



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

**June 24 – 28, 2024
Yerevan – Sevan, Armenia**

Book of Abstracts



International Programme Committee

P.A. Aleksandrov
V.A. Bushuev
A.S. Gogolev
L.Sh. Grigoryan
S.B. Dabagov
P.V. Karataev
V.R. Kocharyan

A.H. Melikyan
A.H. Mkrtchyan
D.V. Roshchupkin
A.A. Saharyan
W.K. Saryan
H.A. Sarkisyan
A.V. Targonskiy

Organizing Committee

A.K. Atanesyan
D.E. Bagdasaryan
A.A. Danghyan
H. F. Khachatryan

V.Kh. Kotanjyan
G.V. Margaryan
T.R. Muradyan
M.S. Vasilyan

Sponsored by

*Institute of Applied Problems
of Physics NAS RA*



*Ministry of Education, Science, Culture and
Sports RA Science Committee*



Contact information:

Phone: (+374 10) 245 – 886,
(+374 10) 245 – 896

E-mail: school@iapp.am,
infoschooliapp@gmail.com

URL: <http://school.iapp.am>

UDC 53(082)

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

Organized by the

Institute of Applied Problems of Physics, National Academy of Sciences of the Republic of Armenia

ISBN 978-9939-1-1875-8

© Publisher: Institute of Applied Problems of Physics, 2024

Contents

Lectures

A. A. Saharian

2D Materials, Emergent Gravity and Quantum Field Theory.....9

D.V. Roshchupkin

Ferroelectric Lithium Niobate-Tantalate Crystal $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$10

A.M. Petrosyan

New Salts of Amino Acids, Discovery of a New Class of Salts and their Possible Applications.....11

L.Sh. Grigoryan, A.A. Saharian, M.L. Grigoryan, V.Kh. Kotanjyan, H.F. Khachatryan

Features of Radiation of Charged Particles in Dielectric Loaded Cylindrical Waveguides.....12

H.A. Sarkisyan

Exactly Solvable Model of a Pair-Interacting Hole Gas in Lens-Shape GeSi QDs.....13

A.H. Melikyan

Chemical Bonding in Molecules.....14

A.S. Abrahamyan

Nikola Tesla and Acoustoplasma.....15

K.R. Trouni

The Phenomenon of Interference Absorption of X-ray Radiation in a Perfect and Distorted Crystal Lattice.....16

T.M. Bakhshiyani, G.H. Hovhannisyan

Proton-induced Reaction Cross Section Measurements Via Stacked-foil Target Technique.....17

A.H. Mkrtchyan, M.A. Hovhannisyan, S.A. Mkhitarian, A.P. Antonyan, A.R. Mnatsakanyan,

A.M. Minasyan, H.R. Drmeyan

On Existing Methods and Devices Suitable for Continuous Analog Visible Recording of Seismic and Acoustic Signals.....18

P.V. Karataev

John Adams Institute – a Platform for Scientific Research and Education.....19

S.B.Dabagov

Surface Channeling of Beams in Capillary Waveguides.....20

Abstracts

N. Margaryan, H. Badalyan, E. Aleksanyan

Probing the Effect of 15.5 MeV Proton Beam on the Optical and Structural Properties of Graphene Layers.....22

G.S. Tonoyan, G. Giester, V.V. Ghazaryan, A.Y. Badalyan, R.Yu. Chilingaryan, A.A. Margaryan, A.H. Mkrtchyan, A.M. Petrosyan

Halogenoplumbates of Glycine and β -Alanine.....23

N.S. Gharibyan, R.P. Sukiasyan, A.G. Ayvazyan, A.A. Danghyan, A.K. Atanesyan

The Study of Novel Crystal L-Arg \cdot 2SSA \cdot H $_2$ O.....24

D. Roshchupkin, D.V. Irzhak, K. Pundikov

X-ray Diffraction by Surface Acoustic Waves.....25

A.Zh. Khachatryan, S.H. Harutyunyan, L.E. Khachikyan, T.R. Muradyan, V.N. Aghabekyan, G.A. Harutyunyan

The Plane Wave Diffraction on a Flat Area from Randomly Orientated Rectangular Slits.....27

S.H. Harutyunyan, T.R. Muradyan, L.E. Khachikyan, D.E. Baghdasaryan, G.A. Harutyunyan
Experimental Investigation of Mie Scattering.....28

V.I. Lisov, N.Yu. Kazarinov, I.V. Kalagin¹, V.A. Semin

Axial Injection System of U400R Cyclotron of FLNR JINR.....29

D.K. Pugachev, S.L. Bogomolov, A.E. Bondarchenko, K.I. Berestov, K.I. Kuzmenkov, V.N. Loginov, A.N. Lebedev, V.E. Mironov, D.S. Podoynikov

The Results of Preliminary Tests of the ECR Ion Source of the Accelerator Complex DC-140.....30

<i>L.Sh. Grigoryan, A.H. Mkrtchyan, P.A. Aleksandrov, A.A. Saharian, W. Wagner, <u>A.V. Sargsyan</u>, M.L. Grigoryan, H.P. Harutyunyan, H.F. Khachatryan</i>	
Features of Spectral–Angular Distribution of Radiation by a Train of Electron Bunches Passing through the Centre of a Ball.....	31
<i>G. Giester, <u>V.V. Ghazaryan</u>, A.L. Zatikyan, G.S. Tonoyan, A.M. Petrosyan</i>	
Tetrahalogenobismuthates of Dimethylglycine.....	32
<i><u>V.V. Ghazaryan</u>, G. Giester, A.L. Zatikyan, G.S. Tonoyan, A.M. Petrosyan</i>	
Hexahalogenobismuthates of Glycine.....	33
<i>A.H. Mkrtchyan, H.F. Khachatryan, M.A. Hovhannisyan, <u>S.A. Mkhitaryan</u>, A.P. Antonyan, A.R. Mnatsakanyan, A.M. Minasyan, A.S. Abrahamyan, H.R. Drmeyan</i>	
On the Necessity of Designing and Implementing a Territorial Anti–seismic Public Early Warning and Preliminary Protection System.....	34
<i><u>I.R. Bagdasaryan</u></i>	
Some Significant Acoustic Aspects in Building Materials.....	35
<i><u>L.S. Bezhanova</u>, M.S. Vasilyan, A.K. Atanesyan</i>	
Dielectric Response of a Liquid Crystal System to the External Alternating Electric Field.....	36
<i>S.G. Arutunian, G.S. Harutyunyan, A.V. Margaryan, <u>N.M. Manukyan</u>, R.S. Gevorgyan, G.V. Mirzoyan, L.M. Lazarev, M. Chung</i>	
Modeling and Measurement of Structural Changes in Vibrating Wire Using High Stresses and Electrical Pulse Embrittlement Procedure.....	37
<i><u>S.G. Arutunian</u>, M.A. Aginian, M. Chung, M.I. Ivanyan</i>	
Footprint of Lienard–Wiechert Field on a One–dimensional Manifold.....	38
<i>S.G. Arutunian, A.V. Margaryan, <u>G.V. Mirzoyan</u>, L.M. Lazarev, M. Chung, A.S. Vardanyan, V.G. Khachatryan, A.D. Davtyan</i>	
PIN–photodiodes Array for Beam Diagnostics in Accelerators.....	39
<i><u>P. Glumac</u>, Yu. M. Cherepennikov</i>	
Estimation of Cyclotron–based ^{161}Tb Production Yields via $^{160}\text{Gd}(\text{d},\text{n})^{161}\text{Tb}$ Nuclear Reaction.....	40

<i>Yu. M. Cherepennikov, K.V. Afanasyev, R.Kh. Gaisin, V.V. Gauzshtein, M.V. Shevelev</i>	
GEANT4 Simulation of the Application of a SINUS–320 High–current Repetitively Pulsed Electron Accelerator for the Sterilization of Cocoa Powder.....	41
<i>A.I. Soghomonyan, R.E. Soghomonyan, S.M. Movsisyan</i>	
On the Energy Spectrum of an Electron in a Crystal and the Determination of Chemical Markings and Electrode Concentrations.....	42
<i>H.S. Eritsyanyan, A.I. Soghomonyan, A.A. Lalayan, A.L. Margaryan</i>	
Fraunhofer Diffraction by a Slit into a Medium with Wave Irreversibility.....	43
<i>H.F. Khachatryan, L.Sh. Grigoryan, S.B. Dabagov, A.H. Mkrtchyan, V.Kh. Kotanjyan, J.P. Markosyan, A.V. Sargsyan, H.P. Harutyunyan, G.V. Margaryan, A.A. Saharian</i>	
Features of Radiation Generated by a Charged Particle Flying Through a Ball of Dispersive Material.....	44
<i>S.R. Uglov, A.V. Vukolov, M.V. Shevelev</i>	
Measuring the Number of the Internal Betatron Beam Passes through a Thin Target.....	45
<i>S.R. Uglov, A.V. Vukolov, M.V. Shevelev</i>	
Measuring the Period of a Multilayer X–ray Mirror Using X–ray Cherenkov Radiation.....	46
<i>S.R. Uglov, A.V. Vukolov, M.V. Shevelev</i>	
Angular Profile of VUV Emission Produced by 5.7 MeV Electrons near Absorption L Edge of Aluminum.....	47
<i>H.R. Drmeyan, H.G. Margaryan and S.N. Noreyan</i>	
X–ray Interferometric Shift Fringes and Monocrystal “Sandwich”.....	48
<i>Ye.H. Hayrapetyan, H.A. Hunanyan</i>	
High–Precision Light Rangefinder with Phase Modulation Accumulation.....	49
<i>T.H. Sargsyan, M.A. Hovhannisya, S.A. Mkhitarian, L.A. Mahtesyan, A.P. Mahtessian</i>	
Investigations of Giant Radio Galaxy B2 1141+37 Equation Chapter 1 Section 1.....	50
<i>M.K. Manvelyan</i>	
Intraband Absorption in CdSe Nanoplatelets.....	51

<i>Zh. Adamyan, V. Ohanyan</i>	
Tripartite Entanglement in Mixed–Spin Triangle Trimer.....	52
<i>A.S. Abrahamyan, K.G. Sahakyan, R.Yu. Chilingaryan, A.A. Margaryan, A.H. Mkrtchyan, H.T. Hovhanisyan</i>	
Application of the Catastrophe Theory in Experimental Studies.....	53
<i>A.A. Danghyan, L.S. Bezhanova, R.A. Apreyan, R.P. Sukiasyan, N.B. Margaryan, A.K. Atanesyan</i>	
Determination of Energy Band Gap of α-LiIO₃ Doped with Amino Acids	54
<i>A.S. Abrahamyan, R.Yu. Chilingaryan, H.T. Hovhanisyan, A.H. Mkrtchyan, S.H. Chakhoyan, M.H. Sargisyan, S.A. Matevosyan</i>	
Features of Experiments with Acoustoplasma.....	55
<i>A.S. Abrahamyan, A.A. Margaryan, A.H. Mkrtchyan, R.Yu. Chilingaryan</i>	
Features of the Operation of an Acoustoplasma Magnetron.....	56
<i>A.A. Nahapetyan</i>	
Interband Transitions in the Strongly Oblate Asymmetric Ellipsoidal Quantum Dot under the Influence of the Axial Magnetic Field.....	57
<i>E.Yu. Kidanova, V.N. Antonov, A.S. Vardanyan, A. V. Vukolov, B.A. Grigoryan, L.Sh. Grigoryan, P.V. Karataev, H.D. Davtyan, I.A. Kishin, V.R. Kocharyan, A.S. Kubankin, V.V. Margaryan, A.P. Potylitsyn, H.F. Khachatryan, Y. M. Cherepennikov, M. V. Shevelev</i>	
Measurements of Coherent Radiation at the AREAL Accelerator.....	58
<i>A.S. Kubankin, I.A. Kishin, E.Yu. Kidanova</i>	
An Experimental Setup for Accurately Measuring the Thickness of Foil.....	59
<i>I.A. Kishin, E.Yu. Kidanova, A.S. Kubankin, R.M. Nazhmudinov, V.I. Alekseev, A.N. Eliseev</i>	
Investigation of Parametric X–ray Radiation from Highly Oriented Pyrolytic Graphite with Different Mosaicities.....	60
<i>R.A. Karapetyan, J.P. Markosyan, S.A. Mkhitarian, M.A. Hovhannisyan, L.A. Mahtessian, A.P. Mahtessian, T.H. Sargsyan</i>	
HB13 Giant Galaxy and Distribution of Extra Galactic Sources Around it.....	61
<i>A.G. Sargsyan, S.M. Grigoryan, D. E. Baghdasaryan, H.H. Samsonyan, S.G. Khosrovyan</i>	
X–ray Study of Structural Changes in the Liquid–Crystal System AOT–Mixed Solvent Under the Influence of Dimethyl Sulfoxide (DMSO).....	62

<i>K. G. Truni, S.N. Noreyan, A.I. Soghomonyan, R.E. Soghomonyan, V.K. Mirzoyan</i>	
Features of the Change in Dielectric Constant in Crystals in the Presence of an Alternating Electric Field.....	63
<i>S.N. Noreyan, V.R Kocharyan, K.R. Trouni, A.M. Mamyán, M.H. Mesropyan, H.I. Sogomonyan, R.K. Mirzoyan</i>	
X–ray Spectrometer with Controlled Characteristics.....	64
<i>A.V. Shahverdyan, V.V. Margaryan, Yu.M. Cherepennikov, K.G Trouni, A.M Mamyán, R.K. Mirzoyan, V.R. Kocharyan</i>	
Computer Simulation of CT Experiment Results.....	65
<i>T.S. Musayelyan, A.H. Mkrtchyan, Z.S. Musayelyan, Z.H. Mkrtchyan, Sh.S. Panyan</i>	
The Role of 3d Software’s in Developing Models for Innovative Solutions and Sci–Tech Results’ Commercialization.....	66
<i>Sh.S. Panyan, Z.H. Mkrtchyan, T.S. Musayelyan, A.H. Mkrtchyan</i>	
The Importance of Citations and the Essential Science Indicators.....	67
<i>Sh.S. Panyan, T.S. Musayelyan, Z.H. Mkrtchyan, A.H. Mkrtchyan</i>	
Why the Physics and The Physicists Should Have the Target Role in Diplomacy.....	68
<i>A.M. Sedrakyan, N.Z. Grigoryan, V.G. Margaryan</i>	
Applied Physics Problem, the Solution of which is Related to the Idea of Solving Differential Equations.....	69
<i>S.G. Gevorkian, A.V. Karmenyan</i>	
Application of Light Pressure in the Rheology of Biopolymers.....	70

Lectures

2D Materials, Emergent Gravity and Quantum Field Theory

A. A. Saharian*

Institute of Physics, Yerevan State University

1 Alex Manoogian Street, Yerevan, Republic of Armenia, 0025

In the absence of a theory of quantum gravity, currently the influence of the gravitational field on quantum phenomena is investigated within the framework of the semi-classical theory, where the gravitational field is considered as a classical curved background geometry. The corresponding effects are manifested in strong gravitational fields (in the cosmology of the early Universe, in the physics of black holes and superdense stars), which are not available in laboratory conditions. Due to applications in high-energy physics, another important direction is the study of quantum field theory phenomena in models with non-trivial spatial topological. The latter include Kaluza-Klein-type theories, supergravity, and string theories. The talk will review 2D material systems that can serve as analog models for investigating the influence of spatial curvature and topology on the properties of quantum fields. Dirac materials and their various structures will be discussed. In particular, they include carbon nanotubes, nanorings and fullerenes. We will also discuss acoustic oscillations as analogue models for gravitational waves.

*E – Mail: aram.saharian@gmail.com

Ferroelectric Lithium Niobate-Tantalate Crystal $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$

D. Roshchupkin*

*Institute of Microelectronics Technology and High-Purity Materials
of the Russian Academy of Sciences Chernogolovka,
6 Academician Ossipyan Str., Moscow District, Russian Federation, 142432*

The congruent ferroelectric crystal of $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ complex solution was grown by the Czochralski method from $\text{LiNb}_{0.97}\text{Ta}_{0.03}\text{O}_3$ initial charge composition. By choosing the composition of the initial charge it is possible to grow $\text{LiNb}_{(1-x)}\text{Ta}_x\text{O}_3$ crystals of a given composition (with a given value of x) with given crystallographic and physical properties.

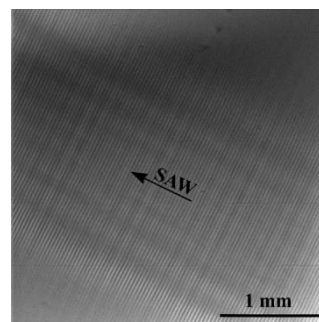
The grown $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ crystal had a good crystal structure perfection and large dimensions, which allowed to measure the crystal unit cell parameter a and to investigate the acoustic properties of the crystal. The value of the crystal unit cell parameter $a = 5.14375 \text{ \AA}$ was measured. It is shown that with increasing of Ta content in the $\text{LiNb}_{(1-x)}\text{Ta}_x\text{O}_3$ crystals there is an increase in the crystal unit cell parameter a . The longitudinal and transverse bulk acoustic wave velocities were measured, the value of which is smaller than the BAW velocity in the LiNbO_3 crystal but higher than the BAW velocity in the LiTaO_3 crystals. The SAW velocity in the YZ –cut of $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ crystal ($V = 3450 \text{ m/s}$) was also measured, which is smaller than the SAW velocity in the YZ –cut of a LiNbO_3 crystal (3488 m/s), but higher than the SAW velocity in the YZ –cut of a LiTaO_3 crystal (3250 m/s).

The investigations demonstrated that the values of the crystal unit cell parameter and the velocities of surface and bulk acoustic waves in the $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ crystal occupy an intermediate value between the corresponding values for the LiNbO_3 and LiTaO_3 crystals. Thus, by changing the ratio of Nb and Ta in the $\text{LiNb}_{(1-x)}\text{Ta}_x\text{O}_3$ crystals, it is possible to change the values of the crystal unit cell parameters and the velocities of surface and bulk acoustic waves.

The figures show a photograph of the grown $\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ crystal and a surface acoustic wave image obtained by scanning electron microscopy method.



*$\text{LiNb}_{0.93}\text{Ta}_{0.07}\text{O}_3$ crystal grown by
the Czochralski method along
polar axis c .*



*SEM image of the
traveling SAW
 $f_0 = 115 \text{ MHz}$,
 $V = 3450 \text{ m/s}$.*

*E – Mail: rochtch@iptm.ru

New Salts of Amino Acids, Discovery of a New Class of Salts and their Possible Applications

A.M. Petrosyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The lecture is devoted to the results obtained at the Institute of Applied Problems of Physics over the past 2018–2024 on new amino acid salts.

Simple salts.

Salts containing various types of dimeric cations.

New class of salts containing different amino acids.

New type of polymorphism.

Possible applications in technology and medicine.

*E – Mail: aram.m.petrosyan@gmail.com

Features of Radiation of Charged Particles in Dielectric Loaded Cylindrical Waveguides

L.Sh. Grigoryan*, A.A. Saharian, M.L. Grigoryan, V.Kh. Kotanjyan,
H.F. Khachatryan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In recent decades, the peculiarities of the radiation of relativistic charged particles moving in waveguides filled with a dielectric, as well as of the propagation of the electromagnetic field in such waveguides, have been actively studied. The interest is motivated by possible applications of such systems in the areas of wakefield acceleration of particles and the development of radiation sources with tunable parameters in relatively wide spectral range including the terahertz one. In this report we review the studies conducted in Lab. 3 of the Institute of Applied Problems of Physics NAS RA in those fields of investigations.

*E – Mail: levonshg@mail.ru

Exactly Solvable Model of a Pair-Interacting Hole Gas in Lens-Shape GeSi QDs

H.A. Sarkisyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In the framework of the exactly solvable Moshinsky model, the pair-interacting hole gas behavior is described in the strongly oblate biconvex lens-shape GeSi QD. The energy spectrum and the wave function of the many-particle system have been defined and energy diagrams for the levels of the center of mass of the system as well as the energy levels of the holes' relative motion have been done. Based on the obtained results the long-wave intraband absorption has been investigated and the thermodynamical characteristics of the considered system have been calculated. It has been shown that the generalized Kohn's theorem is realized in the considered system.

*E – Mail: hayk.sarkisyan@rau.am

Chemical Bonding in Molecules

A.H. Melikyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Three types of interaction between neutral atoms that result in attractive forces are considered. These forces generate four types of chemical bonds: covalent, ionic, hydrogen, and van der Waals. Numerical estimates are given for the bond energy, as well as the features of the spectra of molecules that arise due to one or another type of bond. As an example, the case of a family of diatomic molecules consisting of hydrogen atoms and its isotopes, deuterium and tritium, which are radioactive and play an important role in nuclear physics applications, is considered. These molecules are also of interest in a purely physical sense, since they are the same as each other. The fact is that the electron shells of these three atoms are practically indistinguishable, since the mass of the nucleus cannot have a significant effect on the wave function of a single electron, and the interatomic interactions in six molecules must be identical with great accuracy. It is obvious that the frequencies of harmonic oscillations of atoms in such molecules must be the same and must be inversely proportional to the square root of the reduced mass of the molecule. This assumption is well confirmed by the results of measuring the infrared spectra of molecules. However, it turns out that there are also other features that are revealed purely theoretically. If we assume that the interatomic interaction can be described by the Morse potential, which contains only two parameters – the depth of the potential well and its width, then the formula for the energies of the vibrational levels is quite simple. On the other hand, in the tables of values of measured quantities, the values of three other parameters are usually given – the frequency of harmonic oscillations, the anharmonicity constant and the dissociation energy. It follows that these three quantities must be expressed through two parameters of the Morse potential, which means that these three parameters must satisfy the universal relation that is a consequence of the application of the Morse potential. Comparison with the tabular data showed that this ratio is valid with very high accuracy for all molecules, except for hydrogen, where a deviation of 6% is observed. This fact requires further research.

The presentation is structured in such a way that the need for complex mathematical calculations disappears, and the main attention is paid to the physical side of the processes.

*E – Mail: armen_melikyan@hotmail.com

Nikola Tesla and Acoustoplasma

A.S. Abrahamyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The lecture briefly describes the life of Nikola Tesla, cleared of conspiracy theories and ufology. It explains why he made a large number of experiments, more than 700 patents, but did not write any scientific article.

The author made an attempt to assess his understanding of the areas of physics that arose later, after his work: radiophysics, plasma physics, physical acoustics, ionospheric physics, seismic physics.

It is noted, that Nikola Tesla began experiments with acoustoplasmic phenomena back in the late 19th century, without calling the phenomenon itself somehow

An explanation of some of his experiments is given from the standpoint of acoustoplasma.

*E – Mail: arbel11@mail.ru

The Phenomenon of Interference Absorption of X-ray Radiation in a Perfect and Distorted Crystal Lattice

K.R. Trouni*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The lecture is devoted to the phenomenon of anomalous Bormann absorption under conditions of Bragg diffraction of hard X-rays in perfect and imperfect crystal lattices.

The lecture includes:

1. Discovery of anomalous absorption phenomenon and its physical interpretation.
2. The phenomenon of anomalous absorption in perfect lattices under the conditions of Bragg diffraction of spatially inhomogeneous beams.
3. The phenomenon of interference absorption in weakly deformed net.
4. The phenomenon of interference absorption in strongly deformed net.

*E – Mail: ktrouni@hotmail.com

Proton-induced Reaction Cross Section Measurements Via Stacked-foil Target Technique

T.M. Bakhshiyan^{1*}, G.H. Hovhannisyan²

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²Yerevan State University
1 Alex Manoogian Str., Yerevan, Republic of Armenia, 0025*

Nuclear technology plays an important role in today's life. There are a number of different beneficial uses for nuclear technology in a variety of fields. The excitation function measurements of proton-induced nuclear reactions are useful for solving applied problems related to reactor operation, spent fuel transmutation, astrophysics, etc. They are also necessary to improve and explore the ideal way for medical radioisotopes production.

The knowledge of the excitation functions allows one to approximately determine the production yields of radionuclides and to estimate the impurity fractions. There are microscopic and phenomenological models for calculating the cross-sections of nuclear reactors for energy ranges of interest, but full microscopic understanding of nuclear interactions remains an open problem. Obtaining experimental data on nuclear reaction cross-sections is crucial for verifying the predictions of existing models and refining their parameters. The presence of Cyclotron 18/18 in Yerevan creates a unique opportunity for proton-nuclear reaction investigations.

The main part of the lecture will focus on the stacked foil activation technique combined with high resolution gamma-ray spectroscopy. Simulations using SRIM code was performed to determine the energy in each foil. New experimental cross sections for reactions (p,x) were compared with data from the TENDL-2023 and JENDL-5 libraries. The results will be presented and discussed.

*E – Mail: tiruhibakh@gmail.com

On Existing Methods and Devices Suitable for Continuous Analog Visible Recording of Seismic and Acoustic Signals

**A.H. Mkrtychyan, M.A. Hovhannisyan, S.A. Mkhitaryan^{*}, A.P. Antonyan,
A.R. Mnatsakanyan, A.M. Minasyan, H.R. Drmeyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

It has been established that depending on the characteristics of specific seismic or acoustic signals to be recorded, including their dynamic and frequency characteristics, duration, repeatability, etc., as well as on precise scientific or other tasks to be solved, many different specific technical and operational requirements are imposed on recording devices, which are best met by modern digital recording devices on solid-state storage media. It has been confirmed that despite the development and wide usage of modern digital systems during the last decades for recording seismic and other low-frequency signals, many seismic stations till now in parallel with the digital recording systems use also visible analog recorders for simultaneous analog visible recording of seismic signals, to obtain express controlling visible records, provide operational manual express analysis of seismograms and so on.

Based on a comparative analysis, it has been shown that among analog continuous visible recorders, the most widely used in seismology were light-beam photo galvanometric recording devices for continuous helical recording of seismic signals. However, the high cost and scarcity of photographic media, the need for their chemical processing, additional seismogram errors due to shrinkage of photographic paper after chemical processing, the inability to obtain express information, the lack of intermediate memory, and other disadvantages create several inconveniences in their operation in seismic stations. On the other hand, pen recording instruments were most convenient for direct visible recording, observation of the development of seismic processes, and obtaining express information. However, they have limited frequency and dynamic ranges, recording is mainly carried out with friction, in curvilinear coordinates, etc. It is shown that electroxerographic light-beam oscilloscopes with intermediate memory on electroxerographic media, combine all the advantages of light-beam oscilloscopes and pen recording instruments, are free from their specific disadvantages and can be used in seismic stations with digital recorders for the simultaneous continuous analog visible recording of seismic signals.

^{*}**E – Mail:** sammkhitar@yahoo.com

John Adams Institute – a Platform for Scientific Research and Education

P.V. Karataev*

Royal Holloway, University of London, Egham, Surrey TW20 0EX, United Kingdom

John Adams institute (JAI) for accelerator science is a joint venture between University of Oxford, Imperial College and Royal Holloway College. It aims in training and supervising of the next generation of scientists through world class research. We try to harmonize research, training through research, industrial applications, and outreach. activities. The talk will overview JAI activities and prospective.

*E – Mail: pavel.karataev@rhul.ac.uk

Surface Channeling of Beams in Capillary Waveguides

S.B. Dabagov*

*Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati,
Via Enrico Fermi 40, 00044 Frascati, Italy*

The movement of beams in hollow channels formed by the internal walls of capillaries is primarily determined by multiple small-angle scattering (reflection). It can be described in the approximation of surface channeling. In this case, the potential of the surface interaction in micro- and nano-capillaries is effectively influenced by the curvature of the reflecting surface. After presenting an analysis of previously performed studies on the propagation of X-rays and thermal neutrons in capillaries, the formalism of surface channeling is developed for beams of charged particles, in particular, moving in curved cylindrical capillaries. Alternative theories explaining experimental results on beam propagation through capillaries are based on simple thermodynamic assessments, various diffusion models, as well as the outcomes of direct numerical simulations. Our work represents the first attempt to explain the efficient passage of a charged beam through a capillary from a quantum mechanics perspective. This approach enabled us to investigate the interaction potential in surface channeling analytically. It will be shown that, depending on the characteristics of the incident particle and the dielectric forming the channel walls, the interaction potential can be either repulsive or attractive. This explains the effective transmission of beams by various hollow structures.

*E – Mail: sultan.dabagov@lnf.infn.it

Abstracts

Probing the Effect of 15.5 MeV Proton Beam on the Optical and Structural Properties of Graphene Layers

N. Margaryan, H. Badalyan^{*}, E. Aleksanyan

A. Alikhanyan National Science Laboratory

2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

Liquid phase exfoliation is a simple and affordable method for graphene production [1,2]. It can find applications in extreme conditions such as proton radiation background in space [3]. This study presents the effect of irradiation with 15.5 MeV protons on the infrared spectra and structural properties of liquid-phase exfoliated graphene [4]. The influence of adsorbed acetone molecules and functional groups on these characteristics is described. Subsequently, samples undergo irradiation up to fluence of 10^{15} proton/cm² using a cyclotron source. Fast Fourier Transform Infrared (FTIR) spectra of irradiated and non-irradiated samples are compared. Changes in absorption, reflection, and transmission behaviors induced by irradiation are identified. The effect of irradiation on the density of defects in graphene is studied by means of Raman spectroscopy. A comparative analysis of FTIR and Raman spectra reveals that the Fermi level decreases after irradiation. This effect is further validated by studying the I–V characteristics of both irradiated and non-irradiated samples.

References

1. N. Margaryan, N. Kokanyan, and E. Kokanyan, Investigation of Properties of Graphene Quantum Dots and Carbon Nanotubes Synthesized in a Colloid Solution, *J. Contemp. Phys.*, 56 (2021) 260–264
2. N. Margaryan, N. Kokanyan, E. Kokanyan, *Journal of Saudi Chemical society*, 23 (2019) 13–20.
3. T. Scalia, L. Bonventre, M. Terranova, From Protosolar Space to Space Exploration: The Role of Graphene in Space Technology and Economy, *Nanomaterials*, 13 (2003) 680.
4. N. Margaryan et al, 15.5 MeV proton irradiation treatment of liquid phase exfoliated graphene. *Diamond and Related Materials*, V 146, (2024), 111224.

^{*}E – Mail: hovo.badalyan.03@gmail.com

Halogenoplumbates of Glycine and β -Alanine

**G.S. Tonoyan^{1*}, G. Giester², V.V. Ghazaryan¹, A.Y. Badalyan³,
R.Yu. Chilingaryan¹, A.A. Margaryan¹, A.H. Mkrtchyan¹, A.M. Petrosyan¹**

¹*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

²*Institute of Mineralogy and Crystallography, University of Vienna,
Josef-Holaubek-Platz 2, Vienna, Austria, A-1090*

³*A. Alikhanyan National Science Laboratory
2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036*

In this work, an attempt was made to obtain similar crystals with the simplest amino acids, glycine (Gly) and β -alanine (β -Ala). We managed to obtain a crystal (GlyH)(PbBr₃) (**I**) of similar composition and determine crystal structure (space group $P2_12_12_1$, $Z=4$). Despite the similar composition, the (GlyH)(PbBr₃) crystal does not have a perovskite structure: the anion has a chain structure. Glycinium cations form hydrogen bonds of the O–H \cdots Br and N–H \cdots Br type with the anion chain. Attempts to obtain the corresponding crystal (GlyH)(PbI₃) were unsuccessful. Instead, crystals of (GlyH)₆(Pb₃I₁₂) (**II**) (space group $P\bar{1}$, $Z=1$) were formed. The unit cell contains one formula unit, and the asymmetric unit contains half of formula unit. Two of three glycinium cations, A– and B–, form (A⁺ \cdots A⁺) type dimeric cations (where A⁺ is a singly charged cation), while the third C–cation forms a hydrogen bond O–H \cdots I with the discrete Pb₃I₁₂⁶⁻ anion. The (A⁺ \cdots A⁺) type (GlyH \cdots GlyH) dimeric cation for glycine was not known previously [2]. Attempts to obtain (β -AlaH)(PbBr₃) led to the crystallization of (β -AlaH)₂(PbBr₄) (**III**) (space group $P2_1/n$, $Z=4$) and (β -AlaH)₆(Pb₄Br₁₄) (**IV**) (space group $P\bar{1}$, $Z=2$). In structures (**III**) and (**IV**), anions have a chain structure. The carboxyl groups of cations form hydrogen bonds with the anion chain. In the structure of (**IV**), there are six independent A–, B–, C–, D–, E– and F–cations. A– β -AlaH and B– β -AlaH cations form centrosymmetric (A⁺ \cdots A⁺) type dimeric cations with their symmetry-related cations, while C– β -AlaH and D– β -AlaH as well as E– β -AlaH and F– β -AlaH pairs form acentric (A⁺ \cdots A⁺) type dimeric cations.

The work was supported by the Science Committee of RA, in the frame of the research project № 21AG-1D015

*E – Mail: itonoyan1@gmail.com

The Study of Novel Crystal L–Arg·2SSA·H₂O

N.S. Gharibyan^{1*}, R.P. Sukiasyan¹, A.G. Ayvazyan²,

A.A. Danghyan¹, A.K. Atanesyan¹

¹Institute of Applied Problems of Physics

*of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²Molecule Structure Research Center NAS of Armenia,
of the National Academy of Sciences of the Republic of Armenia
26 Azatutyun Ave., Yerevan, Republic of Armenia, 375014*

The L–arginine (L–Arg) and amino acid salts have unique properties such as nonlinear optical and piezoelectric properties. The polar P2₁ and P1 groups also exhibit pyroelectric and ferroelectric effects. So far, the following crystals of amino acid salts suitable for application are known with desirable properties: pyroelectric TGS and LADB, nonlinear optical LAP, as well as BPI. Salicylic acid and its derivatives, particularly 5–sulfosalicylic acid dihydrate (C₇H₆O₆S·2H₂O or SSA·2H₂O), are known for their anti–inflammatory activity. Therefore, the search for and study of L–Arg and SSA·2H₂O salts is of interest. This is both for finding crystals with the above–mentioned properties and for studying structural features and formation mechanisms.

This work refers to the growth and study of the L–Arg·2SSA·H₂O (L–Arg·C₇H₆O₆S·H₂O) crystal obtained from the interaction of L–Arg and SSA·2H₂O in a 1:2 molar ratio. The crystal was studied and identified using FT–IR spectroscopy. This technique revealed that the L–arginine cation in the crystal is double charged. The crystal and molecular structure of the L–Arg·2SSA·H₂O was determined by the X–ray diffraction method at 120K. It crystallizes in the monoclinic system (sp. gr. P2₁), unit cell parameters: a=12.58800(18)Å, α=90°, b=7.17366(10)Å, β=98.3453(14)°, c=15.0946(2) Å, γ=90°, Z=2, V=1348.64Å³. The crystal is composed of one L–Arg²⁺ cation, two C₇H₅O₆S[–] anions, and H₂O molecule. The guanidyl group of L–Arg is connected to SO₃ of SSA by A–type hydrogen bonds. In the (a b) plane, cavities of sizes 4 and 9Å occur, corresponding to the (0 0 1) face index of crystals.

This work is partially supported by the MSE RA, project No.21T–2F116 – 2021.

*E – Mail: nellygharibyan50@gmail.com

X-ray Diffraction by Surface Acoustic Waves

D. Roshchupkin^{*}, D.V. Irzhak, K. Pundikov

*Institute of Microelectronics Technology and High-Purity Materials
of the Russian Academy of Sciences Chernogolovka,
6 Academician Ossipyan Str., Moscow District, Russian Federation, 142432*

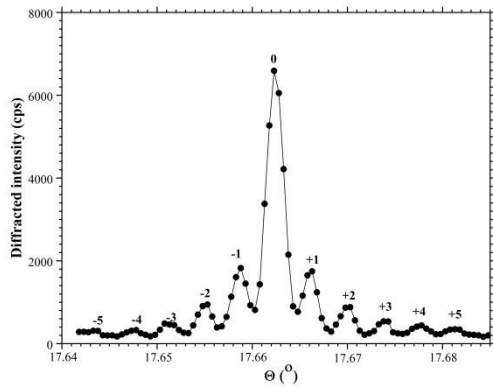
The process of X-ray diffraction by acoustically modulated LiNbO₃ and LiTaO₃ crystals on a laboratory X-ray source in the scheme of a triple-crystal X-ray diffractometer has been investigated. For excitation of the surface acoustic waves (SAW) with wavelength $\Lambda=4\ \mu\text{m}$ the structures of the interdigital transducers were fabricated by electron beam lithography.

Excitation of the SAW in the crystal leads to sinusoidal modulation of the crystal lattice, which eventually acts as a diffraction lattice and results in diffraction satellites on the rocking curve around the Bragg peak. While the angular divergence between the diffraction satellites is determined by the SAW wavelength and the interplanar spacing in the crystal, the number and intensity of the diffraction satellites are determined by the amplitude of the SAW. Usually, the diffraction process is investigated on a synchrotron radiation source, but in this work, studies were first performed on a laboratory X-ray source using an crystal-analyzer. The diffraction process was investigated on different acoustic cuts of the LiNbO₃ and LiTaO₃ crystals. It has been demonstrated that the SAW amplitude depends on the electromechanical coupling coefficient in the crystals, then different numbers of diffraction satellites are observed in different crystal cuts.

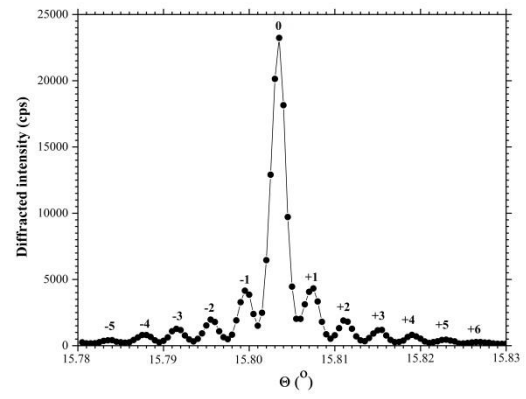
The figures show the rocking curves of the 112° Y-cut of a LiTaO₃ crystal and 128° Y-cut of a LiNbO₃ crystal, measured at the amplitude of the input signal applied to the IDT $U = 2.2\ \text{V}$. In the case of the 112° Y-cut of a LiTaO₃ crystal, 5 diffraction satellites can be observed on the rocking curve, which corresponds to the SAW amplitude $h = 2.07\ \text{Å}$, and in the case of the 128° Y-cut of a LiNbO₃ crystal, 6 diffraction satellites can be observed on the rocking curve, which corresponds to the SAW amplitude $h = 2.64\ \text{Å}$. The SAW amplitude is determined from the expression $h = nd / 2\pi$, where n is the number of diffraction satellites on the rocking curve, d is the interplanar spacing.

Thus, the method of X-ray diffraction allows us to study the process of acoustic wave propagation in solids.

^{*}**E – Mail:** rochtch@iptm.ru



Rocking curve of the 112° Y-cut of a LiTaO₃ crystal modulated by SAW. $\Lambda=4 \mu\text{m}$, $f=826 \text{ MHz}$.



Rocking curve of the 128° Y-cut of a LiNbO₃ crystal modulated by SAW. $\Lambda=4 \mu\text{m}$, $f=826 \text{ MHz}$.

The Plane Wave Diffraction on a Flat Area from Randomly Orientated Rectangular Slits

**A.Zh. Khachatrian^{1*}, S.H. Harutyunyan², L.E. Khachikyan², T.R. Muradyan²,
V.N. Aghabekyan², G.A. Harutyunyan²**

¹*National Polytechnic University of Armenia
105, Teryan Str., Yerevan, Republic of Armenia 0009*

²*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In the work the far field diffraction of a plane wave falling normally on a flat area from randomly orientated slits is considered. The presented theoretical study is determined by the need for a qualitative and quantitative explanation of the diffraction patterns observed in a light scattering on a system of *NaCl* microcrystals deposited on a flat glass substrate with small transverse dimensions and a rectangular shape in the plane of the substrate [1],[2]. A discussion of the statistical properties of the diffraction pattern is carried out on the basis of corresponding calculations of the scattered field intensity averaged over random parameters of the structure. We discuss the case of a system with structural disorder and compositional order. Structural disorder suggests that the arrangement of rectangular microcrystals on the glass substrate, as well as their orientation, is random. The compositional order assumes that all crystals are the same size. the consideration is carried out on the basis of a recently developed method of approximate description of the superposition field of a system of many point sources [3–5].

References

1. S.H. Harutyunyan, L.E. Khachikyan, G.A. Harutyunyan, Armenian journal of physics 13, 310 (2020).
2. S H Harutyunyan et al 2023 J. Phys.: Conf. Ser. 2657 012015.
3. A.Zh. Khachatrian, Journal of Contemporary Physics 56, 303 (2021).
4. A.Zh. Khachatrian, Journal of Contemporary Physics 57,127 (2022).
5. A.Zh. Khachatrian, A.S. Avanesyan, V.N. Aghabekyan, A.F. Parsamyan, Journal of Contemporary Physics 57, 243 (2022).

*E – Mail: ashotkhachatrian@gmail.com

Experimental Investigation of Mie Scattering

**S.H. Harutyunyan, T.R. Muradyan^{*}, L.E. Khachikyan, D.E. Baghdasaryan,
G.A. Harutyunyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

An experimental set up for detail study of light scattering on the single particles (Mie scattering) is presented [1].

The angular distribution of scattered light intensity dependence on the particles size, geometry and refractive index are experimentally studied [2]. The results are compared with theoretical calculations [3]. On the bases of obtained results a laboratory device for air born particle analyses is developed.

References

1. Hong Du, "Mie-scattering calculation," Appl. Opt. 43, 1951–1956 (2004).
2. S.H. Harutyunyan, L.E. Khachikyan, G.A. Harutyunyan, A.L. Margaryan, D.E. Baghdasaryan and T.R. Muradyan. Generator of Monodisperse Droplets and Some Applications. 2023 J. Phys.: Conf. Ser. 2657 012015.
3. B Hourahine et al 2012 J. Phys.: Conf. Ser. 367 012010.

^{*}**E – Mail:** tigran.muradyan.86@mail.ru

Axial Injection System of U400R Cyclotron of FLNR JINR

V.I. Lisov^{1*}, N.Yu. Kazarinov¹, I.V. Kalagin¹, V.A. Semin¹

¹Joint Institute for Nuclear Research

6 Joliot–Curie Str., Dubna Moscow Region Russian Federation, 141980

Flerov Laboratory of Nuclear Reaction of Joint Institute for Nuclear Research continues the works under reconstruction the cyclotron U400. U400R complex is created on the basis of U400 heavy ion accelerator which has been operating at the Laboratory since 1978. U400R is designed for production of accelerated ion beams of atomic mass in the range $A=4 \div 209$ and energy $0.8 \div 25$ MeV per unit mass. The intensity of the accelerated ions will be about 2.5 pmcA for ^{48}Ca ions. Synthesis of superheavy elements is this cyclotron main direction of research. The design of the axial injection system of the U400R cyclotron is presented in this report.

*E – Mail: lisov@jinr.ru

The Results of Preliminary Tests of the ECR Ion Source of the Accelerator Complex DC–140

**D.K. Pugachev^{1*}, S.L. Bogomolov¹, A.E. Bondarchenko¹,
K.I. Berestov¹, K.I. Kuzmenkov¹, V.N. Loginov¹, A.N. Lebedev¹,
V.E. Mironov¹, D.S. Podoynikov¹**

¹Joint Institute for Nuclear Research

6 Joliot–Curie Str., Dubna Moscow Region Russian Federation, 141980

The Accelerator Complex DC–140, developed at the Flerov Laboratory of Nuclear Reactions (JINR), is dedicated machine for applied research (electronic components testing, materials science, track membrane production, etc.). The research requires high–intensity charged ion beams of gases (Ar, Kr, Xe, etc.) and also of metals, such as Fe, Bi etc. with energy of about 2.1 MeV/u and A/Z ratio in the range from 7.58 to 8.25, and with energy of 4.8 MeV/u and with mass–to–charge ratio A/Z in the range from 5.0 to 5.5. The cyclotron complex will be equipped with the new ECR ion source DECRIS–5M with the working frequency of 18 GHz.

The report presents the description of the main systems of the DECRIS–5M and the results of preliminary test at the ECR ion sources test bench.

*E – Mail: lisov@jinr.ru

Features of Spectral–Angular Distribution of Radiation by a Train of Electron Bunches Passing through the Centre of a Ball

**L.Sh. Grigoryan¹, A.H. Mkrtchyan¹, P.A. Aleksandrov²,
A.A. Saharian¹, W. Wagner³, A.V. Sargsyan^{1*}, M.L. Grigoryan¹,
H.P. Harutyunyan¹, H.F. Khachatryan¹**

*¹ Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*² National research centre "Kurchatov institute"
1 Akademika Kurchatova pl., Moscow, Russian Federation, 123182*

*³ National Research Nuclear University Moscow Engineering Physics Institute
31 Kashirskoe Hwy., Moscow, Russian Federation, 115409*

The peculiarities of spectral–angular distribution of radiation generated by a rectilinearly and uniformly moving train of bunches of charged particles is theoretically studied. It is assumed that the particle bunches cross a ball made of conductive or composite material passing through its center. The work is based on the corresponding exact analytic solutions of Maxwell’s equations. The generalized Drude–Lorentz–Sommerfeld formula for the dielectric function of material of the ball is used in numerical calculations.

It is shown that there may be peaks in the emission spectrum of particles at some “resonance frequencies” with the wavelengths of the order of ball radius. The values of the spectral density of radiated energy at these specific frequencies may be many times larger than the values of that quantity at adjacent frequencies. The peaks in the spectrum of radiation generated by the particles disappear if one replaces the ball by a plane–parallel plate made of the same materials, with a thickness equal to the diameter of the ball. A visual explanation of this phenomenon is given.

The work was partially supported by the Science Committee of RA, in the frames of the research project № 21AG–1C069.

***E – Mail:** *anush.sarg@gmail.com*

Tetrahalogenobismuthates of Dimethylglycine

G. Giester¹, V.V. Ghazaryan^{2*}, A.L. Zatikyan³, G.S. Tonoyan²,
A.M. Petrosyan²

¹*Institute of Mineralogy and Crystallography, University of Vienna,
Josef-Holaubek-Platz 2, Vienna, Austria, A-1090*

²*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia,
25 Hrachya Nersessyan Str., Yerevan, Republic of Armenia, 0014*

³*Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*

In this work, we report the results of the preparation and investigation of dimethylglycine (DMG) salts containing BiI_4^- , BiBr_4^- and BiCl_4^- anions: $(\text{DMGH})(\text{BiI}_4)\cdot\text{H}_2\text{O}$ (**I**) (space group, $P2_1/n$, $Z=4$), $(\text{DMG})(\text{BiBr}_4)(\text{H}_3\text{O})$ (**II**) (space group, $P2_1/n$, $Z=4$) and $(\text{DMGH})(\text{BiCl}_4)$ (**III**) (space group, $P2_1/n$, $Z=4$). All three anions have polymeric (chain) structures. The structures of (**I**) and (**II**) are similar, while the structure of (**III**) is completely different. In the structure of (**I**) carboxyl group of the dimethylglycinium cation is characterized by C1–O1 and C1–O2 bond lengths of 1.290(6) Å and 1.230(5) Å, respectively. Dimethylglycinium cation forms a hydrogen bond O1–H1 \cdots OW with a water molecule, which in turn forms hydrogen bonds with O2 atom of symmetry-related cation and with anion. In the structure of (**II**) carboxylate group of dimethylglycine moiety is characterized by C1–O1 and C1–O2 bond lengths of 1.267(9) Å and 1.250(8) Å, respectively. Hydroxonium cation forms hydrogen bonds with O1 atom, with O2 atom of symmetry-related cation and with anion.

In the structure of (**III**) carboxyl group of the dimethylglycinium cation in the absence of water molecule, forms a centrosymmetric ($\text{A}^+\cdots\text{A}^+$) type dimeric cation with symmetry-related cation. Previously the ($\text{A}^+\cdots\text{A}^+$) type dimeric cation was not known for dimethylglycine.

The resulting crystals were also characterized by IR and Raman spectroscopy, the band gaps were determined by the diffuse reflectance method, and also determined from electronic structure calculations using the DFT method.

The work was supported by the Science Committee of RA, in the frame of the research project № 21AG-1D015

*E – Mail: vahram.ghazar@gmail.com

Hexahalogenobismuthates of Glycine

V.V. Ghazaryan^{1*}, G. Giester², A.L. Zatikyan³, G.S. Tonoyan¹,

A.M. Petrosyan¹

¹*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia, 25 Hrachya Nersessyan Str.,
Yerevan, Republic of Armenia, 0014*

²*Institute of Mineralogy and Crystallography, University of Vienna,
Josef-Holaubek-Platz 2, Vienna, Austria, A-1090*

³*Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*

This work presents the results of the preparation and study of glycine salts containing the discrete hexahalogenobismuthate anion BiX_6^{3-} : $(\text{GlyH})_3(\text{BiCl}_6) \cdot 2\text{H}_2\text{O}$ (**I**) (space group, $Pna2_1$, $Z=4$), $(\text{GlyH})_3(\text{BiBr}_6) \cdot 2\text{H}_2\text{O}$ (**II**), (s. g. Cc , $Z=4$), $(\text{GlyH})_3(\text{BiBr}_6) \cdot 3\text{H}_2\text{O}$ (**III**) (s. g. $P2_1/n$, $Z=4$), $(\text{GlyH})_4(\text{BiBr}_6)(\text{Br}) \cdot \text{H}_2\text{O}$ (**IV**) (s. g. $P\bar{1}$, $Z=2$), $(\text{GlyH})_3(\text{BiI}_6) \cdot 2\text{H}_2\text{O}$ (**V**) (s. g. $P2_1/n$, $Z=4$). Crystals (**I**) and (**II**) have a similar structure. The carboxyl groups of two cations form hydrogen bonds with water molecules, and the third one with an anion. In structure (**III**), the carboxyl groups of the cations form hydrogen bonds with water molecules. In structure (**IV**), the carboxyl groups of two cations form hydrogen bonds with a water molecule, the third with the BiBr_6^{3-} anion, while the fourth cation forms a centrosymmetric ($\text{A}^+ \cdots \text{A}^+$) type dimeric cation with a symmetry-related cation, where A^+ is a singly charged cation. Although the composition of crystal (**V**) is the same as that of crystals (**I**) and (**II**), the structure of (**V**) is completely different from the structures of (**I**) and (**II**). Of three A-, B-, and C-cations in the structure of (**V**), B- and C-cations form acentric ($\text{A}^+ \cdots \text{A}^+$) type dimeric cation, while A-cation forms centrosymmetric ($\text{A}^+ \cdots \text{A}^+$) type dimeric cation with symmetry-related cation. Thus, in the structures of (**IV**) and (**V**) there are $(\text{GlyH} \cdots \text{GlyH})$ dimeric cations. Previously, such dimeric cations were not known for glycine. The resulting crystals were also characterized by IR and Raman spectroscopy, the band gaps were determined by the diffuse reflectance method, and also determined from electronic structure calculations using the DFT method.

The work was supported by the Science Committee of RA, in the frame of the research project № 21AG-1D015

*E – Mail: vahram.ghazar@gmail.com

On the Necessity of Designing and Implementing a Territorial Anti-seismic Public Early Warning and Preliminary Protection System

**A.H. Mkrtchyan¹, H.F. Khachatryan¹, M.A. Hovhannisyan¹,
S.A. Mkhitarayan^{1*}, A.P. Antonyan¹, A.R. Mnatsakanyan¹, A.M. Minasyan¹,
A.S. Abrahamyan¹, H.R. Drmeyan¹**

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Significant advances in contemporary science, technologies, and implementation of Earthquake Early Warning Systems (EEWS) in several countries have increased the effectiveness and feasibility of short-term early warnings of pending earthquake shocks and the application of territorial EEWS. Despite the universal recognition of the effectiveness of EEWSs usage, their positive experience in many countries, as well as the heavy human and material losses caused by previous destructive earthquakes, the continuous high seismic activity and risks, as well as the very low seismic resistance of many objects, still there is not implemented and operating territorial EEWS in RA.

From this point of view, the Armenian Nuclear Power Plant (ANPP) is a partial exception in RA, where in the 1970s, the “Armatom” and Special Experimental Design and Technology Institute (SEDTI) NAS RA created and installed an anti-seismic industrial protection system (SIAZ) to shut down the ANPP reactor in case of shocks above the specified level. Based on the 1988 Spitak catastrophic earthquake lessons and for early warning and protection of the ANPP from seismic waves of higher intensity than the planned threshold, the SIAZ-3 target EEWS was designed and installed in the 2000s in the ANPP, whose early warning triggering seismic sensors were placed in several tens of kilometres away from the ANPP.

Among the works and experience carried out in the direction of the creation and installation of EEWSs in RA, it can be also mentioned the many years of positive experience of the SEDTI NAS RA in the field of seismic equipment designing and production, as well as the proposal of some authors and organizations to create an EEWS around the Yerevan which did not receive later practical application. Thus, from the point of view of increasing the seismic safety of RA, the designing, creation, and introduction of a unified integrated territorial system allowing advanced anti-seismic protection of at least the most important objects of RA is an important problem.

*E – Mail: sammkhitar@yahoo.com

Some Significant Acoustic Aspects in Building Materials

I.R. Bagdasaryan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The article aims to ensure acoustic "comfort" in the design of modern buildings. The significance of the influence of acoustic aspects in indoor environments is addressed. Such physical phenomena as sound, elastic (sound) vibrations, sound waves in different mediums, their generation and perception, propagation, interaction with the environment, and various applications are considered. Since energy dissipation occurs at multiple physical levels in modern building materials, it has been shown that fiber construction materials have a high sound absorption coefficient at medium and low frequencies. A reliable method of combining two types of solutions (acoustic soundproofing and sound-absorbing building materials) has been established. Furthermore, for indoor spaces in buildings and structures, stone wool is proposed as an acoustic sound-absorbing material, based on its advantages in terms of physical and mechanical properties.

*E – Mail: Baghdasaryan.irina.8@gmail.ru

Dielectric Response of a Liquid Crystal System to the External Alternating Electric Field

L.S. Bezhanova^{*}, M.S. Vasilyan, A.K. Atanesyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

This work has experimentally investigated the temperature and frequency dependencies of the dielectric spectra of thermotropic liquid crystals (LC) for a series of mesomorph phases. The measurements were conducted on oriented LC systems (with a thickness of the LC layer $10 \div 20 \mu\text{m}$) in the frequency range of 10^2 to 10^4 Hz.

From the obtained results for the temperature and frequency dependencies of the dielectric permittivity in the SmC^* phase, it follows that at low frequencies, relaxation processes in ferroelectric LC systems (SmC matrix/chiral additive) occur corresponding to the displacements of molecular ensembles due to the interaction of their permanent dipoles with an external electric field. Macroscopically, this interaction manifests in the periodic variation of the helix pitch. The frequency dependence of the transverse component of the dielectric permittivity (ϵ_{\perp}) in the SmA phase indicates weak dispersion of ϵ_{\perp} near the $\text{SmC}^* \rightleftharpoons \text{SmA}$ transition. A relaxation process has been detected in the SmA phase with a frequency an order of magnitude smaller than the dispersion frequency in the SmC^* phase.

It has been found that the values of ϵ_{\perp} in the nematic phase of NLC systems adhere to the law of additivity, whereas the behavior of the clearing point does not align with the mentioned law. It's demonstrated that the jumps in ϵ_{\perp} during the $\text{NLC} \rightarrow \text{IL}$ phase transition are attributed to the increasing alignment of transverse dipoles of neighboring molecules towards a parallel arrangement, confirming the Chandrasekhar correction made in the theory for the static dielectric constants of NLC.

^{*}**E – Mail:** libezhanova@gmail.com

Modeling and Measurement of Structural Changes in Vibrating Wire Using High Stresses and Electrical Pulse Embrittlement Procedure

**S.G. Arutunian^{1,2}, G.S. Harutyunyan¹, A.V. Margaryan¹, N.M. Manukyan^{1*},
R.S. Gevorgyan¹, G.V. Mirzoyan^{2,1}, L.M. Lazarev¹, M. Chung³**

¹*A. Alikhanyan National Science Laboratory*

2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

²*Center for the Advancement of Natural Discoveries using Light Emission
(CANDLE) Synchrotron Research Institute*

31, Acharyan Str., Yerevan, Republic of Armenia 0022

³*Pohang University of Science and Technology*

77 Cheongam-ro, Nam-gu, Pohang, South Korea, 37673

The work aims to develop a monitor that registers structural changes in materials as they occur. Long-term on-line measurement of such changes is useful in the nuclear power engineering, where reactor vessel materials are subjected to intense neutron irradiation and embrittle with prolonged irradiation. This paper describes studies where a tension of the order of tensile strength is applied to a wire-shaped specimen so that the wire material undergoes plastic deformation. A short current pulse is then applied through the wire, which causes embrittlement of the wire. Both processes are measured by means of changes in the natural frequency of a pre-tensioned wire, which serves as a test sample. Experimental results are presented for different ratios of wire pre-tension and short pulse energy, as well as for their cyclic repetition.

*E – Mail: femto@yerphi.am

Footprint of Lienard–Wiechert Field on a One–dimensional Manifold

S.G. Arutunian^{1,3*}, M.A. Aginian¹, M. Chung², M.I. Ivanyan³

¹*A. Alikhanyan National Science Laboratory*

2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

²*Pohang University of Science and Technology*

77 Cheongam-ro, Nam-gu, Pohang, South Korea, 37673

³*Center for the Advancement of Natural Discoveries using Light Emission*

(CANDLE) Synchrotron Research Institute

31, Acharyan Str., Yerevan, Republic of Armenia 0022

A method is developed that determines parametric expressions of the electromagnetic field of a charged particle moving in vacuum on one–dimensional manifolds and does not require solving the retardation equation (the spatial distribution of the field is found on the basis of exact Lienar–Wichert equations). The method is applied to a charged particle moving along a helical trajectory. One–dimensional manifolds are represented by straight lines in the plane orthogonal to the helix axis. Field domains with maximal amplitudes are identified and their motion with time is considered. It is shown that these domains are marked by the regions of the electric field line concentrations.

*E – Mail: femto@yerphi.am

PIN–photodiodes Array for Beam Diagnostics in Accelerators

**S.G. Arutunian^{1,2}, A.V. Margaryan¹, G.V. Mirzoyan^{2,1*}, L.M. Lazarev¹,
M. Chung³, A.S. Vardanyan², V.G. Khachatryan², A.D. Davtyan²**

¹A. Alikhanyan National Science Laboratory

2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

²Center for the Advancement of Natural Discoveries using Light Emission

(CANDLE) Synchrotron Research Institute

31, Acharyan Str., Yerevan, Republic of Armenia 0022

³Pohang University of Science and Technology

77 Cheongam–ro, Nam–gu, Pohang, South Korea, 37673

Due to the specific features of their structure, PIN–photodiodes are responsive to charged particles and neutrons in addition to being sensitive to visible radiation, and can be used as detectors of neutron, proton and electron beams. In this work, a device consisting of 64 PIN–photodiodes with photodiode spacing of 10 mm is presented. Preliminary inter–calibration of the photodiodes was performed using light irradiation at different intensities. The first experiments were performed on the electron beam of the AREAL accelerator at the beam exit from the vacuum chamber at different distances from the exit window. The obtained data were compared with the results of measurements by a reference dosimeter. The possibilities of using the proton beam facilities of the Cyclotron 18 accelerator were discussed.

*E – Mail: femto@yerphi.am

Estimation of Cyclotron–based ^{161}Tb Production Yields via $^{160}\text{Gd}(\text{d},\text{n})^{161}\text{Tb}$ Nuclear Reaction

P. Glumac^{1*}, Yu. M. Cherepennikov^{1,2}

¹*National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

²*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In recent years, significant effort has been made to avoid possible future shortage of medical radioisotopes, particularly of the isotope $^{99\text{m}}\text{Tc}$, as well as to introduce new routes of production for new isotopes. In that manner, as substitute for reactor–produced, thus not suitable for production in clinical environment, ^{177}Lu , isotope ^{161}Tb is proposed. Of special interest is isotopes possibility to be combined with ^{152}Tb , which is proposed to be excellent diagnostic isotope, and form novel theranostic radiopharmaceuticals.

In the presented theoretical study, the cyclotron–based production rate of ^{161}Tb isotope is estimated under different operation regimes of the cyclotron. To accomplish this, a highly enriched ^{160}Gd target (98% purity) in form of the oxide powder (Gd_2O_3) is irradiated by a continuous deuteron beam. Wide range of projectile particle energies (up to 30 MeV) and particle currents (20–150 μA) is being considered.

Moreover, a separate analysis of all possible channels of ^{161}Tb production (from the same reaction) and yield calculation for influential radioactive impurities is conducted. Special attention is given to the isotope ^{161}Gd , which appears as a radioactive impurity but subsequently decays to ^{161}Tb via beta decay, forming an additional production channel for the desired isotope.

It is concluded that most adequate, yet achievable, initial energy for deuterons is 20 MeV. However, the maximum end–of–bombardment activity is 27 MBq (after 55 days in the beam with a current of 150 μA), which is insufficient for the most therapeutic procedures. The absolute maximum activity is expected to be measured 3.6 days after the bombardment and is projected to be 35.7 MBq (for a beam current of 150 μA).

*E – Mail: gp05@tpu.ru

GEANT4 Simulation of the Application of a SINUS–320 High–current Repetitively Pulsed Electron Accelerator for the Sterilization of Cocoa Powder

**Yu. M. Cherepennikov^{1,2*}, K.V. Afanasyev³, R.Kh. Gaisin³, V.V. Gauzshtein⁴,
M.V. Shevelev²**

*¹ Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

*³SPE CORAD,
84/AЖ Revolution Sh., St. Petersburg, Russian Federation, 195248*

*⁴Institute of High Current Electronics,
2/3 Academichesky Ave., Tomsk, Russian Federation, 634055*

One of the methods used for sterilizing food products involves treating the latter with ionizing radiation. The irradiation process is carefully controlled by respecting the parameters and processing times in order to achieve certain results. Sterilization treatments using ionizing radiation help prevent the growth of microorganisms responsible for food spoilage, such as bacteria and mold, by affecting their molecular structure. Two types of particles can be used during these procedures: electrons and gamma quanta. The impact of these types of ionizing radiation treatments on matter is fundamentally the same. The difference between them lies primarily in the source of their origin.

The report investigates the possibility of using a SINUS–320 repetitively pulsed electron accelerator for the sterilization of food products, particularly for cocoa powder. The study was performed via statistical modelling using GEANT4 simulation toolkit. The results are presented as a depth dose distribution calculated in cocoa powder for various parameters of exposure. The initial data for the study were the accelerating voltage (350 kV, 400 kV, 450 kV and 500 kV), the thickness of the aluminum anode foil (30 μm , 50 μm and 70 μm), and the thickness of the irradiated layer of cocoa powder (3 mm, 4 mm and 5 mm).

*E – Mail: yuryche89@gmail.com

On the Energy Spectrum of an Electron in a Crystal and the Determination of Chemical Markings and Electrode Concentrations

A.I. Soghomonyan*, R.E. Soghomonyan, S.M. Movsisyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The energetic, optical, thermal and some other properties of crystals depend on the energy state of the valence electrons. When considering the electronic properties of solids, we are primarily interested in determining the energy spectrum, chemical potential and electron concentration. Many physical properties of crystals are determined precisely by the external valence electrons. The stationary state of all particles is described by the Schrödinger equation

The main task is to find the energy spectrum of valence electrons, that is, the electron energy and its wave function should be determined from the Schrödinger equation. The value of the chemical potential and electron concentration was also found.

If a constraint is imposed on this wave function, then the Schrödinger equation will have a solution not for any energy values, but only for some, which are the solution to the Schrödinger equation and precisely determine the energy levels (energy spectrum) of a solid body.

However, due to the huge number of independent variables, the Schrödinger equation cannot currently be solved in a general form. Therefore, to find an approximate solution to the Schrödinger equation, a number of simplifying propositions are resorted to. One of them is the so-called valence approximation.

Using an analytical method, it was shown that the density of electronic states increases in proportion to $E^{1/2}$ and represents the energy distribution of possible electronic states. Whether these possible electron states are occupied or free is decided by the statistical behavior of the electron collective, which obeys the Fermi–Dirac distribution $f(E) = \frac{1}{\exp\left(\frac{E(p) - \mu(T)}{T}\right) + 1}$

where $\mu(T)$ is called the chemical potential of the electron. At temperature $T=0$, the distribution

$$\text{function } f(0) = \begin{cases} 0, \text{ by } E > \mu(0) \\ 1, \text{ by } E < \mu(0) \end{cases}$$

This means that all states $E < \mu(0)$ are occupied by electrons, and when $E > \mu(0)$ are empty.

*E – Mail: arkady.soghomonyan@mail.ru

Fraunhofer Diffraction by a Slit into a Medium with Wave Irreversibility

H.S. Eritsyanyan¹, A.I. Soghomonyan¹, A.A. Lalayan², A.L. Margaryan^{1*}

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²Institute of Physics, Yerevan State University
1 Alex Manoogian Str., Yerevan, Republic of Armenia, 0025*

Fraunhofer diffraction by a slit into a medium that has natural optical activity and is located in a magnetic field that causes magneto-optical activity in the medium is considered. Due to the simultaneous presence of these two types of optical activity, the waves are irreversible – the dissimilarity of phase velocities for mutually opposite directions of light propagation, not perpendicular to the magnetic field. Irreversibility leads to peculiarities in the distribution of minima (and maxima). Formulas are derived for the directions of minima when the external magnetic field is perpendicular to the slit plane and when perpendicular to the slit boundaries, which is parallel to the slit plane. In the second case, the diffraction pattern is asymmetric relative to the plane of symmetry of the experimental installation.

*E – Mail: margastghik@gmail.com

Features of Radiation Generated by a Charged Particle Flying Through a Ball of Dispersive Material

**H.F. Khachatryan¹, L.Sh. Grigoryan¹, S.B. Dabagov²,
A.H. Mkrtchyan¹, V.Kh. Kotanjyan¹, J.P. Markosyan¹, A.V. Sargsyan¹,
H.P. Harutyunyan¹, G.V. Margaryan^{1*}, A.A. Saharian^{1,3}**

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014
²Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Frascati,
Via Enrico Fermi 40, 00044 Frascati, Italy*

³Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025

The results of theoretical investigation of the spectral and angular distributions of the radiation generated by a charged particle crossing a ball of dispersive material in vacuum, are presented. Previously, in the case of a non–dispersive dielectric ball it was shown that strong peaks appear in the spectral distribution of the radiation intensity for certain values of the problem parameters. In this work we show that by choosing the dispersion law it is possible to achieve the generation of powerful radiation not in narrow bands, but over a fairly wide frequency range.

The work was partially supported by the Science Committee of RA, in the frames of the research project № 21AG–1C069.

*E – Mail: gayanamargaryan3@gmail.com

Measuring the Number of the Internal Betatron Beam Passes through a Thin Target

S.R. Uglov*, **A.V. Vukolov**, **M.V. Shevelev**

*National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

Applying effect of recirculation of a relativistic electron beam through internal targets of cyclic accelerators to increase the efficiency of using an electron beam when producing radiation in the X-ray and VUV range is considered in a number of theoretical and experimental works [1–3].

In this report we present the results of experiment to determine the multiplicity of interaction of an internal betatron beam with an electron energy of 33 MeV with a “thin” (5 μm) Cu target. In the experiment, the yield of characteristic X-ray radiation Cu $K_{\alpha\beta}$ was measured for a “thick” (1.5 mm) and “thin” target in the “forward” and “backward” directions relative to the direction of the electron beam. The multiplicity of the adventure was approximately 24 times.

The recirculation effect is particularly attractive for increasing the radiation yield from a multilayer periodic target known as a multilayer X-ray mirror, used as a radiator to produce quasi-monochromatic ultra-soft X-ray radiation. The thickness of such a freely hanging structure (without a substrate) or on a very thin substrate [4] is a fraction of a micron. The small thickness of the target should lead to a multiple increase in the number of passes of the electron beam compared to the thin Cu target used in the experiment. The work was supported by the Russian Science Foundation, grant No. 23–22–00187.

References

1. V.K. Grishin et al., Vesty MGU, 1996, Vol.3, N1, 83
2. V.V.Kaplin, S.R.Uglov, O.F.Bulaev et al., NIM B, Vol.173, 3, 2001
3. H.Yamada, D.Hasegawa, T.Yamada, A.I. Kleev, D. Minkov, N.Miura, A.Moon, T.Hirai, M. Haque, Biomedical Physics, Vol.8, 43, 2014
4. S R Uglov, V V Kaplin, A S Kubankin, J–M Andre, K Le Guen, Ph Jonnard, S de Rossi, E
5. Meltchakov and F Delmotte, Journal of Physics: Conference Series, Vol.732, 012017, 2016

*E – Mail: uglov@tpu.ru

Measuring the Period of a Multilayer X–ray Mirror Using X–ray Cherenkov Radiation

S.R. Uglov*, **A.V. Vukolov**, **M.V. Shevelev**

*National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

The spectrum of quasi–monochromatic radiation in the vacuum ultraviolet (VUV) region generated by relativistic electrons in the periodic structure of a multilayer X–ray mirror (SPS) could be experimentally studied using diffraction of radiation on another multilayer X–ray mirror [1]. In this work, for mirrors used in the study of SPS in the VUV range, an experimental design is proposed to measure the period of a multilayer mirror using Cherenkov radiation (XChR) of elements such as Al, Be and Si [2,3]. The use of ultra–soft X–ray radiation from XChR will make it possible to clarify the periods of the upper layers of X–ray mirrors. The experiment will be carried out at the Microtron M5 installation (Tomsk) [4] using an electron beam with an energy of 5.7 MeV. Note that the use of the conventional scheme based on characteristic radiation lines excited by 5.7 MeV electrons, is inferior to XChR in terms of the angular radiation density $dN/d\Omega$ by 2 orders of magnitude [1]. The work was supported by the Russian Science Foundation, grant No. 23–22–00187.

References

1. M.V.Shevelev, S.R.Uglov and A.V.Vukolov, Journal of Instrumentation Vol.19, C04049, 2024
2. S.Uglov, A.Vukolov, V.Kaplin, L.Sukhikh and P.Karataev, EPL (Europhysics Letters), Vol.118, №8, 34002, 2017
3. S. R. Uglov, A.V.Vukolov, Journal of Instrumentation, Vol.16, P07043, 2021
4. S.R.Uglov, V.V.Kaplin, L.G.Sukhikh, A.V.Vukolov, JETP Letters, Vol.100, №8, 503, 2014

*E – Mail: uglov@tpu.ru

Angular Profile of VUV Emission Produced by 5.7 MeV Electrons near Absorption L Edge of Aluminum

S.R. Uglov*, A.V. Vukolov, M.V. Shevelev

*National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

In their paper [1] the authors have experimentally shown that Vavilov–Cherenkov radiation with energy $E = 72.6$ eV is generated by 5.7 MeV electrons near the absorption L edge of aluminum. In this report, we show the experimental results of the angular distribution profile of the of VUV radiation produced by 5.7 MeV electrons near the absorption L edge in Al target $1\mu\text{m}$ thick. An experimental study of the angular distribution profile of radiation consisted of scanning the angular distribution of radiation after scattering radiation from the aluminum target on a multilayer mirror for several angles of inclination of the mirror. To scan along the angle φ , a special system was developed for moving the detector along an arc with a center coinciding with the virtual image of the radiation source in the multilayer mirror. The scanning range was $4^\circ < \varphi < 11^\circ$. The angular distribution profiles of VUV radiation were measured for photon energy $E = 72.6$ eV, corresponding to Vavilov–Cherenkov radiation, and for energy $E = 83$ eV outside the region of anomalous dispersion, corresponding only to transition radiation.

The work was supported by the Russian Science Foundation, grant No. 23–22–00187.

References

1. Sergey Uglov, Artem Vukolov, Valery Kaplin, Leonid Sukhikh and Pavel Karataev, EPL, Vol.118, №8, 34002, 2017

*E – Mail: uglov@tpu.ru

X–ray Interferometric Shift Fringes and Monocrystal “Sandwich”

H.R. Drmeyan^{*}, H.G. Margaryan and S.N. Noreyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The structures of the displacement fringes recorded from two–block crystalline systems with a non–diffracting zone, depending on both the thickness of the blocks and the width of the non–diffracting zone, are investigated. The interference wave field of the X–ray narrow–gap double–block interferometer is theoretically investigated and the intensity distribution in the pattern obtained from it is determined. It is proved that the period of displacement fringes is directly proportional to the sum of block thicknesses. The relation between the period of the displacement fringes and the width of the non–diffracting zone is revealed. It is shown that when the blocks are close enough to each other and their total thickness satisfies the condition, then the interference pattern of the displacement lines is observed, and with increasing width of the non–diffracting zone the period of the displacement fringes decreases. It is experimentally proved that at the minimum value of the total thickness or the maximum value of the width of the non–diffracting zone, for a given experiment, the periods of the mixing fringes become impossible to register: the period is very small, the resolution of the interference system is insufficient.

***E – Mail:** *drm–henrik@mail.ru*

High–Precision Light Rangefinder with Phase Modulation Accumulation

Ye.H. Hayrapetyan^{1,2*}, H.A. Hunanyan¹

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014
²National University of Architecture and Construction of Armenian
105 Teryan Str., Yerevan, Republic of Armenia, 0009*

To increase the accuracy of the light rangefinder, a two–phase measurement method is used when two receiving signals are formed, shifted relative to each other by 180°. For this purpose, a rotating phase plate at $\lambda//2$ is used. At the same time, there is an increase in the accuracy of linear measurements, but the microwave modulation power remains high, about 150–160 Watts.

The paper suggests the possibility of reducing the modulation power by using a light modulator on a KDP crystal of a special design. For this purpose, in the light modulator, the second end of the electro–optical crystal and the clamping contact at the junction are made in the form of two orthogonal planes, the intersection line of which is parallel to one of the induced axes of the crystal. The orthogonal planes of the electro–optical crystal are made reflective. In such a crystal, the incoming beam is reflected twice without changing the modulation polarization and exits the crystal with an accumulation of modulation, leading to a decrease in microwave power and an increase in the signal–to–noise ratio by eliminating internal reflections of the crystal on the photo detector.

*E – Mail: hayrapetyanyeghisabet@gmail.com

Investigations of Giant Radio Galaxy B2 1141+37

**T.H. Sargsyan^{3*}, M.A. Hovhannisya¹, S.A. Mkhitarian¹, L.A. Mahtesyan¹,
A.P. Mahtessian²**

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²Byurakan Astrophysical Observatory After V.A. Ambartsumian (National Value)
of National Academy of Sciences of the Republic of Armenia
Byurakan, Aragatzotn Province, Republic of Armenia, 0213*

*³European College in Armenia Foundation
10 Davit Anhaght Str. Yerevan, Republic of Armenia, 0037*

The giant radio galaxy B2 1141+37 consists of two high-intensity radio galaxies, B2 1141+37A and B2 1141+41B, both of which emit strongly in both the radio and optical bands. The galaxy B2 1141+37A is an FR II type galaxy with a relatively weak radio source at its centre and two strong radio sources at a distance of 2–3 min in the 1400 MHz range (FIRST catalogue). In the optical range, there are two very powerful galaxies close to each other. The galaxy is located at a distance of approximately 500 0 Mps ($z=0.114820 \pm 2.00e-5$) and has a size of 75 kps. Studies of the distribution of extragalactic sources have been carried out in the range of six degree radius around the galaxy B2 1141+37A, in which the radio galaxy B2 1141+41B is also located. The distribution of quasars in that range shows that there is a deficit in the number of quasars at certain distances, which may be due to the inhomogeneity of the universe. Deficiency is observed mainly for values of z from 2 to 3.

*E – Mail: tsargsyan380@gmail.com

Intraband Absorption in CdSe Nanoplatelets

M.K. Manvelyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Let us to consider the electron states in NPL. In such structures, the effects of polarization in the z -direction cannot be ignored due to the significant difference in the dielectric constant between the NPL and the surrounding materials. The description of this phenomenon was successfully produced using Ritova and Keldysh formulas. Based on this the Hamiltonian of the problem is written as follows:

$$\hat{H} = -\frac{\hbar^2 \Delta_{xy_e}}{2\mu_{xy,e}} - \frac{\hbar^2 \Delta_{z_e}}{2\mu_{z,e}} + U_{conf}(z) + U_{self}(z) + U_{conf}(x, y), \quad (1)$$

where $U_{conf}(z) = \begin{cases} U_0, & |z_i| > L_z/2 \\ 0, & |z_i| \leq L_z/2 \end{cases}$; $U_{conf}(x, y) = \begin{cases} \infty, & (x, y) \in NPL \\ 0, & (x, y) \notin NPL \end{cases}$, $U_{self}(z)$ is the self-potential. To proceed further, we apply the adiabatic approximation to separate slow in-plane motion and fast motion in the growth direction. The motion in the z -direction is confined with both $U_{conf}(z)$ and $U_{self}(z)$, in-plane motions confined only with $U_{conf}(x, y)$, so for axial and radial directions we have the following equations

$$\begin{cases} \left(-\frac{\hbar^2}{2\mu_{z,e}} \frac{d^2}{dz_e^2} + U_{conf}(z) + U_{self}(z) \right) \psi(z) = E_z \psi(z), \\ \left(-\frac{\hbar^2}{2\mu_{xy,e}} \left(\frac{d^2}{dx_e^2} + \frac{d^2}{dy_e^2} \right) + U_{conf}(x, y) \right) \psi(x, y) = E_{xy} \psi(x, y). \end{cases} \quad (2)$$

Equations (2) can be calculated by using numerical methods. Base on this intraband optical absorption can be investigated.

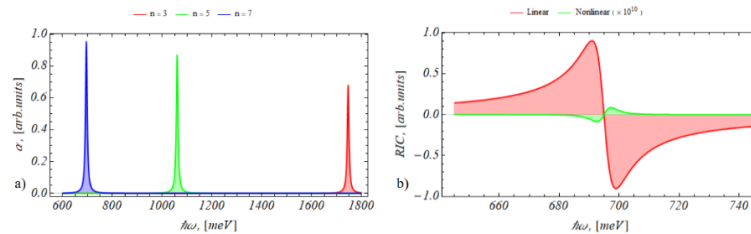


Fig. 1. Intraband optical absorption coefficient for various numbers of atomic layers (a) and refractive index change (b) dependencies on incident light energy

*E – Mail: manvel.manvelyan@rau.am

Tripartite Entanglement in Mixed–Spin Triangle Trimer

Zh. Adamyan^{1,2*}, V. Ohanyan^{1,2}

¹*Laboratory of Theoretical Physics,*

Yerevan State University, 1 Alex Manoogian Str., Yerevan, Republic of Armenia, 0025

²*Center for the Advancement of Natural Discoveries using Light Emission*

(CANDLE) Synchrotron Research Institute

31, Acharyan Str., Yerevan, Republic of Armenia 0022

Heisenberg model spin systems offer favourable and manageable circumstances for generating and manipulating quantum states that exhibit entanglement. This work considers the mixed spin–(1/2,1/2,1) Heisenberg model trimer with two different but isotropic Landé g –factors and with two different exchange interactions. The study undertakes the task of finding the optimal parameters to create entangled states and control them by external magnetic field.

The primary objective of this work is to examine the tripartite entanglement of a system and the dependence of the tripartite entanglement on various system parameters, notably the non–conserved magnetization, spin exchange interaction constants and the external magnetic field. There were considered two cases of between particle interaction, antiferromagnetic and ferromagnetic interactions. Both positive and negative Landé g –factors have been discussed.

To quantify the tripartite entanglement in this work have been used entanglement measure namely tripartite negativity.

*E – Mail: zhirayr.adamyan@ysu.am

Application of the Catastrophe Theory in Experimental Studies

**A.S. Abrahamyan, K.G. Sahakyan, R.Yu. Chilingaryan^{*}, A.A. Margaryan,
A.H. Mkrtchyan, H.T. Hovhanisyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In experiments, we measure only a small part of the parameters of the real multidimensional world. All unaccounted parameters contribute to the statistical error. The more parameters we can take into account, the more accurate the result will be. Often, it is not a detailed study of the dependence of each parameter on each of the others separately that is necessary, but only a qualitative study – the determination of special points. In this case, the mathematical theory of catastrophes can be applied. It is known that any curve can be described using polynomials of different degrees. The equation of one of the seven elementary catastrophes is selected as a polynomial. Based on the number of control parameters considered in the experiment. Control parameters are included as coefficients in the equation of the corresponding catastrophe. For example, if the number of control parameters is 4, then it is advisable to select the equation of the catastrophe of the fifth degree with three coefficients. In this way, several catastrophe equations are compiled (but of one selected type) for several different values of the control parameters. The question remains: we conducted the experiment only for a few values of the control parameters. It is possible that the singular points will be somewhere inside the region of experimental values (intermediate values of the parameters) and we simply did not notice them. Using the catastrophe theory, we will be able to determine whether there are singular points at intermediate values of the control parameters. Using the example of glow discharge plasma with acoustic impact, the possibility of studying the dependencies and characteristics of the object under study using catastrophe theory is demonstrated. Using the theory of catastrophes, the phase transition points for the parameters of the acoustoplasma obtained in the experiment were determined. It was found that most phase transitions begin at a modulation frequency greater than 0.5 kHz. But there are also phase transitions between individual control parameters at a frequency below 0.5 kHz. We would not have noticed this, without using the described technique. Such phase transitions allow us to explain the large increase in the energy capacity of the acoustoplasma, compared to ordinary plasma, without acoustic disturbance. The use of this technique in various fields of science and technology is considered.

^{*}**E – Mail:** rychi072@gmail.com

Determination of Energy Band Gap of α -LiIO₃ Doped with Amino Acids

**A.A. Danghyan^{1*}, L.S. Bezhanova¹, R.A. Apreyan¹, R.P. Sukiasyan¹,
N.B. Margaryan², A.K. Atanesyan¹**

¹*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

²*A. Alikhanyan National Science Laboratory
2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036*

In this study, using the X-ray fluorescence spectrophotometer in the spectral range of 190–1100 nm, the determination of the energy band gap of undoped and amino acids (L-Alanine, L-Arginine, L-Valine, Glycine) doped $\alpha - LiIO_3$ single crystals, exhibiting large piezoelectric, elastic-optic, non-linear optical, and photophysical properties [1, 2] were carried out. Depending on the dopant, it is possible to vary the width of the forbidden zone, thereby changing the physicochemical properties of the investigated specimen. A precise definition of the band gap energy of the specimens under study is crucial for identifying their photophysical properties.

To determine the energy band gap of the investigated crystals, a method based on the simultaneous fitting of many absorption mechanisms to the spectral dependence of the Kubelka–Munk function, estimated from diffuse reflection data, as well as Tauc's method, has been applied. The absorption and reflection spectra have been obtained. The spectral analysis shows that at low dopant concentrations, additional electron states appear in the band gap of the crystals. The obtained luminescence spectra also indicate the presence of additional electronic states at room temperature. The numerical approximation of the luminescence spectra of the investigated crystals is performed.

This work is partially supported by the Ministry of Science and Education RA, project No.21T–2F116 – 2021.

References

1. A.A. Danghyan, Arm. J. Physics, 15(2–3), 2022, 74–78
2. A.A. Danghyan, R.P. Sukiasyan, R.A. Apreyan, A.K. Atanesyan, J. Cryst. Growth, 627, 2024, 127534.

*E – Mail: ata.ysu@mail.ru

Features of Experiments with Acoustoplasma

**A.S. Abrahamyan*, R.Yu. Chilingaryan, H.T. Hovhanisyan, A.H. Mkrtchyan,
S.H. Chakhoyan, M.H. Sargisyan, S.A. Matevosyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Plasma is a self-consistent medium and a change in one of the parameters leads to a change in many others. That is, to a transition from one equilibrium state to another. In acoustoplasma, we ourselves constantly modulate the discharge current and this leads to a permanent change in many parameters of acoustoplasma. But these changes are cyclical. Therefore, quasi-equilibrium states are possible in acoustoplasma, when parameters fluctuate around the equilibrium state. During the modulation period, phase transitions are possible that significantly change the parameters of acoustoplasma. For example, the discharge resistance can change significantly. From close to a short circuit, to close to an idle state. Conventional power supplies fail in such modes. The design of special power supplies for acoustoplasma devices is described.

Measurements in high-voltage circuits have always caused difficulties. High-voltage linear optocouplers operating in circuits with voltages of 20 kV and more are described.

Acoustoplasma has memory. After the acoustic impact is removed, all parameters are restored to the initial state of the plasma without acoustic disturbance within a certain time (from a second to 30 minutes). Therefore, working with acoustoplasma, is careful filtering of currents and voltages from parasitic modulation, as well as maintaining a waiting mode until all parameters come to the state necessary for a given experiment.

During the modulation period, part of the discharge current, flowing into the tube, is spent on creating new charged particles in the acoustoplasma. Therefore, the electric current flowing into the tube and the current flowing out of the tube are not equal. Only their average values are equal. It is necessary to simultaneously measure the currents from both the anode and cathode sides.

The discharge tube is also an acoustic resonator, so measurements are necessary not only at resonant frequencies, but also at antiresonance and quasi-resonance frequencies.

*E – Mail: arbel11@mail.ru

Features of the Operation of an Acoustoplasma Magnetron

A.S. Abrahamyan, A.A. Margaryan*, A.H. Mkrtchyan, R.Yu. Chilingaryan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Acoustoplasma magnetrons (APM) were developed and patented at our Institute and can be used for various purposes. For example, for generating high-frequency oscillations, for creating various plasma-reactive engines, for creating plasma-chemical reactors, etc. The report discusses experiments on the use of APM for thin film deposition. APM has the properties of both magnetron and glow discharges. Firstly, the cathode of such a discharge works in the same way as in a conventional magnetron, but in addition the discharge has a positive column, similar to a glow discharge. It is in the positive column that acoustoplasma effects appear. In a conventional magnetron there is no positive column, the anode is located close to the cathode. In APM, the distance between the anode and cathode must be large enough to allow the formation of a positive discharge column with acoustoplasma. That is, in magnetron mode only the cathode operates. This results in an increase in anode voltage compared to a conventional magnetron. Secondly, the substrate being deposited is either located close to the anode or is electrically connected directly to the anode. Therefore, electrons and negative ions (if an electronegative buffer gas is used) bombard the substrate with energy sufficient to knock atoms out of the substrate, etching the substrate and the deposited layer occurs. Because of this, on the one hand, the coating application process slows down. On the other hand, various coating defects that weaken the adhesion to the substrate surface will be more easily etched in the discharge than the defect-free part. As a result, the coating will be denser and more defect-free. By changing the discharge current, pressure and type of buffer gas, the speed of such etching can be controlled. They will differ for different sprayed substances and buffer gases. Thirdly, the spraying mode can be changed so much that instead of a dense coating we get a porous coating. Moreover, dense and porous coatings can be obtained in one technological process sequentially. Fourthly, it is possible to spray oxides and other compounds with variable stoichiometry. For example, you can spray NiO_x , where x – can be greater than one, less than one, or equal to one. The deposition of various metals (Ag, Al, Cu, Ge, Si, Ti, W, Zn) and metal oxides (TiO_2 , NiO_x , Ni_2O_3 , ZnO) was studied.

The main goal of this cycle of work is to create a new generation of solar cells.

*E – Mail: art16101@gmail.com

Interband Transitions in the Strongly Oblate Asymmetric Ellipsoidal Quantum Dot under the Influence of the Axial Magnetic Field

A.A. Nahapetyan*

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The interband absorption in the asymmetric strongly oblate ellipsoidal quantum dot has been considered in the effective mass approximation, while the system is under the influence of the axial homogeneous magnetic field. The threshold frequency of the interband absorption and the selection rule of the interband transitions have been defined. The absorption resonant frequencies' dependences on the magnetic field's magnitude and the geometrical parameters of QD have been investigated.

*E – Mail: n.aram2097@gmail.com

Measurements of Coherent Radiation at the AREAL Accelerator

**E.Yu. Kidanova^{*}, V.N. Antonov², A.S. Vardanyan³, A.V. Vukolov⁴,
B.A. Grigoryan³, L.Sh. Grigoryan⁵, P.V. Karataev², H.D. Davtyan³,
I.A. Kishin¹, V.R. Kocharyan⁵, A.S. Kubankin¹, V.V. Margaryan⁵,
A.P. Potylitsyn⁴, H.F. Khachatryan⁵, Y.M. Cherepennikov⁵, M.V. Shevelev⁴**

¹*Belgorod State National Research University*

85, Pobedy str., Belgorod, Russian Federation, 308015

²*Royal Holloway, University of London, Egham, Surrey TW20 0EX, United Kingdom*

³*Center for the Advancement of Natural Discoveries using Light Emission*

(CANDLE) Synchrotron Research Institute

31, Acharyan Str., Yerevan, Republic of Armenia 0022

⁴*National Research Tomsk Polytechnic University*

30 Lenin Ave., Tomsk, Russian Federation, 634050

⁵*Institute of Applied Problems of Physics*

of the National Academy of Sciences of the Republic of Armenia

25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014

The paper presents the results of an experimental study on electromagnetic radiation in the sub-terahertz frequency range, using the methods of coherent transition radiation (CTR) and coherent Cherenkov radiation (CCR). As targets, a thin silicon plate with an aluminum coating and a conical teflon resonator were used as targets. The AREAL linear accelerator, with an energy of 3.6 MeV and located at the CANDLE Synchrotron Research Institute in Yerevan, served as the electron source. By using an interferometer assembled according to the Martin–Puplett scheme, the frequency spectra of the radiation were obtained, which allowed us to estimate the length of the electron beam. Radiation was recorded using ZBD–F detectors, designed for frequencies ranging from 33.5 to 50 GHz, 60 to 90 GHz, and 90 to 140 GHz. [1] The report describes the experimental setup and present preliminary experimental results.

References

1. Virginia Diodes Ltd. <https://vadiodes.com/en/zbd>

^{*}**E – Mail:** 28kidanova28@gmail.com

An Experimental Setup for Accurately Measuring the Thickness of Foil

A.S. Kubankin^{1,2}, I.A. Kishin^{1,2*}, E.Yu. Kidanova¹

¹Belgorod State National Research University

85, Pobedy str., Belgorod, Russian Federation, 308015

²Lebedev Physical Institute of the Russian Academy of Sciences

53 Leninskiy Ave., Moscow, Russian Federation, 119991

The paper presents an experimental setup for determining the thickness of metal and organic foils with an accuracy above 0.5 microns. The principle of operation of the stand is based on the effect that occurs when X-ray radiation interacts with matter: a decrease in the intensity of X-rays when passing through a layer of matter. It is worth noting that when performing measurements on the developed installation, the objects under study must sufficiently absorb X-ray radiation, therefore, the installation allows you to control the energy of incident X-ray radiation in the range from 8 to 30 keV. Additionally, the installation allows you to diagnose inhomogeneities in the foil by the recorded spectrum of X-ray radiation that has passed through the foil under study. For organic foils such as carbon fiber or mylar, the installation operates in the soft X-ray range up to 10 keV in the mode of energy dispersive analysis of the X-ray signal transmitted through the object under study and scattered by the object.

The work was carried out with the financial support of the competitive part of the state assignment for the creation and development of laboratories, project № FZWG–2020–0032 (2019–1569).

*E – Mail: ivan.kishin@mail.ru

Investigation of Parametric X–ray Radiation from Highly Oriented Pyrolytic Graphite with Different Mosaicities

I.A. Kishin^{1,2*}, E.Yu. Kidanova¹, A.S. Kubankin^{1,2}, R.M. Nazhmudinov^{1,2},
V.I. Alekseev², A.N. Eliseev²

¹*Belgorod State National Research University*

85, Pobedy str., Belgorod, Russian Federation, 308015

²*Lebedev Physical Institute of the Russian Academy of Sciences*

53 Leninskiy Ave., Moscow, Russian Federation, 119991

The paper presents the results of an experiment on the generation of parametric X–ray radiation in the interaction of relativistic electrons with highly oriented pyrolytic graphite with various mosaicities: $0.4^\circ \pm 0.1^\circ$, $0.8^\circ \pm 0.1^\circ$, $1.7^\circ \pm 0.1^\circ$ and $3.5^\circ \pm 1.5^\circ$. The measurements were carried out in the Department of High Energy Physics of the LPI at the Röntgen–1 setup. Radiation in the range from 1 to 10 keV was detected at an observation angle of 180° relative to the electron velocity using a X–Ray spectrometer X–123 SDD. The measurement of the spectra at different angles of orientation of the target allowed us to construct the orientation dependences of the PXR output for the first four observed diffraction peaks corresponding to the crystallographic planes (002), (004), (006) and (008). The correspondence of the experimental data obtained with the PXR kinematic theory for mosaic crystals was verified [1], which was modified for the considered geometry of the experiment. A good correspondence between the theory and experimental data for PXR reflexes from the crystallographic planes (002) and (004) is shown. The discrepancy between the experimental data and the theory, noticeable for the PXR reflexes from the crystallographic planes (006) and (008), may indicate the influence of another type of radiation on the measurement results.

The work was carried out with the financial support of the competitive part of the state assignment for the creation and development of laboratories, project № FZWG–2020–0032 (2019–1569).

References

1. Kubankin A. S., Nasonov N. N. On the possibility of using parametric X–ray radiation to study the anisotropy of crystal mosaicity // *Journal of Surface Investigation. X–Ray, Synchrotron and Neutron Techniques. X–ray., synchrotron. and a neutron. research.* 2008. No. 4. pp. 76–79.

*E – Mail: ivan.kishin@mail.ru

HB13 Giant Galaxy and Distribution of Extra Galactic Sources Around it

**R.A. Karapetyan^{1,2*}, J.P. Markosyan¹, S.A. Mkhitarian¹,
M.A. Hovhannisyan¹, L.A. Mahtessian¹, A.P. Mahtessian³, T.H. Sargsyan**

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

²Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025

*³Byurakan Astrophysical Observatory After V.A. Ambartsumian (National Value)
of National Academy of Sciences of the Republic of Armenia
Byurakan, Aragatzotn Province, Republic of Armenia, 0213*

As the results of other giant galaxies and quasars (NGC6251, 1502+10, 0923+39, 3C219, NGC315, 1055+1) have shown, the ones which have already been published, giant radio galaxies make it possible for us to reach our main goal: find data about in homogeneity of space by using the distribution of extra galactic sources and see if space is homogeneous or not. These investigations of radio galaxy HB13 are typically the same and our goal is to find out, how the extra galactic sources are distributed around the galaxy. Our investigations have shown, that the present visual data in radius of 6 degrees does not make it possible to make any conclusions about inhomogeneity of space. Not to mention that more accurate investigations are vital for that area, new observations which require more sensitive telescopes.

References

1. Kuaamicz Agnieszka, Jamrozy Marek Bronarska Katarzyna, Janda–Boczar Katarzyna, Saikia D. J. “An Updated Catalog of Giant Radio Sources”. [2018ApJS..238....9K](#).
2. [Masson C. R.](#) “HB13 a radio galaxy with interesting jets”. [1979MNRAS.187..253M](#).
3. M.A. Hovhannisyan, S.A. Mkhitarian, L.A. Mahtessian, J.G. Vardanyan, J.P. Markosyan, A.M. Minasyan, A.P. Mahtessian. “Studies of NGC315 galaxy and the distribution of extra galactic objects around it”. NIMA, Volume 1060, March 2024, 169098.

*E – Mail: rozakarapetyan2003@gmail.com

X-ray Study of Structural Changes in the Liquid-Crystal System AOT-Mixed Solvent Under the Influence of Dimethyl Sulfoxide (DMSO)

A.G. Sargsyan, S.M. Grigoryan, D. E. Baghdasaryan,
H.H. Samsonyan*, S.G. Khosrovyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In this work were studied X-ray and morphological studies of changes in the structure of the liquid crystal system of the AOT base in a mixed solvent n-heptane-water under the influence of different concentrations of Dimethyl sulfoxide (DMSO). The latter is aimed at improving the selected biomembrane model, as Dimethyl sulfoxide (DMSO) is a unique solvent with very low toxicity and is present in many food products.

X-ray and polarization microscopy methods are used in the work, which make it possible to carry out research at the molecular and supramolecular levels.

Our previous studies have shown that the (AOT) – n-heptane–water liquid–crystal system can serve as a model of a biological membrane. In figure is shown the of AOT–n–heptane–water Structural system changes depending on concentration DMSO. It has been established that the influence of DMSO, by changing the degree of hydration of the polar core, changes the characteristic parameters of the lamellar phase of the liquid crystal organization.

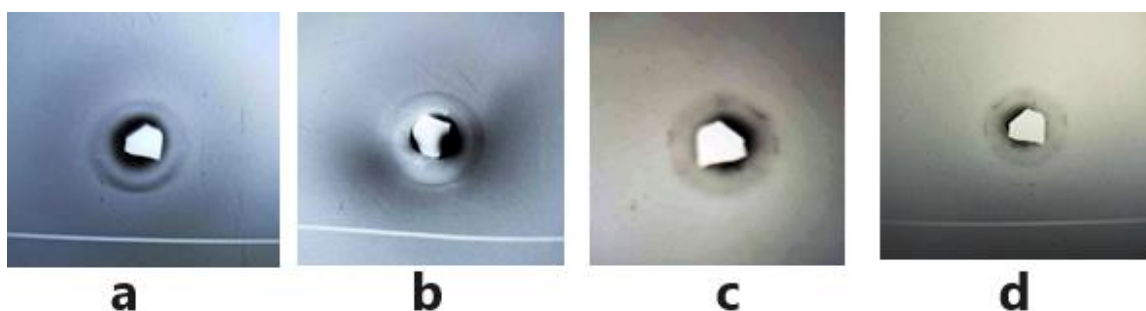


Fig. 1. Structural changes depending on concentration DMSO

- a. AOT–55%, DMSO–2,9%
- b. AOT–70%, DMSO–3,6%
- c. AOT–75%, DMSO–3,8%
- d. AOT–51%, DMSO–2,9%

*E – Mail: Hasmik.samsonyan@yandex.ru

Features of the Change in Dielectric Constant in Crystals in the Presence of an Alternating Electric Field

K. G. Truni, S.N. Noreyan, A.I. Soghomonyan*,

R.E. Soghomonyan, V.K. Mirzoyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

This work examines the features of changes in dielectric constant ε depending on the frequency of the applied alternating electric field and provides a theoretical justification for this phenomenon.

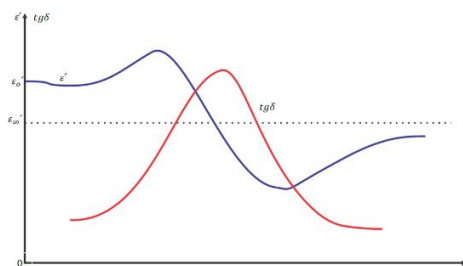
It has been revealed that in the presence of an alternating electric field, a change in ε occurs due to the screening of free, weakly bound ions and electrons formed as a result of polarization (total dipole moment) of the medium.

When describing polarization oscillations P and electrical intensity E using the complex amplitude method, ε is represented as a complex quantity:

$\varepsilon = \varepsilon' - i\varepsilon''$, and ε' and ε'' depend on the frequency ω and relaxation time τ , and the ratio $\varepsilon'' / \varepsilon' = \operatorname{tg} \delta$ determines the dielectric losses in the medium.

The phase shift δ depends on the ratio of times τ and $T = 2\pi / \omega$. It is shown that at $\tau \ll T$ ($\omega \ll 1/\tau$, low frequencies) the direction of P changes simultaneously with E , i.e. $\delta = 0$. The corresponding value of ε' is denoted by ε'_0 . At $\tau \gg T$ ($\omega \gg 1/\tau$, high frequencies) polarization does not keep pace with changes in E , i.e. $\delta \rightarrow \pi$ and ε' in this case denote (ε'_∞)

It is obvious that $\varepsilon'_0 \neq (\varepsilon'_\infty)$, and in variable fields ε' turns out to be a function of ω . Near $\omega = 1/\tau$ there is a change in ε' from ε'_0 to (ε'_∞) (dispersion region) and the dependence of $\operatorname{tg} \delta$ on ω passes through a maximum. In the case of ionic and electronic polarizations, the dependences of ε' and $\operatorname{tg} \delta$ on ω are shown in Fig. 1.



*E – Mail: arkady.soghomonyan@mail.ru

X–ray Spectrometer with Controlled Characteristics

**S.N. Noreyan, V.R Kocharyan, K.R. Trouni*, A.M Mamyán,
M.H. Mesropyan, H.I. Sogomonyan, R.K. Mirzoyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

In this work, Laue diffraction of narrowly collimated (collimation angle $\approx 3''$) polychromatic X–ray radiation in a quartz single crystal under the influence of a temperature gradient is investigated. Since the angular width of the collimated polychromatic X–ray beam is much smaller than the angular dispersion between the $\text{MoK}\alpha_1$ and $\text{MoK}\alpha_2$ lines for the specified atomic planes, simultaneous reflection of the $\text{K}\alpha_1$ and $\text{K}\alpha_2$ lines is impossible. In our experiment, the crystal was adjusted for the $\text{MoK}\alpha_1$ line. In the presence of a temperature gradient, the integral intensity of the reflected $\text{MoK}\alpha_1$ line increases to saturation, and the cross section of the reflected beam narrows, this leads to a narrowing of the Bormann triangle.

In addition to the reflected $\text{MoK}\alpha_1$ line, at a certain threshold value of the temperature gradient, the $\text{MoK}\alpha_2$ line also appears. The applied temperature gradient leads to deformation of the crystal lattice, with a simultaneous continuous change in the interplanar distance and orientation of the reflecting atomic planes, which in turn leads to local satisfaction of the Bragg condition for different beam wavelengths in different sections of the Bormann triangle, as a result of which the polychromatic radiation is spatially redistributed over the spectrum. Thus, we have a new type of polychromatic X–ray spectrometer, for which the linear and angular dispersion depend on the magnitude of the temperature gradient, as an analogue of an optical range prism.

*E – Mail: ktrouni@hotmail.com

Computer Simulation of CT Experiment Results

**A.V. Shahverdyan^{1*}, V.V. Margaryan¹, Yu.M. Cherepennikov^{1,2}, K.G Trouni¹,
A.M Mamyan¹, R.K. Mirzoyan¹, V.R. Kocharyan¹**

*¹Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

*²National Research Tomsk Polytechnic University
30 Lenin Ave., Tomsk, Russian Federation, 634050*

Computer simulation has become an invaluable tool in the field of computed tomography (CT) for predicting and analyzing experimental results. CT is a powerful imaging technique that allows for non-invasive visualization of the internal structure of various samples. During a CT experiment, X-rays pass through the sample and detectors record the radiation intensity after interaction with the sample.

The acquired two-dimensional projections of a three-dimensional sample are processed using mathematical models, such as inverse Radon transformation, to reconstruct the linear absorption function $\mu(x,y)$ representing the sample. Different algorithms can be employed for the three-dimensional reconstruction of the original $\mu(x,y)$ function. To test the efficiency of these algorithms, complex-shaped samples are crucial in both experimental and simulation studies. In this study, we present an algorithm for simulating CT images of diverse 3D-printed samples, allowing for a comparison between simulated and actual CT experiment results. The use of computer simulation enhances the understanding of the CT imaging process and aids in the development and validation of reconstruction algorithms.

*E – Mail: shahverdyan.93@mail.ru

The Role of 3d Software's in Developing Models for Innovative Solutions and Sci-Tech Results' Commercialization

**T.S. Musayelyan^{*}, A.H. Mkrtchyan, Z.S. Musayelyan, Z.H. Mkrtchyan,
Sh.S. Panyan**

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

There are many programs for 3D modeling. Today, everyone chooses IT software according to their profession, making the job easier and trendier. They differ in their functionality, tasks and cost. It is known that many IT softwares for physics and mathematics are used by physicists in physics and related fields.

However, in order to create experimental samples, prototypes and useful models of the results created on the basis of research, it is necessary to switch to 2D, 3D design and engineering softwares. It is often difficult to find out on your own the most suitable software for a specific job, because there are many of them, but there are programs that become even more perfect with time and remain in demand, increasing the KPI of the job.

In the course of this research, a number of 2D and 3D modeling software were studied and compared, which facilitate the obtaining of experimental samples and useful models based on the results of innovative solutions and scientific and technological developments. In some cases, it is necessary to use several programs at the same time to make the work look complete. Currently, many 2D and 3D programs are being developed, due to which the change made in any dimension is simultaneously reflected in all dimensions, automatically changing all calculations of engineering drawings and model building.

The following softwares and software packs have been professionally reviewed: Autodesk AutoCAD (works with DWF, DWG and DXF formats), ArchiCAD, SolidWorks, Autodesk 3ds Max, Autodesk Fusion 360, Solid Edge, SketchUp, Zbrush, Revit, OpenSCAD, CATIA, CAE Suite and PRADIS, LS-Dyna, Ansa, Ansys, Ansys CFX, Fluent, Ansa, Salome, Code-Aster, OpenFoam softwares and software packs, FreeCAD, Student Blender, and others. The professional review and comparison of softwares for the field of application is revealed and abridged for presentation.

^{*}**E – Mail:** musayelyan.tatevik@gmail.com

The Importance of Citations and the Essential Science Indicators

Sh.S. Panyan, Z.H. Mkrtchyan*, T.S. Musayelyan, A.H. Mkrtchyan

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

Citation analysis is a branch of bibliometrics and explores the relationship between authors and authored papers.

This research discusses the development of citation analysis, its perspectives, and considers it as a research method. The ricochet has been done for paying tribute to the authors, evaluating the papers done by the authors, providing feedback to the authors of the papers, correcting and criticizing the papers, crediting the authorization of and notoriety of the papers, substantiating claims, and others.

Citation analysis has evolved with the development of new techniques, tools, measures and standards, and this has led to the use and analysis of different types of citations in studies.

The specialized application of the latter can increase the positioning and rankings of the RA scientists and science in ESI, ISI, SSCI Citation Rankings, which includes over 22 fields.

Citations' Rankings are grouped into a) academic, scientists, scholar rankings; b) Institutional ranking; c) national rankings; d) journal rankings; e) highly cited papers; f) hot papers; g) baselines, benchmarks.

The ESI page structure reflects the relationship between various pages.

Page menus are: –

- a) scientists, institutions, countries, journals (links to Alpha List Pages)
- b) highly cited, hot papers, (links to Search Pages; Alpha List Pages)
- c) research trends (links to one level higher than Alpha List Pages and Search Pages, that is Rankings Pages and Papers Pages)
- d) baseline (links to Average Citation Rates, Percentiles)

*E – Mail: shushanik0194@gmail.com

Why the Physics and The Physicists Should Have the Target Role in Diplomacy

Sh.S. Panyan², T.S. Musayelyan⁴, Z.H. Mkrtchyan^{1*}, A.H. Mkrtchyan³

*Institute of Applied Problems of Physics
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

The research on revealing the role of the physicians and the physics in the science diplomacy and the diplomacy itself is looped. In research, in the tables (1–4) are grouped the fields of wide spectrum of the physics that influence on the science diplomacy, where research results of every single subfield and concept can become the milestone for diplomacy and state. Therefore, every single scientist– physicist who is developing world result in these fields of physics would have a dominant negotiation stone in diplomacy. In the Table 4, the field of applied physics (applied problems of physics) is seen with its broad spectrum of problems the physics is in and the world leaders are interested in. The top developed countries are doing their best to have the leading role in all these subfields and control the innovations, the enlightening and the progress of the societies all over the world through becoming the innovators, the enlighteners and the diplomats of science.

The Scientific Advisory boards of physicists are advising the top governing bodies through centuries. The significant number of the best diplomats worldwide who played a significant role in peace diplomacy are physicists.

Table 4. Applied physics (applied problems of physics) subfields

Acoustics	Geophysics	Laser physics	Photonics	Biophysics
Atmospheric physics	Communication physics	Quantum information science	Physical oceanography	Materials physics
Accelerator physics	Engineering physics	Medical physics	Physical chemistry	Quantum electronics
Agrophysics	Econophysics	Nanotechnology	Photovoltaics	Optoelectronics
Quantum chemistry	Chemical physics	Physics of computation	Vehicle dynamics	Solid–state devices
	Fluid dynamics	Optics	Plasma physics	

*E – Mail: zarahmkrtchyan@gmail.com

Applied Physics Problem, the Solution of which is Related to the Idea of Solving Differential Equations

A.M. Sedrakyan^{1*}, N.Z. Grigoryan², V.G. Margaryan³

¹ *National Polytechnic University of Armenia, Faculty of Applied Mathematics and Physics 105, Teryan Str., Yerevan, Republic of Armenia, 0009*

² *National Polytechnic University of Armenia, Institute of Energy and Electrical Engineering 105, Teryan St., Yerevan, Republic of Armenia, 0009*

³ *Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*

It was shown in the work that the complex motion of a material point thrown from a height with speed relative to the horizon, which is the sum of two independent motions, the solution of the well-known problem in the format of interdisciplinary communication in separate locations to the idea of the differential of the function.

It is known that one of the obvious methods of developing theoretical knowledge, mental and intellectual abilities of students (high school students) is the systematic approach and application of interdisciplinary communication during problem solving.

Therefore, the development and approach of new methodological directions for solving problems in the course of physics always remains one of the important goals of increasing the effectiveness of teaching physics. In order to understand the interdisciplinary connection, the work presents the problem of the complex movement of a material point known from kinematics, the solution of which leads to the idea of the derivative.

A body thrown at a speed relative to the horizon performs a free fall in the vertical direction, and moves along a curved trajectory in the horizontal direction. This problem was solved with ordinary simple mathematical equations without applying derivative and differential concepts.

*E – Mail: asedrakyan.phys@gmail.com

Application of Light Pressure in the Rheology of Biopolymers

S.G. Gevorkian^{1,4}, A.V. Karmenyan^{2,3*}

¹*Institute of Physics, Academia Sinica*

128, Sec. 2, Academia Rd., Nangang Dist., Taipei City 115201, Taiwan (R.O.C.)

²*Biophotonics and Molecular Imaging Research Center,*

National Yang Ming University, Taipei, Taiwan

No. 1001, Daxue Rd. East Dist., Hsinchu City 300093, Taiwan

³*Department of Physics, National Dong Hwa University, Hualien, Taiwan*

No. 1, Sec. 2, Da Hsueh Rd. Shoufeng, Hualien 974301, Taiwan, R.O.C

⁴*A. Alikhanyan National Science Laboratory*

2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

Precise measuring the deforming force and observation of the deformation dynamics along with difficulties of micro sample preparation are the main problems which make the micro-scale experiments difficult. Here we present a method for direct observation and measurements of mechanical parameters of elastic microfibrils in air using the pressure of optical light. For DNA microfibers, observation of the behavior dynamics of mechanical characteristics and the method sensitivity to changing the structure are demonstrated.

*E – Mail: artashes@mail.ndhu.edu.tw

The scientific school–conference was organized by the
Institute of Applied Problems of Physics,
National Academy of Sciences of Armenia

Editors: A.K. Atanesyan
M.S. Vasilyan

*Published by the Institute of Applied Problems of Physics, NAS of Republic of
Armenia, 25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014*

110 printed copies

ISBN 978-9939-1-1875-8



9 789939 118758