II International Scientific School–Conference on Acoustophysics named after Academician A. R. Mkrtchyan

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Book of Abstracts

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Lectures

Radiation Processes on Acoustic Superlattices

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The influence of acoustic waves on various physical processes in media is among the main directions of the investigations in the Institute of Applied Problems of Physics (IAPP) NAS RA. Academician A. R. Mkrtchyan was the initiator of those studies. A number of interesting theoretical results predicted by the scientists in IAPP has been experimentally confirmed. In the present talk we describe several radiation processes in crystals excited by volume and surface acoustic waves. They include the transition radiation on acoustic superlattices, bremsstrahlung of high–energy electrons and creation of electron positron pairs in crystals in the presence of hypersonic waves, the Smith–Purcell radiation on surface waves, and transition radiation on an interface with a dynamical periodic structure. We also discuss the quantum radiation (dynamical Casimir effect) induced by surface waves on a planar boundary. All these considerations show that the acoustic waves can serve as an effective mechanism to control the parameters of various kinds of radiation processes.

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Status of X–ray Acoustooptics at the Institute of Microelectronics Technology and High Purity Materials Russian Academy of Sciences

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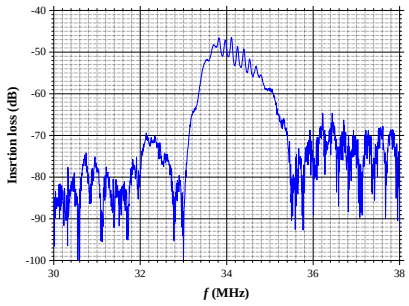
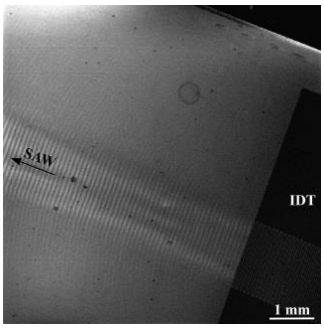
The possibilities of studying the process of excitation and propagation of surface acoustic waves in piezoelectric crystals by electrical measuring methods, scanning electron microscopy and X–ray diffraction are demonstrated. While the electrical measuring method allows comparison between the input and output signals of an acoustic–electronic device, the methods of scanning electron microscopy and X–ray diffraction allow direct investigation of the SAW propagation process on the surface of a piezoelectric substrate. The process of SAW harmonic visualization capability in the wavelength range from 100 μm to 4 μm was investigated by different methods.

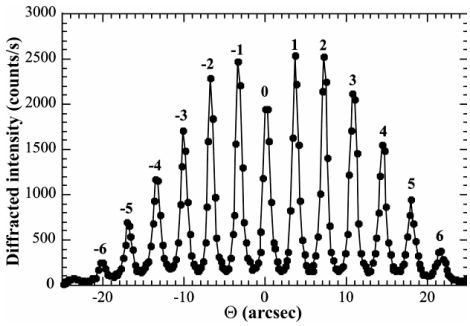
The most sensitive is the method of X–ray diffraction, which allows to investigate acoustic wave processes with minimal amplitudes. If the electro–measuring method and the method of scanning electron microscopy are mainly qualitative methods, the method of X–ray diffraction is a quantitative method and allows to determine the wavelengths and amplitudes of acoustic waves.



Amplitude–frequency response. First harmonic $H = 1$, $\Lambda_1 = 100\ \mu m$, $f_1 = 34.88\ MHz$



SEM microphotograph of first harmonic $H = 1$, $\Lambda_1 = 100\ \mu m$, $f_1 = 34.88\ MHz$



Rocking curve of the YZ −cut of a $LiNbO_3$ *crystal modulated by SAW. The eleventh harmonic* $H = 11$, $\Lambda_{11} = 9\ \mu m$, $f_{11} = 377\ MHz$.

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Review of Investigations in the Field of Acoustophysics Conducted in Lab. 3 of IAPP

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One of the areas of research conducted in the IAPP is the study of the influence of different media on the radiation processes generated by relativistic electrons (channeling radiation, transition radiation, Cherenkov radiation, diffraction radiation, etc.). Additionally, many interesting phenomena arise when acoustic fields are excited in media. This is exactly the field of study of acoustophysics. In this report the review of studies conducted in lab. 3 of IAPP in these fields is presented.

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Cherenkov Diffraction Radiation: Generation and Applications

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Polarization radiation is a phenomenon appearing when a fast charged particle moves through or passes by a medium. When the charged particle moves in the vicinity of a medium atom, it interacts with its electron shell deforming it. Therefore, the atom has a disbalance of charge with positive dominance on one side and negative on the other. Such atomic state is called a dipole. When a large fraction of atoms are oriented dipoles, the medium is said to be polarised. Polarization state is not stable. The electron shell oscillates around the heavy nucleus emitting waves called *polarization radiation (PR).* The PR might be induced even when the particle does not directly interact with medium, i.e. the electron multiple scattering and bremsstrahlung processes are missing. It prevents the beam parameter degradation. On the other hand the radiation intensity is high enough to be detected by modern detection systems. It provides an opportunity to develop non–invasive methods for charged particle beam diagnostics, to observe and monitor the beam parameters in an on–line mode.

The Lecture will review the mechanisms of polarization radiation defined by the geometry of the radiators. The main part of the lecture will focus on the spectral–spatial properties of Cherenkov Diffraction Radiation. The theoretical expectations will be presented and discussed. Key experimental results and ChDR applications for charged particle beam diagnostics will be presented. The future experimental activity and prospects will be analysed.

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Some Problems of Dynamic Diffraction of Short–Wave Radiation in a Crystal Lattice

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The lecture is devoted to theoretical and experimental problems of the interaction of short–wave radiation (X–rays, slow neutrons) with a crystal lattice. In particular,

- Basic equations of dynamic diffraction of X–ray and neutron radiation. Mathematical foundations for the representation of solutions. Some particular analytical solutions of the Takagi's equations: ideal lattice, perfect lattice, lattice with linear dependence on deformation field coordinates, lattice with quadratic dependence on deformation field coordinates.
- Eikonal approximation in a lattice with a weak deformation field.
- Optical principлes of the formation of diffraction fields of short–wave radiation.
- The main effects accompanying dynamic diffraction and their interpretation based on the theory of dynamic scattering.
- Dynamic scattering of radiation in perfect crystals.
- Dynamic scattering in crystals with defects, including crystals under the influence of external influences (thermal, mechanical, acoustic fields, etc.)
- Problems of diffractive optics and basic optical elements (monochromators, collimators, lenses, etc.)

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Detecting Methods of the Ionizing Radiation Flux Density Distribution in the Beam Cross Section

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This report is devoted to methods of measuring transverse profiles of radiation beams. The registration of the transverse profiles is important for both research tasks and actual applications. The high precision determination of the spatial parameters of wide–aperture beams of sizes of 20 cm or more involves numerous difficulties. The spatial and energy parameters of the radiation beams are generally obtained using matrix detectors consisting of a large number of ionization chambers or semiconductor detectors, the fluorescent screen in conjunction with an optical camera system, radiometry films. In addition, the approach based on integral transformations by inverse Radon reconstruction of data that could be obtained by multiple scanning of the beam find wide application.

This work is supported by the RSF project No. 19-79-10014-П.

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Methods of Training of Some Questions Section of Optics "Wave Optics"

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It is presented historical review about main laws of optics and the major development of theory of light phenomena.

The themes "Inference of Light" and "Diffraction of Light" is presented in a popular science way, based on the fact that the light is a wave process.

The idea of coherence wave and optical length of paths of light rays given in this context. It is presented some interferometric devices and questions of their use.

Some Fresnel and Fraunhofer diffraction tasks are discussed

It is presented features of X–ray diffractions.

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Impact of International Scientific Conferences on Scientific Communities and Economy of the Country

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Sound and Its Influence on Medium

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Proposal of a Common Scientific, Technical and Educational Task for Students and Teachers of the School of Acoustophysics Named After Academician A.R. Mkrtchyan

V.K. Sarian[1*], R.V. Meshcheryakov[2], A.H. Mkrtchyan[3]

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The lecture will present a project to create a system of radically reducing the risk of human losses in the metropolis of Yerevan in the event of rapidly developing natural and man–made emergencies. The lecture proposes to involve the students of the school in solving this urgent interdisciplinary task. In the process of studying at the school, highly qualified specialists in various natural science disciplines will be trained.

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Comparative Analysis of Existing Methods and Devices Suitable for Recording Various Seismic Processes

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The generalized data on the kinematic, dynamic, and frequency characteristics of seismic signals caused by the earth's crust vibrations from near and distant earthquakes, as well as information on their frequency and duration are given.

It is explained how these data make it possible to formulate the necessary technical requirements for recording devices and evaluate the possibilities of using various methods and corresponding recording devices for recording seismic signals from various seismic processes.

It is also explained that, depending on the specific seismological tasks to be solved, various additional specific technical and operational requirements are also imposed on seismic recording devices.

It is established that despite the development and wide usage of modern digital systems and instruments for recording and processing seismic signals, seismic stations also widely use visible analog recorders, of which, in terms of their technical and operational characteristics, electrographic seismic oscilloscopes with continuous and standby analog visible recording of signals on a simple paper are very promising.

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Explanation of the Phenomenon of Electromagnetic Induction (EMI) of Faraday from the Perspective of "Gravitational" Charges

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Based on the analogy of the systems of equations of the propagation of bending–shear waves in a "cantilever" beam and the current in single–wire and two–wire long lines, it follows that there are three independent gravitational charges (pure [impulsive] – ν with sec^{-1} dimension, energetic [linear] – λ, [λ]=м; and forceful [accelerating] α, [α]=м·sec^{-2}) and a magnetic charge. Additionally, there are their vortex analogues, namely gravitational, magnetic, and electric stable monopoles and triplets. as well as their vortex counterparts; gravitational, magnetic and electrical stable monopoles and triplets.

Based on the three gravitational charges from de Broglie formula $m \cdot v = \frac{h}{\lambda}$ and the Schrödinger equation for a freely and uniformly rectilinearly moving body with mass *m*, the following equation has been derived:

$$2\lambda v_{\text{г}} \cdot \lambda v_{\text{ф}} = c^2 = V_{\text{г}} \cdot V_{\text{ф}} \qquad (1)$$

From equation (1), it follows that when a body with mass *m* is in motion, two different de Broglie waves exist within it, the lengths of which differ by a factor of two. The carried out research provides the basis for proposing a fundamentally new model for the formation of the electromotive force $\varepsilon = -\frac{d\Phi}{dt}$ in Faraday's law of electromagnetic induction. It is as follows: during any change of magnetic flux (field) or movement of a beam in a magnetic field with velocity v, gravitational charges λ and *v*, [λ]=м and [v]= sec^{-1} arise in it, which, according to the laws $E = vB$ and $E = \frac{c^2}{v}B$ transform into electric and "magnetic" monopoles (charges).

In this process, they create "electric fields" $2E^-$ and $E^+(M)$, which are physically identical (isomorphic), and their sum is equal to E^-.

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Crystals with Polar Symmetry of a New Class of Amino Acids Salts

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Recently, a new class of amino acid salts containing different amino acids was discovered in our group. Most salts in this class are salts of the type [A(1)H...A(2)]X, where A(1) and A(2) are protonated and neutral amino acids, respectively, with strong hydrogen bond, X is any anion. More than a dozen of them have polar symmetry and can exhibit pyroelectric and ferroelectric properties.

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Seismo–Acoustic Emission and Earthquake Prediction

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Earthquake prediction is an important issue in modern seismology. Despite numerous geophysical, geodynamic, hydrogeochemical and other seismic prediction precursors the prediction of earthquakes is still an unsolved scientific problem. During recent years, along with seismological precursors, methodological approaches are applied to study changes in the frequency response of natural disturbances, as well as the occurrence of seismic–acoustic emission effects connected with anomalous changes in the stress–strain state of the geological environment of the Earth's crust. Under the influence of tectonic stress anomalous accumulations occur in the form of elastic–plastic deformation in separate plates of dislocations in the Earth's crust which have the role of stress concentrators. Later, the consolidation of separate carriers, the so–called meso elements, occurs within which stress disturbances and an abrupt change in the frictional properties of the geological environment occurs, leading to the formation of a fault line of a strong earthquake.

The organization and implementation of research in this direction is an extremely relevant scientific and applied problem for the seismically active and hazardous territory of Armenia.

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Applications of Radioisotopes in Medicine

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Physicians use medical isotopes for diagnostic and therapeutic purposes. Physical and nuclear characteristics of therapeutic and diagnostic isotopes are not the same. However, there is a need for specific "theranostic" single radionuclides or radionuclide pairs that have emissions that allow pre-therapeutic low-dose imaging as well as high-dose therapy in the same patient. The reason is that the use of one isotope for radioimmunotherapy and another one for performing biodistribution and imaging studies to predict the dosimetry and toxicity before initiating the therapy is hazardous. Two different elements, even with similar biochemistry, can have some important dissimilarities, resulting in an inconsistency between diagnostics and therapy. Therefore, it is best, if possible, to use the same theranostic radionuclide with the same electronic structure and, therefore, with the same chemical and biochemical properties for both diagnostics and therapy.

Radioactive tracers are made up of carrier molecules that are bonded tightly to a radioactive atom. These molecules vary greatly depending on the purpose of the scan. Some tracers employ molecules that interact with a specific protein or sugar in the body and can even employ the patient's own cells.

SPECT (Single Photon Emission Computed Tomography) imaging instruments provide 3D images of the distribution of radioactive tracer molecules that have been introduced into the patient's body. The 3D images are computer generated from a large number of projection images of the body recorded at different angles. SPECT imagers have gamma camera detectors that can detect the gamma ray emissions from the tracers that have been injected into the patient. The cameras are mounted on a rotating gantry that allows the detectors to be moved in a tight circle around a patient who is lying motionless on a pallet.

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PET (Positron Emission Tomography) scans also use radiopharmaceuticals to create three-dimensional images. The main difference between SPECT and PET scans is the type of radiotracers used. While SPECT scans measure gamma rays, the decay of the radiotracers used with PET scans produce positrons. Positron react with electrons in the body and when these two particles combine they annihilate each other. This annihilation produces two photons that shoot off in opposite directions. The detectors in the PET scanner measure these photons and use this information to create images of internal organs.

The Fourier Method and the Method of the Green's Functions as a Manifestation of the Causality Principle in Classical Mechanics.

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Within the framework of the presented report some issues of the Fourier method and the Green's function method are discussed as applied to certain problems of classical mechanics. On the example of problems of motion under the action of a force varying in time, as well as forced oscillation of a harmonic oscillator, the relationship between these two methods is highlighted. The importance of knowledge of advanced and retarded solutions, as well as their connection with the initial and final conditions of the problem, is also discussed. The importance of knowledge of advanced and retarded solutions, as well as their connection with the initial and final conditions of the problem, is also discussed. With regard to a complex consideration the role of poles overpassing is omitted.

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Acustoplasma States

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In an acoustically disturbed plasma, long–lived acoustic lattices of standing waves can be formed. Such acoustic lattices lead to the creation of lattices of the parameters of the plasma itself, which significantly change the parameters of the plasma medium. This made it possible to consider a plasma medium with an arbitrary acoustic perturbation as a new acoustoplasmic medium. The paper considers acoustoplasma, which is obtained as a result of the modulation of the discharge current. Experimental results and new phenomena due to the acoustoplasmic medium are presented, as well as the features of the acoustoplasmic medium and the difficulties that arise when describing it analogously to a classical plasma.

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Generator of Monodisperse Droplets and some Applications

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A device for generation of monodisperse droplets of variable size and generation frequency is presented. The solid particles were formed by drying of droplets of different solutions in the glass tube. Experimental investigation has been performed in order to create periodical structures (particularly photonic crystals) using these solid particles. For focusing and "trapping" of particles thermophoretic force is applied. For fabrication of opal photonic crystals self–assembly techniques is used.

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Receptive Field Surround Influences on the Neuron's Activity in Extrastriate Area 21a

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The neurophysiological mechanisms underlying the central analysis of visual information still remain a fundamental problem in visual physiology. The spatio–temporal organization of receptive fields (RF) of neurons in the visual formations of the cerebral cortex plays a crucial role in processing and encoding incoming visual information. It is well–established that any changes in the parameters of a presented stimulus, such as magnitude, shape, contrast, direction, angle, and speed of movement, can result in changes in the neuron response, including complete suppression. It is reasonable to hypothesize that this behavior of neurons is attributed to the involvement of many interconnected neuron groups, various both qualitatively and quantitatively, in the formation of the response. The main objective of the present study was to identify patterns of modulating influences exerted on the neuron response patterns when the space surrounding their RFs was stimulated. The experimental results presented in this study demonstrated that the parallel and synchronous activation of the surrounding RF space significantly modulates the response patterns of neurons in the 21a region to the moving visual stimuli. This modulation can have both facilitating and inhibitory effects. Interestingly, the irritation of the near environment of the RFs often produced a relieving effect on the neuron responses, while the activation of more distant areas in the visual field frequently led to the inhibition or even complete suppression of responses. The data obtained suggest that the coordinated interaction among a multitude of simultaneously activated neurons with overlapping RFs may play a crucial role in the integration and diversification of incoming visual information.

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Fundamental and Applied Aspects of X-ray and Thermal Neutron Beams Channeling in Capillary Structures

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In this overview presentation, I want to show the development of the theory of X-ray transmission through polycapillary optical systems and microchannel plates, based on the principles of beam channeling in micro- and nanocapillaries, as well as the corresponding history.

The results obtained confirm the theoretical predictions about the wave nature of the passage of X-rays through capillary structures, which makes it possible to consider capillary based systems as promising for use in modern and under construction sources of high-power electromagnetic radiation based on free electron lasers.

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Advanced Channeling Technologies for Accelerator & Radiation Physics: from Crystal to Laser/Plasma/Capillary based Beam Guides

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Channeling is the phenomenon well-known in the physics world mostly related to the motion of the beams of charged particles in aligned crystals. Since the beginning of 1970s channeling of high-energy leptons (electrons/positrons of several MeV up to hundred GeV energies) and hadrons (protons/ions of tens GeV up to several TeV energies) has been applied at various famous world research centers within different national/international projects related to the phenomenon utilization to handle the beams as well as to produce high power X-ray and gamma radiation sources.

However, recent studies have shown the feasibility of channeling phenomenology application for description of other various mechanisms of interaction of charged as well as neutral particles beams in solids, plasmas and electromagnetic fields covering the research fields from crystal/laser/plasma based beam guides and collimators to capillary guides for charged beams and X-rays/neutrons.

This review talk is devoted to actual channeling-based projects that have been realizing since so-called renaissance of channeling studies started in the end of last century. The future possible developments in channeling physics for accelerator physics will be analysed within the presentation.

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Abstracts

Advanced Piezoelectric Crystals for Acoustoelectronics

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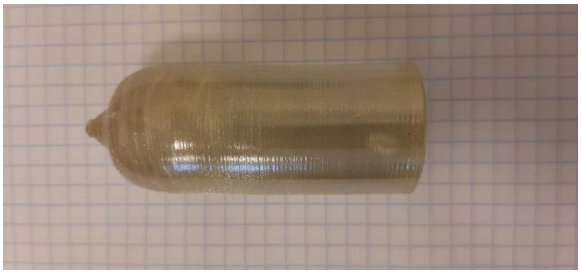
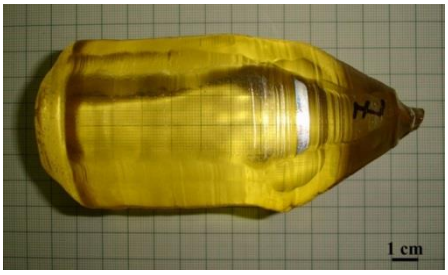
Ferroelectric crystals $LiNb_{0.88}Ta_{0.12}O_3$ and piezoelectric crystals $Ca_3TaGa_3Si_2O_{14}$ were grown by the Czochralski method. These materials are promising for acoustoelectronics, acoustooptics and optoelectronics. The structural perfection of monocrystals and composition distribution were investigated, acoustic and piezoelectric properties of crystals were studied. Temperature dependences of crystal properties have been considered. Thermal expansion coefficients have been measured.

Ferroelectric crystals of $LiNb_{0.88}Ta_{0.12}O_3$ solid solutions combine high values of piezoelectric moduli from $LiNbO_3$ crystals and high temperature stability of acoustic properties from $LiTaO_3$ crystals. Piezoelectric moduli, surface and bulk acoustic wave velocities were measured in these crystals.

$Ca_3TaGa_3Si_2O_{14}$ piezoelectric crystals have good temperature properties and small acoustic velocities, which makes it possible to create miniature acoustoelectronic devices and sensors.



$LiNb_{0.88}Ta_{0.12}O_3$ crystal grown by the Czochralski method along axis c.



3'' ordered $Ca_3TaGa_3Si_2O_{14}$ crystal.

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Two–Crystal Systems with None Diffraction Zone

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The problem of X–ray interferometric imaging of a narrow non–diffracting zone between the plates of a two–block system is considered. Using the Riemann function for the Takagi equations, the wave functions of two pairs of interfering X–ray beams are constructed in integral form in the case of the initial beam from a point source.

$$\Psi_{1,2}^{(e)}(\xi,\eta,R) = A\int_{-\infty}^{+\infty}\frac{\sqrt{\omega^2+1}\mp\omega}{\omega^2+1}e^{-P(\omega)d\,+\,iF(\omega,\ \ \xi-x_0\mp\Delta x)\,\mp\,iT}d\omega. \qquad (1)$$

For large values of the parameter d/Λ_0, to calculate the integral (1) by the stationary phase method at points far enough from the caustics and foci, we can restrict ourselves to the quadratic term of the series of the phase function F(ω).

The points of the stationary phase ω_{kj} are determined from the condition that the function is equal to zero $\frac{\partial F}{\partial \omega}$:

$$\omega_{kj} = \omega(j)(\xi - x_0 \mp \Delta x) \qquad (2)$$

where $\{\omega^{(j)}(x)\}$ is the set of solutions of the equation

$$\frac{\omega}{\sqrt{\omega^2+1}} - \frac{ds}{d}\omega + \frac{2\gamma_o\gamma_h}{sin2\theta_B}\frac{x}{d} = 0 \qquad (3)$$

From here, for the geometrical places of the interference maxima, we obtain

$$\xi = \frac{sin2\theta_B}{2\gamma_o\gamma_h}\,\frac{\Lambda\,\tilde{n}}{2\,\Delta x}\,\left(d_s - \frac{d}{\sqrt{(\frac{\Lambda\,\tilde{n}}{2\,\Delta x})^2+1}}\right) + x_o \qquad (4)$$

where

$$\tilde{n} = n + \frac{T}{\pi} \qquad (n\ =\ 0;\pm1,\pm2) \qquad (5)$$

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Particularly when $d_s \ll d$

$$\xi = \frac{sin2\theta_B}{2\gamma_o\gamma_h} \frac{\Lambda\,\tilde{n}}{2\,\Delta x}\, d_s + x_o \qquad (6)$$

The first of the limiting cases (4) gives a picture formed without taking into account diffraction phenomena in vacuum, and the second (6)– the asymptotes of the interference pattern of the "Billet lens" at large distances from the foci.

Two–crystal systems with different parameters have been designed, interference patterns have been recorded. Theoretical and experimental data have been compared.

Formation of Moiré Pictures in a Three–Block X–ray Interferometer and Their Control by External Mechanical Influence

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A wave optical treatment based on the spherical wave approximation worked out for three–crystal system. An X–ray three–block interferometer with a thin neck between the analyzer block and the mirror block was designed. The mutual arrangement of these blocks is changed with the help of thin levers with weights at the ends, which make it possible to rotate the analyzer block with the splitter blocks (S) and the mirror block fixed. Sectional topograms of interference patterns at different torques show that rotational moire prevails in the recorded moiré patterns shown in Fig.1.

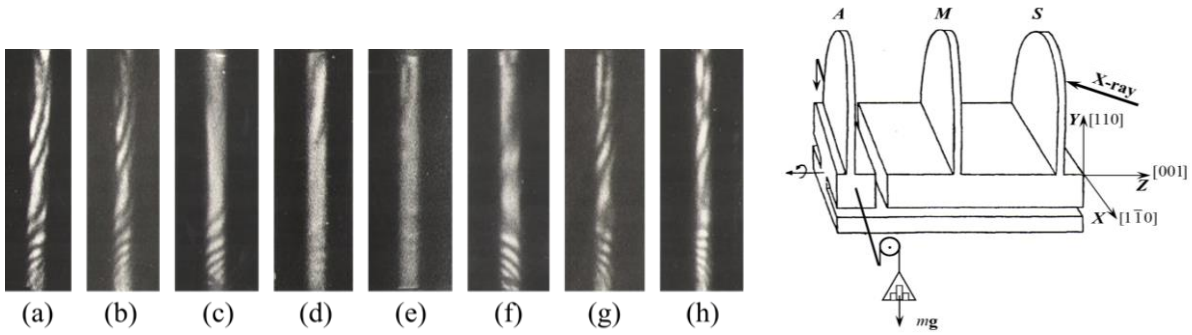

Fig.1. Sectional topograms and designed X–ray interferometer.

With an increase in the mechanical torque, the period of the moiré fringes increases, and at a certain value of the moment, the moiré pattern disappears and the interference field becomes uniform, which means that the interferometer becomes “ideal”. A further increase in the torque leads to the appearance of a rotational moire with a change in the sign of the slope of the interference fringes. A theoretical interpretation of all observed phenomena is given.

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A Project to Develop a System for Radically Reducing the Risk of Human Casualties in the Yerevan Metropolis in The Event of Rapidly Developing Natural and Man–Made Emergencies

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A practical and urgent task in the AR, which can be quickly implemented by scientists participating in the school and conference and other scientists of the National Academy of Sciences of the Republic of Armenia.

In 2022, an article was published in the journal published by the IFZ RAS «Dynamics of changes in the seismic risk of the territory of a large city over time, due to the vulnerability of apartment buildings (for example, Yerevan)». It is advisable to give the names of the authors and their places of work: Nazaretyan S. N., (Territorial Seismic Protection Service of the Ministry of Emergency Situations of the Republic of Armenia), Gevorkyan M. R., (Institute of Geological Sciences of the National Academy of Sciences of the Republic of Armenia), Igityan G. A and Mirzoyan L. B. (Yerevan State University). The article assessed the technical condition of the housing stock of apartment buildings in Yerevan as unable to withstand earthquakes and planned measures for reconstruction.

At our previous conferences, we presented methods for radically reducing the risk of human and material losses using sensors based on Mesabauer effect sensors and a system of individualized control of self–evacuation of users to a safe zone in case of occurrence, developed by scientists of the IAPP NAS RA. The lessons of the recent catastrophic earthquake in Turkey translate the academic nature of the mentioned studies and conclusions into the rank of documents

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of particular importance, since they belong to the increased risk category in the field of protection of the population and infrastructure of the capital of the Republic of Armenia, Yerevan, where a third of the population lives. The essence of the proposed project is to combine the efforts of our organizations and under the auspices of the National Academy of Sciences of Armenia for the practical implementation of the system of protection of the population of Yerevan from possible earthquakes. It should be noted that the implementation will not require large costs and can be implemented by the end of 2024.

Problems Leading to the Need of Changing the Concept of Gravitational Charge

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Macroseismic studies of the impact of destructive earthquakes have shown that many destructions of buildings and structures and other anomalous phenomena have inexplicable form. Therefore, there is a need to develop such calculation schemes for the swaying of buildings and structures, which take into account the huge values of seismic accelerations observed in real–time. In order to develop a new theory of seismic resistance (NTS), the results obtained during swaying of a homogeneous beam of constant cross–section of length l with the following boundary conditions are important: task 1 – a cantilever beam; task 2 – both ends of the beam are strongly pinched; task 3 – one end is strongly pinched, and the other satisfies the condition $\dot{U}_x(l,t) = 0,\ (\varphi(l,t) = 0)$. As a result of introducing the concepts of instantaneous center of rotation, instantaneous moment of inertia and given lengths, it was possible for the first time to decompose the formulation of the problem of elastic wave bending propagation into two subproblems and reduce the order of the equations being solved from the fourth to the second. From the studies of problem 1, it follows that the process of the onset of bending–shearing fluctuations occurs from the free end of the cantilever beam. Therefore, at the free end of the beam, the force $F(l,t)$ and the moment of force $\mathrm{M}(l,t)$ simultaneously appear, the modules of which are equal to $\frac{1}{2}f(x,t)$ и $\frac{1}{2}\cdot\frac{I}{S}\cdot\dot{f}_x(x,t)$, respectively, forming a connected pair (similar to a Cooper pair). When considering the question of how F(l,t) and M(l,t) bound pair is developed, we must accept (make a conclusion), by analogy as the conduction current in the single–wire line is spread, that there are "gravitational charges" that are polarized at the free end of the beam and create F(l,t) and M(l,t) bound pair.

As further shown, there are 3 independent gravitational charges: pure (impulse) – ν which has sec–1 dimension; energy (linear)–λ, [λ]=m; strength (accelerating)–α, [α]=м·sec–2, and their vortex analogues.

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Rentgenographic Study of Structural Changes in AOT / H–Heptane–Water Liquid Crystal System Depending on the Concentration of Components

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Structural changes in the sodium salt of di–(2–ethylhexyl)sulfosuccinic acid (AOT) – n–heptane–water liquid–crystal system depending on the AOT concentration in the n–heptane–water mixed solvent were studied using the X–ray diffraction method. The studies were carried out in a wide range of concentrations from 27 to 92% AOT in a mixed solvent n–heptane/water=5.8. ratio.

The mesomorphism of a liquid–crystal system is found out depending on the concentration of the system. It is confirmed that at concentrations above 50%, a liquid crystal structure with an intradomain "flat" liquid crystal layered phase takes place. There are lamellae of monomolecular thickness (L2) with a hydrated water layer between the layers and bimolecular thickness (L1) with an excess of organic n–heptane. In highly concentrated samples, “bound” water (hydration water) remains in the interlamellar space, while in the organic space, AOT and n–heptane chains are dipped into each other with a certain amount of n–heptane. The structural parameters of the compactness of the liquid crystal system, the thickness of the formed layers, the surface area per molecular head on the surface of the layers depending on the concentration and thickness of the bound water layer are revealed.The liquid crystal system under study can serve as a model for studying various problems of biological membranes.

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Study of Emissions of Acoustic and Electromagnetic Waves Generated by a Shock Wave

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This report is devoted to the study of various types of radiation (acoustic and electromagnetic waves) caused by a shock wave. It is assumed that these radiations are the result of the vortex motions of the gas generated by the shock wave. Waves of different frequencies are emitted by different vortices.

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Fraunhofer Diffraction by a Slit in the Medium Has the Magneto–Optical Faraday Effect

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Fraunhofer diffraction by a slit on an opaque screen between a vacuum and a nonmagnetic dielectric medium in the presence of magneto–optical activity suspended in the medium by an external constant magnetic field is considered. Some features of the diffraction pattern are revealed for different directions of the external magnetic field.

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To the Problem of a Wave Field Description

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Within the framework of the report, the problem of an approximate description of the wave field is discussed. In particular, on the basis of examples of the interference and the grating diffraction the necessary and sufficient conditions for applying the Fresnel and Fraunhofer approximations are analyzed. The well–known Talbot effect is considered. A direct relationship between the fractional Talbot effect and the slit width of a diffraction grating is shown.

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A Differentiation Method for Solving Ordinary Differential Equations

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A new method for solving ordinary differential equations is suggested. As it is shown the differential equation can be solved not only by means of integration of its differentiation as well. It is shown that the differential equation can be solved not only by integration, but also by differentiation. The developed method is applied for consideration of corresponding equations for the exponential function and trigonometric functions.

In the framework of the developed method the simple approach for derivation of Taylor series of a function is demonstrated. Based imminently on the geometric definition the connections between trigonometric functions and their derivatives are obtained as well. The well–known Euler formula is also produced, which establishes a connection between trigonometric functions and exponential functions.

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Dynamical Behavior of Phase Transitions in Liquid Crystals under Ultrasound Field

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In this paper we report the results of study the influence of acoustic field both on the process of the interface formation and on the rate of phase boundary propagation at phase transitions from nematic liquid crystal (NLC) to isotropic liquid (IL).

Experimental studies were carried out in acoustically "rigid" drop as well as in "rigid" and "soft" cells of sandwich type, one substrate of which was a piezo quartz's X–cut plate. In cells 20, 50,100 mm thick there were researched liquid crystals (LC) of planar and as well as of homotropic orientation. The frequency of an ultrasonic field made 3,77–4 MHz.

The temperature of the sample was controlled to within$\pm 0{,}3℃$. The mesophases and the rate of phase boundary propagation have been examined by combination of optical polarized light microscopy and the devised plant for the measurement of the boundary propagation rate.

Preliminary studies indicate the existence of vortex flow of LC in acoustic fluxes. In isotropic phase such flow isn't observed. As a rule, phase transition begins on that area of the sample, where the rate of vortex flow maximum and has directivity from the center of the cell or drop to its edges. In vicinity of the point, where phase transitions begins, the turbulence disappear and phase boundary arises, the rate of propagation of which depends on intensity of ultrasonic field. It should be noted, that intensity of ultrasonic field influences also on the temperature of phase transition.

The most interesting part of this study concerns the following: I– $LC \leftrightarrow IL$ boundary under ultrasonic field has a closed curve form, whereas the electric field improves the linear form of the boundary; II– ultrasonic field reduces phase transition temperature.

The paper also considers isotropic phase nucleation in a NLC phase at the $NLC \leftrightarrow IL$ phase transition under the ultrasonic field. The values of isotropic phase germ's radius r were found from the condition $\partial\,\Delta\phi/\partial r = 0$, were $\Delta\phi$ is the variation of the thermodynamic potential under the phase transition. In addition to the terms governed by the heat of transition and surface

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tension, parameter $\Delta\phi$ involves contributions due to the elastic energy of NLC and to the ultrasonic field. For investigated LC obtained values for r are followings: $r = 3{,}8 \cdot 10^{-5} sm$ without ultrasonic field and $r = 4{,}3 \cdot 10^{-5} sm$ under ultrasonic field($f = 4MHz$). It indicates the increase on probability of formation of a germ of an isotropic phase at the phase transition $NLC \leftrightarrow IL$ under the ultrasound. This computed values are in good agreement with experimental data, in particular, with depression of the $NLC \leftrightarrow IL$ phase transition temperature in the presence of ultrasonic field.

Further work is in progress to determine the efficiency of ultrasonic field on kinetics of the phase transition and of getting a possibility to regulate kinetics.

IR Vibration and Characterization of All L–Arginine Halides

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Search and study of salts of L–arginine (L–Arg) is of interest both from the point of view of the discovery of crystals with NLO, pyroelectric and piezoelectric properties, and from the point of view of studying the structural features and mechanisms of formation [1,2]. The crystals {L–Arg·HCl ($P1, P2_1$), L–Arg·HCl·H_2O ($P2_1$), L–Arg·2HCl ($P2_1$) and L–Arg·2HCl·H_2O ($P2_12_12_1$)} were studied by spectroscopic and thermal methods and the exact conditions for obtaining all crystals are indicated [3]. The authors [4] claim to have studied the L–Arg·HBr crystal, but all data are consistent with the L–Arg·HBr·H_2O ($P2_1$) crystal data. Crystal L–Arg·2HBr·H_2O (P1) has good pyroelectric properties and wider temperature range compared to the TGS crystal [5]. Three compounds were successfully obtained and identified from the L–Arg + HBr + aq system, of which L–Arg·HBr·H_2O ($P2_1$) [1], L–Arg·2HBr·H_2O (P1) [5] were known, and anhydrous type of L–arginine hydrobromide (L–Arg·HBr) was a novel finding in this study. The conditions for the formation of all compounds were described. Moreover, we present and compare the FT–IR ATR spectra and other properties of all obtained crystals from the L–Arg+HCl+H_2O and L–Arg+HBr+H_2O systems. Based on the IR spectrum, it can be claimed that L–Arg·HCl ($P2_1$) and the novel compound L–Arg·HBr are isostructural.

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Optical Properties of Graphene Layers Exfoliated in an Aminoacid Medium

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Carbon nanostructures and especially graphene is under the general attention of international science society due to their unique physical properties and huge application potential [1]. At present, intensive research is being carried out to develop simple low–temperature methods for the synthesis of graphene and related materials [2]. The methods based on exfoliation deserve special attention, among other methods. In turn, graphene layers synthesized by liquid–phase exfoliation (LPE) exhibit interesting optical properties, especially when doped simultaneously in solution [2].

In this paper optical properties of graphene layers exfoliated in an aminoacid medium are discussed. For this FTIR and UV–Vis spectra are measured and analyzed. As the fingerprint of any carbon nanostructutre, Raman spectra of the obtained samples are measured and analysed. The analysis of above–mentioned spectra shows the aminoacide doping effect on the optical properties of the samples. The influence of aminoacide medium on the Fermi level is studied.

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Experimental Demonstration of Super–radiant Emission of Coherent Cherenkov Diffraction Radiation

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Electromagnetic radiation in terahertz (THz) frequency range has attracted an enormous interest due to the number of applications including security and medicine. When THz radiation is transmitted through a medium, the matter leaves spectral signatures in the radiation spectrum bearing information about the medium itself. The existing tabletop generators have disadvantages related to either low intensity, or limited bandwidth, or low photon frequency. Accelerator based THz light sources are the most promising these days, however the best generation mechanism has not been decided yet. The energy losses due to THz process are usually very low. We are working on the technology that will help us to amplify the energy loss and increase the THz radiation intensity. We propose to utilise a super–radiant regime appearing when the radiation is generated by a sequence (train) of identical bunches. As a mechanism we propose to use Cherenkov diffraction radiation (ChDR) appearing when a fast charged particle moves in the vicinity of and parallel to a dielectric interface.

The talk will include theoretical prediction and experimental activity towards understanding of coherent Cherenkov diffraction radiation phenomenon in super–radiant regime. The material was published in P. Karataev, K. Fedorov, G. Naumenko, K. Popov, A. Potylitsyn, A. Vukolov, Scientific Reports 10, 20961 (2020). The presentation will overview the super–radiant regime and discuss the limitation for intensity and monochromaticity.

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Features of Scattering of a Plane Electromagnetic Wave on a Conductive Ball

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The phenomenon of scattering of a plane electromagnetic wave on a nonmagnetoactive conductive ball is studied. The dispersion of electromagnetic waves inside the ball material is taken into account.

A special case of this phenomenon (the radius of the ball is much smaller than the wavelength of the scattered wave) lies in the basis of the work of the spaser, which can have a wide range of important practical applications.

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Dynamics of Cosmological Models in the Presence of a Source with Negative Energy Density

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This study delves into an investigation of the dynamic properties of cosmological models within a general framework encompassing n+1–dimensional spacetime. We explore these models in the context of two distinct sources, the first being a cosmological constant and the second characterized by a barotropic equation of state. The energy densities associated with each source can have both positive and negative values. We approach the system of cosmological equations for curved spacetime as a second–order autonomous dynamical system. This study systematically identifies critical points and determines their types for every conceivable scenario. Furthermore, we construct phase diagrams that depict the distinct cases and their corresponding cosmological dynamics.

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Radiation of Surface Polaritons by an Annular Beam Moving inside a Cylindrical Waveguide

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We investigate the emission of surface polaritons by an annular beam of charged particles, moving inside a dielectric cylinder, parallel to its axis. It is assumed that the cylinder is immersed into a homogeneous medium with negative dielectric permittivity. By using the Green's tensor the expressions for scalar and vector potentials and for electromagnetic field strengths are provided inside and outside the cylinder. The contribution of surface polaritons in electromagnetic field strengths are investigated separately. The energy fluxes through the plane perpendicular to the cylinder axis are evaluated in the interior and exterior media. The energy flux is directed towards the charge motion inside the cylinder and towards the opposite direction in the exterior region. Depending on the ratio of dielectric permittivities, the total energy flux can be either positive or negative.

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Measurement of the Ion Beams Transverse Profile

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This study describes the detecting device development and approbation using for measurement of the flux density distribution in the transverse plane of the high–energy charged particle beams by the multi–angle scanning method. Currently, there is a need to improve detection systems both for ionization radiation installations that are at the stage of creation or modernization, and for already operating ion and proton accelerators. Hence, precision monitoring systems are needed to determine such characteristics of the beams as the intensity, position and spatial distribution of the beam in real time.

Existing measuring systems do not meet all the necessary requirements, and therefore, the task of developing a detecting device for recording the spatial and energy characteristics of high–energy proton and ion beams becomes relevant.

This study presents the results of the detecting device development for measuring the characteristics of high–energy charged particles beams. It was based on the previously proposed concept of the beam transverse intensity distribution determination with the help mathematical reconstruction of beam profiles obtained by multiple scanning at different angles with a fixed angular step. This approach will make it possible to determine the total density distribution of the beam in the transverse plane and to ensure continuous control of the high–energy charged particle beam parameters during hadron radiotherapy.

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Photonuclear Production of Medical Isotopes

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In recent years, the interest towards data on photonuclear reactions has sharply increased as they are an efficient method to produce some radioisotopes with high radio–purity. An example is the production of the scandium–47 isotope from a titanium target. ^{47}Sc is a dual–purpose theranostic radionuclide, which can be used for imaging and therapy. It has a half–life $T_{1/2}$ of 3.35 days and is an emitter of low energy β–radiation ($E_{\beta avg}$ =162 keV), which makes ^{47}Sc a good candidate for radiotherapy. The emission of γ–rays with energies of 159 keV (I_γ =68.4%) makes it suitable for SPECT/CT visualization as well. ^{47}Sc can also be used together with positron emitters ^{44}Sc and ^{43}Sc to provide PET/CT pre–therapy information. There are multiple ways to produce ^{47}Sc, we discussed the linear electron accelerator production in ^{nat}Ti(γ,x)^{47}Sc reaction.

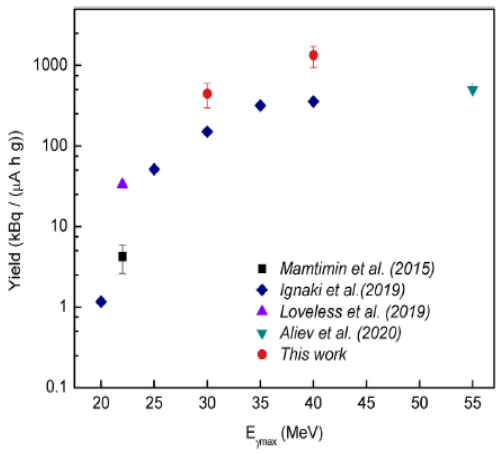

Fig. 1. Experimentally measured yields of ^{47}Sc obtained in photonuclear reaction on ^{nat}Ti target at different endpoint energies of the bremsstrahlung photons.

The specific activity of the medical radioisotope ^{47}Sc formed in the ^{nat}Ti(γ,x) reaction and the amount of the resulting impurities were analyzed. Even though cyclotron reactions usually

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have a much higher yields, we show that for photonuclear production of ^{47}Sc the yield is comparable to the usual yields in cyclotron experiments, but it gives a higher purity of ^{47}Sc, with the exception of the ^{nat}V(p,x)^{47}Sc cyclotron based reaction. An impurity–free ^{47}Sc in photonuclear reactions can be produced via irradiation of enriched ^{48}Ti target at the $E_{\gamma max}$ = 22 MeV, the threshold energy of the ^{48}Ti(γ,pn)^{46}Sc reaction.

Influence of Cation Porphyrins on DNA Damage during Irradiation by X–rays

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In this work, the effect of TOEPyP4 porphyrins on DNA damage induced by X–ray beams was investigated. The influence of X–ray radiation with different doses on DNA isolated from the calf thymus, as well as DNA/TOEPyP4 complexes, was investigated. To study the influence of the presence of porphyrins on radiation indused DNA damages with different relative concentrations of complexes were investigated (r = 0.01; 0.04, where r = Cporf./CDNK). Then an attempt was made to reveal the possible potentiating effects of porphyrins on DNA damage depending on the concentration of porphyrins and the radiation dose. The studies were carried out by the spectroscopy melting method in 10–3 M NaCl buffer solution, pH 7.2. From obtaining dates, the dependence of the protective or radiation–enhancing properties of porphyrins on the relative concentrations – irradiation dose combination is evident.

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Generation of radiation on forbidden transitions in the region of 654–658 nm in an acoustoplasmic medium

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In the region of the FPS spectrum of nitrogen in acoustoplasma, under laboratory conditions, the generation of intense lines was experimentally obtained at forbidden transitions of a singly ionized nitrogen molecule at 654.81 and 658.36 nm. The intense lines obtained correspond to the stimulated emission mechanism. The intensity of the forbidden lines significantly (up to 17 times) exceeded the intensity of neighboring lines in the spectrum of the FPS band of nitrogen. Spectroscopic studies did not allow resolution of the rotational spectrum; however, the width of the lines at the forbidden transitions is much narrower than the vibrational–rotational bands of the spectrum of nitrogen FPS. The result obtained is explained by an analogue of Raman scattering and an acoustoplasmic medium, which remove the prohibitions characteristic of dipole radiation. As one of the mechanisms for narrowing the obtained lines, it is proposed to consider the selection of a part of the rotational transitions due to the Coriolis force.

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Use of the Catastrophe Theory in Acoustoplasmic Research.

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The acoustoplasma is self–consistency medium and characterized by a multitude of parameters. This makes it difficult to describe it with simple mathematical equations or even with a system of differential equations. Often, the primary need is not to fully describe the system but to identify points of unstable equilibrium and jumps of parameters. The application of catastrophe theory to the study of acoustoplasma behavior, specifically regarding phase transitions and parameter jumps is described. The experimentally obtained database makes it possible to build a mathematical model of the process under study. Utilizing catastrophe theory, this model then allows us to determine critical points of unstable equilibrium and phase transitions in the considered mathematical model of acoustoplasma.

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Studies of the 1101+38 Galaxy and the Distribution of Extragalactic Objects around it

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The galaxy 1101+38=Mak421 is a very active BL Lac galaxy and has a great influence on extragalactic sources around it. Our studies of the distribution of extragalactic sources in the vicinity of this galaxy show that these extragalactic sources are distributed in this region homogeneously, which is most clearly manifested in the case of quasars.

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The Computer Program for Preparation of Exam Tests

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The basic principles of operation of a computer program designed to create examination tests are presented. The program will use a database containing five thousand questions and tasks, each of which has several options.

Assignments should be divided according to the degree of difficulty and by topic, which will maintain the proportions provided for in the examination order. The selection and classification of tasks will be made taking into account the recommendations of experienced specialists in this field. The program must have a self–development mechanism, with elements of artificial intelligence.

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An Antihail System Bathed on the Acoustophysics Phenomena

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The present paper is devoted to development and creation of remote controlled system of an acoustic system for effecting on aqueous formations in atmosphere. Taking into account the preliminary theoretical calculations a series of laboratory samples of generators of acoustic waves of different frequency with controllable output power upto 120DB have been developed and created. Samples with utilization of the method of phase shift and some methods acoustophysics have been created. The experimental field investigations with the usage of all created samples have been conducted. During the experimental researches temporary and frequency ultrasonic spectrums have been registered. The preliminary analysis of the obtained results, at first shows that utilization of acoustophysics methods on sveral time encrease the working capacity and reduces the energetic cost of untihail systems and finally gives the opportunity to control some atmospheric phenomena.

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Utilization of Biological Objects as Seismic–Acoustic High Sensitive Receivers

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In the presented work possibility of utilization of biological objects as ultrasensitive registering systems of the seismic – acoustic waves of different frequency is viewed. Unique sensitive systems to registerate superweek acoustic vibrations with usage of some methods acoustophysics have been developed and framed. During the experimental laboratory and field reserach the temporary and frequency spectrums of acoustic wave's propogated from different artificial and natural soureces of acoustic waves have been registered, in particular the spectrums of acoustic responses of biological objects originated due to interaction of biological objects with seismic – acoustic vibrations have been registered. As explored targets white and field mice and rats have been used. The preliminary analysis of the obtained experimental results gives the opportunity to extend the knowledge in the field of seismology, and also to increase the statistics at recording of seismic – acoustic vibration, as well as to enhace the probability of forecasting of occurrence of the seismic loci.

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Acoustic Properties of the Lake Parz Lich

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This study is continuation of the research on the process of propogation of acoustic waves of different frequency in multilayered mediums containing inhomogeneities, which have some resonance characteristics. In this work as such inhomogeneity we have choosed the Lake Parz Lich. The Lake Parz Lich is located on the territory of the Republic of Armenia. The underlying multilayered stratums structure and the form of the Lake Parz Lich were investigated. The characteristic background noise, the main resonant frequency and the coefficients of transmission of acoustic waves through layered structures with different orders of arrangements of the layers were esperimentaly determined. By the aim to colibrate the registered spectrumes, an unique artificien source of acoustic wave sources with controlled parameters were developed and created. The appropriate temporal and frequency spectra from artificial and natural sources of acoustic waves experimentally detected. The registrations of acoustic waves were conducted in parallel with specially developed unique registration systems of super week acoustic waves, standard acustic receivers and seismographs. The comprehensive analyzes shows that the obtained experimental data are in good agreement with theoretical calculations.

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