT, with some modification, was a method implemented to find the solution of [non]linear PDEs. Its transformed general solution U comprised a Laurent series set of combinatorial or trigonometric-based generating functions [3]. One should consider the transformed general solution U as a transformed effective or string field. After one assessed the maximal and minimal power n , through which the Laurent series of various types of elementary practical or string field γ or γ' , their conjugate is eventually truncated, (s)he plugs in the predefined function f into the transformed general solutions for effective or string fields ϕ_l , ϕ'_l , ϕ_l^μ , $\phi_l^{\mu\mu}$, $\phi_l^{\mu\nu}$, $\phi_l^{\nu\mu}$, Ψ_m , and Ψ'_m :

$$\begin{aligned}
\Phi_l(\xi) &= \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}(\sum_{k=0}^{\infty} 2f(\xi)^k S_k(0)^i)^j + bl_{ij}(\sum_{k=0}^{\infty} 2C_k(0)^i f(\xi)^k)^j), \\
\Phi'_l(\xi) &= - \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}(\sum_{k=0}^{\infty} 2f(-\xi)^k S_k(0)^i)^j + bl_{ij}(\sum_{k=0}^{\infty} 2C_k(0)^i f(-\xi)^k)^j), \\
\Phi_l^\mu(\xi) &= e^{-\tau} \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}^\mu(\sum_{k=0}^{\infty} 2f(\xi)^k S_k(0)^i)^j + bl_{ij}^\mu(\sum_{k=0}^{\infty} 2C_k(0)^i f(\xi)^k)^j), \\
\Phi_l'^\mu(\xi) &= -e^\tau \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}'^\mu(\sum_{k=0}^{\infty} 2f(-\xi)^k S_k(0)^i)^j + bl_{ij}'^\mu(\sum_{k=0}^{\infty} 2C_k(0)^i f(-\xi)^k)^j), \\
\Phi_l^{\mu\nu}(\xi) &= \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}^{\mu\nu}(\sum_{k=0}^{\infty} 2f(\xi)^k S_k(0)^i)^j + bl_{ij}^{\mu\nu}(\sum_{k=0}^{\infty} 2C_k(0)^i f(\xi)^k)^j), \\
\Phi_l'^{\mu\nu}(\xi) &= - \sum_{i=1}^2 \sum_{j=-n}^n (al_{ij}'^{\mu\nu}(\sum_{k=0}^{\infty} 2f(-\xi)^k S_k(0)^i)^j + bl_{ij}'^{\mu\nu}(\sum_{k=0}^{\infty} 2C_k(0)^i f(-\xi)^k)^j), \\
\Psi_m(\xi) &= e^{-\tau} \sum_{i=1}^2 \sum_{j=-n}^n (cm_{ij}(\sum_{k=0}^{\infty} 2f(\xi)^k S_k(0)^i)^j + dm_{ij}(\sum_{k=0}^{\infty} 2C_k(0)^i f(\xi)^k)^j), \\
\text{and} \\
\Psi'_m(\xi) &= -e^\tau \sum_{i=1}^2 \sum_{j=-n}^n (cm_{ij}(\sum_{k=0}^{\infty} 2f(-\xi)^k S_k(0)^i)^j + dm_{ij}(\sum_{k=0}^{\infty} 2C_k(0)^i f(-\xi)^k)^j),
\end{aligned}$$

where Φ_l and Φ'_l are the transformed scalar bosonic effective or string fields, Φ_l^μ and $\Phi_l'^\mu$ are transformed vector bosonic effective or string fields, $\Phi_l^{\mu\nu}$ and $\Phi_l'^{\mu\nu}$ are the transformed tensor bosonic effective or string fields, Ψ_m and Ψ'_m are the transformed fermionic effective or string fields, and τ is a specific ansatz transformed time variable or

$$\tau = \alpha_\tau t.$$

The parameter/coefficient p_k was defined as combinatorial numbers to the i -th power like

$$p_k = 2S_k(0)^i$$

and

$$p_k = 2C_k(0)^i.$$

The square root of the k -th Fibonacci number at/about zero, or $S_k(0)$, was

$$S_k(0) = \sin\left(\frac{\pi k}{2}\right),$$

while the k -th Chebyshev T or U (not to be confused with the transformed general solution of the effective or string field) number at/about zero, or $C_k(0)$, was

$$C_k(0) = \cos\left(\frac{\pi k}{2}\right).$$

For this article, the parameter/coefficient q_j was either al_{ij} or bl_{ij} for bosonic effective or string field while the parameter/coefficient q_j was either cm_{ij} or dm_{ij} were used for the fermionic effective or string fields, where $l = 1, 2, \dots, n_l$ and $m = 1, 2, \dots, n_m$.

Ultimately, mesonic effective or string fields exhibit as a hyperbolic secant function raised by some power. In contrast, gauge bosonic and fermionic effective or string fields can be expressed as a logistic function raised by some power. Figure 1 claims odd integer spin bosonic or half-spin fermionic string fields possess open strings whose vibratory modes satisfy solely Dirichlet boundary conditions; the strings, called D-branes, about such fields, have endpoints that are fixed in spacetime [83,86,87]. Thus, *GFT* implies the odd integer spin bosonic or half-spin fermionic string field's cm_{ij} are equal to *null*. On the contrary, Figure 1 suggests that other string fields, such as fields that comprise even integer spin bosonic strings (excluding those that describe scalar particles), can be closed or open strings [76,85,86,87]. They possess vibratory modes that satisfy solely Neumann boundary conditions; these fields have string endpoints that are free to roam in

spacetime [76,85,86,87]. In short, open string fields that behave like gauge bosons, such as photons and gluons, have al_{ij}^μ equal to *null* and bl_{ij}^μ exist as a 4 X 1 vector, while open string fields that behave like pseudoscalar and vector mesons retain a bl_{ij} equal to *null*.

On the contrary, closed string fields that behave like tensor bosons possess $bl_{ij}^{\mu\nu}$ equal to *null* and $al_{ij}^{\mu\nu}$ exist as a 4 X 4 matrix. The endpoints of the open string fields are fermions.

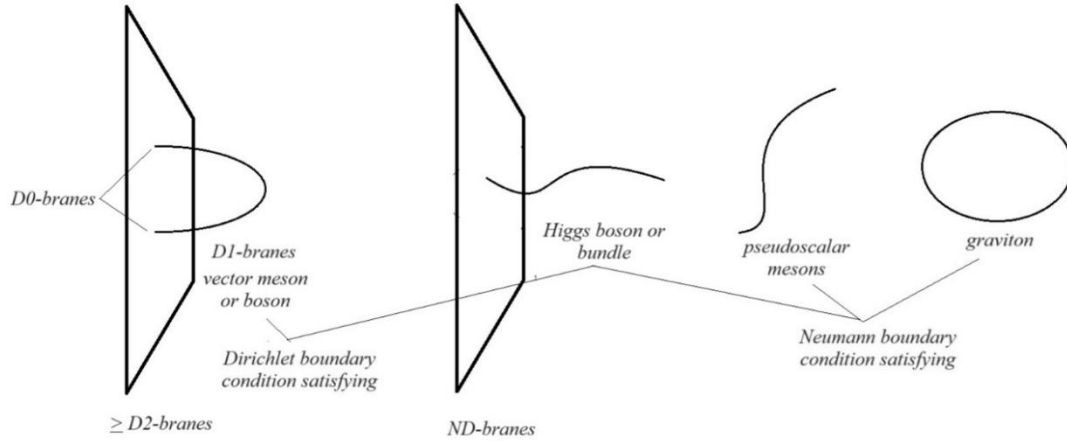


Figure 1: examples of relativistic strings.

For this paper's purposes, al_{ij}^μ , bl_{ij}^μ , and $al_{ij}^{\mu\nu}$ can be expressed as

$$al_{ij}^\mu = al_{ij}(1,1,1,1),$$

$$bl_{ij}^\mu = bl_{ij}(1,1,1,1),$$

and

$$al_{ij}^{\mu\nu} = al_{ij} \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

Finally, most operations involve Hadamard multiplication, mainly if limited to two vectors.

3.2.) On- and off-shell rest mass assessment via renormalization

The expression for renormalization within a volume V was:

$$m_U = \frac{1}{2} \int |U(\xi)U^*(\xi)|dV,$$

where m_U was the mass-energy equivalence for a compound effective or string field U and its conjugate U^* . Assuming the spherical volume, using Manhattan/taxicab-like distance ξ , for compound effective or string field U was equal to the following expression [75]:

$$V = \frac{\pi\xi^3}{6},$$

the formula for renormalization became the following:

$$L[\phi] = \frac{1}{2} \partial_\mu \phi \partial^\mu \phi' - \frac{1}{2} c^2 M^2 \phi \phi' + L_{interactions},$$

$$L[\phi^\mu] = \frac{1}{2} \partial_\mu \phi^\mu \partial^\mu \phi'^\mu - \frac{1}{2} c^2 M^2 \phi^\mu \phi'^\mu + L_{interactions},$$

and

$$L[\phi^{\mu\nu}] = \frac{1}{2} \partial_\mu \phi^{\mu\nu} \partial_\nu \phi'^{\mu\nu} + \frac{1}{2} \partial_\nu \phi^{\mu\nu} \partial_\mu \phi'^{\mu\nu} + \frac{1}{2} \partial_\mu \phi^{\mu\nu} \partial^\mu \phi'^{\mu\nu} - \frac{1}{2} c^2 M^2 \phi^{\mu\nu} \phi'^{\mu\nu} + L_{interactions},$$

respectively. (Note: If a gauge boson is a constituent of another particle, one should use the quantum telegraph Lagrangian formalism. On the contrary, if a

$$m_U = |2 \int_0^\infty \frac{1}{4} \pi \xi^2 U(\xi) U^*(\xi) d\xi|,$$

or

$$m_U = |\int_{-\infty}^\infty \frac{1}{4} \pi \xi^2 U(\xi) U^*(\xi) d\xi|.$$

If the field pertains to either a vector or tensor boson, an individual must find the (root) mean (square) of m_U for the former and implement a trace on m_U , then divided by four to the latter.

4.) Examples

This section explores and expands upon two basic Lagrangian equations needed to solve the effective and string fields associated with this paper. One Lagrangian density formalism for either a fermion or gauge boson field involving the Dirac equation, with its complex conjugate field:

$$L[\psi] = h(\partial_\mu \psi \partial^\mu \psi' + g_2 |\psi|^2)$$

or

$$L[\phi^\mu] = h(\phi^\mu \partial^\mu \phi'^\mu + g_2 |\phi^\mu|^2).$$

Either equation obeys canonical commutation relations and is converted to the Schrodinger equation if the process is Markovian or the quantum telegraph equation if the process is not Markovian [105]. For this paper's intentions, all functional derivatives of the above equations will not involve a Markov process, yielding the quantum telegraph equation. On the other hand, the inhomogeneous Klein-Gordon equations for a (pseudo)scalar, vector, and tensor mesons/boson are

vector meson is considered a composite particle, then (s)he should use the inhomogeneous Klein-Gordon Lagrangian equation.) The values g_2 is an interaction

constant generally equal to unity, while the value h equals a positive integer if the particle/string is presented initially or a negative integer if the particle/string is a by-product [16,44]. Also, the number h equals the coefficient associated with a specific term in the inhomogeneous Klein-Gordon Lagrangian. The principles of least action have several bold Lagrangian terms: ϕ represents the set of scalar bosonic effective or string fields, ϕ^μ represents the set of vector-based bosonic effective or string fields, $\phi^{\mu\nu}$ represents the set of tensor bosonic effective or string fields. On the other hand, ψ_i and ψ_f signify the initial and final fermionic effective or string fields, respectively. Also, ' symbolizes the conjugate fields.

Supplementary material included with this study is Mathematica® spreadsheets of the following examples of *EFT* solved by *GFT*. The supplementary material also contains an instance of linearized gravitational waves solved via *GFT*. **Finally, the results between *EFT* and *SFT* were equal!**

4.1.) The cause of the deviation in the muon g-2 experiment

$$= g_1 \phi_i (|\psi_{f1}|^2 + |\psi_{f2}|^2 + 2|\phi_f^\mu|^2)$$

then the principle of least action for pion decay is as defined as:

$$\begin{aligned} S[\phi_i, \phi_f^\mu, \psi_{f1}, \psi_{f2}] = & -g_1 \phi_i (|\psi_{f1}|^2 + |\psi_{f2}|^2 + 2|\phi_f^\mu|^2) - g_2 (|\psi_{f1}|^2 + |\psi_{f2}|^2 + 2|\phi_f^\mu|^2) \\ \int dx^4 (& -2 \partial_\mu \phi_f^\mu \partial^\mu \phi_f^\mu - \partial_\mu \psi_{f1} \partial^\mu \psi_{f1}' - \partial_\mu \psi_{f2} \partial^\mu \psi_{f2}' \\ & - \frac{1}{2} c^2 M^2 \phi_i \phi_i' + \frac{1}{2} \partial_\mu \phi_i \partial^\mu \phi_i' \end{aligned}$$

Claiming ϕ_i is the pionic effective or string field, ϕ_f^μ is the unknown bosonic effective or string field, and ψ_{f1} is one of the valence muonic effective or string fields, while ψ_{f2} is the valence muon neutrino-based effective or string field associated with the decay of the pion, the functional derivative of the principle of least action yields at least four transformed Hamiltonian equations:

$$\begin{aligned} ai\psi_{f1\xi} + \alpha_\tau i\psi_{f1\tau} - \frac{\alpha_\tau^2}{c^2} \psi_{f1\tau\tau} - \frac{\alpha\alpha_\tau}{c^2} \psi_{f1\xi\tau} - \left(\frac{\alpha^2}{c^2} - (\beta_1^2 + \beta_2^2 + \beta_3^2) \right) \psi_{f1\xi\xi} &= g_1 \phi_i \psi_{f1} + g_2 \psi_{f1}, \\ ai\psi_{f2\xi} + \alpha_\tau i\psi_{f2\tau} - \alpha_\tau^2/c^2 \psi_{f2\tau\tau} - \alpha\alpha_\tau/c^2 \psi_{f2\xi\tau} - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \psi_{f2\xi\xi} &= g_1 \phi_i \psi_{f2} + g_2 \psi_{f2}, \\ (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{i\xi\xi} + c^2 M^2 \phi_i &= g_1 (\psi_{f1} \psi_{f1}' + \psi_{f2} \psi_{f2}' + 2\phi_f^\mu \phi_f^{\mu'}), \end{aligned}$$

and

$$ai\phi_{f\xi}^\mu + \alpha_\tau i\phi_{f\tau}^\mu - \alpha_\tau^2/c^2 \phi_{f\tau\tau}^\mu - \alpha\alpha_\tau/c^2 \phi_{f\xi\tau}^\mu - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{f\xi\xi}^\mu = g_1 \phi_i \phi_f^\mu + g_2 \phi_f^\mu.$$

After solving for any arbitrary parameters/coefficients and constants whenever possible and setting g_1 and g_2 to unity, then assuming the self and mixing interaction mass-energy equivalence equation, one can derive the following mass-energy equivalences:

$$\begin{aligned} m_{\psi_{\text{muon}}} &= \frac{1}{72} \pi (-6 + \pi^2) |d1_{12}|^2, \\ m_{\psi_{\text{muon neutrino}}} &= \frac{1}{288} \pi (-6 + \pi^2) |9 M^4 - 4(2b2_{12}^2 + d1_{12}^2)|, \\ m_{\phi_{\text{pion}}} &= \frac{1}{32} \pi (-6 + \pi^2) |M|^4, \end{aligned}$$

and

$$m_{\phi_f^\mu} = \frac{1}{72} \pi (-6 + \pi^2) |b2_{12}|^2.$$

After using the three most former expressions and the known rest masses for the particles or relativistic strings of interest, one can solve for the arbitrary parameters/coefficients $b2_{12}$, $d1_{12}$, and constant M using known values for items of interest. Next, the rest mass of the unknown particle or relativistic string is calculated to be 1.70×10^7 eV or 17 MeV.

4.2.) Glueball estimations

A glueball is a hypothetical particle solely comprised of gluons [58]. Particle physics theories suggest

The muon g-2 experiment attempts to measure a muon's magnetic dipole moment or g-factor accurately, and Fermilab is currently conducting it [17,55]. The experiment involves injecting the muons from the decay of pseudoscalar pions into a storage ring and then measuring the muon's g-factor. Theoretically, the strength of the magnetic dipole moment is supposed to be exactly two. Any deviation from this, the latter value claims there are likely additional particles in the standard model in the storage ring.

So far, the laboratory has experimented two times. The results of the first two experiments suggested that the anomalous magnetic moment, which is $a_\mu = \frac{g-2}{2}$, had deviated by a factor of 0.00116592 [33]. Ultimately, this data implied there was likely at least one additional particle that is a by-product of a pion but not currently listed in the standard model.

Assuming the additional particle is a vector boson ϕ_f^μ and the Lagrangian term for interactions is as follows:

$$L_{\text{interactions}}[\phi_i, \phi_f^\mu, \psi_{f1}, \psi_{f2}]$$

contemporary colliders should detect them. Although there is anecdotal evidence pointing to the existence of these particles, they have not been explicitly identified [47,58].

Since a gluon is a vector boson ϕ_i^μ and the Lagrangian terms for interactions of the entanglement type are as follows:

$$L_{\text{interactions}}[\phi_f, \phi_i^\mu, \psi_{i1}, \psi_{i2}] = g_1 (|\phi_i^\mu \psi_{i1}| \phi_f + |\phi_i^\mu \psi_{i2}| \phi_f),$$

then, the principle of least action for the decay of a meson should be as follows:

$$S[\phi_f, \phi_i^\mu, \psi_{i1}, \psi_{i2}] = -g_1(|\phi_i^\mu \psi_{i1}|^2 + |\phi_i^\mu \psi_{i2}|^2) - g_2(|\psi_{i1}|^2 + |\psi_{i2}|^2 + 2|\phi_i^\mu|^2) \int dx^4 (-\partial_\mu \phi_i^\mu \partial^\mu \phi_i^\mu - \partial_\mu \psi_{i1} \partial^\mu \psi_{i1}' - \partial_\mu \psi_{i2} \partial^\mu \psi_{i2}' - \frac{1}{2} c^2 M^2 \phi_f \phi_f' + \frac{1}{2} \partial_\mu \phi_f \partial^\mu \phi_f').$$

Suggesting ϕ_f is the mesonic effective or string field, ϕ_i is the gluonic effective or string field, and ψ_{i1} is one of the valence quark effective or string fields,

while ψ_{i2} is the other valence quark effective or string field present in the decay of the meson, the functional derivative of the principle of least action yields at least four transformed Hamiltonian equations:

$$\begin{aligned} \alpha i \Psi_{i1\xi} + \alpha_\tau i \Psi_{i1\tau} - \alpha_\tau^2/c^2 \Psi_{i1\tau\tau} - \alpha \alpha_\tau/c^2 \Psi_{i1\xi\tau} - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \Psi_{i1\xi\xi} &= g_1 \phi_f \Psi_{i1} + g_2 \Psi_{i1}, \\ \alpha i \Psi_{i2\xi} + \alpha_\tau i \Psi_{i2\tau} - \alpha_\tau^2/c^2 \Psi_{i2\tau\tau} - \alpha \alpha_\tau/c^2 \Psi_{i2\xi\tau} - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \Psi_{i2\xi\xi} &= g_1 \phi_f \Psi_{i2} + g_2 \Psi_{i2}, \\ (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_f \xi_\xi + c^2 M^2 \phi_i &= g_1 (\phi_i'^\mu \Psi_{i1} + \Psi_{i2}' \phi_i^\mu), \end{aligned}$$

and

$$\alpha i \phi_{i\xi}^\mu + \alpha_\tau i \phi_{i\tau}^\mu - \alpha_\tau^2/c^2 \phi_{i\tau}^\mu - \alpha \alpha_\tau/c^2 \phi_{i\xi\tau}^\mu - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{i\xi\xi}^\mu = g_1 \phi_f \phi_i^\mu + g_2 \phi_i^\mu.$$

After solving for any arbitrary parameters/coefficients and constants whenever possible and setting g_1 and g_2 to unity, and using the self and mixing interaction mass-energy equivalence equation, one can derive the following mass-energy equivalences:

$$\begin{aligned} m_{\psi_{i1}} &= \frac{1}{72} \pi (-6 + \pi^2) |d1_{12}|^2, \\ m_{\psi_{i2}} &= \frac{\pi (-6 + \pi^2) | \frac{(9M^4 - 4b2_{12}d1_{12})^2}{b2_{12}^2} |}{1152}, \\ m_{\phi_f} &= \frac{1}{32} \pi (-6 + \pi^2) |M|^4, \end{aligned}$$

and

$$m_{\phi_i}^\mu = \frac{1}{72} \pi (-6 + \pi^2) |b2_{12}|^2.$$

One may also assume that the gluonic effective or string field ϕ_i^μ forms a glueball. In other words, the mass of a glueball would constitute the mass-energy equivalence of gluonic effective or string field. After using the three most former expressions and the known rest masses for the particles or relativistic strings of interest, one can solve for the arbitrary parameters/coefficients $b2_{12}$, $d1_{12}$, and constant M using known values for items of interest. Check the table for calculations of glueballs.

A table of predicted glueball masses derived from various meson decays is featured below:

	Quark 1/ $m_{\psi_{i1}}$ (eV)	Quark 2/ $m_{\psi_{i2}}$ (eV)	Meson/ m_{ϕ_f} (eV)	Glueball/ $m_{\phi_i}^\mu$ (eV)
charged pion	2.20*10 ⁷	4.70*10 ⁶	1.40*10 ⁸	1.49*10 ⁹ [65]
neutral pion (pair)	2.20*10 ⁶	4.70*10 ⁶	1.35*10 ⁸	1.39*10 ⁹ [65]
neutral kaon	4.70*10 ⁶	9.60*10 ⁷	4.98*10 ⁸	1.72*10 ⁹ [65]
J/psi meson	1.28*10 ⁹	1.28*10 ⁹	3.10*10 ⁹	1.87*10 ⁹ [66,67]

4.3.) Assessment of tetraquarks mass via decay by-products.

Recently, LHC at CERN found that the four charmed tetraquark $c\bar{c}c\bar{c}$, which had a rest mass of 6.9 GeV, decayed into the vector meson and sigma glueball σ [98,99,100].

Assuming the tetraquark is a scalar bosonic entity ϕ_i and the Lagrangian term for entanglement interaction is as follows:

$$L_{interactions}[\phi_i, \phi_{f1}^\mu, \phi_{f2}^\mu] = 2g_1 |\phi_{f1}^\mu \phi_{f2}^\mu| \phi_i,$$

then the principle of least action for $c\bar{c}c\bar{c}$ decay into vector J/ψ mesons and s glueball is defined as:

$$S[\phi_i, \phi_{f1}^\mu, \phi_{f2}^\mu] = \int dx^4 (-2g_1 |\phi_{f1}^\mu \phi_{f2}^\mu| \phi_i - 2g_2 (|\phi_{f1}^\mu|^2 + |\phi_{f2}^\mu|^2) - \partial_\mu \phi_{f1}^\mu \partial^\mu \phi_{f1}^\mu - \partial_\mu \phi_{f2}^\mu \partial^\mu \phi_{f2}^\mu - \frac{1}{2} c^2 M^2 \phi_i \phi_i' + \frac{1}{2} \partial_\mu \phi_i \partial^\mu \phi_i').$$

One may also deem that the tetraquark effective or string field ϕ_i is comprised of the vector meson J/ψ or glueball σ effective or string fields ϕ_{f1}^μ and ϕ_{f2}^μ , respectively. The functional derivatives of the Lagrangian yields three evolution equations:

$$\begin{aligned} (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{i\xi\xi} + c^2 M^2 \phi_i &= g_1 (\phi_{f2}^\mu \phi_{f1}^\mu + \phi_{f1}^\mu \phi_{f2}^\mu), \\ \alpha i \phi_{f1\xi}^\mu + \alpha_\tau i \phi_{f1\tau}^\mu - \alpha_\tau^2/c^2 \phi_{f1\tau\tau}^\mu - \alpha \alpha_\tau/c^2 \phi_{f1\xi\tau}^\mu - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{f1\xi\xi}^\mu &= g_1 \phi_i \phi_{f1}^\mu + g_2 \phi_{f1}^\mu, \\ \text{and} \\ \alpha i \phi_{f2\xi}^\mu + \alpha_\tau i \phi_{f2\tau}^\mu - \alpha_\tau^2/c^2 \phi_{f2\tau\tau}^\mu - \alpha \alpha_\tau/c^2 \phi_{f2\xi\tau}^\mu - (\alpha^2/c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{f2\xi\xi}^\mu &= g_1 \phi_i \phi_{f2}^\mu + g_2 \phi_{f2}^\mu. \end{aligned}$$

After solving for any arbitrary parameters/coefficients and constants whenever possible and setting g_1 and g_2 to unity, then assuming the self and mixing interaction mass-energy equivalence equation, one can derive the following mass-energy equivalences:

$$\begin{aligned} m_{c\bar{c}c\bar{c}} &= \frac{1}{32} \pi (-6 + \pi^2) |M|^4, \\ m_{J/\psi} &= \frac{1}{72} \pi (-6 + \pi^2) |b2_{12}|^2, \end{aligned}$$

and

$$m_{\sigma} = \frac{9\pi(-6+\pi^2)|\frac{M^8}{b_{212}^2}|}{2048}.$$

After using the two latter expressions and the known rest masses for the particles or relativistic strings of interest, one can solve for the arbitrary parameters/coefficients b_{212} and constant M using known values for the vector meson J/ψ or glueball σ . Plugging in the value M into the former expression claims, the mass of the four-charm tetraquark is $6.90 \cdot 10^9$ eV.

4.4.) Photon analysis linked to a binary black hole merger

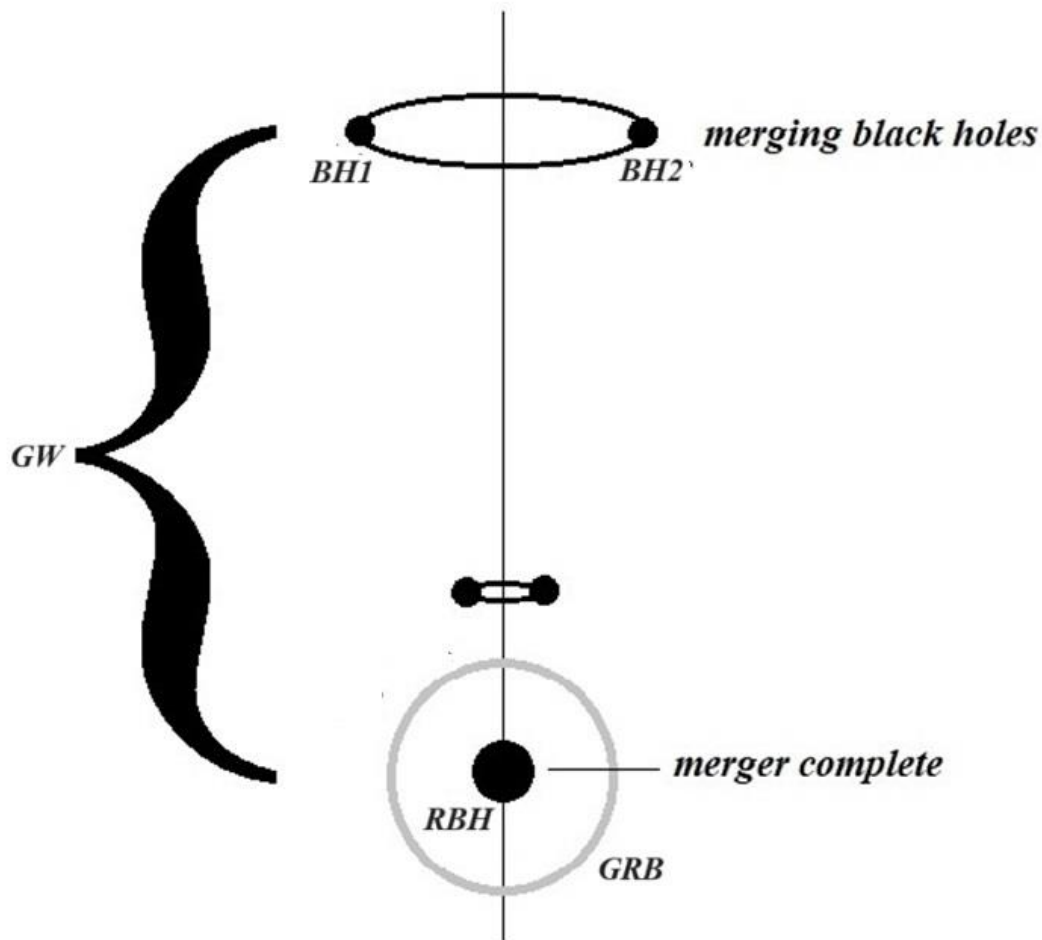
Black holes (BH) were objects in the universe that had much speculation and excellent study. In the 18th century, Pierre-Simon Laplace and John Michell proposed that the universe possessed objects whose gravitational fields were so intense that light could not escape them [31]. Two centuries later, David Finkelstein and Karl Schwarzschild could make primitive solutions that were used to define such entities [69,70,93] initially. It was not until the 1960s that BH became a regular prediction in the general theory of relativity [37].

While undergoing mergers in spacetime, BH was known to emit gravitational waves (GW) and possibly some forms of light [49,94]. In 1916, Albert Einstein postulated that BH created ripples in spacetime in his great work, the General Theory of Relativity [46]. Before Einstein pinpointed the primary source of GW, Poincare, and Heaviside stated there were gravity's

equivalent to electromagnetic waves [71,72]. In 2015, the first GW was detected by LIGO gravitational wave detectors. Finally, Atura Tanikawa and associates claimed that g -ray bursts were also emitted during the BH merger [74].

Quantum entanglement (QE) may be the primary mechanism for merging BHs. Leonard Susskind and Juan Maldacena generated a conjecture stating BH were like two entangled particles, or Einstein-Podolsky-Rosen pair, connected by a wormhole or Einstein-Rosen bridge [13]. Thus, they established the following relationship: ER = EPR. For this study, we used the previous equation to signify BH-QE.

In the first section of this study, we generate a Lagrangian to define BH-QE. Upon functional differentiation of this Lagrangian, we derive three quantum telegraph equations and two inhomogeneous nonlinear Klein-Gordon equations, or QT-KG. Assuming the three quantum telegraph equations described the two BH associated via ER = EPR and the merged BH while the inhomogeneous Klein-Gordon equations represented GW and photons, we used the generating function technique (GFT) to solve for the three BH, GW, and photons. Then, we try to predict the mass equivalents for photon emission, given we know the values of the three BH and GW. Ultimately, we concluded that population III stars were the source of BH mergers since they produced g -ray photons predicted via BH-QE system of equations.



Assuming black holes are vector boson-like and the Lagrangian term for interactions, such as entanglement, is as follows:

$$L_{interactions}[\phi_{i1}^\mu, \phi_{i2}^\mu, \phi_f^\mu, \phi_G^{\mu\nu}, \phi_\gamma^\mu] = g_1 \phi_G^{\mu\nu} (|\phi_{i1}^\mu \phi_\gamma^\mu| + |\phi_{i2}^\mu \phi_\gamma^\mu| - |\phi_f^\mu|^2) g_{\mu\nu},$$

then the principle of least action for the merger of a binary black hole system is as follows:

$$S[\phi_{i1}^\mu, \phi_{i2}^\mu, \phi_f^\mu, \phi_G^{\mu\nu}, \phi_\gamma^\mu] = \int d^4x (g_1 \phi_G^{\mu\nu} (|\phi_{i1}^\mu \phi_\gamma^\mu| + |\phi_{i2}^\mu \phi_\gamma^\mu| - |\phi_f^\mu|^2) g_{\mu\nu} + g_2 (|\phi_{i1}^\mu| + |\phi_{i2}^\mu| + 2|\phi_f^\mu| - |\phi_f^\mu|) g_{\mu\nu} - \frac{1}{2} c^2 M^2 \phi_G^{\mu\nu} \phi_G^{\mu\nu} g_{\mu\nu} + \frac{1}{2} g_{\mu\nu} \partial_\mu \phi_G^{\mu\nu} \partial_\mu \phi_G^{\mu\nu} + \partial_\mu \phi_G^{\mu\nu} \partial_\nu \phi_G^{\mu\nu} + \partial_\nu \phi_G^{\mu\nu} \partial_\mu \phi_G^{\mu\nu}).$$

Deeming $\phi_G^{\mu\nu}$ is the gravitational wave/gravitonic practical or string field involved in the merger, ϕ_γ is the photonic effective or string field, ϕ_{i1}^μ is the first black hole, and ϕ_{i2}^μ is the second black hole effective or string

fields involved in the merger, and ϕ_f^μ is the residual black hole effective or string field, the functional derivative of the principle of least action yields at least six transformed Hamiltonian equations:

$$\begin{aligned} \alpha i \phi_{i1\xi}^\mu + \alpha_\tau i \phi_{i1\tau}^\mu - \alpha_\tau^2 / c^2 \phi_{i1\tau\tau}^\mu - \alpha \alpha_\tau / c^2 \phi_{i1\xi\tau}^\mu - (\alpha^2 / c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{i1\xi\xi}^\mu &= g_1 \phi_G^{\mu\nu} \phi_{i1}^\mu + g_2 \phi_{i1}^\mu, \\ \alpha i \phi_{i2\xi}^\mu + \alpha_\tau i \phi_{i2\tau}^\mu - \alpha_\tau^2 / c^2 \phi_{i2\tau\tau}^\mu - \alpha \alpha_\tau / c^2 \phi_{i2\xi\tau}^\mu - (\alpha^2 / c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{i2\xi\xi}^\mu &= g_1 \phi_G^{\mu\nu} \phi_{i2}^\mu + g_2 \phi_{i2}^\mu, \\ \alpha i \phi_{f\xi}^\mu + \alpha_\tau i \phi_{f\tau}^\mu - \alpha_\tau^2 / c^2 \phi_{f\tau\tau}^\mu - \alpha \alpha_\tau / c^2 \phi_{f\xi\tau}^\mu - (\alpha^2 / c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{f\xi\xi}^\mu &= g_1 \phi_G^{\mu\nu} \phi_f^\mu + g_2 \phi_f^\mu, \\ \alpha i \phi_{\gamma\xi}^\mu + \alpha_\tau i \phi_{\gamma\tau}^\mu - \alpha_\tau^2 / c^2 \phi_{\gamma\tau\tau}^\mu - \alpha \alpha_\tau / c^2 \phi_{\gamma\xi\tau}^\mu - (\alpha^2 / c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{\gamma\xi\xi}^\mu &= g_1 \phi_G^{\mu\nu} \phi_\gamma^\mu + g_2 \phi_\gamma^\mu. \end{aligned}$$

And

$$4AT \phi_{G\xi\xi}^{\mu\nu} + (\alpha^2 / c^2 - (\beta_1^2 + \beta_2^2 + \beta_3^2)) \phi_{G\xi\xi}^{\mu\nu} g_{\mu\nu} + c^2 M^2 \phi_G^{\mu\nu} g_{\mu\nu} = g_1 ((\phi_{i1}^\mu \phi_\gamma^{\mu\nu} + \phi_\gamma^\mu \phi_{i2}^{\mu\nu}) - \phi_f^\mu \phi_f^{\mu\nu}) g_{\mu\nu},$$

$$\text{where } AT = \begin{pmatrix} -\frac{\alpha^2}{c^2} & 0 & 0 & 0 \\ 0 & -\beta_1^2 & 0 & 0 \\ 0 & 0 & -\beta_2^2 & 0 \\ 0 & 0 & 0 & -\beta_3^2 \end{pmatrix} \text{ and } g_{\mu\nu} = \begin{pmatrix} g_{11} & 0 & 0 & 0 \\ 0 & g_{22} & 0 & 0 \\ 0 & 0 & g_{33} & 0 \\ 0 & 0 & 0 & g_{44} \end{pmatrix},$$

AT is the Ansatz transform tensor, and $g_{\mu\nu}$ is the metric tensor. After solving for any arbitrary parameters/coefficients whenever possible and constants, setting g_1 and g_2 to unity, and applying the mass-energy equivalence equation to one element of the transformed solutions, assume the following relationships for determining the mass-energy equivalents of fermion and bosonic effective or string fields associated with the BH-QE system of equations were true:

$$\begin{aligned} m_{\phi_{i1}^\mu} &= \frac{1}{72} \pi (-6 + \pi^2) |b3_{12}|^2 \\ m_{\phi_{i2}^\mu} &= \frac{1}{4608} \pi (-6 + \pi^2) \left| \frac{9m^4 + 8b2_{12}b3_{12} - 8b5_{12}^2}{b2_{12}^2} \right|, \end{aligned}$$

$$\begin{aligned} m_{\phi_f^\mu} &= \frac{1}{72} \pi (-6 + \pi^2) |b5_{12}|^2 \\ m_{\phi_G} &= \frac{1}{128} \pi (-6 + \pi^2) |M|^4, \end{aligned}$$

and

$$m_{\phi_\gamma^\mu} = \frac{1}{72} \pi (-6 + \pi^2) |b2_{12}|^2$$

After using the four most former expressions and the known rest masses for the large-scale structures or relativistic strings of interest, one can solve for the arbitrary parameters/coefficients $b2_{12}$, $b3_{12}$, $b5_{12}$ and constant M using known values for items of interest. Ultimately, (s)he obtained the following table of photons for the first several GWs detected by LIGO:

Specific GW	BH 1/ $m_{\phi_{i1}}$ (solar masses)	BH 2/ $m_{\phi_{i2}}$ (solar masses)	Residual BH/ m_{ϕ_f} (solar masses)	GW/ m_{ϕ_G} (solar masses)	Photons/ m_{ϕ_γ} (erg)
<u>GW150914</u>	35.6	30.6	63.1	3.1	4.40*10 ⁵⁵
<u>GW151012</u>	23.3	13.6	35.7	1.5	2.60*10 ⁵⁵
<u>GW151226</u>	13.7	7.7	20.5	1.0	1.47*10 ⁵⁵
<u>GW170104</u>	31.0	20.1	49.1	2.2	3.54*10 ⁵⁵
<u>GW170608</u>	10.9	7.6	17.8	0.9	1.25*10 ⁵⁵
<u>GW170729</u>	50.6	34.3	80.3	4.8	5.26*10 ⁵⁵
<u>GW170809</u>	35.2	23.8	56.4	2.7	3.99*10 ⁵⁵
<u>GW170814</u>	30.7	25.3	53.4	2.6	3.69*10 ⁵⁵
<u>GW170818</u>	35.4	26.7	59.4	2.7	4.24*10 ⁵⁵
<u>GW170823</u>	39.5	29.0	65.4	3.3	4.56*10 ⁵⁵

5.) Conclusion

Via *EFT* and *SFT*, one will likely identify particle X17 as the culprit causing the deviation in the muon $g-2$ experiment. The additional by-product from pion decay that coexists with the muons in the Fermilab storage ring has a rest mass of 17 MeV. This is the same mass as particle X17, a hypothetical protophobic spin-0 boson first captured by the ATOMKI and then JINR [101,102,103].

EFT and *SFT* might provide an accurate means to calculate glueballs derived from the decay of mesons. The rest of the masses of glueballs, condensed gluonic particles, or relativistic strings, established from the decay of pions and kaons, derived in this paper were consistent with CERN data [65]. Therefore, the theories discussed in this study could adequately estimate the masses of glueballs derived from the decay of other mesons.

EFT and *SFT* claimed that the initial gravitational waves detected by VIRGO/LIGO were generated from binary black hole mergers and were likely accompanied by g -ray bursts, or GRB. The theories in this study claimed the earliest observed binary black hole mergers likely emitted g -ray bursts at $\sim 10^{55}$ erg. It is well known that many cosmological phenomena emit g -ray bursts. However, this range of energy for photons suggested the merging BH likely existed in the first generation or hypothetical population III stars [8].

Establishing a **Triality** between Quantum Information Theory (*QIT*), *EFT*, and *SFT*. Information theory is known as the study of uncertainty in the quantum realm, and its basic unit of information is the qubit, a two-state quantum mechanical system [104]. If an individual lets $c_2 = ic_1$, then (s)he obtains:

$$f(\xi) = c_1 e^{-\eta}$$

or

$$f(\xi) = c_1 e^{-i\xi}.$$

This expression is associated with the exponential map of a qubit [104]. Also, if one applies Euler's formula to the above expression, (s)he obtains the sinusoidal wave function f discussed in section 3. The above statements imply there is an intimate link between a qubit, physical body/particle, and string.

Conflicts of Interests

The author of this paper has no conflicts of interest.

References

1. Paspriou, "A BRIEF TOUR INTO THE HISTORY OF GRAVITY: FROM DEMOCRITUS TO EINSTEIN," American Journal of Space Science, vol. 1, no. 1, pp. 33–45, Jan. 2013, doi: 10.3844/ajssp.2013.33.45.
2. "A Geometric Theory of Everything," Scientific American, 2010.
3. R. L. Jackson, "A possible theory of partial differential equations," UVP, no. 3, 2021, doi: 10.21685/2072-3040-2021-3-3.
4. C. Jer and K. Rejzner, "Algebraic Quantum Field Theory -- an introduction." arXiv, Nov. 18, 2019. Accessed: Jan. 11, 2024. Online. Available: <http://arxiv.org/abs/1904.04051>
5. R. Penco, "An Introduction to Effective Field

Theories".

6. K. Wray, "An Introduction to String Theory".
7. D. S. Stutts, "Analytical Dynamics: Lagrange's Equation and its Application – A Brief Introduction," THE CALCULUS OF VARIATIONS, 1995.
8. Y. Suwa and K. Ioka, "Gamma-ray bursts of the first generation of stars".
9. A. Blais, A. L. Grimsmon, S. M. Girvin, and A. Wallraff, "Circuit Quantum Electrodynamics," Rev. Mod. Phys., vol. 93, no. 2, p. 025005, May 2021, doi: 10.1103/RevModPhys.93.025005.
10. J. D. Martin, A. Roggero, H. Duan, J. Carlson, and V. Cirigliano, "Classical and quantum evolution in a simple coherent neutrino problem," Phys. Rev. D, vol. 105, no. 8, p. 083020, Apr. 2022, doi: 10.1103/PhysRevD.105.083020.
11. B. Zwiebach, "Closed String Field Theory: An Introduction." arXiv, May 07, 1993. Accessed: Jan. 11, 2024. Online. Available: <http://arxiv.org/abs/hep-th/9305026>
12. C. Y. Cardall, "Coherence of neutrino flavor mixing in quantum field theory," Phys. Rev. D, vol. 61, no. 7, p. 073006, Mar. 2000, doi: 10.1103/PhysRevD.61.073006.
13. J. Maldacena and L. Susskind, "Cool horizons for entangled black holes," Fortschritte der Physik, vol. 61, no. 9, pp. 781–811, Sep. 2013, doi: 10.1002/prop.201300020.
14. R. Durrer, "Cosmological Perturbation Theory".
15. P. Peter, "Cosmological Perturbation Theory." arXiv, Mar. 13, 2013. Accessed: Jan. 11, 2024. Online. Available: <http://arxiv.org/abs/1303.2509>
16. A. N. Ikot, O. A. Awoga, and B. I. Ita, "Exact Solutions of the Klein–Gordon Equation with Hylleraas Potential," Few-Body Syst, vol. 53, no. 3–4, pp. 539–548, Oct. 2012, doi: 10.1007/s00601-012-0434-y.
17. T. Gorringer, "Fermilab muon $g-2$ experiment," EPJ Web Conf., vol. 179, p. 01004, 2018, doi: 10.1051/epjconf/201817901004.
18. A. Kumar, "Fundamentals of Quantum Mechanics".
19. P. Fleury, Gravitation: from Newton to Einstein. 2019. doi: 10.1007/978-3-030-32001-0.
20. S. Scherer, "Introduction to Chiral Perturbation Theory." arXiv, Oct. 29, 2002. Accessed: Jan. 11, 2024. Online. Available: <http://arxiv.org/abs/hep-ph/0210398>
21. A. V. Manohar, "Introduction to Effective Field Theories." arXiv, Apr. 16, 2018. Accessed: Jan. 10, 2024. Online. Available: <http://arxiv.org/abs/1804.05863>
22. Y. Grossman, "Introduction to Flavour Physics," in LHC Phenomenology, E. Gardi, N. Glover, and A. Robson, Eds., Cham: Springer International Publishing, 2015, pp. 35–80. doi: 10.1007/978-3-319-05362-2_2.
23. P. Skands, "Introduction to QCD," in Searching for New Physics at Small and Large Scales, Nov. 2013, pp. 341–420. doi: 10.1142/9789814525220_0008.
24. J. Cardy, "Introduction to Quantum Field Theory".

25. D. Morin, "Introduction to quantum mechanics," . INTRODUCTION TO QUANTUM MECHANICS.
26. W. Siegel, Introduction to string field theory. in Advanced series in mathematical physics, no. 8. Singapore: World Scientific, 1988.
27. R. Jackiw, "Introduction to the Yang-Mills quantum theory," Rev. Mod. Phys., vol. 52, no. 4, pp. 661–673, Oct. 1980, doi: 10.1103/RevModPhys.52.661.
28. L. Álvarez-Gaumé and M. A. Vázquez-Mozo, "Introductory Lectures on Quantum Field Theory".
29. R. H. Brandenberger, Lectures on the Theory of Cosmological Perturbations, vol. 646. 2004. doi: 10.1007/b97189.
30. M. Rinaldi and V. Vento, "Meson and glueball spectroscopy within the graviton soft wall model," Phys. Rev. D, vol. 104, no. 3, p. 034016, Aug. 2021, doi: 10.1103/PhysRevD.104.034016.
31. C. Montgomery, W. Orchiston, and I. Whittingham, "MICHELL, LAPLACE AND THE ORIGIN OF THE BLACK HOLE CONCEPT," J. Astron. Hist. Herit., vol. 12, no. 2, pp. 90–96, Jul. 2009, doi: 10.3724/SP.J.1440-2807.2009.02.01.
32. D. Cremer, "Møller–Plesset perturbation theory: from small molecule methods to methods for thousands of atoms," WIREs Comput Mol Sci, vol. 1, no. 4, pp. 509–530, Jul. 2011, doi: 10.1002/wcms.58.
33. A. Keshavarzi, K. S. Khaw, and T. Yoshioka, "Muon $g-2$: A review," Nuclear Physics B, vol. 975, p. 115675, Feb. 2022, doi: 10.1016/j.nuclphysb.2022.115675.
34. B. D. S. L. Torres, T. R. Perche, A. G. S. Landulfo, and G. E. A. Matsas, "Neutrino flavor oscillations without flavor states," Phys. Rev. D, vol. 102, no. 9, p. 093003, Nov. 2020, doi: 10.1103/PhysRevD.102.093003.
35. BESIII Collaboration et al., "Observation of a structure at $1.84 \text{ GeV}/c^2$ in the $3(\pi^+\pi^-)$ mass spectrum in $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$ decays," Phys. Rev. D, vol. 88, no. 9, p. 091502, Nov. 2013, doi: 10.1103/PhysRevD.88.091502.
36. B. P. Abbott et al., "Observation of Gravitational Waves from a Binary Black Hole Merger," Phys. Rev. Lett., vol. 116, no. 6, p. 061102, Feb. 2016, doi: 10.1103/PhysRevLett.116.061102.
37. K. Schwarzschild, "On the gravitational field of a mass point according to Einstein's theory." arXiv, May 12, 1999. Accessed: Jan. 11, 2024. Online. Available: <http://arxiv.org/abs/physics/9905030>
38. E. P. Verlinde, "On the Origin of Gravity and the Laws of Newton," J. High Energ. Phys., vol. 2011, no. 4, p. 29, Apr. 2011, doi: 10.1007/JHEP04(2011)029.
39. "(PDF) Cygnus X-1: A Spinning Black Hole?" Accessed: Jan. 11, 2024. Online. Available: https://www.researchgate.net/publication/1817344_Cygnus_X-1_A_Spinning_Black_Hole
40. D. M. Gingrich, "Practical Quantum Electrodynamics".
41. A. S. Blum and D. Rickles, Eds., Quantum gravity in the first half of the twentieth century: a sourcebook = Edition Open Sources, 1. Auflage. in Edition Open Sources, no. 10. Berlin: Edition Open Access, 2018.
42. D. Rickles, "Quantum Gravity: A Primer for Philosophers".
43. A. Westphal and D. Hamburg, "Quantum Mechanics and Gravitation".
44. A. I. Arbab, "Quantum Telegraph equation: New matter wave equation," Optik, vol. 140, pp. 1010–1019, Jul. 2017, doi: 10.1016/j.ijleo.2017.05.002.
45. B. S. DeWitt, "Quantum Theory of Gravity. I. The Canonical Theory," Phys. Rev., vol. 160, no. 5, pp. 1113–1148, Aug. 1967, doi: 10.1103/PhysRev.160.1113.
46. A. Einstein, "Relativity: The Special and General Theory".
47. A. S. Kronfeld and C. Quigg, "Resource Letter QCD-1: Quantum chromodynamics," American Journal of Physics, vol. 78, no. 11, pp. 1081–1116, Nov. 2010, doi: 10.1119/1.3454865.
48. B. Moziak, "SEARCH FOR INVISIBLE DECAYS OF THE J/ψ RESONANCE".
49. R. Perna, D. Lazzati, and B. Giacomazzo, "Short Gamma-Ray Bursts from the Merger of Two Black Holes," ApJL, vol. 821, no. 1, p. L18, Apr. 2016, doi: 10.3847/2041-8205/821/1/L18.
50. I. Miškovičová, M. Hanke, J. Wilms, M. Nowak, K. Pottschmidt, and N. Schulz, "Spectroscopy of the Stellar Wind in the Cygnus X-1 System," Acta Polytechnica, vol. 51, Mar. 2011, doi: 10.14311/1332.
51. P. Carenza, "Stockholm University, OKC".
52. H. j. String Field Theory -- A Modern Introduction, vol. 980. 2021. doi: 10.1007/978-3-030-65321-7.
53. K. Becker, M. Becker, and J. H. Schwarz, "String Theory and M-Theory".
54. M. H. Poincaré, "Sur la dynamique de l'électron," Rend. Circ. Matem. Palermo, vol. 21, no. 1, pp. 129–175, Dec. 1906, doi: 10.1007/BF03013466.
55. J. Mott, "The Muon $g - 2$ experiment at Fermilab".
56. S. Godfrey, "THE PHENOMENOLOGY OF GLUEBALL AND HYBRID MESONS".
57. H. Zinkernagel, "The Philosophy behind Quantum Gravity," THEORIA, vol. 21, no. 3, pp. 295–312, Sep. 2006, doi: 10.1387/theoria.522.
58. V. Mathieu, N. Kochelev, and V. Vento, "The Physics of Glueballs," Int. J. Mod. Phys. E, vol. 18, no. 01, pp. 1–49, Jan. 2009, doi: 10.1142/S0218301309012124.
59. J. Binney, "The Physics of Quantum Mechanics".
60. J. D. Fraser, "The Real Problem with Perturbative Quantum Field Theory," The British Journal for the Philosophy of Science, vol. 71, no. 2, pp. 391–413, Jun. 2020, doi: 10.1093/bjps/axx042.
61. R. B. Laughlin and D. Pines, "The Theory of Everything," Proc. Natl. Acad. Sci. U.S.A., vol. 97, no. 1, pp. 28–31, Jan. 2000, doi: 10.1073/pnas.97.1.28.
62. C. Leung, "THE THEORY OF EVERYTHING".
63. R. L. Jackson, "The Utilization of the Generating Function Technique in the Discovery of Solutions

for the Three-Dimensional Navier-Stokes Equation System,” *OJFD*, vol. 12, no. 01, pp. 86–95, 2022, doi: 10.4236/ojfd.2022.121005.

64. C.K. Skylaris, “Perturbation Theory,” *Physical & Theoretical Chemistry Laboratory South Parks Road, Oxford* 2006

65. C. Amsler, C. Hanhart, “Non-qq mesons,” *Particle Data Group Review*. 2017

66. M. Ablikim, M.N. Achasov, O. Albayrak, D.J. Ambrose, F.F. An, Q. An, BESIII Collaboration, “Observation of a structure at 1.84 GeV/c(2) in the $3(\pi^+\pi^-)$ mass spectrum in $J/\psi \rightarrow \gamma 3(\pi^+\pi^-)$ decays.” *Physical Review D*, 88 (9). <https://dx.doi.org/10.1103/PhysRevD.88.091502>. 2013

67. B. Moziak, “Search for invisible decays of the J/ψ resonance,” *Rensselaer Polytechnic Institute ProQuest Dissertations Publishing*, 2010

68. Martinez-Núñez, S., Kretschmar, P., Bozzo, E., Oskinova, L. M., Puls, J., Sidoli, L., Sundqvist, J. O., Blay, P., Falanga, M., Fürst, F., Giménez-García, A., Kreykenbohm, I., Kühnel, M., Sander, A., Torrejón, J. M., & Wilms, J. “Towards a unified view of inhomogeneous stellar winds in isolated supergiant stars and supergiant high mass X-ray binaries.” 2018 <https://doi.org/10.1007/s11214-017-0340-1>

69. B. L. Webster, P. Murdin, “Cygnus X-1—a Spectroscopic Binary with a Heavy Companion?”, *Nature*, 235 (5332): 37–38. 1972

70. K. Finkelstein, “Past-Future Asymmetry of the Gravitational Field of a Point Particle,” *Phys. Rev.* 112 (May 15): 965-967 1958

71. H. Poincare, “Sur la dynamique de l'electron.” *C.R. T.140* (1905) 1504-1508

72. O. Heaviside, “A Gravitational and Electromagnetic Analogy,” Part I, *The Electrician*, 31: 281-282 1983

73. B.P. Abbott, (LIGO Scientific Collaboration and Virgo Collaboration). “Observation of Gravitational Waves from a Binary Black Hole Merger,” *Phys. Rev. Lett.* 116 (6): 061102. 2016

74. R. Perna, D. Lazzati, B. Giacomazzo, “Short Gamma-Ray Bursts from the Merger of Two Black Holes,” *The Astrophysical Lett.* 821:L18 (6pp), 2016 April 10: 1-6. 2016

75. H. Colakoglu, “Volume of a Tetrahedron in the Taxicab Space”. In: *Missouri Journal of Mathematical Sciences* 21, pp. 21–27. 2009

76. K. Wray, “An Introduction to String Theory”.

77. R. C. Myers, “Nonabelian Phenomena on D-branes,” *Class. Quantum Grav.*, vol. 20, no. 12, pp. S347–S372, Jun. 2003, doi: 10.1088/0264-9381/20/12/302.

78. G. W. Moore and G. Segal, “D-branes and K-theory in 2D topological field theory”.

79. G. Moore, N. Nekrasov, and S. Shatashvili, “D-Particle Bound States and Generalized Instantons,” *Communications in Mathematical Physics*, vol. 209, no. 1, pp. 77–95, Jan. 2000, doi: 10.1007/s002200050016.

81. D. S. Freed and E. Witten, “Anomalies in string theory with D-branes,” *Asian Journal of Mathematics*, vol. 3, no. 4, pp. 819–852, 1999, doi: 10.4310/AJM.1999.v3.n4.a6.

82. M. R. Douglas, D. Kabat, P. Pouliot, and S. H. Shenker, “D-branes and Short Distances in String Theory,” *Nuclear Physics B*, vol. 485, no. 1–2, pp. 85–127, Feb. 1997, doi: 10.1016/S0550-3213(96)00619-0.

83. R. Dijkgraaf, L. Hollands, P. Sułkowski, and C. Vafa, “Supersymmetric gauge theories, intersecting branes and free fermions,” *J. High Energy Phys.*, vol. 2008, no. 02, pp. 106–106, Feb. 2008, doi: 10.1088/1126-6708/2008/02/106.

84. R. Blumenhagen, M. Cvetič, S. Kachru, and T. Weigand, “D-brane Instantons in Type II String Theory”.

85. E. Bergshoeff, J. Lahnsteiner, L. Romano, and J. Rosseel, “The Supersymmetric Neveu-Schwarz Branes of Non-Relativistic String Theory,” *J. High Energ. Phys.*, vol. 2022, no. 8, p. 218, Aug. 2022, doi: 10.1007/JHEP08(2022)218.

86. D. Berenstein and E. Dzienkowski, “Open spin chains for giant gravitons and relativity,” *J. High Energ. Phys.*, vol. 2013, no. 8, p. 47, Aug. 2013, doi: 10.1007/JHEP08(2013)047.

87. V. Balasubramanian, A. Kar, S. F. Ross, and T. Ugajin, “Spin structures and baby universes,” *J. High Energ. Phys.*, vol. 2020, no. 9, p. 192, Sep. 2020, doi: 10.1007/JHEP09(2020)192.

88. Hajarolasvadi, S. “A new hybrid numerical scheme for simulating fault ruptures with near fault bulk inhomogeneities.” 2016 <https://core.ac.uk/download/158315427.pdf>

89. 이., & 조. 근사 원방 경계조건을 이용한

HAWT의 Navier-Stokes 유동해석.

한국항공우주학회지. 2008

<http://www.dbpia.co.kr/Article/932962>

90. Electroweak epoch - Wikipedia. https://en.wikipedia.org/wiki/Electroweak_epoch

91. What is astrophysics? | Space | EarthSky. <https://earthsky.org/space/definition-what-is-astrophysics/>

92. Redhead, M. (1980). Models in Physics. The British Journal for the Philosophy of Science. <https://doi.org/10.1093/bjps/31.2.145>

93. S. Sadiq, A. Alias. “Black holes formations and dark fabric distortions.” 2022 <https://core.ac.uk/download/524625565.pdf>

94. B. Zhang, B. “The Delay Time of Gravitational Wave — Gamma-Ray Burst Associations.” 2019 <https://core.ac.uk/download/225356190.pdf>

95. M. M. Ivanov, “Effective Field Theory for Large Scale Structure.” *arXiv*, Dec. 16, 2022. Accessed: Jan. 26, 2024. Online. Available: <http://arxiv.org/abs/2212.08488>

96. Z. Vlah, U. Seljak, M. Y. Chu, and Y. Feng, “Perturbation theory, effective field theory, and oscillations in the power spectrum,” *J. Cosmol. Astropart. Phys.*, vol. 2016, no. 03, pp. 057–057, Mar. 2016, doi: 10.1088/1475-7516/2016/03/057.

97. H. Erbin, *String Field Theory -- A Modern Introduction*, vol. 980. 2021. doi: 10.1007/978-3-030-65321-7.

98. Z. Kuang, K. Serafin, X. Zhao, and J. P. Vary, “All-charm tetraquark in front form dynamics,” *Phys. Rev. D*, vol. 105, no. 9, p. 094028, May 2022, doi:

10.1103/PhysRevD.105.094028.

99. R. J. Lloyd and J. P. Vary, “All-charm tetraquarks,” *Phys. Rev. D*, vol. 70, no. 1, p. 014009, Jul. 2004, doi: 10.1103/PhysRevD.70.014009.

100. R. Tiwari, D. P. Rathaud, and A. K. Rai, “Spectroscopy of all charm tetraquark states,” *Indian J Phys*, vol. 97, no. 3, pp. 943–954, Mar. 2023, doi: 10.1007/s12648-022-02427-8.

101. K. U. Abraamyan et al., “Observation of structures at ~ 17 and ~ 38 MeV/c² in the $\gamma\gamma$ invariant mass spectra in pC, dC, and dCu collisions at $\sqrt{s_{\text{lab}}}$ of a few GeV/c per nucleon.” *arXiv*, Nov. 30, 2023. Accessed: Jan. 26, 2024. Online. Available: <http://arxiv.org/abs/2311.18632>

102. Y. Hiçiyılmaz, S. Khalil, and S. Moretti, “Light Z' Signatures at the LHC,” *Phys. Rev. D*, vol. 107, no. 3, p. 035030, Feb. 2023, doi: 10.1103/PhysRevD.107.035030.

103. D. S. Firak et al., “Confirmation of the existence of the X17 particle,” *EPJ Web Conf.*, vol. 232, p. 04005, 2020, doi: 10.1051/epjconf/202023204005.

104. A. J. et al., “Quantum Algorithm Implementations for Beginners,” *ACM Transactions on Quantum Computing*, vol. 3, no. 4, pp. 1–92, Dec. 2022, doi: 10.1145/3517340.

105. J. Dunkel and P. Hänggi, “Relativistic Brownian motion,” *Physics Reports*, vol. 471, no. 1, pp. 1–73, Feb. 2009, doi: 10.1016/j.physrep.2008.12.001.

ZOOLOGY

SPECIES COMPOSITION AND NUMBER OF RODENT CARRIERS OF THE PLAGUE PATHOGEN IN THE (MOYINKUM DESERT PLAGUE FOCUS IN 2021

Bely D.,

*Head of the laboratory of epizootology of especially dangerous infections
Republican State Institution "Zhambyl Anti-Plague Station" of the Committee of Sanitary and Epidemio-
logic Control of the Ministry of Health of the Republic of Kazakhstan, Taraz city*

Niyazaliev K.,

zoologist

*Republican State Institution "Zhambyl Anti-Plague Station" of the Committee of Sanitary and Epidemio-
logic Control of the Ministry of Health of the Republic of Kazakhstan, Taraz city*

Nurbaev K.,

zoologist

*Republican State Institution "Zhambyl Anti-Plague Station" of the Committee of Sanitary and Epidemio-
logic Control of the Ministry of Health of the Republic of Kazakhstan, Taraz city*

Kopkova A.,

zoologist

*Republican State Institution "Zhambyl Anti-Plague Station" of the Committee of Sanitary and Epidemio-
logic Control of the Ministry of Health of the Republic of Kazakhstan, Taraz city*

Sayakova Z.

Candidate of Biological Sciences, Senior Scientific Associate

*Republican State Enterprise "Institute of Zoology", Ministry of Science and Higher Education of the Repub-
lic of Kazakhstan,*

Almaty city

DOI: [10.5281/zenodo.11624546](https://doi.org/10.5281/zenodo.11624546)

Abstract

The work was carried out taking into account the specific epizootic situation of plague in 2020, on the territory where the course of plague among mammals has been observed for more than 40 years, which is a constant potential threat of epidemic of this infection among the population. Taking into account the fact that plague epizootic was detected by bacteriological method during rodent plague testing in spring 2015, and in the fall of the same year local low-intensity plague epizootic was detected by serological method in the tract "Shynyrau kudyk", indicating the continuation of the epizootic, as well as intensive human economic activity in the active Moyinkum desert plague focus, in the spring season of 2021. studies of the state of fauna and rodent abundance in the Western Remnant Landscape-Epizootologic Region (LER) were conducted. During the research period, the territory on the area of 3000 km², which is a part of the Moyinkum desert plague focus, was surveyed. Among rodents, large and small gerbils, yellow gopher and small marmoset were studied, among predators - fox, skogpa, buzzard and harrier. Rodent abundance was low.

Keywords: rodents, natural plague focus, landscape-epizootologic region, carriers of the plague pathogen, great gerbil, small gerbils.

Introduction. The plague epizootic in the study area was detected in spring 2012 at the following points: "Satybaldy" 1 culture of plague was isolated from the greater sandfly and 1 seropositive greater sandfly was detected, "Kadyrbek" 1 culture of plague was isolated from the greater sandfly; "Shynyrau kudyk" 1 seropositive greater sandfly was detected; plague epizootic was detected at the following points: "Satybaldy" ur. "Kadyrbek" 1 culture of plague was isolated from the great sandfly; "Shynyrau kudyk" - 1 seropositive great sandfly was found; the plague epizootic was characterized as local, intensive, occurred on a total area of 300 km² [1]. In the fall of 2012, no epizootic process was registered in this territory.

In spring 2013 local low-intensity epizootic of plague was detected by serologic method in tracts "Kokdala", Baikozha, headquarters Bekmurat, Sadykzhal, Kuzendidala, Suzhal-1. The plague epizootic at all sites was characterized as local, low-intensity and occurred on a total area of 600 km² [1]. From the

fall of 2013 to the fall of 2014, despite the survey of the territory, no plague epizootics were registered.

In spring 2015, the epizootic process was registered by bacteriological method on the area of 500 km² in the tract "Shokai" isolated 5 strains of *Y. pestis* from fleas of the great gerbil burrows of the plague pathogen from the flea of the burrows of the great gerbil *Xenopsylla gerbilli minax*. In the tract "Koizhigit" 1 culture of the plague pathogen was isolated from the suspension of the great gerbil in the tract "Zhaylybek" 1 culture of the plague pathogen was isolated from the red-tailed gerbil and in the tract "Kokdala" 1 culture of the plague pathogen was isolated from the great gerbil, around the settlement "Kishi Kokdala" 1 culture of the plague pathogen was isolated from the flea of the great gerbil burrows: *Xenopsylla gerbilli minax*. The plague epizootic was characterized as local low-intensity. In the fall of 2015, local low-intensity plague epizootic was detected by serological method in Shynyrau kudyk. The plague epizootic at all sites was characterized as

local, low-intensity and flowed over a total area of 100 km² [1]. From 2016 to the fall of 2017, despite the survey of the territory, the plague epizootic was not detected.

In spring 2018, a local low-intensity plague epizootic was detected in the tracts "Satybaldy" (1 seropositive great sandfly was isolated), "Kadyrbek" 2 seropositive great sandflies were isolated; The plague epizootic at all sites was characterized as local, low-intensity and flowed over a total area of 200 km². An inter-epizootic period was observed from fall 2019 to spring 2021.

The main host of the plague pathogen is the great gerbil. Great Sandpiper settlements are mostly sporadic and occur in small groups [2-4]. The density of settlements is very low. Only in the extreme northwest in a relatively small area and in some places in the southeast along the southern edge of the sands, colony density is somewhat higher. Numbers of the Greater Sandpiper in these areas averaged 3.0 individuals per 1 ha, varying from 0.5 to 4.5 individuals per year [5-7]. In addition, the Noon Sandpiper, Grebeschik's Sandpiper and Red-tailed Sandpiper inhabit the area. The Noon Sandpiper dominates among the Small Sandpipers. The abundance of the Yellow Gopher is also low. Other rodents are rare. The vectors are fleas of sandflies, mainly of the Greater Sandpiper [8-9]. According to long-term averages, their number in the habitat of the Greater Sandpiper is 140 specimens per 1 ha, with annual variations from 24 to 535 [10-12].

The purpose of our research was to study the state of the fauna and to conduct an inventory of the number of rodents in the Western Remnant Landscape-Epizootologic Area, as well as their natural enemies - predatory animals.

Materials and Methods.

Great Sandpiper was captured from 10-12 rodent colonies. Traps were placed 1.5 km apart. On one colony 2-3 traps were placed, for a more uniform survey of the territory, 1-2 gerbils were captured from each colony on average, after which the traps were moved to colonies that had not been trapped. First of all, the survey was conducted in the vicinity of settlements, by sectors and was aimed at searching for local epizootics in the places of plague pathogen establishment and adjacent areas.

During the spring season of 2021, 500 rodents, including the greater sandfly, were captured.

The population of the greater sandfly was counted using the route-colonial method, while the lesser sandflies and other small rodents were counted using the trap-night method.

The trapping of Greater Red-tailed Sandpipers was carried out with special traps placed at the entrance to the burrows of these rodents. No more than 2 gerbils were captured per colony, after which the traps were moved to other colonies.

Small Sandpipers were counted by placing 100 traps with standard bait (bread moistened with vegetable oil) in a line at 5-meter intervals in the main habitats, as well as traps placed on colonies of large sandpipers.

Counts of Yellow Gophers were carried out on autoroutes (number of sightings per 1 km). Small gopher

tortoises were counted at dusk in the light of car headlights (number of sightings per 1 or 10 km of route).

Numbers of rodents were determined by the trap-night method. When counting in settlements, at least 20% of the total number of objects were surveyed. Small settlements with up to 20 houses were surveyed completely. At the same time with counting the number of rodents, four-legged predators were counted by trapping them in traps placed on colonies of Great Sandpipers.

The number of raptors was judged by the number of birds seen per daylight hours.

To conduct stationary observations of the Greater Sandpiper, 3 fixed points were selected, which most fully reflect the landscape-ecological peculiarity of the surveyed area. The following ecological observations were carried out at the stationary points of permanent record:

- a/ observations of rodent population composition and breeding intensity;
- b/ counting the number of embryos in pregnant females;
- c/ registration of repeated pregnancy and embryo resorption;
- d/ study of multi-year population dynamics of the great gerbil;
- e/ change of colonies, interspecific contacts, rodent mobility, etc.

Results

During the period of work from 28.05.2020 to 16.07.2021 the survey was conducted on the area of - 3000 sq. km². The abundance of Great Sandpiper (*Rhombomys opimus* (Lichtenstein, 1823)) in the whole LER per 1 km² amounted to 228 individuals, with colony occupancy of 37.6 %. Colony density averaged 146 per 1 km². The average number of Greater Sandpipers per colony was 4.6 individuals. The percentage of minor rodents caught in traps was 0 % per 100 l/n.

Counting of the number of the main carrier of the plague pathogen is carried out before the release of young animals. In the study area, 51.8% of animals survived the winter period, which stabilized the number of the main carrier in most parts of the LER.

In general, the number of Great Sandpipers per 1 km² in spring 2021 was 256, with a range of 77 to 384, and 141 in spring 2020, with colony occupancy rates of 37.6 % and 43.6 %, respectively.

During the 2021 summer season, 196 Great Sandpipers were captured in the Western Remnant LER, of which 67 (34.2 %) were sexually mature males and 112 (57.1 %) were sexually mature females. Of the sexually mature females: 35 (31.3 %) were yearlings, 67 (59.8 %) were littered, and only 7 (6.3 %) were pregnant. Young were captured 17 (8.7 %), of which 10 (58.8 %) were young males and 7 (41.2 %) were young females.

The ratio of sexually mature females to males, was 1.7:1. The percentage of females participating in reproduction was 66.1%.

The number of embryos per pregnant female was 2.7, ranging from 1 to 5. The breeding intensity index was 22.

Numbers of the Noon Sandpiper (*Meriones meridianus* (Pallas, 1773)) are generally low in the area. For example, the percentage of their occurrence per 600 l/n was 0% in the LER.

Numbers of Red-tailed Sandpiper (*Meriones libycus* (Lichtenstein, 1823)) are generally low in the area. The percentage of their occurrence per 600 l/n in the LER was - 0.

Numbers of Grebe Sandpiper (*Meriones tamariscinus* (Illiger, 1811)) are generally very low in the area. For example, in the LER the percentage of their occurrence per 500 l/n was - 0%.

In the Western Remnant LER this summer, numbers of Ruffs remain at a low level. No geese were caught in fishing gear. At dusk single animals were encountered on the routes, and 10 Little Ruffs (*Allactaga elater* (Lichtenstein, 1825)) were recorded per 10 km of the auto-route (or 1.0% per 1 km of the route). Their numbers may increase slightly in the fall of 2021.

Numbers of yellow gophers (*Spermophilus fulvus* (Lichtenstein, 1832)) on the territory of the Western Remnant LRR were below average. Gophers were not specifically captured during material sampling.

Three routes were established to record the abundance of yellow gophers:

The total area of these routes was 3 km², 15 yellow gophers were encountered, with an average of 0.15 animals per 1 km².

Numbers of terrestrial predators (weasels, bandages, ferrets) in the area were counted visually and by trapping. Four-legged predators were not specifically captured. Their numbers are still low. A total of 2 Red Foxes (*Vulpes vulpes* (Linnaeus, 1758)) were recorded.

Among raptors, an average of 2 birds were seen per daylight hours, mainly Buzzards (*Buteo rufinus* (Cretzschmar, 1827)). Nests of buzzards contained mainly 2 eggs, but not more than 3 eggs. In addition to Buzzards, Osprey Pandion haliaetus (Linnaeus, 1758), Harrier (*Circus pygargus* (Linnaeus, 1758)) were recorded, approximately 1 - 4 birds of prey per 10 km of the vehicle route.

Weather conditions are characterized according to the data of the weather station located in Oyyk settlement. The winter of 2020-2021 was snowy with rare precipitation in the form of snow (18 days). The winter temperature background was close to the average long-term data and was -8.4. Spring was relatively cool and prolonged.

In the 1st decade of March the temperature background was +4.10 C, in the 2nd decade of the month - 1.10 C. In the 3rd decade of the month and average air temperature amounted to +8.30 C. The average monthly air temperature was +3.80, last year +7.00 C, with a norm of +1.7 0C. Precipitation in the form of rain fell in the 1st, 2nd, 3rd decade (11 days). Snow cover on the soil surface was recorded until March 20, while last year it was until February 7. The transition from 00°C to above zero temperatures was recorded on March 19 (February 13 last year).

In April, the weather was stable, within multiyear values. Air temperature in the first ten-day period was + 10.70 C, in the second ten-day period + 15.10 C, in the third ten-day period + 16.70C. Precipitation fell in

the form of rain in the second and third ten-day periods of the month (accompanied by strong easterly winds in the first and second ten-day periods). Rare flowering of tulips was observed in the first, second and third ten-day periods of April. Rare flowering of poppies was observed in the third decade of April. The vegetation condition assessment was low due to weak vegetation of ephemerals and ephemerooids. In general, weather conditions in April were favorable for rodent activity.

In May, the weather was stable, moderately warm but windy, with strong easterly winds prevailing. Precipitation fell in the first and second decades of the month (3 times). Air temperature was +21.30 C in the first decade, +23.00 C in the second and +28.40 C in the third. Assessment of vegetation condition was unsatisfactory, ephemerals and ephemerooids vegetated poorly, wormwood and sagebrush grew poorly, meager flowering of poppies continued until the third decade of May.

In general, it can be said that the spring of 2021 was late and drier than the spring of the previous year. The forage base for rodents was insufficient due to weak vegetation of desert vegetation, climatic conditions were satisfactory and sufficient for rodent activity (Table 1).

Thus, the abundance of the Greater Sandpiper here remains below average. Thus, the number of animals in summer of this year was 266 animals per 1 km², with an average colony occupancy rate of 38.2%. The index of intensity of the main carrier remained at the last year's level and amounted to 22. The average number of embryos per pregnant female was 2.7. Taking into account the above-mentioned data, it can be assumed that by the fall of 2021 the number of the greater sandfly in the whole territory under favorable weather and climatic conditions will be higher than last year's data, therefore, the possibility of a local epizootic of plague in the fall of 2021 is not excluded in this territory.

References

1. Atshabar. B.B., Burdelov L.A., Izbanova U.A., Lukhnova L.Y., Meka-Mechenko T.V., Meka-Mechenko V.G., Kunitsa T.N., Sadovskaya V.P., Saptaev S.K., Sarmantaeva A.B., Sansyzbayev E.B., Nurmakhanov T.I., Abdel Z.J., Kozhakhmetova M.K., Aimakhanov B.K., Kuznetsov A.N., Sagiev Z.A., Kulbaeva M.M., Alybaev S.D.; Bekshin J.M., Esmagametova A.S., Zhumadilova Z.B.; Kazakov S.V., Kuatbaeva A.M. Passport of regions of Kazakhstan on especially dangerous infections. // Quarantine and zoonotic infections in Kazakhstan. - Almaty, 2015. - 179 p. (in Russian).
2. Rapoport L.P., Saylaubekuly R., Rakhimov K., Tulemisov R.K. Main results of long-term study of autonomous plague foci in sandy deserts of South Kazakhstan: spatial and biocenotic structure, gostability, features of the epizootic process // Quarantine and zoonotic infections in Kazakhstan. - Almaty, 2016. - Vol. 1. - P. 33-40. (in Russian).
3. Rapoport L.P. Comparative analysis of members of the plague parasitic system of the northern and southern desert subzones and their role in epizootics //

Quarantine and zoonotic infections in Kazakhstan. - Almaty, 2012. - Vol. 2. - P. 7-13. (in Russian).

4. Sadovskaya V.P., Syzdykov M.S., Kuznetsov A.N. Integration of epizootologic and epidemiologic data using geographic information technology for monitoring of natural plague foci in Kazakhstan // *Izvestiya Vuzov (Kyrgyzstan)*. - 2011. - № 9. - P. 37-39. (in Russian).

5. Rapoport L.P., Rakhimov K.R., Putyatin V.V., Balabas N.G., Orlova L.M., Kovtun I.P., Kondratenko L.P., Mochalova E.P. To the question of asynchrony of plague epizootics in different areas of Moyinkum // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2002. - Issue. 5. - P. 83-87. (in Russian).

6. Rapoport L. P. On the recurrence of plague epizootics in some parts of the Moyinkum autonomous plague focus // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2003. - Vol. 2 (8). - P. 38-42. (in Russian).

7. Rapoport L. P. Materials on the spatial structure of plague epizootics in the Moyinkum autonomous focus // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2004. - Vol. 1 (9). - P. 47-50. (in Russian).

8. Rapoport L. P., Shishkina T. S., Trofimov A. S., Rakhimov K. R. To the question of the role of "unblocked" fleas in plague epizootics in Moyinkum // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2003. - Issue. 2 (8). P. 147-148. (in Russian).

9. Rapoport LP, Shishkina TS, Rakhimov KR, Trofimov AS, Balabas N. G. On the role of "blocked" fleas in plague epizootics in Moyinkum // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2004. - Vol. 1 (9). - P. 108. (in Russian).

10. Rapoport L. P., Melnichuk E. A., Orlova L. M., Nuriev H. H. Comparative analysis of flea fauna and their epizootological significance in the deserts of Southern Kazakhstan // *Zoological Journal*. - 2010. - T. 89. - Vol. 9. - P. 83-87. (in Russian).

11. Rapoport L. P. Density of the greater sandfly and plague epizootic process in the Moyinkum natural focus // *Quarantine and zoonotic infections in Kazakhstan*. - Almaty, 2006. - Vol. 1-2 (13-14). - P. 192-193. (in Russian).

12. Bely D.G. Meka-Mechenko V.G., Niyazaliev K.K., Nurbaev K.T., Sadovskaya V.P., Sayakova Z.Z. Current state of the rodent fauna in the Moyinkum desert plague focus // *Biological Sciences of Kazakhstan*. - 2021. - № 4. - P. 30-41. (in Russian).

№84, 2024
Slovak international scientific journal

The journal has a certificate of registration at the International Centre in Paris – ISSN 5782-5319.

The frequency of publication – 12 times per year.

Reception of articles in the journal – on the daily basis.

The output of journal is monthly scheduled.

Languages: all articles are published in the language of writing by the author.

The format of the journal is A4, coated paper, matte laminated cover.

Articles published in the journal have the status of international publication.

The Editorial Board of the journal:

Editor in chief – Boleslav Motko (Bratislava) Slovakia

The secretary of the journal – Milica Kovacova (Bratislava) Slovakia

- Lucia Janicka – (Bratislava) Slovakia
- Stanislav Čerňák – (Bratislava) Slovakia
- Miroslav Výtisk – (Nitra) Slovakia
- Dušan Igaz – (Nitra) Slovakia
- Terézia Mészárossová – (Banská Bystrica) Slovakia
- Peter Masaryk – (Rzeszów) Poland
- Filip Kocisov – (Wrocław) Poland
- Andrej Bujalski – (Košice) Slovakia
- Jaroslav Kovac – (Trnava) Slovakia
- Paweł Miklo – (Bratislava) Slovakia
- Jozef Molnár – (Bratislava) Slovakia
- Tomajko Milaslavski – (Nitra) Slovakia
- Natália Jurková – (Bratislava) Slovakia
- Jan Adamczyk – (Prague) Czech Republic
- Boris Belier – (Bratislava) Slovakia
- Stefan Fišan – (Bratislava) Slovakia
- Terézia Majercakova – (Wien) Austria
- Ekaterina Semko (Kyiv) Ukraine

1000 copies

Slovak international scientific journal

Partizanska, 1248/2

Bratislava, Slovakia 811 03

email: info@sis-journal.com

site: <http://sis-journal.com>