ASRP 2025

IV International Scientific School for Radiation Physics and Related Applications named after Academician Alpic Mkrtchyan

June 16 – 21, 2025
Yerevan – Gyumri, Armenia

Book of Abstracts

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Contact information:

Phone: (+374 10) 245 – 886,
(+374 10) 245 – 896
E–mail: school@iapp.am,
infoschooliapp@gmail.com
URL: http://school.iapp.am

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ASRP 2025 - Alpic School for Radiation Physics

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Lectures

Luminescence and Radiation Sensing Across a Wide Range of Doses and Dose Rates

D.A. Bradley[1,2*]

[1]Applied Physics and Radiation Technologies Group, CCDCU
Sunway University, 5 Jalan UniversitiBandar Sunway, Petaling Jaya, Malaysia, 47500
[2] School of Mathematics and Physics, University of Surrey, Stag Hill, University Campus, Guildford, United Kingdom, GU2 7XH

We are developing radioluminescence (RL) and passive light–generating systems for a range of applications, initial studies concerning doped silica optical fibers and time–resolved radiation dosimetry. Merits for biomedical interests include high spatial–and–temporal resolution, wide dynamic range, and real–time operability in various in vivo and ex vivo environments. For Ge–doped optical fibers irradiated using a linac at rates between 0.1– and 600 MU/min (and pulse durations of a few μs), linear response has been obtained with counting circuit gate times of between 50 and 100 μs, responses being largely free of the degrading effects of afterglow. Subsequent radiation processing dosimetric studies have concerned evaluation of kGy doses using undoped silica fibers of differing hydroxyl (OH) content. For electron doses from 10 to 70 kGy, greater OH content has been observed to provide the greater sensitivity while reduction in OH content leads to a shift towards longer wavelength in the peak wavelength of the RL spectrum. For the low dose regime of NORM (naturally occurring radioactive material) and contaminant depositions internal to pipework, various of the more conventional active devices have difficulty in localizing the presence of the beta active radionuclide 210Pb, most particularly in relation to downstream gas pipelines. Characterization has been made of an optical fiber system based on a LYSO:Ce scintillator, tested to–date for a range of μGy/h dose rates. Results point to a number of potential applications, not least verification of contaminant–free pipework subsequent to cleansing operations using high–pressure water jetting, also various industrial and security scenarios applications. If time allows, finally we will examine a PTFE tape photoluminescence reader combination, creating the possibility of a passive system of dosimetry in medical diagnostic applications and radon measurement evaluations.

[*]**E – Mail:** *d.a.bradley@surrey.ac.uk*

Cancer and Tissue Risks from Occupational Radiation: Impact on Safety Standards and Future Directions

A. Sulieman*

Radiology Sciences Department, College of Applied Medical Sciences,
King Saud Bin Abdulaziz University for Health Sciences,
P.O. Box 2477, Al–Ahsa, Saudi Arabia, 31982

Ionizing radiation, a classified carcinogenic agent, necessitates the implementation of robust radiation protection policies, regulations, and tools to ensure staff safety. Staff members, who work with or in proximity to radiation sources, face the risk of tissue reactions (cataracts and erythema) and cancer induction. To prevent these risks and reduce the probability of cancer and hereditary effects, international and national regulations have been developed. This work is intended to evaluate the current reported radiation risks from various medical procedures and their implications on clinical practice. It will also examine the pivotal role of regulatory limits in determining annual dose limits based on risk models. The International Atomic Energy Agency (IAEA) recommends annual dose limits of 20 mSv per year in 1991 average of over 5 years, with a maximum of 50 mSv in any single year following the International Commission on Radiological Protection (ICRP) recommendation. In the United States, the nuclear regulatory commission (NRC) has set the annual dose limit of 50 mSv (50 rem) to an individual organ or tissue other than the lens of the eye, as determined by the deep–dose equivalent and the committed dose equivalent. These limits, which include a conservative buffer to account for uncertainties in radiation risk models, ensure that most workers receive far less than 20 mSv/year due to strict workplace controls, thereby keeping radiation exposure as low as reasonably achievable (ALARA) and preventing significant health risks. The 50 mSv/year limit is well below the dose needed to cause immediate harm (typically > 500 mSv in a short time). However, the study reviewed the current reported incidence, which showed that an increasing number of interventional radiology personnel exceed the dose limits, with many tissue reactions (cataracts) and cancer incidences reported. The variation in the annual dose limits is due to reports showing no strong excess cancer risk below ~100 mSv. Both dose limits provided adequate protection for the staff, and the majority of medical practices ranged from 1.0 to 10.0 mSv per year. The improvement of the detector's technology in medical imaging, with precise X–ray beam collimation and operators' awareness, made the dose limit a ceiling rather than a target. In light of the Linear No–Threshold (LNT) model, which assumes any radiation dose can cause cancer, the future holds promise for further reduction of the annual dose based on the current reported risks and the availability of advanced imaging modalities that reduce the staff's unnecessary exposure.

* **E – Mail:** abdelmoneim_a@yahoo.com

Investigation of Surface Acoustic Waves Propagation in Solids Using X–Ray and SEM Methods

D.V. Roshchupkin*

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

Application of methods of X–ray diffraction on laboratory and synchrotron radiation sources, scanning electron microscopy (SEM) allowed to investigate the process of excitation and propagation of different types of surface acoustic waves in piezoelectric crystals (Rayleigh surface acoustic waves, pseudo–surface acoustic waves, Lamb waves).

While SEM method allows to visualize the acoustic waves in piezoelectric materials, X–ray diffraction methods allow not only to visualize acoustic wave fields in solids, but also to investigate by X–ray diffraction method and to obtain real information about the amplitudes of acoustic waves. Also X–ray diffraction methods allow us to determine the attenuation of acoustic waves along the depth of the crystal and along the direction of the surface acoustic wave propagation.

Different types of the surface acoustic waves (SAW) are excited by the same interdigital transducer (IDT), but at different frequencies. While Rayleigh surface acoustic waves are purely surface acoustic waves, pseudo–surface waves are waves that flow away deep into the crystal. Lamb waves are also excited by the same IDT, but from the opposite side of the crystal. The excitation and propagation of SAW in layered structures is also an interesting topic. The process of SAW propagation in the LiNbO3/Si bonded structure is considered. In this case IDT allows to excite the SAW in the single–crystal layer of LiNbO3, at the LiNbO3/Si interface and in the near–surface layer of Si. The SAW excitation frequencies are different because the SAW propagation velocities in different layers differ.

***E – Mail:** *rochtch@iptm.ru*

The First Station in Russia for Combining X–ray Coherent and Incoherent Methods in Geology and Geochemistry

A.S. Gogolev*

[2] National Research Tomsk Polytechnic University

30 Lenin Ave., Tomsk, Russian Federation, 634050

Overview of the undulator station 1–1 "Microfocus" SRF SKIF, including the implemented set of experimental methods, matched X–ray optical design, operating modes, experimental scenarios and expected parameters of radiation beams on the sample. Optical and thermal–mechanical solutions are substantiated, achievable spatial resolutions are estimated. The feasibility of combining "coherent" and "traditional" methods in the hard X–ray range is shown – "multimodality" of the station when studying one sample.

* **E – Mail:** *gogolev@tpu.ru*

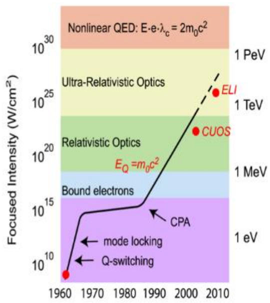
High–intensity LASER–matter Interaction

D. Giulietti*

Physics Department of the Pisa University,
Largo Bruno Pontecorvo 3, I–56127 Pisa, Italy

Experimental activity in the field of high–intensity radiation–matter interaction actually began with the creation of the first pulsed LASER (Ruby laser, 1960). In fact, only thanks to the great brightness of the LASER sources has it been possible to obtain intensities never achieved before in the waist of the focusing optics. Subsequently, the maximum achievable intensities increased in step with the evolution of the modes in which the LASER systems could work (free running, Q–switching, mode–locking) and the pulses generated in the oscillator could be amplified. It is precisely thanks to the innovative technique of amplification of ultra–short pulses (Chirped Pulse Amplification) that it is currently possible to reach intensities that exceed 10^{21} W/cm^2 on a time scale of a few tens of femtoseconds. The type of phenomena that occur in radiation–matter interaction depends not only on the intensity of the radiation, but also on the duration of the pulse. For this reason, the phenomena that occur at the typical intensities of an experiment dedicated to the physics of Inertial Confinement Fusion [1] (t ≈ns, I≈10^15 W/cm^2) are very different from those in experiments dedicated to the acceleration of particles in LASER produced plasmas [2], where the pulse durations are a few tens of femtoseconds and the intensities exceed 10^{18} W/cm^2.

The main physical processes underlying the high–intensity LASER–matter interaction, the characteristics of the plasma produced, and the multiple applications allowed will be presented.



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***E – Mail:** *danilo.giulietti@unipi.it*

Radiation Processes in Dielectric Cylindrical Waveguides

A. A. Saharian*

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

Dielectric cylindrical waveguides are widely used for confining and guiding of electromagnetic waves in relatively wide range of frequencies. They have found numerous technological and scientific applications in telecommunications, medicine, material science, photonics and quantum optics. In this presentation, we will discuss the applications of dielectric cylindrical waveguides in the generation of various types of electromagnetic radiation by charged particles interacting with the waveguide. The influence of the dielectric waveguide on the spectral and angular characteristics of the Cherenkov and synchrotron radiations is examined. It will be demonstrated that under specific conditions pertaining to the parameters of the charged particle motion strong narrow peaks emerge in the spectral and angular distributions of the radiations. We also consider the radiation by charged particles on guiding modes of cylindrical waveguide and the generation of surface polaritons. The spectral distributions of the corresponding energy losses are discussed.

***E – Mail:** *saharian@ysu.am*

Free Electron Coherent Sources and Conventional Laser Devices

G. Dattoli*

*ENEA Frascati Recreation Center Via Enrico Fermi 45 00044 Frascati (Roma***)**

Coherent sources of radiation, from "free" electrons, are playing a prominent role in Physics and applied science.

Even though they are described as "non–conventional" lasers, they share a noticeable amount of physics with atomic or molecular lasers.

In this lecture we describe the possibility of developing a unified point of view to their treatment, by introducing an appropriate set of physical quantities constituting the common threads for their analytical study.

We will not establish mere formal analogies and make an accurate analysis of the relevant physical origins.

* **E – Mail:** *pinodattoli@libero.it*

Interaction of Ultraintense Particle Beams with Dense Matter: Coherent Effects of Stopping and Radiation

A. Curcio*

Sapienza University of Rome

Piazzale Aldo Moro, 5, 00185 Roma RM, Italy

The theory of Coherent Stopping Power (CSP) of ultradense charged particle beams propagating in a dense matter is presented. CSP corresponds to a collective inelastic collision which adds to the ordinary stopping power of individual particles. Unlike the latter, which depends only on the particles' energy, CSP depends upon many more parameters such as the total charge of the ensemble and its charge density and shape. This paves the way for a broad variety of non–standard methods to tailor particle absorption and penetration in a dense matter. CSP losses can be explained both by collective excitations of single or multiple molecules and by the emission of coherent Cherenkov radiation. Given the advent of ultraintense particle sources and their use for relevant applications, CSP could be of great interest for future experiments.

* **E – Mail:** *alessandro.curcio@uniroma1.it*

Salts of Amino Acids with Dimeric, Trimeric and Tetrameric Cations: A Review

A.M. Petrosyan[1*], G. Giester[2], G.S. Tonoyan[1], M. Fleck[2], V.V. Ghazaryan[1]

[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 (UZA II) Room number 2A 254 1090 Vienna, Austria

Various kinds of amino acid salts are known, which are interesting from both fundamental and applied points of view. In the present review crystals with dimeric, trimeric and tetrameric cations are considered. Crystals and structure types of salts with dimeric cations prevail; currently the following ones have been observed: $(A^{+}\cdots A)$, $A^{+}(A^{+}\cdots A)$, $[A(1)^{+}\cdots A(2)]$, $A(1)^{+}[A(2)^{+}\cdots A(2)]$, $[A(1)^{+}[A(1)^{+}\cdots A(2)]$, $(A^{+}\cdots A^{+})$, and $(A^{2+}\cdots A^{+})$, $[A(1)^{2+}\cdots A(2)]$, where A is an amino acid and A(1), A(2) are different amino acids. Besides trimeric $(A^{+}\cdots A\cdots A^{+})$ cations also two types of tetrameric cations exist, $[A^{+}\cdots(A^{+}\cdots A)\cdots A^{+}]$ and $[2A^{+}\cdots A\cdots A^{+}]$. All these salts are characterized by strong to very strong hydrogen bonds. Some crystals exhibit ferroelectric and pyroelectric properties.

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[*]**E – Mail:** *aram.m.petrosyan@gmail.com,*
apetros@iapp.am

Coherent Cherenkov Diffraction Radiation in Super–radiant Regime

P. Karataev*

John Adams Institute at Royal Holloway, University of London
Egham, Surrey TW20 0EX, United Kingdom

Cherenkov diffraction radiation (ChDR) appears when a fast charged particle moves in the vicinity of and parallel to a dielectric interface. This is a member of polarization radiation family, because the radiation arises as a result of dynamic polarization of a medium. Coherent ChDR is generated in the wavelength range longer than or comparable to the longitudinal size of the bunch. In this case all electrons emit radiation more or less in phase stimulating each other's emission. In this case the radiation intensity is proportional to a square of bunch charge resulting in an enormous increase in the number of photons.

When the coherent ChDR is generated by a periodical sequence of bunches, the radiation fields from all bunches in a train interfere resulting in further amplification of the light at discrete frequencies defined by the accelerating (RF) frequency and its harmonics. This regime is known a super–radiant emission and can be used to produce ultra–monochromatic lines of radiation with intensity defined by single bunch length. For example, if the bunch length is a 100 fs, multi–THz frequencies can be produced. If the number of bunches in a train is a 104, relative monochromaticity of 10–4 – 10–7 can be achieved. Generating such a short bunch is rather challenging. Nevertheless, the generation mechanisms can be investigated in a lower frequency range. This lecture will summarize the experimental results obtained by our collaboration on generation of intense ultra–monochromatic ChDR radiation in mm–wavelength range.

***E – Mail:** *pavel.karataev@rhul.ac.uk*

Compton Backscattering as an X–ray Source: Present and Future

A.A. Tishchenko*

National Research Nuclear University Moscow Engineering Physics Institute
31Kashirskoe hwy., Moscow, Russian Federation, 115409

Inverse Compton scattering, or as it is often called, Compton backscattering (CB) is one of the most classical and along with that modern subjects of intensive research. In this lecture I will reach out two main areas of research into Compton backscattering.

First, this is the role of CB in astronomy as a source of information about the Universe: cosmic rays, the Sunyaev–Zeldovich effect and so on.

Second, I will talk about radiation sources based on Compton and Thomson backscattering in two variants: compact sources of relatively soft X–rays, suitable for medicine, biology and other laboratory studies and applications, and the sources of hard photons, up to gamma–rays, at large accelerator facilities. In this context, i will review the current state of the art and prospective ideas for future research, and briefly outline the latest cutting–edge ideas that are being discussed today: the possible key role of coherence, crab–crossing schemes (which result in the record luminosities in collider physics, but have not yet been realized in Compton backscattering), quantum effects, the role of superluminal sources (without violation of postulates of special relativity), and a few other interesting ideas.

***E – Mail:** *Tishchenko@mephi.ru*

One and Few–Particle Optics of Quantum Dots with Complicated Geometry

H.A. Sarkisyan*

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

In my lecture I'll present recent results of the description the optical absorption in lens–shaped ellipsoidal and conical quantum dots for single particle as well as few–particle transitions. It'll be shown that for the specific geometries of quantum dots it is possible to use adiabatic description of such systems. We show that for the pair–interacting few–particle gas we can apply some of the exactly solvable quantum mechanical models for analytical description of the intraband transitions. Some of the recent results of experiment will be discussed.

***E – Mail:** *hayk.sarkisyan@rau.am*

A 4D Monte Carlo Evaluation of Source Dynamics in HDR Brachytherapy Afterloaders

F. Moradi[1*], D.A. Bradley[2,3], H. T. Zubair[1], H.A. Abdul Rashid[1, 4]

[1]Center for Fiber Networking and Communication,
COE for Intelligent Network, Multimedia University,
Persiaran Multimedia, 63100, Cyberjaya, Selangor, Malaysia
[2]Applied Physics and Radiation Technologies Group, CCDCU,
Sunway University, 46150 PJ, Malaysia
[3]School of Mathematics and Physics, University of Surrey, Guildford, GU2 7XH, UK
[4]Faculty of Engineering Technology, University College TATI (UC TATI),
24000 Kemaman Terengganu, Malaysia

High–dose–rate (HDR) brachytherapy relies on the precise positioning of a radioactive source through applicators or needles to deliver conformal dose distributions to tumors while sparing adjacent healthy tissue. However, most conventional treatment planning systems do not explicitly model the dose contribution during the entire source transit phase, including entry into the body, movement between dwell positions, and return to the afterloader's safe position. This simplification may lead to underestimation of doses to tumour and organs at risk (OARs), particularly in anatomically complex or deeply situated treatment sites. Following the investigation of source motion in intraluminal esophageal brachytherapy, the current study broadens the scope to interstitial techniques and evaluates the impact of source speed and acceleration profiles across different commercial HDR afterloader systems. Using time–resolved (4D) Monte Carlo simulations implemented in TOPAS, realistic source trajectories were modelled to reflect clinical delivery conditions. Comparative dosimetric analysis was conducted to quantify the effects of system–specific transit behaviour on target and OAR doses. The results underscore the importance of incorporating source motion into dosimetric evaluations, as variations in device kinematics can significantly influence both therapeutic and unintended radiation exposures.

[*]**E – Mail:** *moradifarhad@ymail.com*

Radiological Procedures Frequency, Collective Effective Dose, and Cancer Risk: A Single Center Study in Saudi Arabia

A. Sulieman[1*], M. Alkhorayef[2], A. Otainy[3], D. Bradley[4,5]

[1]Radiological Sciences Department, College of Applied Medical Sciences – Al Ahsa, King Saud bin Abdulaziz University for Health Sciences, Kingdom of Saudi Arabia

[2]Department of Radiological Sciences, College of Applied Medical Sciences, King Saud University, P.O Box 10219 Riyadh 11433, Saudi Arabia

[3]Radiological Sciences Department, King Khalid Hospital, Alkharj, Saudi Arabia

[4]Applied Physics and Radiation Technologies Group, CCDCU, Sunway University, Malaysia

[5]School of Mathematics and Physics, University of Surrey, Guildford, United Kingdom

According to the World Health Organization, Saudi Arabia ranked 26th among healthcare levels globally. In 2023, over 18 million radiology procedures were conducted in public and private hospitals. This study aims to estimate radiological procedures frequency and annual collective and per capita effective dose in 2023–2024. Information was collected from King Khalid Hospital, Alkharj, Saudi Arabia. The radiological procedures, including computed tomography (CT), fluoroscopy, and interventional radiology (IR) procedures, were investigated. The collective effective dose was estimated using established Saudi Food and Drug Administration (SFDA) dose coefficients and procedure–specific frequency data. Subsequently, the attributable lifetime cancer risk was calculated based on current risk models and population demographics proposed by the International Commission on Radiological Protection (ICRP). The annual number of examinations was 500 thousand radiographic X–ray procedures (23% were CT procedures, representing 80% of the collective dose). The total collective per procedure is 1.2 mSv, resulting in the cancer risk of 1 cancer per 105 procedures, on average. The study revealed that 17% of radiographic procedures are not adequately justified, and 28% of the patient doses are higher than the institutional diagnostic reference level. The study revealed that proper justification and optimization can reduce the collective dose by up to 45%. The study highlights the importance of optimizing radiation protection practices and implementing strategies to minimize unnecessary exposure in the Saudi Arabian population. Furthermore, this study provides valuable baseline data for future risk assessments and the development of evidence–based policies to ensure the safe and effective use of radiological procedures.

[*]**E – Mail:** *abdelmoneim_a@yahoo.com*

Light in Dark Places, Radiation Sensing and Extremes: Carbonaceous Media for Luminescence–Based Surface Dosimetry

D.A. Bradley[1,2*]

[1]Applied Physics and Radiation Technologies Group,
CCDCUSunway University,
5 Jalan UniversitiBandar Sunway, Petaling Jaya, Malaysia, 47500
[2] School of Mathematics and Physics, University of Surrey, Stag Hill, University Campus,
Guildford, United Kingdom, GU2 7XH

Present work continues research into the viability of commercially available small dimension carbonaceous media for ionizing radiation dosimetry and radiation damage studies, in part examining the relationship between structural alterations, surface–area–to–volume ratio and carbon content. Dose dependency characterizations have been undertaken for rods and sheets for a range of sources, energies and dose, as for example in determining responses in use of Co^{60} irradiations delivering doses from 0.5 Gy to 20 Gy. Dependency variation can be viewed using a range of dose–sensitive techniques, including the Raman intensity ratio ID/IG, with D signifying defect density and G that of graphite, the ratio reflecting the dominating effect of defect generation and dose–driven defect annealing. Of the various media investigated, that possesing the greatest surface area–to–volume ratio perhaps unsurprisingly also exhibits the greatest thermoluminescence yield per unit mass. In respect of medical dosimetry, we have sought to confront the challenge posed in matching skin thickness with skin dose, the near tissue equivalence of several promising skin dosimeters also being discussed.

[*]**E – Mail:** *d.a.bradley@surrey.ac.uk*

Replicating Blazed Si Diffraction Gratings for the X–ray Range

L.I. Goray[1,2,3,4,*], D.V. Mokhov[1,2], T.N. Berezovskaya[2], A.V. Uvarov[2], K.Yu. Shubina[2], N.D. Prasolov[5], N.A. Kostromin[1,2], S.A. Dashkov[1,2], A.D. Buravleuv[1,2,3,5]

[1]Saint Petersburg Electrotechnical University,
5 Professor Popov Str., St. Petersburg, Russian Federation, 197022
[2]Alferov University, 8/3 Khlopin Str., Let. 'A', St. Petersburg, Russian Federation, 194021
[3]Institute for Analytical Instrumentation,
31–33 Ivana Chernykh Str., Let. 'A', St. Petersburg, Russian Federation 198095
[4]Space Research Institute of the Russian Academy of Sciences (IKI)
84/32 Profsoyuznaya Str., Moscow, Russian Federation, 117997
[5]Ioffe Institute of the Russian Academy of Sciences
26 Polytekhnicheskaya Str., Russian Federation, 194021

There are two principal ways to achieve ultra–high spectral resolution and maximal diffraction efficiency by blazed (with triangular groove profiles) gratings in the short–wave range (from hard X–rays to vacuum UV): (1) using high–orders diffraction with low and medium groove densities; (2) using first–orders diffraction with high and ultra–high groove densities. Due to the hard–to–solve problem of removing nubs obtained on monocrystal silicon grooves during anisotropic wet etching, most studies focused on the development of the most promising Si gratings with a blaze with small and ultra–small periods. Our group has made progress in fabricating and testing master blazed gratings operating in high orders and having the record efficiency. However, the production of high–quality large–size master gratings with any groove frequency is still a very complex technological task.

In order to accurately transfer shallow triangular reliefs and preserve perfect characteristics of masters of X–ray (short–wave) Si gratings during copying, we use atomic–level contactless methods of applying inorganic materials to the surface of the master grating grooves. To obtain a replica of a Si grating, thermally sprayed Au is used as a transfer layer, since it has poor adhesion to silicon and has good adhesion to metal, which serves as the material of the filling layer. In addition, gold is widely used as a reflective coating in the X–ray and IR ranges. We also selected galvanically applied Au as the material of the filling (alignment) layer, which allowed us to fill the profile and obtain a leveled plane for gluing. As a result, a gold grating is glued to the silicon substrate of the copy and mechanically separated from the Si grating master.

[*]**E – Mail:** *lig@pcgrate.com*

Radiation of Relativistic Electrons in Spherically Symmetric Media

L.Sh. Grigoryan[1*], **S. Dabagov**[2], **A.A. Saharian**[1], **K.S. Aramyan**[1], **H.F. Khachatryan**[1]

[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]*INFN Laboratori Nazionali di Frascati, 40 Via E. Fermi, Frascati (RM), Italy, I–00044*

The relaxation of the polarization of the medium as a result of interaction with charged particles leads to the formation of various types of radiation processes. Examples that have been studied in detail in the literature include Cherenkov radiation (CR), transition radiation, and diffraction radiation. The radiation processes mentioned above are also sources of electromagnetic radiation with controllable characteristics in different frequency ranges. In this presentation, we will discuss the peculiarities of electromagnetic field generated by charged particles or bunches moving along various trajectories in spherically symmetric layered media. Specifically, it has been demonstrated that the impact of boundaries on radiation processes can exhibit a resonant character.

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

[*]**E – Mail:** *levonshg@mail.ru*

New Acceleration Techniques Based on Laser–Produced Plasmas

D. Giulietti*

Physics Department of the Pisa University,
Largo Bruno Pontecorvo 3, I–56127 Pisa, Italy

When the Chirped Pulse Amplification allowed to amplify ultrashort laser pulses (mode–locking generated), it became possible to use the intense electric fields of the plasma electron waves (excited by those pulses) to accelerate electrons up to a few GeV on centimeter scale.

However, it can be said that laser–plasma acceleration was born by chance, during the first experiments in which the absorption processes (and related phenomena) of ultrashort and ultra–intense laser pulses in plasmas were investigated, within the framework of activities of interest for Inertial Confinement Fusion [1]. In fact, the very short duration of the pulses (≈30fs) spontaneously induced the excitation of electron plasma waves at densities of $\approx 10^{18}$ cm^3, at which accelerating electric fields of up to 10^9 V/cm can be generated. This is a quasi–resonant excitation mechanism, produced by ponderomotive forces, which occurs when the duration of the laser pulse is approximately half the oscillation period of the wave tL ≈ Tp/2, or tL·c ≈ lp/2 [2]. The experiments that followed have highlighted how it is possible, with the same duration of the laser pulse, to excite electronic plasma waves even at slightly higher densities, provided that the intensity of the radiation is sufficiently high. The possibilities offered by this new acceleration technique, thanks to its compactness and consequent cost–effectiveness compared to the classic techniques based on the use of RF cavities, have stimulated research activities in this field throughout the world. In Italy, following successful experiments conducted at the Ecole Polytechnique by a group of researchers from Pisa University, the INFN launched a Strategic Project (PLASma Acceleration and MONochromatic X–ray radiation, PLASMONX) through which it equipped itself, at the LNF, with the first electron accelerator based on laser–produced plasmas [3]. It is thanks to this pioneering activity that INFN was subsequently involved in European projects such as ELI, HiPER and more recently EuPRAXIA. Currently the main effort being made is to extend the acceleration length and to reduce the energy spread and divergence of the accelerated electron bunch. Among the most promising activities regarding the extension of the acceleration length is that in which one tries to produce a plasma (several centimeter long) produced by an electric discharge inside a capillary [4, 5].

***E – Mail:** *danilo.giulietti@unipi.it*

The physical mechanisms on which is based the Laser Plasma Acceleration, and the related applications will be presented.

Reference.

1. D. Giulietti, et al., Phys.Rev.Lett., 79, 1997, 3194.
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Advanced Electron Sources for Novel Radiotherapy Applications

L. Giuliano*

Sapienza University of Rome

Piazzale Aldo Moro, 5, 00185 Roma RM, Italy

FLASH radiotherapy is an emerging and highly promising technique in cancer treatment that delivers ultra–high dose rate radiation in extremely short pulses—typically within milliseconds. This novel mode of dose delivery triggers the so–called FLASH effect, which has demonstrated the remarkable ability to spare healthy tissues while maintaining effective tumor control, potentially revolutionizing the therapeutic ratio in radiotherapy.

In this lecture, we will explore the origins and current understanding of the FLASH effect from both biological and physical perspectives, analyzing the key parameters — such as dose rate, total dose, and pulse structure — that govern its onset. Special attention will be given to recent advancements in electron radiation sources specifically designed or adapted for FLASH applications, including developments in accelerator technology and experimental setups.

* **E – Mail:** *lucia.giuliano@uniroma1.it*

Investigation of the Possibility of Transferring Excess Heat from a Working Nuclear Power Plant to the Ground under Lunar Conditions

P.A. Alexandrov[1*], A.V. Beklemisheva[1], I.F. Sotnikov[1], V.A. Kirsh[1]

National Research Centre "Kurchatov Institute"
1 Akademika Kurchatova Sq., Moscow, Russian Federation, 123182

It is supposed to heat the Lunar soil with water vapor, which is obtained by contact heating of the soil. According to published data, water in the form of ice makes up from 5% to 30% of the lunar soil by mass. The soil in cold traps is at a temperature of – 200 ℃ and as a result heats up to 200 ℃ and is ejected (not a closed contour along the ground).

[*] **E – Mail:** *Alexandrov_PA@nrcki.ru*

Abstracts

Quantum–Mechanical Description of a Single Photon Moving in a Nanofiber with Scattering by Randomly Located Quantum Dots

A.S. Gevorkyan[1,2*]

[1]Institute for Informatics and Automation Problems
of the National Academy of Sciences of the Republic of Armenia,
1 P. Sevak Str., Yerevan, Republic of Armenia, 0014
[2] A. B. Nalbandyan Institute of Chemical Physics
of the National Academy of Sciences of the Republic of Armenia
5/2 P. Sevak Str., Yerevan, Republic of Armenia, 0014

Until now, the quantum–mechanical theory of the photon has not been sufficiently developed; moreover, the wave function of the photon is often considered a contradictory concept. For the photon, there is only the quantum theory of electromagnetic radiation, which, except for the frequency or wavelength, does not provide any other information about the spacetime structure and other properties of the photon. The main reason for the difficulties is that photons are never non–relativistic and can be freely emitted and absorbed in a medium, so there is no law of conservation of the number of photons, which makes its description within the usual paradigm of quantum mechanics, if not impossible, then extremely difficult. Meanwhile, theoretical attempts to determine the wave functions of the photon have a rich history and date back to the time of the formation of quantum mechanics itself. It is important to note that quantum mechanics, which seeks to give a complete description of various natural phenomena, must have not only a qualitative but also a quantitative description of the wave function of such a fundamental physical particle as a photon. The problem is becoming increasingly important due to the rapid growth in the number of experiments on the generation and detection of single photons, related to such important areas as quantum computing and quantum cryptography, quantum measurements, quantum communications, and other ultra–sensitive quantum technologies, itc.

Within the framework of the Langevin–Klein–Gordon–Fock type equation, the motion of a single photon in a waveguide with randomly located quantum dots is considered. The evolution of the photon wave function is studied in detail, taking into account multiple elastic and inelastic scatterings that occur with it during propagation in a waveguide. Mathematical expectations of the probabilities of transitions to Bell states are constructed in the form of integral representations.

[*]**E – Mail:** *g_ashot@sci.am*

Geometric Resonance and Dispersion Relations

M.I. Ivanyan[1*], **B.A. Grigoryan**[1], **A.H. Grigoryan**[1, 2], **L.V. Aslyan**[1], **V.Sh. Avagyan**[1,3], **A.S. Vardanyan**[1], **V.G. Khachatryan**[1]

[1] *Center for the Advancement of Natural Discoveries using Light Emission (CANDLE) Synchrotron Research Institute*
31, Acharyan Str., Yerevan, Republic of Armenia 0022
[2]*Yerevan State University, 1 Alex Manoogian Street, Yerevan, Armenia, 0025,*
[3]*A. Alikhanian National Scientific Laboratory (Yerevan Physics Institute),*
2 Alikhanian Brothers Street, Yerevan, Armenia, 0036

When a charged point particle moves parallel to the axis of a two–layer cylindrical metal–dielectric waveguide with a sufficiently small thickness of the internal dielectric coating, its radiation field has a single–mode character, i.e., the frequency distributions of both the longitudinal and transverse impedances of the waveguide contain a single, clearly expressed narrow–band resonance. However, at frequencies significantly exceeding the main resonant frequency, a sequence of low–amplitude secondary resonances is detected, which, nevertheless, due to their low amplitude, do not violate the single–resonance character of the radiation as a whole. The article examines the patterns of occurrence of the mentioned side resonances, in particular, their geometric nature is revealed: the location of their resonant frequencies is completely determined by the thickness of the dielectric coating and the value of its dielectric constant and does not depend on either the radius of the waveguide or the ordinal number of the multipole component of the expansion of the radiation field. It is shown that the "geometric" resonance frequencies generated by particle radiation in a two–layer cylindrical metal–dielectric waveguide in the case of a perfectly conducting outer wall coated from the inside with a dispersion–free dielectric layer correspond to singularities in the dispersion relations of the eigenmodes of the same waveguide, which determine the discontinuous nature of their solutions at resonance frequencies. Replacing the perfectly conducting wall with a wall with a highly conducting metal leads to the elimination of singularities in the dispersion relations and to the occurrence of perturbations on the dispersion curves at the same frequencies.

[*]**E – Mail:** *ivanian@asls.candle.am*

Study of the influence of ultrasonic radiation on aqueous solutions of methane, ethylene and their mixtures

A.H. Davtyan[1], N.M. Poghosyan[1], S.D. Arsentev[1*], R.Yu. Chilingaryan[2], A.S. Abrahamyan[2]

[1]Institute of Chemical Physics after A.B. Nalbandyan
of the National Academy of Sciences of the Republic of Armenia
5/2 Paruyr Sevak Str., Yerevan, Republic of Armenia 0014
[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

One of the methods of influencing chemical reactions is the use of ultrasound. In this case, most chemical reactions in ultrasonic fields occur in aqueous solutions in the presence of cavitation. It is known that under the influence of cavitation, the direction and speed of chemical reactions occurring in a solution can change significantly. In a number of cases, processes may occur that are not feasible under normal conditions.

Wide opportunities may open up when hydrocarbon oxidation processes are carried out under such extraordinary conditions (temperatures up to 20.000℃; pressures of several thousand bar, and heating and cooling rates of >1000℃ s^{-1}).

The aim of this work is to study the kinetic regularities of oxidative conversion of methane, ethylene and their mixtures under the influence of ultrasound on their aqueous solutions in the absence and presence of oxygen.

The transformation of methane, ethylene and their mixtures in aqueous solutions under the influence of ultrasonic radiation with a frequency of 22 and 44 kHz under cavitation conditions was studied. It was found that formaldehyde, which is the main product, is formed even if there is no dissolved oxygen in the initial solution. This fact proves that under the influence of cavitation, methane and ethylene can directly interact with water. It was shown that the rate of accumulation of formaldehyde depends on the power of the supplied ultrasonic radiation, radiation frequency and the amount of molecular oxygen introduced into the system.

Based on quantum chemical calculations a possible scheme for the formation of formaldehyde is proposed.

[*]**E – Mail:** *arsentiev53@mail.ru*

Polyiodide of Dimethylglycine (DMG–½H···½H–DMG)(I_3)(I_2)

V.V. Ghazaryan[1*], **G. Giester**[2], **G.S. Tonoyan**[1], **A.M. Petrosyan**

[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 (UZA II) Room number 2A 254 1090 Vienna, Austria

Polyiodides have emerged as compounds of interest both for their practical application and in the context of supramolecular chemistry. In the synthesis of halogenometallates the incorporation of polyiodide anions leads to an increase of absorption in the visible region and helps to achieve a narrower bandgap which was additional motivation to investigate polyiodides independently. We have previously reported on polyiodides of betaine, L–proline, L–arginine and L–cystine. In the present work the salt of dimethylglycine (DMG–H–DMG)(I_3)(I_2), crystallizing in the monoclinic space group *C*2/*c*, is studied. The structure exhibits a symmetric dimeric cation of dimethylglycine formed through strong hydrogen bonding with a short O···O distance of 2.459(3) Å. In this O–H···O moiety the hydrogen atom position is disordered and split into two positions separated by a two–fold axis, each with a 50% H–atom occupancy. The compound further contains a triiodide anion (centered at the Wyckoff position 4d with site symmetry $\bar{1}$) and a diatomic iodine (centered around a 2–fold axis). The compound features an ordered chain arrangement of cations stabilized via aforementioned hydrogen contact as well as N–H···O hydrogen bonds. The powder of black, shiny crystals exhibits strong absorption in the UV–Vis region, thus exhibiting narrow bandgaps of 1.87 eV and 1.62 eV for direct and indirect transitions, respectively.

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*E – Mail: *vahram.ghazar@gmail.com*

Halogenostannates of Glycine, Sarcosine, Dimethylglycine, Betaine and β–alanine

G.S. Tonoyan[1*], **G. Giester [2]**, **A.M. Petrosyan[1]**

[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 (UZA II) Room number 2A 254 1090 Vienna, Austria

Halide organic–inorganic materials were classified as attractive semiconducting materials. Such hybrid materials with amino acids are proposed for this aim. Among these, halogenostannates demonstrated an unprecedented level of tunability in bandgaps across the entire visible spectrum [1]. We hereby present seven new halogenostannates with amino acids glycine (Gly), sarcosine (Sar), dimethylglycine (DMG), betaine (Bet) and β–alanine (β–Ala): $(GlyH)_2SnBr_6·2H_2O$ (*s.g.* $P2_1/c$, Z=2), $(SarH···SarH)_2SnBr_6$ (*s.g.* $P\bar{1}$, Z=1), $(DMGH)_2SnBr_6·2H_2O$ (*s.g.* $P2_1/n$, Z=2), $(BetH···BeH)_2SnBr_6$ (*s.g.* $P2_1$/n, Z=2), (β–AlaH···β–AlaH)$_2$SnBr$_6$ (*s.g.* $P2_1$/n, Z=4), (β–AlaH)$_2$SnCl$_6$ (*s.g.* $P2_1/c$, Z=4), (β–AlaH)$_2$SnCl$_4$ (*s.g.* $P2_1/m$, Z=2) and $(SarH)_2SnCl_4$ (*s.g.* $C2/c$, Z=4). In salts $(GlyH)_2SnBr_6·2H_2O$, $(SarH···SarH)_2SnBr_6$, $(DMGH)_2SnBr_6·2H_2O$, $(BetH···BeH)_2SnBr_6$, (β–AlaH···β–AlaH)$_2$SnBr$_6$ and (β–AlaH)$_2$SnCl$_6$ anions have zero–dimensional (0D) structure, while in (β–AlaH)$_2$SnCl$_4$ and $(SarH)_2SnCl_4$ anions have one–dimensional (1D) structure. In the structures of $(SarH···SarH)_2SnBr_6$, $(BetH···BeH)_2SnBr_6$ and (β–AlaH···β–AlaH)$_2$SnBr$_6$, an $(A^+···A^+)$ type dimeric cation exists.

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[*]**E – Mail:** *itonoyan1@gmail.com*

Sonochemical Synthesis of Copper Nanomaterials from 3D Printing Waste

L. Anjo[1*], **G. Davoodi**[2*]

[1]*Center for the Advancement of Natural Discoveries using Light Emission (CANDLE)*
Synchrotron Research Institute
31, Acharyan Str., Yerevan, Republic of Armenia 0022
[2]*Armenian National Agrarian University*
74 Vahan Teryan Str., Yerevan, Republic of Armenia, 0009

Additive manufacturing (AM) waste high in copper was employed as an eco–friendly precursor in this study for the formation of luminescent copper–containing nanomaterials. The sonochemical process using a bath–type ultrasonic reactor (40 minutes, 99% power) was applied to convert 3D–printing metallic waste into nanostructures based on oxides using acoustic cavitation. Three different additive systems, namely polyvinylpyrrolidone (PVP), barium peroxide (BaO_2), and iminodiacetic acid (IDA), were screened for regulating nucleation, oxidation, and stabilization. Morphological analysis by Scanning Electron Microscopy (SEM) revealed a transition from micrometer–sized spherical grains to densely packed, homogeneous nanofibers, consistent with additive complexity. Energy Dispersive X–ray Spectroscopy (EDS) confirmed near–stoichiometric Cu:O ratios. Photoluminescence (PL) spectroscopy under excitation with 370 nm and 400 nm wavelengths exhibited strong broad blue emission with a maximum at approximately 424–430 nm. All these effects can be attributed to redox–mediated cavitation. The increased PL, nanoscale tunability, and compositional tunability indicate high promise for optoelectronic and photocatalytic uses. Ultrasonic irradiation, as an acoustic wave–based method to tune nanoscale morphology, enhance photoluminescence, and compositional control suggest promising applications in optoelectronics and photocatalysis.

[*]**E – Mail:** *anjo@asls.candle.am*
[*]**E – Mail:** *Gevick.davoodi@gmail.com*

Vibrational Spectroscopy of Chlorinated and Dechlorinated Graphene Layers

H.I. Badalyan[1*], T.V. Ohanyan[1], E. Aleksanyan[1], A. Hovhannisyan[2], A. Harutyunyan[2], N.B. Margaryan[1]

[1]A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

[2]The Scientific and Technological Center of Organic and Pharmaceutical Chemistry, 26 Azatutian Str., Yerevan, Republic of Armenia, 0014

Graphene, a single–layer carbon lattice, exhibits outstanding mechanical, electronic, and thermal properties [1, 2]. We developed a liquid–phase chlorination method to covalently attach Cl atoms to graphene, confirmed by Raman and FTIR spectroscopy [3]. We also investigated dechlorination via targeted proton–beam irradiation, which restores the graphene lattice. Raman metrics—D/G–band shifts, 2D/G ratios, and defect peaks—clearly track both chlorination and dechlorination. Complementary Raman mapping, zeta–potential, and I–V profiling reveal changes in spatial uniformity, surface charge, and transport behavior. This approach enables defect–tunable, radiation–resistant graphene devices, highlighting Raman spectroscopy as a key tool for process control and nanoscale functionalization.

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[*]**E – Mail:** *hovhannes.badalyan@aanl.am*

The Effect of Ultrasound Radiation on Potassium Iodide Solutions

A.H. Davtyan*, **S.D. Arsentev, H.A. Harutyunyan**

Institute of Chemical Physics after A.B. Nalbandyan
of the National Academy of Sciences of the Republic of Armenia
5/2 Paruyr Sevak Str., Yerevan, Republic of Armenia 0014

The introduction of ultrasonic vibrations into aqueous solutions can lead to the emergence of cavitation, which is expressed in the emergence and collapse of vapor–gas bubbles, under certain conditions. In this case, the relatively low average energy of ultrasonic vibrations is concentrated in a small volume of vapor–gas bubbles, reaching high values. As a result, high temperatures (on the order of several thousand degrees) and high pressures (hundreds of atmospheres) are realized inside the vapor–gas bubbles. In a number of cases, processes that are impossible under normal conditions may occur.

The study of the effect of ultrasound on an aqueous solution of potassium iodide was carried out at ultrasound frequencies ν = 22 and 44 kHz. The development of the process was monitored by the amount of molecular iodine accumulating in the solution.

It was shown that when an aqueous solution of potassium iodide was exposed to ultrasound radiation, it was found that if cavitation occurs, the I^- ions are reduced to molecular iodine. In this case, the process of iodine release occurs in an oscillatory mode. It has been shown that the rate of iodine release and its maximum concentration depend on the ultrasound intensity, the concentration of potassium iodide solution and the ultrasound frequency. Moreover, increasing the concentration of potassium iodide in the initial solution above 5–6% does not lead to a further increase in the concentration of the formed iodine. The dependence of the maximum iodine concentration on the amplitude of the waveguide end oscillations is nonlinear and average rate of accumulation in the solution of molecular iodine is maximum at an oscillation amplitude of the waveguide end of 17–24 mkm.

* **E – Mail:** *aramdav@ichph.sci.am*

Cherenkov Radiation from Transparent Plate for Beam Diagnostics

A. Potylitsyn[1], D. Shkitov[1], A. Vukolov[1], A. Baldin[2], V. Bleko[2], V. Bleko[2], V. Kobets[2], P. Karataev[3], Yu. Cherepennikov[1,4], M. Shevelev[1*]

[2]National Research Tomsk Polytechnic University

30 Lenin Ave., Tomsk, Russian Federation, 634050

[2]Joint Institute for Nuclear Research

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

[3]John Adams Institute at Royal Holloway, University of London

Egham, Surrey TW20 0EX, United Kingdom

[4]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

Optical beam diagnostics based on transition radiation (TR) is widely used to measure both transverse and longitudinal bunch sizes. However, in installations based on modern acceleration techniques (laser–plasma, etc.), the intensity of the resulting beam may be insufficient for TR diagnostics. The application of alternative, more intense radiation mechanisms will improve the accuracy of optical diagnostic methods, particularly in low–intensity beam diagnostics.

This report presents the results of detailed studies comparing the characteristics of Cherenkov radiation (ChR) with traditional TR in the context of beam diagnostics.

The experiment was carried out using an electron beam from the LINAC–200 accelerator with an energy of 18 MeV. Radiation detection was performed at an angle of 90 degrees relative to the electron beam using the TAMRON lens with a focal length of 18–400 mm and a CCD camera. The TR and ChR targets used were an aluminized silicon wafer and a corundum plate (0.5 mm thickness). When focusing “on the target”, the dimensions of the “light footprint” of a collimated electron beam with a diameter of 5 mm on both targets were measured.

The shape of both footprints was approximated by a Gaussian in the vertical and horizontal directions with parameters $\sigma v=\sigma h=1.97$ mm (TR target) and $\sigma v=5.02$ mm and $\sigma h=2.16$ mm (ChR radiator). The registaered intensity of TR and ChR was determined after subtracting the “background” contribution. As a result, the ratio between the photon yield of TR and ChR was 1:9.6. This result agrees reasonably with theoretical calculations.

[*]**E – Mail:** *mvshev@tpu.ru*

Observation of Coherent Cherenkov Radiation from a Pair of Electron Bunches at the AREAL Accelerator

P.V. Karataev[1], L.Sh. Grigoryan[2], Yu.M. Cherepennikov[2], B.A. Grigoryan[3], A.S. Vardanyan[3], H.D. Davtyan[3], A.S. Yeremyan[3], H.F. Khachatryan[2], V.V. Margaryan[2], S.G. Khosrovyan[2*], I. Kishin[4], E. Kidanova[4] V.R. Kocharyan[2]

[1]John Adams Institute at Royal Holloway, University of London, Egham, Surrey, TW20 0EX, UK

[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

[3] Center for the Advancement of Natural Discoveries using Light Emission

(CANDLE) Synchrotron Research Institute

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

The results of an experimental study of the spectral distribution of coherent Cherenkov radiation from a pair of electron bunches at the AREAL Accelerator are presented. As a target, a cylindrical Teflon resonator is used. Coherent effects were studied depending on the distance between the bunches, which varied from 2 to 11 ps. Radiation was recorded using QOD (Broadband Quasi– Optical Detector based Schottky Barrier Diode), designed for frequencies ranging from 30 to 1000 GHz. The obtained results were compared with previous experimental data and theoretical estimates.

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[*]**E – Mail:** *sonyakhosrovyan@mail.ru*

Peculiarities of Radiation of a Relativistic Electron Passing Through a Dielectric Ball

L.Sh. Grigoryan, A.A. Saharian, G.V. Margaryan*, J.P. Markosyan, H.P. Harutyunyan, 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

We present the results of theoretical and Geant4 simulations studies of the spectral and angular distributions of the radiation generated by a charged particle crossing a dielectric ball embedded in vacuum. For non–dispersive dielectric ball, it has previously been demonstrated that, for specific values of the problem parameters, the radiation exhibits a resonant character in narrow frequency ranges. In the present presentation we show that, when dispersion is taken into account, the generation of powerful radiation in a fairly wide frequency range becomes a possibility. The results of Geant4 simulations are also provided for a more realistic case of an electron flying through a vacuum channel in a dielectric ball.

The work was partially supported by the Science Committee of RA, in the frames of the research project № 25RG–1C157.

* **E – Mail:** *gayanamargaryan3@gmail.com*

Energy Fluxes for Surface Polaritons Emitted by Annular Beams in Cylindrical Waveguides

G.V. Chalyan[1*], **A.A. Saharian**[1,2], **S.J. Sargsyan**[1]

[1]*Institute of Physics, Yerevan State University,*
1 Alex Manoogian St., Yerevan, Republic of Armenia, 0025
[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

We investigate the radiation emitted by a circular annular electron beam propagating parallel to the axis of a dielectric cylinder embedded in a homogeneous medium. Expressions are provided for the potentials and the strengths of the electric and magnetic fields inside and outside the cylinder, considering a general dispersion relation for the two media. The energy flux through the plane perpendicular to the waveguide axis is evaluated. It is shown that in the medium with negative dielectric permittivity the direction of the energy flux is opposite to the direction of the beam motion. Numerical results are provided for the spectral distribution of the energy flux, using the Drude model for dielectric response.

[*] **E – Mail:** *gorchalyan@gmail.com*

Studies of the Characteristics of the Extended Quasar 0735+17 on the Distribution of Extragalactic Sources around it

V. A. Hovhannisyan[1,2*], M. A. Hovhannisyan[1], S. A. Mkhitaryan[1], L. A. Mahtesyan[1], A.P. Mahtessian[3]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia
25 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2] *Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*
[3]*Byurakan 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

The identifications of radio sources with angular sizes greater than 20'; with quasars are not definite. Quasars cannot be radio sources with such large dimensions. They are very compact not only in the optical domain but also in the radio domain. The reason these radio sources are identified with quasars is due to the presence of a compact radio source within the extended radio source, which is identified with a specific quasar. The work presents the spectral and structural characteristics of the 0735+17 quasar. We also describe the distribution of other quasars around this quasar. A large number of quasars are found within a 6–degree radius of 0735+17, which is sufficient for statistical analysis. The data on the distribution of quasars in that area do not support the assumption that the quasars are homogenously distributed. However, it is equally difficult to conclude that the distribution is not homogeneous.

[*]**E – Mail:** *vahehovhannisyan173@gmail.com*

Evaluating Radiation Safety in SPECT/CT Lymphoscintigraphy: CT Dose Monitoring and Documentation Gaps

H. Salah[1*], A Sulieman[2]

[1]*INAYA Medical College, Nuclear Medicine Department, Riyadh, Saudi Arabia*
[2]*Department of Radiological Sciences, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences*
P.O. Box 2477, Al–Ahsa, Al Hofuf 31982, Saudi Arabia

This study assesses radiation doses from the CT component of SPECT/CT scans used in lymphoscintigraphy procedures at a single institution. Data from 130 patients were analyzed, focusing on CT dose metrics, including CTDIvol, SSDE, and DLP, alongside technical parameters such as tube current, collimation, and pitch. Results showed an average CTDIvol of 2.07 ± 1.25 mGy (range: 0.08–7.11 mGy), DLP of 81.01 ± 62.15 mGy·cm (range: 3.38–264.58 mGy·cm), and SSDE of 4.97 ± 1.35 mGy (range: 3.14–8.25 mGy). Fixed tube voltage (130 kV) and variable tube current (mean: 65.41 mA, max: 195 mA) were observed, with collimation and pitch tailored to protocols. The CT doses align with diagnostic reference levels, suggesting adherence to safety standards. These findings emphasize protocol optimization and standardized reporting to ensure patient safety while maintaining diagnostic efficacy in hybrid SPECT/CT imaging.

[*]**E – Mail:** *hassan.salah.ibrahim1@gmail.com*

Evaluation of Pediatric Radiation Effective Dose and Cancer Risks during Computed Tomography Examinations

M. Albogami[1*], A. Suliemani[2], M. Alkhorayef[3], D. Bradley[4,5]

[1]*Radiology Department, Alnakheel Medical Center, Riyadh, Saudi Arabia*

[2]*Radiology Sciences Department, College of Applied Medical Sciences, King Saud Bin Abdulaziz University for Health Sciences, P.O. Box 2477, Al–Ahsa 31982, Saudi Arabia*

[3]*Department of Radiological Sciences, College of Applied Medical Sciences, King Saud University, P.O Box 10219 Riyadh 11433, Saudi Arabia*

[4]*Applied Physics and Radiation Technologies Group, CCDCU, Sunway University, Malaysia*

[5]*School of Mathematics and Physics, University of Surrey, Guildford, United Kingdom*

Computed tomography (CT) is a vital diagnostic tool in paediatric medicine, but its associated ionizing radiation raises concerns about long–term cancer risks. Children are particularly vulnerable due to their rapidly dividing cells and longer life expectancy for radiation–induced effects to manifest. Epidemiological studies, including extensive cohort analyses, suggest a small but statistically significant increase in cancer incidence, particularly leukaemia and brain tumours, following paediatric CT exposure, with risk proportional to cumulative radiation dose. Therefore, protecting them from radiation exposure is essential to minimize cancer risk and prevent deterministic effects. This study estimates the effective dose from paediatric computed tomography (CT) brain, head, neck, and abdomen procedures. Over nine months, 145 CT procedures were conducted during six months at King Khalid Hospital Alkharj. The overall mean and range of patients' age (y) are 5 (1.1–12.5). The mean dose length product (DLP), in mGy.cm, and volume CT index (CTDIvol, in mGy) were 450 and 26 per CT procedure for age groups 0 ≤5.0 and 6.0 ≤12.5 years, respectively. The study revealed that 5.7% and 10.3% were higher than the national Saudi Diagnostic Reference Level (DRL). The effective dose per procedure ranged from 3.6 to 7.2 mSv resulting in cancer risk probability up to 1 per 104 CT procedure. Therefore, it is recommended that the scan length be reduced to ensure that patients receive the lowest possible radiation dose while maintaining the image quality. Optimizing the radiation dose is necessary by using the lowest possible dose to obtain diagnostic–quality images. It is crucial to stress the need for precisely adjusting CT scan parameters to the child's size and specific clinical needs to reduce the projected carcinogenic risks and provide individualized care.

[*]**E – Mail:** *mohbgmi@hotmail.com*

Cyclotron Production of Medical Isotope ^{124}Sb

T.M. Bakhshiyan[1,2*], N.S. Gharibyan[1,2], G.H. Hovhannisyan[2]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia,
25 Hrachya Nersisyan, Yerevan, Armenia, 0014
[2]*Yerevan State University, 1 Alex Manoogian Str., Yerevan, Republic of Armenia, 0025*

Antimony–124 (^{124}Sb) is a promising radionuclide for medical applications, particularly in low–dose rate intravascular brachytherapy (IVBT), due to its unique nuclear characteristics. High–energy β–particles (1–2 MeV and higher) are effective for local tumor or restenosis treatment. Low–energy γ–rays (20–300 keV) are suitable for imaging, dosimetry, and monitoring the treatment process without significant deep tissue penetration. Researches indicate that it can be successfully used to prevent recurrent restenosis of blood vessels, which accrue after invasive angioplasty.

We investigated proton–induced nuclear reactions on enriched tin ^{124}Sn (91.9%). The cross–sections were measured up to an energy of 18 MeV using the stacked–foil activation technique. The measurements were performed at the CYCLON 18/18 cyclotron in Yerevan, Armenia.

Besides measuring the production cross–section of the ^{124}Sb isotope ($T_{1/2}$ = 60.2 d), formed in the $^{124}Sn(p,n)$ reaction, we also measured the cross sections of the reactions $^{124}Sn(p,pn)^{123m}Sn$ ($T_{1/2}$ = 40.06 min) and $^{124}Sn(p,3n)^{122}Sb$ ($T_{1/2}$ = 2.72 d). The excitation function of the $^{124}Sn(p,n)^{124}Sb$ reaction has a maximum at 8–9 MeV, and the influence of the ^{122}Sb impurity can be easily avoided by choosing an initial beam energy of less than 16.96 MeV. The co–produced ^{123m}Sn isotope is short–lived.

However, the presence of a small impurity (2.4%) of the ^{122}Sn isotope in the target material resulted in a strongly pronounced gamma line at 158 keV (the interference line of ^{117m}Sn ($T_{1/2}$ = 13.61 d), ^{117}Sb ($T_{1/2}$ = 2.8h), ^{117m}In ($T_{1/2}$ = 1.94 h), and ^{117g}In ($T_{1/2}$ = 43.8 min). Therefore, the isotopic purity of the target is critical for the production of ^{124}Sn.

[*]**E – Mail:** *tiruhibakh@gmail.com*

X–ray Tomographic and Spectroscopic Study of Bronze Jewellery from the Teishebaini Burial Site (Armenia)

Yu. Cherepennikov[1,2*], V. Margaryan[1], A. Shahverdyan[1], N. Filatov[2], V. Kocharyan[1], H. Simonyan[3]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia
25 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2]*National Research Tomsk Polytechnic University*
30 Lenin Ave., Tomsk, Russian Federation, 634050
[3] *Yerevan State University, 1 Alex Manoogian St., Yerevan, Republic of Armenia, 0025*

The study of Urartian metallurgy remains a significant topic in the investigation of metal production in the Ancient Near East during the first half of the first millennium BC. Excavations conducted between 2014 and 2016 at the newly discovered necropolis of Teishebaini (Karmir Blur), a city of the Kingdom of Urartu, uncovered over 250 burials, yielding several hundred metal artefacts. The majority of these were bronze items, including jewellery, weapons, horse harness and chariot components, seals, and other objects.

To gain insight into the manufacturing techniques and chemical composition of personal possessions and funerary offerings, metal artefacts from Burial N12 were analysed using X–ray–based methods. Historical and comparative analysis dates this burial to the 7th century BC.

Bronze artefacts, specifically four bracelets and a necklace, were examined using X–ray fluorescence (XRF) and X–ray micro–computed tomography (μCT). XRF analysis revealed a highly uneven distribution of the primary alloy constituents—copper and tin—within the samples. μCT imaging provided detailed insights into the metalworking techniques employed in the production of these items, shedding light on the craftsmanship of Urartian jewellers.

[*]**E – Mail:** *yuryche89@gmail.com*

Investigating Double–Slit Dynamical X–ray Diffraction in Silicon Crystals

V.R. Kocharyan, S.N. Noreyan, V.V. Margaryan*, V.N. Aghabekyan, M.H. Mesropyan, A.M. Mamyan, A.E. 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

An experimental investigation of double–slit dynamic X–ray diffraction in silicon crystals demonstrates that Young's interference fringes can be formed in the cross section of the reflected beam, depending on the distances between the monochromator and the slits, as well as between the slits themselves. The study reveals that the number of observable fringes is influenced by both the crystal thickness and the Bragg reflection order. This diffraction method offers potential applications for determining the refractive index of materials by measuring fringe displacement relative to the beam center, as well as for addressing other interference phenomena in the X–ray wavelength range.

* **E – Mail:** *mar.vardan84@gmail.com*

X–ray Diffraction Study of Deformation Fields Induced by Temperature Gradient in Single Crystals

V.R. Kocharyan, K.G. Trouni, K.T. Hayrapetyan, V.V. Margaryan, M.H. Mesropyan, T. Dovlatyan*, I.A. Babayan, V.K. Mirzoyan, A.V. Shahverdyan, S.N. Noreyan

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

It is well known that the appropriate choice of the deviation function is very important in order to obtain a certain intensity, spectral and spatial distribution in the diffracted beams formed as a result of X–ray diffraction beam in deformed crystals. To describe the deviation function, it is sufficient to provide the dependence of the bending radius and interplanar distances of the reflecting atomic planes on the coordinate.

In this paper, the deviation function of the deformation field in a crystal caused by an external temperature gradient was investigated using the narrow collimated polychromatic X–ray diffraction beam method.

A rectangular parallelepiped plate made of an X–cut quartz single crystal was used one of the edges (heated) of which was parallel to the reflecting planes $(10\bar{1}0)$. To determine the deformation field formed in the sample at different temperature distributions, topograms of the cross–section of the beam reflected from $(10\bar{1}0)$ reflecting atomic planes in Laue diffraction geometry at different distances from the sample were recorded using a coordinate detector with a resolution of 55 μm. To provide different temperature distributions in a crystal, a special device was prepared, allowing to move the thin heating spiral, parallel to the lateral surface of the sample.

As a result, the average values of the bending radius and interplanar distance of the reflecting atomic planes in the direction of beam propagation in the single crystal were determined for different positions of the heater. It was shown that the spectral width of the reflected beam and the spatial distribution of the spectrum in the beam strongly depend on the position of the heater.

* **E – Mail:** *tigdov@yahoo.com*

Spatial Resolution Optimization of Sensor Arrangement Around a Monolithic Scintillator

N. Alekseev*, **A. Gogolev, N. Filatov, S. Chistyakov, V. Eruntsov**

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

Preclinical positron emission tomography (PET) requires high spatial resolution of the detector. A monolithic scintillator detector block is one of the promising approaches due to its ability to estimate the depth of interaction (DOI) and improve resolution through processing multiple channels and analyzing light distribution. The typical construction of such a block is a matrix of silicon photomultipliers (SiPMs) attached to a larger surface of the scintillator. This design has several difficulties, such as edge effects, a high number of readout channels, and resolution degradation with increasing distance from the sensors matrix.

One way to achieve better resolution is to apply an alternative sensor arrangement. Modeling is useful for such optimization tasks. Geant4 provides precise modeling of optical processes and particles interactions. However, sufficient statistical data must be collected for accurate resolution estimation. Additionally, the resolution is influenced by the estimation algorithm, calibration procedures, and other factors.

In this work, an optical model is provided. The optical model formulates the dependence of registered pixel values based on pixel placement and distance. Model factors for calculations are solid angle and Fresnel's reflection coefficient. A resolution criterion, analogous to SNR, was introduced for position estimation. The mean value of this criterion over the entire volume can be calculated within an acceptable time using multithreaded fast numerical integration algorithms.

The model was developed for a LYSO scintillator with dimensions 30×30×15 mm. Subsequently, a Geant4-based model was used for precise optical simulation and resolution evaluation.

* **E – Mail:** *nva11@tpu.ru*

High Resistive Radiation Detectors based on Optoelectronic Transimpedance Convertor with MOS Photovaricap

B.O. Semerjyan*, D.A. Kananov, M.S. Alexanyan

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

In order to use very high-resistance detectors, we have proposed an interface for working with them [1]. In this interface, we propose a MOS structure as a modulating device. Modulation of the MOS capacitance occurs by LED lighting of this structure. The aim of this research is to analyze the main characteristics of a novel type of dynamic capacitor that utilizes a surface metal-oxide-semiconductor (MOS) photovaricap (PV) as the regulating element when detecting signals from high resistive radiation detectors [2–3]. For the creation of surface MOS PVs, samples of p-Si with varying resistivity were chosen. A thin layer of SiO_2 was deposited on these samples, onto which a translucent metallic electrode was applied. Modulation of the PV capacitance was achieved by illuminating it with a gallium arsenide LED. As a result, the capacitance of the PV changed, producing a variable voltage across the load resistor, which was then amplified and recorded. It was observed that the settling time of the useful signal is determined by two factors: the first is the RC chain composed of the load resistance of the radiation detectors and the input capacitance of the PV, and the second is slow relaxation phenomena in the structure of the MOS PV that lead to the screening of the induced charge. The transimpedance conversion coefficient, in turn, is determined by the characteristics of the MOS PV as a dynamic capacitor and the features of the photo capacitance as a semiconductor element. The conducted research showed that MOS PVs can be applied to register small DC currents and voltages from high resistive radiation detectors. In this case, ordinary narrow-band or wide-band amplifiers with relatively low input resistance can be used instead of electrometric amplifiers with mechanical dynamic capacitors. The considered circuit has been experimentally tested with commercial resistors.

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* **E – Mail:** *semicsemer@ysu.am*

Cumulative Radiation Burden from High–Resolution Chest CT: Effective Dose and Lifetime Cancer Risk Analysis

H. Adam[1], N. Tamam[2], M. Alkhorayef[3], A. Sulieman[4*]

[1]*College of Medical Radiologic Science, Sudan University of Science and Technology, P.O. Box 1908, Khartoum 11111, Sudan*

[2]*Princes Nourah bint Abdulrahman University, College of Sciences, Physics Department, Riyadh, Saudi Arabia*

[3]*Department of Radiological Sciences, College of Applied Medical Sciences, King Saud University, P.O Box 10219 Riyadh 11433, Saudi Arabia*

[4]*Radiological Sciences Department, College of Applied Medical Sciences – Al Ahsa, King Saud bin Abdulaziz University for Health Sciences, Kingdom of Saudi Arabia*

High–Resolution Computed Tomography (HRCT) is widely employed in the diagnosis of lung diseases, demonstrating a sensitivity of 95% and a specificity of 85%. Chest CT is frequently used for the diagnosis and monitoring of disease progression, outcomes, and treatment effectiveness. CT is associated with radiogenic risks, which refer to the potential risk of developing cancer due to exposure to ionizing radiation. It is crucial to assess the benefits and risks to adequately justify the surgery for patients. This study evaluated the radiation dosage and associated cancer risk for patients undergoing high–resolution chest CT scans. A total of 150 patients were assessed, comprising 70%) and 30% female, with a mean age of 50± 12 years, spanning from 22 to 70 years. All patients underwent a high–resolution CT chest scan. The radiation dose parameters were quantified as volume CT dose index (CTDIvol in mGy) and dose length product (DLP (mGy.cm)). The mean CTDIvol(mGy) was 9.5 mGy with a standard deviation of 3.50, within a range of 5.0 to 19.0 mGy. The mean DLP was 350.2 ± 132.66 mGy.cm, with a range of 179.0 to 734.0. The effective dosage for HRCT in the patient was determined to be 6.0 mSv, corresponding to three cancer risks per ten thousand procedures. This study demonstrates that the radiation dosage aligns with HRCT protocol parameters. Explicit justification criteria are essential to ensure that the benefits outweigh the expected risks. Interpatient variability is attributed to variations in patient weight and the imaging techniques utilized.

[*]**E – Mail:** *abdelmoneim_a@yahoo.com*

The Influence of X-ray Radiation on DNA and Platinated DNA Complexes in the Presence of Porphyrin

L. Aloyan[1,2*], L. Mkrtchyan[3], A. Avetisyan[1]

[1]Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025
[2]A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)" foundation 2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036
[3]Institute of Applied Problems of Physics of the National Academy of Sciences of the Republic of Armenia 25, Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014

This study examines the effects of X-ray radiation on DNA and platinated DNA complexes in the presence of AgTOEPyP4 porphyrin. We investigated varying relative concentrations of porphyrin-DNA complexes (r = 0.01, 0.02, 0.04, where r = Cporf/CDNA) and conducted a comparative analysis with platinated DNA complexes (r = 0.025, where r = cis-Pt/CDNA) at a radiation dose of 2 Gy. This approach builds on our previous resulsts for studying DNA-radiation and DNA/porphyrins complexes radiation interactions and extends the methodological framework outlined in the FLAP Collaboration. Melting curves of DNA and cisplatin-DNA complexes at different relative concentrations of AgTOEPyP4 porphyrin were obtained using an Agilent Cary 3500 Multizone UV-Vis spectrophotometer at a heating rate of 1°C/min. The melting temperature (Tm) and melting interval (ΔT) served as indicators of double-helix stability and the occurrence of strand breaks in DNA molecules following radiation exposure.

Our findings demonstrate that the presence of porphyrin stabilizes DNA molecules, resulting in higher melting temperatures with increasing porphyrin concentration. For DNA/cisplatin complexes, the melting temperature decreases with higher relative concentrations of cisplatin. Upon X-ray irradiation with a 2 Gy dose, however, the DNA/ cis-Pt complex exhibited stabilization, probably connecting with presence of cis-Pt molecule. The presence of porphyrins molecules we obtained a different picture of the changes in melting temperature depending on the concentration of porphyrin.

These results contribute to our understanding of porphyrin-DNA interactions and their response to radiation. The observed effects between AgTOEPyP4, DNA, and cisplatin have potential implications for radiation biology and applications in cancer treatment research. Further investigation of these molecular interactions may provide valuable insights into the mechanisms of radiation effects on DNA-drug complexes and inform the development of novel approaches for cancer therapy.

*E – Mail: *aloyan@ysu.am*

Design of a Radioluminescence Dosimetry System with Photon Energy Discrimination Capability for Area Monitoring

F. Moradi[1*], H. T. Zubair[1], D. A. Bradley[2,3], H. A. Abdul Rashid[1, 4]

[1]*Center for Fiber Networking and Communication, COE for Intelligent Network, Multimedia University, Persiaran Multimedia, 63100, Cyberjaya, Selangor, Malaysia*

[2]*Applied Physics and Radiation Technologies Group, CCDCU, Sunway University, 46150 PJ, Malaysia*

[3]*School of Mathematics and Physics, University of Surrey, Guildford, GU2 7XH, UK*

[4]*Faculty of Engineering Technology, University College TATI (UC TATI), 24000 Kemaman Terengganu, Malaysia*

Area monitoring, including environmental and workplace radiation surveillance, is essential in settings with significant radiation exposure such as nuclear reactors, accelerator facilities, contaminated waste sites, and NORM–affected zones in the oil and gas industry. Photon energies in these environments typically range from 20–30 keV to several MeV, requiring dosimetry systems whose response accounts for energy dependence. This study explores the feasibility of using a real–time radioluminescence (RL) fiber dosimetry system designed to correct for energy–dependent detector response via photon energy discrimination. The system comprises multiple RL sensors with varying filtration layers, each coupled to transmission fibers. The primary scintillator is a 2 cm long, 1 mm diameter cerium–doped silica fiber, selected for its high sensitivity and well–characterized energy–dependent behaviour. Monte Carlo simulations using the TOPAS/Geant4 code were conducted to model the RL sensors and design filter combinations for energy correction, following ISO 4037 recommendations. The Low Air Kerma Rate Series was used as the reference photon spectra, and dosimeter responses were evaluated relative to the ^{137}Cs reference energy. Simulation results suggest that an optimized combination of filtered RL elements can support photon energy estimation and correction of dosimeter response, enabling improved accuracy in the calculation of ambient dose equivalent, $H^*(10)$. The proposed real–time RL dosimetry system offers potential for enhanced dose assessment in workplace monitoring, contributing to improved radiation protection and operational safety.

[*]**E – Mail:** *moradifarhad@ymail.com*

Proton Absorbed Dose from Laser–Accelerated Proton Beamline (LAP) Based on RPA Method

S.A. Mahdipour[1*], M. Shafeei Sarvestani[1], S.B. Dabagov[2], A. Mowlavi[3]

[1]Department of Physics, Bojnurd Student Research Institute, Iran
[2]INFN Laboratory Nazionali di Frascati RAS P.N. Lebedev Physical Institute
NR Nuclear University MePhI
[3]Department of Physics, Hakim Sabzevari University, Sabzevar, Iran

Radiation Pressure Acceleration (RPA) and Target Normal Sheath Acceleration (TNSA) are the two most significant methods for planning Laser–Accelerated Proton Beam (LAP) systems. LAP technology has inspired innovative applications that can leverage the unique properties of proton bunches, distinguishing them from conventionally accelerated proton beams. In our other simulation, we presented a fundamental model of the proton beam line based on two pulsed power solenoids (RPA), utilizing Monte Carlo simulations with the GEANT4 toolkit. In these articles, the adjustment of the magnetic field of the first solenoid and the precise calculation of the flux of primary protons and secondary particles produced by the beamline has been conducted. This article introduces the second solenoid, providing detailed specifications, and incorporates it into the previous simulations, adjusting its magnetic field to an optimal state. Additionally, the absorbed dose due to RPA protons in the water phantom has been calculated. The results indicate that as the energy dispersion of the incident protons increases, the width of the Bragg peak gradually expands, and the peak's location shifts to shallower depths. Furthermore, filtering protons with lower energy in the beamline alters the trend in the absorbed dose curve. The calculations presented in this paper serve as a preliminary step toward completing the full simulation of the RPA beamline and facilitating future clinical studies.

[*]**E – Mail:** *Ali.mahdipour88@yahoo.com*

Radiation Resistance of Willemite Samples Irradiated with Electron and Proton. Geant4 Simulations

A.H. Badalyan[1,2*], V.V. Harutyunyan[1], E.M. Aleksanyan[1], N.E. Grigoryan[1], A.G. Arestakyan[1], A. Papikyan[1], G. Hovsepyan[1], A.K. Atanesyan[2]

[1]*A. Alikhanian National Scientific Laboratory (Yerevan Physics Institute),*
2 Alikhanian Brothers Street, Yerevan, Armenia, 0036
[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

Enhanced thermal barrier coatings (TBCs) have the potential to facilitate the operation of next–generation gas turbines at increased combustion temperatures. Considerable research efforts are currently focused on the development of novel materials that surpass the performance of conventional industry standards. Beyond their use in turbines, TBCs are also being investigated for aerospace applications, particularly as protective layers capable of withstanding extreme thermal environments. This is especially critical for spacecraft, which are continuously exposed to cosmic radiation in the form of high–energy protons and electrons in the MeV range. Accordingly, it is essential to thoroughly evaluate the behavior of these coatings under irradiation conditions. In the present study, we examine the irradiation tolerance of silicate–based compounds synthesized via a hydrothermal microwave–assisted method. Specifically, we investigated the effects of proton irradiation on zinc silicates (willemite) and cerium–doped zinc silicates, exposing them to 15.5 MeV proton beams at fluencies ranging from 10^{13} to 10^{15} protons per square centimeter (p/cm^2). Building upon our previous findings, which demonstrated the superior resistance of Ce–Zn_2SiO_4 to electron irradiation relative to undoped zinc silicate, the current results indicate that these materials also exhibit notable resilience under proton irradiation. Moreover, the crystal structure of the materials remained stable post–irradiation, highlighting their potential suitability for high–radiation environments. Comprehensive computational modeling of these processes has been performed utilizing the GEANT4 simulation toolkit.

[*]**E – Mail:** *anush.badalyan@yerphi.am*

Features of Channeling and Spontaneous Radiation of Electrics in the Main Crystallographic Planes of a Barium Titanate Crystal in the Cubic Phase

N.V. Maksyuta, V.I. Vysotskii, A.O. Stakhova*, D.N. Maksyuta

Faculty of Radio Physics, Electronics and Computer Systems,
Taras Shevchenko National University of Kyiv
4g Akademika Hlushkova Ave, Kyiv, Ukraine, 03187

This paper continues the study of the features of spectral distributions of spontaneous radiation arising from the channeling of relativistic (including weakly relativistic) electrons in complex crystals, which was started in [1, 2]. In particular, the channeled motion in the main crystallographic planes (100), (110) and (111) of the $BaTiO_3$ crystal is studied at temperatures above the Curie temperature, when this crystal with a perovskite structure is in the cubic (paraelectric) phase. It was shown that in all the principal planes on one period there are two potential wells with different depths. As a result of the numerical solution of the Schrödinger equation using a technique similar to [1, 2], the transverse energy levels and the corresponding wave functions were found for those Lorentz–factors that were used in work [3] in the case of electron channeling in the (111) planes in the ionic crystal LiF. Using these data, spectral distributions of spontaneous emission were also calculated and it was shown that, due to the deeper potential wells in the $BaTiO_3$ crystal than in the LiF crystal, the intensities of spontaneous short–wave radiation are higher.

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***E – Mail:** *stakhovaanastasiia@gmail.com*

Dissolution Station “KATIL” for Medical Radiometals Production Using Solid Targets

A.A. Manukyan*, **A.A. Grigoryan, D.A. Arshakyan, K.A. Hovhannisyan, N.M. Dobrovolski, V.Kh. Elbakyan, G.A. Hovhannisyan, R.K. Dallakyan**

A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)" foundation
2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036

The Isotopes Research and Production Department at A. Alikhanyan National Science Laboratory (AANL) develops production technologies for medical use of Ga, Cu, and Tc radiometals [1–3], using solid targets irradiated by an 18 MeV proton beam from an IBA C18 cyclotron. Solid targets yield higher activity than liquid ones but are harder to transport to the hot cell for processing. In contrast, liquid targets are easily transferred via tubing. To overcome this, the team decided to dissolve the solid target in the irradiation vault and then transfer the solution through tubes–a method used by other groups. The Nirta Solid Compact Model TS06 module holds the target, which drops into a custom–built dissolution station called “KATIL” after irradiation.

KATIL seals around the target holder and circulates dissolution liquid using a peristaltic pump until the target fully dissolves. The solution is then sent to the hot cell. The system, including the pump, valves, and heater, is remotely controlled via PC software, ensuring radiation safety.

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***E – Mail:** *a.manukyan@aanl.am*

Photoionization Cross Section of Hydrogen–like Donor Impurity in CdSe Nanoplatelets

M.K. Manvelyan[1*], M.A. Mkrtchyan[1], S.B. Dabagov[2], H.A. Sarkisyan[1]

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

In this paper the hydrogen–like donor impurity states in CdSe nanoplatelet have been studied using the approximation and numerical methods. The impact of polarization effects caused by a significant mismatch of dielectric constants between the nanoplatelet and the surrounding medium is considered within the framework of the Ritova–Keldysh theory and the Takagahara model. The interaction between the electron and the impurity is taken into account by averaging the Coulomb potential. The binding energy (energy difference without and with impurity), photoionization (optical transition, which takes place from the impurity ground state to the conduction sub–band (excited states without impurity) under the influence of optical excitation) cross section dependencies from nanoplatelet sizes, monolayers number and incident photons light energy (Fig.1) have been investigated.

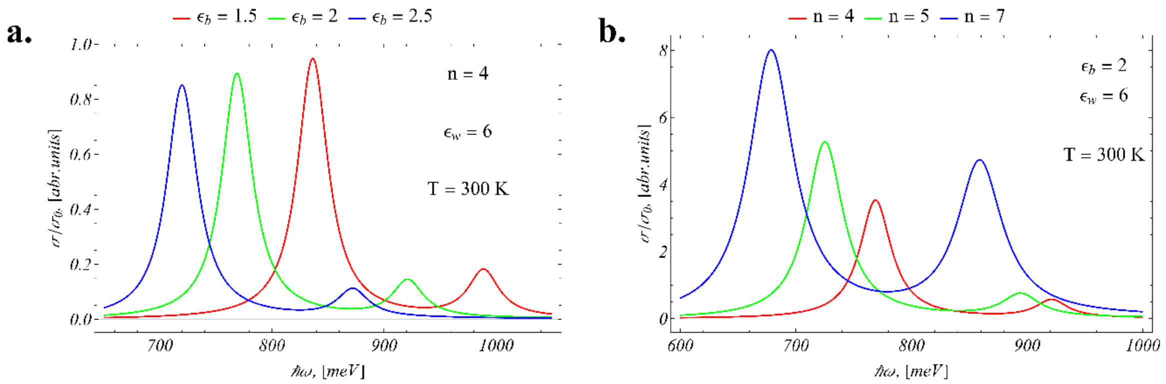

Fig. 1. Photoionization cross section dependency from incident light photons energy for different surrounding medium dielectric constants (a), and monolayers number in nanoplatelet (b)

[*] **E – Mail:** *manvel.manvelyan@rau.am*

Terahertz Optical Transitions in an Asymmetric Ellipsoidal GeSi QD Containing Few–particle Hole Gas in the Presence of a Magnetic Field

A.A. Nahapetyan [1*], M.A. Mkrtchyan[1], H.A. Sarkisyan[1]

[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

The intraband optical transitions in the strongly oblate asymmetric ellipsoidal GeSi quantum dot (QD) containing pair–interacting heavy hole gas have been investigated. It has been shown, that due to QD specific geometry, the hole gas localization in the lateral plane XOY is described in the framework of the two–dimensional asymmetric oscillator model. Based on the obtained results, Kohn's generalized theorem in the mentioned system is proven and is shown that under the influence of long–wave radiation in the many–particle system, the one–particle resonant transitions are realized. The frequencies of resonant transitions are defined on the dependence from the magnitude of the magnetic field and geometrical sizes.

[*]**E – Mail:** *n.aram2097@gmail.com*

Monitoring of Structural Changes in Materials under the Exposure of Ionization Radiation Using a Vibrating Wire

S.G. Arutunian[1,2], N.M. Manukyan[1], S.A. Hunanyan[1,*] , A.V. Margaryan[1], E.G. Lazareva[1], M. Chung[3], L.M. Lazarev[1], G.S. Harutyunyan[1]

[1]*A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers, 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-si, Gyeongsangbuk-do, 37673, South Korea

Ionizing radiation (X-rays, proton beams) causes structural changes in materials. If a vibrating metallic wire is subjected to such radiation, the natural frequency of the wire is affected as a result of changes in the elastic characteristics of the material. This paper presents the results of experiments on the impact of X-ray radiation in the range of 100-165 keV and a proton beam with energy 18 MeV on the structure of stainless steel wire. In both cases, an irreversible change in the wire frequency was observed, which indicated residual changes in the structure of the wire material. X-ray diffractometry methods were used to analyse the structural changes.

[*]**E – Mail:** *sargis.hunanyan@aanl.am*

Preparation of Liquid Crystal Elastomers and Study of Their Mechanical and Optical Properties

K. Margaryan*, G. Gevorgyan, K. Julfakyan, M. Harutyunyan, R. Hakobyan

Institute of Physics, Yerevan State University

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

Liquid crystal elastomers (LCEs) are a special class of materials that combine the flexibility of elastomers with the ordered structure of liquid crystals. These materials have polymer chains that are linked to liquid crystal molecules, which align in specific directions, creating a unique combination of properties. LCEs can stretch and bend like elastomers, but they also respond to external stimuli (like temperature or electric fields) by changing shape.

We have developed a technology for preparing liquid crystal elastomers and established a laboratory for their preparation. We are conducting studies of the mechanical and orientational properties of LCEs prepared in the newly established laboratory. In particular, we are studying the dependence of the Young's modulus and Poisson's ratio of elastomers on the concentration of elastomer components, temperature, as well as the dependence of optical properties of elastomers from the perspective of using them as waveplates.

***E – Mail:** *karine.margaryan@ysu.am*

Digital Processing of Electron Beam Images for Glass Plate Irradiation

V.G. Khachatryan[1*], S.G. Arutunian[1,2], V.S. Avagyan[1,2], H.D. Davtyan[1], B.A. Grigoryan[1], M.I. Ivanyan[1], M.I. Petrosyan[1,3], M.M. Sukiasyan[1], S.S. Tatikyan[1], A.S.Vardanyan[1], A.S. Yeremyan[1]

[1]Center for the Advancement of Natural Discoveries using Light Emission (CANDLE) Synchrotron Research Institute 31, Acharyan Str., Yerevan, Republic of Armenia 0022
[2]A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)" foundation 2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036
[3]Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025

In recent years, material irradiation processing experiments have gained significant interest due to their vital role in various fields such as life sciences, material science, and electronics. Accurate and efficient determination of absorbed dose distribution is crucial for optimizing these processes. This study investigates the combination of glass plate irradiation and digital processing of obtained electron beam images to improve the characterization of electron beam transverse profiles and absorbed doses distribution in irradiation experiments. The proposed approach addresses limitations of traditional techniques, including the absence of real-time feedback and insufficient spatial resolution. By integrating glass plate irradiation with advanced digital processing methods, this technique enables high-resolution mapping of dose distribution, providing precise and controlled irradiation for improved processing of matter.

[*]**E – Mail:** *vityakh@gmail.com*

Studies of X–ray Multi–Beam Diffraction Moiré Patterns

H.R Drmeyan[*], H.G. Margaryan, V.N. Axabekyan, S.N. Noreyan

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

This paper presents an experimental study of the formation mechanism of X–ray multi–beam diffraction moiré patterns. A unique four–block interferometer was designed, manufactured, and tested, that enabled successfully obtaining moiré patterns. The results of experimental studies on the dependence of moiré pattern formation on the number and history of contributing waves are presented. Unlike conventional three–block (two–beam) interferometers, this study investigates X–ray diffraction moiré patterns formed with the involvement of three waves. We also examined a case when one of the two interfering waves contained a moiré pattern, while the other did not. Furthermore, the superposition of beams containing moiré patterns (interference of moiré patterns) was investigated using a specially designed and manufactured five–block interferometer. We demostrated that the resulting interference pattern from the superposition of beams containing moiré patterns differed in character (period and visibility) from the individual moiré patterns. This difference indicates that after passing through the fifth block, the moiré patterns undergo diffraction superposition, rather than simple mechanical superposition. Finally, the study demonstrated that the presence of three beams significantly reduces the contrast of the moiré patterns, and in certain cases, allows for mutual compensation of misorientations.

[*]**E – Mail:** *drm-henrik@mail.ru*

Discovery of a Symmetric (L–Orn(H)–H–L–OrnH) (3+)–cation in the Structure of (L–Orn(H)–H–L–OrnH)$(I_3)_3 \cdot 4H_2O$

A.M. Petrosyan[1], G. Giester[2], M.S. Petrosyan[1*], V.V. Ghazaryan[1], A.L. Zatikyan[3]

[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 (UZA II) Room number 2A 254 1090 Vienna, Austria
[3]*Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*

L–Ornithine is one of the amino acids able to establish both singly and doubly charged cations. Under certain conditions it can form salts with a dimeric cation (L–$OrnH_2$···L–OrnH)$^{3+}$, as seen in the structures of (L–$OrnH_2$···L–OrnH)$(Cl)_2(ClO_4)$ and (L–$OrnH_2$···L–OrnH)$(Cl)_2(NO_3)$ [1], where doubly charged L–$OrnH_2$ and singly charged L–OrnH cations are linked through a short O–H···O type hydrogen bond. This study reports the first identification of a symmetric (L–Orn(H)–H–L–OrnH)$^{3+}$ dimeric cation, stabilized by an O–H–O symmetric hydrogen bond, within the new crystal structure of (L–Orn(H)–H–L–OrnH)$(I_3)_3 \cdot 4H_2O$. The O···O distance is quite short, i.e. 2.436(3) Å. The salt crystallizes in the monoclinic space group *C*2, with an ordered chain arrangement of triiodide anions formed through supramolecular halogen bonding. The powder of black, shiny crystals exhibits strong absorption in the visible light region, thus having narrow bandgap of 1.41 eV. DFT calculations confirm the indirect bandgap of 1.374 eV, claiming the contribution of incorporated triiodide.

The work was supported by the Science Committee of RA, in the frame of the research project # 21AG–1D015.

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*E – Mail: *petrosyanmilena17@gmail.com*

Double–Slit X–ray Dynamical Diffraction in the Transmitted and Diffracted Beams

A.P. Aivazyan, M.K. Balyan*, S.A.Petrosyan, V.P.Mkrtchyan

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

The double-slit dynamical X-ray diffraction [1] in the transmitted and diffracted beams is investigated. The features and differences of the intensity distributions in both beams are considered. The expressions for the period of the obtained interference fringes are found. The intensity distributions based on numerical calculations are presented and compared with theoretical predictions obtained based on approximate expressions.

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***E – Mail:** *mbalyan@ysu.am*

X–ray Diffraction Image of a Low–Angle Twist Boundary

<u>L.V.Levonyan</u>*, H.M. Manukyan

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

According to the existing model, the low–angle twist boundary is a two–dimensional superlattice, formed by a net of two mutually perpendicular arrays of screw dislocations, so that in a given array the dislocations have the same Burgers vectors. In this work, we study the problem of spherical X–ray wave diffraction by a crystal with a low–angle twist boundary perpendicular to the crystal surface in Laue geometry. Since in this geometry the diffraction vector is perpendicular to the Burgers vector of one of the screw dislocation arrays, the problem is reduced to diffraction by a one–dimensional superlattice. In [1] it is shown that due to the phenomena of specular and total internal reflection and waveguide propagation of radiation along the dislocation wall, focusing inside the crystal occurs not only at a depth corresponding to an ideal crystal, but also at shallower depths.

As is known, at the diffraction of a spherical X–ray wave by a single crystal in the Laue geometry, the phenomenon of focusing of the weakly absorbed mode of the diffracted wave field occurs both inside and outside the crystal – in vacuum. In this work, the behavior of the diffracted wave behind the crystal is investigated. It is shown that at the diffraction of a spherical X–ray wave on a crystal with a low–angle twist boundary perpendicular to the crystal surface in the Laue geometry the wave, propagating behind the crystal is focused not only at a distance corresponding to the focal length for an ideal crystal, but also at greater distances. In this case, the farther the focus is from the exit surface of the crystal, the lower is its intensity.

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* **E – Mail:** *llevonyan@ysu.am*

Nonlinear Photoelasticity of Crystals and Related Effects of Electromagnetic and Acoustic Wave Interaction

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

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

When an electromagnetic wave (EMW) and an acoustic wave (AW) propagate simultaneously in the same region of a crystal, an acousto–optic (AO) interaction arises between them.

As an AW propagates through a crystal, it modulates its dielectric permittivity ε_{ik}, which is the primary mechanism responsible for AO interaction, widely used in practical applications.

This study theoretically investigates the nonlinear photoelasticity of crystals and the related effects of electromagnetic and acoustic wave interaction, as well as the resonant properties of the electronic component of the additional value arising under the influence of AW in the frequency range of ω EMW, where $\triangle E \simeq \hbar\omega$ ($\triangle E$ – the characteristic energy difference of electronic levels in the crystal, $\hbar$ – Planck's constant).

Through theoretical analysis and analytical calculations, the following results have been obtained:

- It has been revealed that even under conditions of low modulation depth, where $|\Delta\varepsilon_{ik}| \ll |\varepsilon_{ik}^0|$, the value of ε_{ik} can be a significantly nonlinear function of the AW amplitude. It has been shown that near resonance Q_{ik}^l condition the values of strongly depend on the frequency ω, reaching a maximum at $\Delta E \simeq \hbar\omega$.
- It has been theoretically predicted that the effect of mutual velocity change of interacting waves may lead (under certain conditions) to the effect of mutual focusing (or defocusing) of electromagnetic and acoustic waves. The characteristic features of this effect have been studied.

*__E – Mail:__ *arkady.soghomonyan@mail.ru*

Fraunhofer Diffraction at a Slit between Two Isotropic Media under Oblique Incidence of a Plane Electromagnetic Wave

A.I. Soghomonyan, H.S. Yritsyan, V.K. Mirzoyan, R.E. Soghomonyan, A.L. Margaryan*

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

In this work, the Fraunhofer diffraction of a plane electromagnetic wave obliquely incident from a homogeneous, isotropic, and non–gyrotropic medium onto a slit is theoretically examined. Behind the slit, there is a similar medium that differs in its optical parameters (ε, μ) from the medium from which the electromagnetic wave is incident.

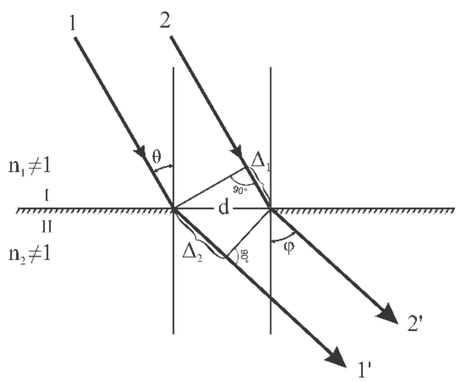

Fig. 1. Schematic of diffraction at a slit between two media under oblique incidence of a plane wave.

When the wave is incident obliquely $\left(\theta \neq 90^0\right)$, the total path difference between the rays diffracted in the φ direction and rays 1 and 2 is determined as $\triangle = \triangle_2 - \triangle_1$ (see Fig. 1), or

$$\triangle = d(\sin\varphi - \sin\theta) \quad (1)$$

where φ is the diffraction angle $\left(0^0 < \varphi < 90^0\right)$, θ is the angle of incidence $\left(0^0 < \theta < 90^0\right)$, and d is the width of the slit.

A formula has been derived, and the conditions for minima have been analyzed. Unlike the case of normal incidence, for oblique incidence, the conditions for minima include the optical parameters of both media, not just the medium into which the electromagnetic wave diffracts.

***E – Mail:** *margastghik@gmail.com*

Cornerstones of the Development, Transformation, and Commercialization of Radiation Technologies Across Targeted Spectra

Z.H. Mkrtchyan[1,2*], A.H. Mkrtchyan[1], T.S. Musayelyan[1]

[1] Institute of Applied Problems of Physics of the National Academy of Sciences of the Republic of Armenia
25 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2] International Scientific Educational Center of the National Academy of Sciences of the Republic of Armenia
24/d Marshal Bagramyan Ave., Yerevan, Republic of Armenia, 0019

In the application, transformation, and commercialization of radiation technologies across disciplines such as archaeology, medical physics, environmental science, functional materials, and crystallography, 5 or 6 stage models are commonly employed to ensure both effective and safe utilization. In medical contexts, more extensive 6 to 7 stage models are often employed to facilitate secure implementation through structured, phase–based transitions. These models are not intended for rapid deployment; instead, they require extended timeframes, strong institutional commitment, and strategically directed efforts to achieve successful outcomes.

The broad scope of the unique characteristics of target areas such as Archaeology, Medical Physics, Environmental Science, Functional Materials, and Crystal Growth, has been taken into account and the applicability of transformation and commercialization models tailored to each field has been evaluated.

Additionally, the application of the "seminavette diamond cut", "cushion old diamond cut," and "pendelogue diamond cut" models has been proposed, with the distinctive features of their design being incorporated into the processes of the transformation and commercialization models. This approach leads to an increase in the number of stages within the transformation and commercialization phases, while simultaneously reducing the timeframes required and minimizing directed efforts, resulting in a more refined and unique outcome.

[*] **E – Mail**: *zarahmkrtchyan@gmail.com*

Development of New Acoustophysical Methods for Deposition of Thin Films

A.S. Abrahamyan, R.Yu. Chilingaryan, H.T. Hovhannisyan, A.A.Margaryan*, K.G. Sahakyan, M.H. Sargsyan, 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

This article presents the results of a study on the development of a thin film deposition technology using different acoustophysical methods. The experimental work examined the following: cathode sputtering in an acoustoplasma discharge; magnetron sputtering; thin films obtained by galvanic method and deposition in solutions and suspensions. To compare the main physical and structural parameters, of thin multilayer film samples which were synthesized using the following methods: 1. using a conventional magnetron and the developed acoustoplasma magnetron. 2. galvanic method with direct current supply, in the presence of an alternating component, as well as in the presence of acoustic field of different frequencies. 3. sedimentation by centrifugation and sedimentation from suspension with absence and presence of acoustic field with different frequencies. The research has shown that it is possible to obtain layers with a denser packing, comparation to existing methods. It is possible to obtain films with less defects due to their partial etching at the same time with the application process.

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* **E – Mail:** *rychi072@gmail.com*

On the Possibility of Using Physical Methods for Bioindication of Radiation Injury Severity in Organisms

H.P. Sargsyan[1*], T.K. Sargsyan[2], M.H. Avetisyan[3], L.H. Sedrakyan[1], N.S. Baghdasaryan[4]

[1]Institute of Chemical Physics after A.B. Nalbandyan
of the National Academy of Sciences of the Republic of Armenia
5/2 Paruyr Sevak Str., Yerevan, Republic of Armenia 0014
[2]"Advanced Technology Group" ATG CJSC, 21/1 Bagrevand Str., Yerevan, Republic of Armenia
[3]Armenian National Agrarian University
74, Vahan Teryan Str., Yerevan, Republic of Armenia, 0009
[4]Clinchoice LLC, 3 Barbusse Str., Yerevan, Republic of Armenia

The accidents at Chernobyl NPP (April 26, 1986) andFukushima–1 NPP (March 11, 2011) have highlighted the pressing challenges in radiation biophysics, including the early diagnostics of radiation injury, assessment of its severity, outcome prediction of radiation sickness, and the development of methods for assessing the effectiveness of therapeutic agents and treatment protocols.

In the present study, an express method has been developed to address these challenges. The method is based on the analysis of diffraction of monochromatic laser radiation on the edges of erythrocytes in a monolayer of whole blood of an irradiated organism. A mathematical model was developed allowing to establish a correlation between the parameters of the erythrocyte distribution function and the characteristics of the intensity distribution in the resulting diffraction pattern observed on the detection screen.

Experimental results demonstrated that the correlation between the studied characteristics exhibits dose– and time–dependent features. It was found that, depending on the radiation dose received and the observation time in the early post–radiation period (one, two and three days after the exposure), the extremum points of the diffraction pattern shift in different way. A criterion was proposed for classifying organisms by the severity of radiation injury at a given dose.

[*]**E – Mail:** *hrachya_sargsyan@mail.ru*

On the Influence of Ionizing Radiation on Erythrocyte Membrane Permeability and the Diffusion Mechanisms of Cell Hydration

H.P. Sargsyan[1*], T.K. Sargsyan[2], L.H. Sedrakyan[1], M.H. Avetisyan[3], N.S. Baghdasaryan[4]

[1]Institute of Chemical Physics after A.B. Nalbandyan
of the National Academy of Sciences of the Republic of Armenia
5/2 Paruyr Sevak Str., Yerevan, Republic of Armenia 0014
[2]"Advanced Technology Group" ATG cjsc 21/1 Bagrevand Str., Yerevan, Armenia
[3]Armenian National Agrarian University
74, Vahan Teryan St., Yerevan, Republic of Armenia, 0009

Numerous studies on the changes in physicochemical and structural properties of erythrocyte membranes following radiation exposure indicate that erythrocytes which do not undergo death or destruction in the early post–radiation period may still undergo alterations in both shape and size. In recent years, alongside experimental research, studies on numerical modeling of diffusion transport processes of microparticles through lipid membranes have also emerged.

In early studies, we experimentally established that the kinetics of changes in the morphological parameters of erythrocytes through one, two and three days after total irradiation of animals exhibits features depending on the dose of ionizing energy received. Analysis of experimental data from other authors indicates that the processes of erythrocyte swelling and shrinkage in the post–radiation period are a consequence of altered membrane permeability. X–ray diffraction data have shown that this is caused by structural changes at the supramolecular and molecular levels, which likely lead to a shift in the dominant mechanisms of diffusion of various substances (including water molecules and their radicals) across the membranes and to a change in the kinetics of diffusion mass transfer between the internal (cellular) and external (plasma) environments, the composition of which deviates significantly from the norm under radiation exposure.

In the present study, within the framework of a general quasi–chemical approach to multicomponent nonlinear diffusion, we developed a mathematical model of a diffusion diode to describe the hydration and dehydration processes of erythrocytes in the early post–radiation period.

[*]**E – Mail:** *hrachya_sargsyan@mail.ru*

Radiation Technologies in Environmental Science

<u>H.S. Panyan</u>[3], T.S. Musayelyan[1], Sh.S. Panyan[1*], Z.H. Mkrtchyan[1,2*]

[1]Institute of Applied Problems of Physics 098003433
of the National Academy of Sciences of the Republic of Armenia
25 Hrachya Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2]International Scientific Educational Center
of the National Academy of Sciences of the Republic of Armenia
24/d Marshal Bagramyan Ave., Yerevan, Republic of Armenia, 0019
[3]Hydrometeorology and Monitoring Center, State Non–Commercial Organization
under the Ministry of the Environment of the Republic of Armenia
46 Charenc Str., Yerevan, Republic of Armenia, 0025

Radiation Technologies in Environmental Science have demonstrated diverse developmental directions. This study focuses on and examines outcomes that have led to advanced technological solutions. The use of ionizing and non–ionizing radiation (such as gamma rays, X–rays, electron beams, and UV radiation) to monitor, treat, or analyze environmental components, nowaday, is extremely important. These methods are often non–invasive and highly sensitive.

Applications of Radiation Technologies in Environment Sciences are grouped into Pollution Monitoring, Waste Treatment, Soil and Groundwater Remediation and Climate Studies. In the Pollution Monitoring the Remote Sensing and Radiotracers are used to monitor air and water quality, to track pollutant pathways in air, water, and soil systems. In the Waste Treatment the Gamma Irradiation is used to Destroy pathogens and organic pollutants in wastewater and sludge, the Electron Beam Processing is effective in degrading toxic chemicals like phenols and dyes in industrial effluents. The Soil and Groundwater Remediation uses Radiolysis with the help of which the high–energy radiation breaks down hazardous organic compounds in contaminated soil and groundwater. In Climate Studies the Radiative forcing models use data about how different gases absorb and emit radiation to predict climate change.

The benefits of using radiation technologies are: non–invasive and real–time data collection; high precision and sensitivity; capabilities of treating contaminants without adding chemicals.. Radiation technologies support countries in using gamma irradiation for sewage sludge disinfection and use spectral radiation data for monitoring greenhouse gases and deforestation.

Here comparative analysis are presented, the opportunities for capacity enhancement are highlighted, and the potential for future local production of such high–tech devices are discussed.

[*]**E – Mail**: *panyan.shushanik@gmail.com*
[*]**E – Mail**: *zarahmkrtchyan@gmail.com*

Experimental Investigation of the Influence of a Temperature Gradient on Asymmetric Reflection of X–rays in Quartz Single Crystals

A.I. Soghomonyan*, S.N. Noreyan, S.M. Movsisyan, R.E. Soghomonyan, A.L. Margaryan

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

This paper presents the results of an experimental study on the effect of a temperature gradient on the characteristics of asymmetric X–ray reflection in quartz single crystals (X–cut) in the Laue geometry.

The presence of a temperature gradient induces bending of the atomic planes and a change in the interplanar spacing across the thickness of the crystal, which in turn affects the parameters of the reflected beam. To analyze the focusing behavior, X–ray films were used to obtain topographs of the cross–sections of the reflected beam at three different distances.

The change in the relative intensity of the diffracted X–ray beam was measured, and the focal length was calculated at different values of the temperature gradient.

As a result of the conducted experimental studies, it was established that with an increase in the temperature gradient, the intensity of the reflected X–ray beam significantly increases, and the focal point shifts closer to the crystal.

***E – Mail:** *arkady.soghomonyan@mail.ru*

High–precision Electro–optical Light Rangefinder

Ye.H. Hayrapetyan[1,2*], H.A. Hunanyan[1], S.K. Petrosyan[1], A.S. Tsaturyan[2], S.D. Movsisyan[2]

[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 University of Architecture and Construction of Armenian
105 Vahan Teryan Str., Yerevan, Republic of Armenia, 0009

The paper considers a functional scheme, which introduces new solutions aimed at improving the accuracy of the laser rangefinder.

For this purpose, an adjustable optical delay line is introduced between the modulator–demodulator and the receiving and transmitting optical system, connected by the output to the measuring unit and the input to the integrator, as well as a rotating transparent disk of variable thickness located between the adjustable optical delay line and the receiving and transmitting optical system. A part of the output end of the electro–optical crystal is made with a reflective coating, and a reflective mirror is located on the side of the input end of the electro–optical crystal.

To simplify the display process and increase its reliability, the minimum indicator and the setting indicator are combined in a cathode ray tube, with an amplifier connected to the horizontal scan plates at the output of the photomultiplier, and a power detector connected to the vertical scan plates via a sawtooth voltage amplifier.

[*]**E – Mail**: *hayrapetyanyeghisabet@gmail.com*

Single–Sided Ohmic Contact Engineering and Leakage Current Reduction in GaAs p–i–n Photodiodes

V. G. Harutyunyan[1,2*], S.D. Zilio[2], M. Colja[3], M. Cautero[3], G. Cautero[3], L. Sbuelz[2], D. Curcio[2], G. Biasiol[2]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia,
25 Hrachya Nersisyan, Yerevan, Armenia, 0014
[2]*Istituto Officina dei Materiali, Consiglio Nazionale delle Ricerche,*
Area Science Park, Strada Statale 14 km 163.5, Basovizza, Trieste, Italy, 34149
[3]*Elettra–Sincrotrone Trieste S.C.p.A.,*
Area Science Park, Strada Statale 14 km 163.5, Basovizza, Trieste, Italy, 34149

Recently, a 3D imager with capacitively coupled GaAs based avalanche photodiode and cross–delay lines (APCDL) was reported for hard X–ray photon detection [1]. This hybrid system is a promising imager offering temporal and spatial resolutions less than tens of picoseconds and hundreds of micrometers, respectively. In this report, we present our results on formation of single–sided ohmic contacts and reduction of leakage current in GaAs p–i–n photodiodes designed for the APCDL hard X–ray imager. The studied photodiode was grown by molecular beam epitaxy. After mesa structure fabrication, Cr/Au metals were deposited by E–beam evaporation to form single–sided contacts. The ohmic contacts are formed on both highly doped p+ layer and low doped (1×10^{16} cm^{-3}) n–type layer by multi–step annealing at maximum of 325 ^{0}C in a nitrogen atmosphere. Besides ohmic contacts, a blocking contact was evaporated after deposition of an isolating SiO_2 layer. This contact formed between the ohmic contacts is used to prevent the flow of shunt current by applying the same potential as that on the anode. The reduction of dark current was demonstrated through current–voltage measurements. Additionally, the capacitive–voltage characteristic and laser responsivity of fabricated detector were investigated.

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[*]**E – Mail:** *vgharutyunyan@gmail.com*

Study of the Dielectric Properties of Nematic Liquid Crystals During the Nematic–Isotropic Liquid Phase Transition

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

As a development of the previous investigation on a specific intermolecular interaction in nematic liquid crystal (NLC) systems, new results of the experimental studies of the dielectric permittivity in NLCs based on biphenyls in the LC state and during the LC → IL phase transition are discussed in this work. Dielectric measurements were carried out on a frequency range from 10 to 10^4 Hz using the capacitive method. The absolute measurement accuracy of $\varepsilon_{\perp}$ and $\varepsilon_{\parallel}$ was maintained in all experiments and amounted to ± 0.02. A measuring field was fixed at $E \approx 20\ V \cdot \mathrm{cm}^{-1}$ intensity in homogeneous and homeotropic alignment cells. Molecular orientation was determined by an external constant magnetic field of 0.3 T.

The analysis of the obtained frequency dependences of the components of the complex permittivity for the nematic phase of the studied LCs was carried out using the Debye equation:

$$\varepsilon'(\omega) = \varepsilon_{\infty} + \frac{\varepsilon_0 - \varepsilon_{\infty}}{1 + i\omega\tau},$$

written in the form:

$$\varepsilon_k'(\varepsilon_k''\omega) = \varepsilon_{0k} - \tau_k \varepsilon_k''\omega$$

$$\varepsilon_k'\left(\frac{\varepsilon_k''}{\omega}\right) = \varepsilon_{\infty k} + \frac{1}{\tau_k}\frac{\varepsilon_k''}{\omega}$$

where ε_{∞} – is the high–frequency dielectric permittivity, ε_0 – is the low–frequency dielectric permittivity, τ – is the relaxation time, the symbol ∥ or ⊥ is used instead of k, depending on the component under consideration. The experimental data were approximated using the Debye and Cole–Cole equations. Based on the experimental data, dependencies $\varepsilon_k'(\varepsilon_k''\omega)$ and $\varepsilon_k'\left(\frac{\varepsilon_k''}{\omega}\right)$ were plotted, and the values of $\varepsilon_{0\perp}$, $\varepsilon_{0\parallel}$, and the relaxation times $\tau_{0\perp}$ and $\tau_{0\parallel}$ were determined.

* **E – Mail:** *libezhanova@gmail.com*

Growth and Study of Nonlinear Optical Crystals: L–Nitroarginine Perchlorate and L–Nitroarginine Tetrafluoroborate

R.P. Sukiasyan*, **R.A. Apreyan**[1], **A.A. Danghyan**[1], **N.S. Gharibyan**[1], **L.S. Bezhanova**[1], **K.Yu. Suponitsky**[2], **A.K. Atanesyan**[1]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia
25 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2]*A.N. Nesmeyanov Institute of Organoelement Compounds of Russian Academy of Sciences*
28 Vavilova Str. GSP–1, Moscow, Russian Federation, 119991

The subject of the present study is nonlinear optical (NLO) crystals: L–nitroarginine perchlorate (L–NNA·$HClO_4$) (I) and L–nitroarginine tetrafluoroborate (L–NNA·HBF_4) (II). The crystal and molecular structure of (I) and (II) crystals were determined by the single crystal X–ray diffraction method at 120 K. These crystallize in the monoclinic system with space group $P2_1$ and Z=2. Unit cell parameters: a=5.1962(10) Å, b=17.903(4) Å, c=7.0030(14) Å, α=γ=90°, β=92.96(3)°, V=650.6(2) Å^3 for (I) and a=5.2329(10) Å, b=18.024(4) Å, c=6.8238(14) Å, α=γ=90°, β=92.94(3)°, V=642.8(2) Å^3 for (II). The (I) and (II) crystals have an isostructural structure as in the analog salts of arginine: {L–Arg·$HClO_4$ [1] and L–Arg·HBF_4 [2] with space group $P2_12_12_1$} and {L–Arg·2$HClO_4$ and L–Arg·2HBF_4 with space group P1 [3, 4]}. The vibrational spectra (Fourier transform infrared and Raman), transparency range, thermal properties, and NLO activity of (I) and (II) crystals were studied. The NLO activities of the (I) and (II) crystals are two times higher than that of the analog salts of arginine. The (I) and (II) crystals were grown as bulk single crystals.

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***E – Mail:** *ruzansukiasyan@iapp.am*

Some Problems Associated with the Standardization of the Light Curve of Type 1a Supernovae

A.P. Mahtessian[1*], G.S. Karapetian[1], M.A. Hovhannisyan[2], L.A. Mahtessian[2], L.E. Byzalov[3], J.M. Sarkissian[4]

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

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

[3]*University of Waterloo, 200 University Avenue West, Waterloo, Ontario, N2L 3G1, Canada*

[4]*CSIRO Parkes Observatory PO Box 276 Parkes NSW 28s70 Australia*

We show that the parameters used to standardize the luminosity of Type 1a supernovae in the SALT2 and SiFTO models depend strongly on the redshift z. Consequently, when standardized with increasing z, the average absolute magnitudes of Type 1a supernovae are artificially increased. This means that for a given apparent magnitude they are, on average, assigned larger distances than they actually are, creating the appearance of their recession with acceleration and requiring the introduction of the concept of antigravity (dark energy) to explain it.

We also show that standardizing the luminosity of Type 1a supernovae violates the fundamental assumption that Type 1a supernovae are distance standards.

We therefore argue that such a standardization is not suitable for measuring the distances to Type 1a supernovae, and hence the accelerating expansion of the Universe is called into question.

[*]**E – Mail:** *amahtes@gmail.com*

On Equivalence of Metal–Dielectric and Single–Layer Dielectric Waveguides in the Problems of Accelerator Physics

M.I. Ivanyan[1*], B.A. Grigoryan[1], A.H. Grigoryan[1, 2], L.V. Aslyan[1], A.S. Vardanyan[1], V.G. Khachatryan[1], M.Z. Karalyan[1], V.Sh. Avagyan[1,3]

[1]*Center for the Advancement of Natural Discoveries using Light Emission (CANDLE) Synchrotron Research Institute 31, Acharyan Str., Yerevan, Republic of Armenia 0022*
[2]*Yerevan State University, 1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025*
[3]*A. I. Alikhanyan National Science Laboratory (Yerevan Physics Institute)" foundation 2 A. Alikhanyan Brothers Str., Yerevan, Republic of Armenia, 0036*

Cylindrical waveguides with a two–layer metal–dielectric wall are widely used in experimental work on splitting beams of charged particles and in designing slow–wave devices. The manufacture of a sufficiently long section of a two–layer (usually copper–dielectric) waveguide is associated with significant technical and financial difficulties. Meanwhile, as shown in the article, many of the characteristic properties of a two–layer waveguide used in the above–mentioned works are possessed by a single–layer dielectric waveguide. In order to demonstrate this, explicit expressions are derived for the longitudinal and transverse impedances for the limiting values of the conductivities of the outer metal wall of the waveguide: infinitely large conductivity (perfectly conducting outer wall) and zero conductivity (single–layer dielectric waveguide with a vacuum outer environment). It is shown that in the case of longitudinal impedance, the formulas for the mentioned limiting cases completely coincide, and in the case of transverse impedance, the coincidence takes place for high frequencies, which is especially important when considering radiation in the terahertz frequency range. Using specific graphical examples, the proximity of the impedance characteristics of copper–dielectric and single–layer dielectric waveguides is shown. In some, quite important cases, the characteristics of the latter qualitatively exceed the indicators of the copper–dielectric waveguide. The main result of the article is the justification of the functional interchangeability of copper–dielectric and single–layer dielectric waveguides in implementing a wide range of accelerator physics problems.

[*]**E – Mail:** *ivanian@asls.candle.am*

GaN Thin Films via Plasma Focus: A Study of Deposition Shots and Annealing Effects

L. Anjo[1*], G. Davoodi[2*], S. Tatikyan[1], A. Grigoryan[1], G. Amatuni[1]

[1]Center for the Advancement of Natural Discoveries using Light Emission (CANDLE) Synchrotron Research Institute
31 Acharyan Str., Yerevan, Republic of Armenia 0022
[2]Armenian National Agrarian University
74, Vahan Teryan Str., Yerevan, Republic of Armenia, 0009

Gallium Nitride (GaN) thin films were deposited on p–type Si(100) substrates using a plasma focus (PF) device, with a view to probing the effect of plasma shot number and post–deposition annealing on their optical and structural properties. The 2, 4, and 6 PF shot exposed films were processed and systematically characterized by X–ray diffraction (XRD), energy dispersive X–ray spectroscopy (EDX), field emission scanning electron microscopy (FESEM), atomic force microscopy (AFM), UV–VIS–NIR spectroscopy, and photoluminescence (PL) measurements.

The results indicated that increasing the number of plasma shots and employing thermal annealing led to substantial improvement in crystallinity, surface morphology, and PL emission peak shifts. The results indicate that the PF method can be used effectively to tailor GaN thin films for optoelectronic devices by varying deposition and annealing parameters.

[*]**E – Mail:** *anjo@asls.candle.am*
[*]**E – Mail:** *Gevick.davoodi@gmail.com*

Manufacturing of Large Aperture Parabolic Mirrors Using Additive Technologies for Focusing Microwave Radiation

D.A. Shkitov[1*], D.D. Zaitsev[1], A.A. Grigorieva[1], N.S. Berdnilov[1], M.V. Shevelev[1*], V.A. Semenov[2], A.A. Solovyev[2]

[1]National Research Tomsk Polytechnic University

30 Lenin Ave., Tomsk, Russian Federation, 634050

[2]High Current Electronics Institute

of the Siberian Branch of the Russian Academy of Sciences

2/3, Academichesky Ave., Tomsk, Russian Federation, 634055

Three–dimensional printing is currently widely used for producing various microwave components, including radiation focusing. Therefore, additive technologies with subsequent metallization were chosen for the manufacture of large aperture parabolic mirrors. These mirrors can be used firstly in a scheme to detect the angular and orientation dependencies of transition radiation and other types of polarization radiation. Secondly, they can be used as part of an interferometer for spectral radiation measurements. This report describes the creation of 3D models and their printing on a 3D printer. It also provides data on applying a metal layer using magnetron sputtering, as well as data of modeling radiation focusing using geometric optics in the COMSOL Multiphysics package.

[*]**E – Mail:** *shkitovda@tpu.ru*
[*]**E – Mail:** *mvshev@tpu.ru*

Determining Electron Binding Energy of Valence Shell Using Polarization Radiation

Yu. Cherepennikov [1,2], M. Shevelev[1*]

[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 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014

In the framework of classical electrodynamics, polarization radiation (PR) is created by a uniformly moving charge within or near a medium. In this scenario, sources of radiation are time–varying currents induced in the medium by the electromagnetic field of a charge. Several types of PR exist, including Cherenkov radiation, transition radiation, Smith–Purcell radiation, and parametric x–ray radiation. One of the key features distinguishing PR is that its spectral properties vary among different types depending on kinematic conditions. However, the shape of the PR spectrum is primarily determined by dielectric permittivity of the medium. Although most experimental studies have centered on the development of radiation sources based on PR. I.M. Frank was the first who propose a technique for measuring and evaluating the permittivity dispersion of metals utilizing PR spectra in the optical range. The application range of this approach can be easily extended to the absorption edge region, where inner electrons become sufficiently excited either to leave the atom or to be promoted to higher energy levels. In this report, we discussed the application of polarization radiation spectrum to determining the fine structure of the absorption edges of the medium. We considered the simple geometry of radiation, where a uniformly moving charge crosses a thin foil obliquely and showed how the spectrum and the photon yield depend on the dielectric permittivity.

[*]**E – Mail:** *mvshev@tpu.ru*

A Study of the Characteristics of a Pulsed Accelerator–Driven BNCT Neutron Source Based on Lithium Targets

S. Li[1], Yu. Cherepennikov[1,2*], S. Pavlov[1], G. Remnev[1]

[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 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014

In recent years, neutron capture therapy (NCT) has transitioned from utilizing reactor neutron sources for research to employing accelerator–driven neutron sources for practical applications, thanks to advancements in accelerator technology. Pulsed accelerators have emerged as a viable option for neutron sources in NCT due to their compact design and cost–effectiveness. When creating accelerator–based neutron sources for NCT the main reaction is considered for potential use is 7Li(p, n)7Be. Limitations associated with the thermophysical properties of lithium actualize the optimization of the target design, especially when generating neutron fluxes using pulsed proton sources. Comparative simulation analyses of neutron yield characteristics from lithium and lithium compounds bombarded by 2–2.5 MeV pulsed proton beams with wide energy spectra have been conducted. The potential for increasing neutron flux has been explored through investigations into target thickness, neutron energy spectrum distribution, and emission angle distribution. The results indicate that optimizing the target's composition and structure significantly enhances neutron yield, providing a theoretical basis and promising prospects for the development of compact BNCT neutron sources.

[*]**E – Mail:** *yuryche89@gmail.com*

Mimicking Biological Soft and Bone Tissues with Commercial 3D–Printed Polymers in Custom Imaging Phantoms

R. Mirzoyan[1], V. Margaryan[1],
K. Der Avanesian[2], V. Kocharyan[1], Yu. Cherepennikov[1*]

[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]*IRA Medical Group (CJSC), 29 Fanarjyan Str., Yerevan, Republic of Armenia, 0052*

3D–printing technologies are increasingly employed across a wide range of applications, including medical imaging. Their current capabilities enable the rapid and cost–effective fabrication of complex geometries, making them well–suited for developing custom imaging phantoms. Recent studies have demonstrated the feasibility of producing image quality test phantoms for planar X–ray imaging using 3D printing [1]. Furthermore, 3D printing is widely used in the creation of anthropomorphic and zoomorphic imaging and dosimetry phantoms that accurately replicate the anatomical shapes and radiological properties of biological tissues [2–3].

A key challenge in this field is the selection of appropriate materials that can accurately simulate the radiation interaction characteristics of various tissues. While standard plastic filaments are generally adequate for mimicking soft tissues, replicating bone tissue properties remains more complex. This study evaluates the suitability of several commercially available, admixed plastic filaments for simulating bone tissue. The assessment was based on Hounsfield units and electron density values derived from CT scans of 3D–printed samples with varying infill densities. Imaging was performed using a Philips Brilliance 64 clinical CT scanner.

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[*]**E – mail:** *yuryche89@gmail.com*

X–ray Cherenkov Radiation from Relativistic Charge in a Periodic Multilayer Structure

A. Konkov[1], **M. Shevelev**[2*]

[1]State Research Center of Russian Federation Troitsk Institute for Innovation and Fusion Research, Joint Stock Company (SRC RF TRINITI JSC),

12 Puhskovykh Str., Troitsk, Moscow, Russian Federation, 108840

[2]National Research Tomsk Polytechnic University

30 Lenin Ave., Tomsk, Russian Federation, 634050

Cherenkov radiation is well–known effect in soft–X–ray range and can be used for organic and inorganic research. To realize such radiation source there is the need to detail study and develop new methods for radiation estimation and optimization. In this report, we demonstrate the simple theoretical model of Cherenkov X–rays produced by a charge passing through a multilayer target for a given angle of incidence. The model takes into account the photoabsorption of X–rays and the radiation phase delay inside the target. We discuss ways of the target parameters optimization to increase the soft–X–ray Cherenkov radiation yield.

[*]**E – Mail:** *mvshev@tpu.ru*

X–ray Diffraction in Different Crystal Cuts Under a Temperature Gradient

V.R. Kocharyan, S.N. Noreyan, V.V. Margaryan,
Yu.M. Cherepennikov, A.E. Movsisyan, V.N. Aghabekyan,
R.K. Mirzoyan*, H.G. Margaryan, M.H. Mesropyan

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 peculiarities of X–ray diffraction from atomic planes of the same family in different cuts of quartz single crystals under the temperature gradient are investigated. Quartz single crystals have the form of rectangular parallelepiped plates with X– and Z–cuts, one edge of which (heated) was oriented parallel to the reflecting planes $(10\bar{1}0)$. The experiments were carried out using collimated polychromatic X–rays in symmetric Laue geometry.

For different values of the temperature gradient applied to the crystal, both sectional topograms at different distances from the crystal and spectra of the reflected beam were obtained. The research results showed that the parameters of the deformation field formed at the same temperature gradient applied perpendicular to the reflecting planes $(10\bar{1}0)$ of the crystal with different cuts are significantly different.

The bending radius of the reflecting atomic planes $(10\bar{1}0)$ was determined depending on the value of the applied temperature gradient for different cuts of the crystal. It was shown that for the same values of the temperature gradient applied to the single crystal, the bending radius in the X–cut sample is always significantly smaller than the bending radius of the Z–cut sample.

* **E – Mail:** *robertmirz2000@gmail.com*

High Resolution Wavelength–Dispersive Spectrometry Based on X–ray Diffraction on Bent Crystals

V.V. Margaryan, S.N. Noreyan, V.R. Kocharyan, M.H. Mesropyan, V.N. Aghabekyan, A.M. Mamyan, H.G. Margaryan, A.V. Shahverdyan, K.G. Trouni*

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

A single crystal X–ray diffraction method has been developed to determine the hard X–ray spectrum with high resolution. The design and performance of the wavelength–dispersive spectrometer are based on diffraction by bent crystals in Laue geometry. It is shown that in this case we lose intensity, but have approximately twice the wavelength–dispersion as in the von Hamos geometry. The spectrometer is equipped with an X–ray diffraction crystal, the reflected atomic plates of which are curved with a temperature gradient and provides an energy resolution of about 0.25 eV and 1 eV in the energy range of 24,000 eV–26,000 eV.

The theoretical analysis of the experimental results is based on the eikonal approximation of the theory of dynamic diffraction of X–rays in a crystal lattice with a slowly changing continuous deformation field. Formulas are obtained that determine the depth in the crystal at which rays with a given deviation from the Bragg condition on the input surface of the crystal and a given wavelength enter the angular region. This makes it possible to determine the spatial width and orientation of the reflected beams with different wavelength of the characteristic spectrum of the original radiation. This, in turn, makes it possible to estimate the spatial and angular dispersion of the proposed spectral analyses experimental scheme.

* **E – Mail:** *ktrouni@hotmail.com*

New Method of Creating Pressure in Brazing Ceramics to Metal

V. Sh. Avagyan[1,2*], A.I. Azizov[1]

[1]Center for the Advancement of Natural Discoveries using Light Emission (CANDLE) Synchrotron Research Institute 31, Acharyan Str., Yerevan, Republic of Armenia 0022

[2]A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers, Yerevan, Republic of Armenia, 0036

The paper presents a new method of metal–ceramic brazing that provides high–quality connections. A technology has been developed for tubular metal–ceramic connections, and a device has been created to create pressure on the connecting parts due to the difference in thermal expansion coefficients. The temperature deformation has been determined by calculation.

Despite the fact that various methods and technologies for the manufacture of metal–ceramic parts have been introduced in the industry, improvement and modification of these existing technologies are still necessary to make them more easily adaptable. In this regard, the selection of appropriate materials and joint design are critical factors in the development of technologies.

To solve the problem of joining tubular products made of ceramics and metals, a method for creating a uniform compressive stress over the entire surface was proposed, based on different coefficients of thermal linear expansion of metals during heating. To analyze the process described above, modeling was carried out based on the finite element method. The results of mathematical modeling can be used to judge the effectiveness of the method of creating compressive stresses between joints of complex–shaped materials. The results of the research are presented.

[*]**E – Mail:** *avagyan@welding.am*

Features of Radiation from Relativistic Electrons Flying Through a Cylindrical Target

L.Sh. Grigoryan, A.A. Saharian, A.V. Sargsyan, H.P. Harutyunyan*, G.V. Margaryan, 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

The results of Geant4 simulations of the spectral and angular distributions of the radiation generated by a charged particle crossing a cylindrical target are presented. Previously, experimental studies of the spectral angular distribution of coherent Cherenkov radiation in the sub–terahertz frequency range from a cylindrical Teflon resonator generated by an electron beam with an energy of 3.6 MeV in the AREAL accelerator have been conducted. In this presentation, we will compare the experimental data with theoretical estimates and Geant4 simulations results.

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***E – Mail:** *haykharoutunyan@list.ru*

The Reciprocity of Illumination and Observation Points in Diffraction Patterns with Maxima

A.Zh. Khachatrian*, G.P. Vardanyan, O.A. Zadoyan

National Polytechnic University of Armenia

105 Vahan Teryan Str., Yerevan, Republic of Armenia 0009

This paper examines the problem of identifying structural features of molecular formations or structures based on diffraction patterns produced by their illumination with a monochromatic spherical wave. It is assumed that the structural elements of these formations, under the influence of an external field, generate spherical waves, and the observed diffracted field represents a superposition of these waves. The analysis is conducted within the framework of the kinematic approach, emphasizing both direct and inverse diffraction problems.

Conditions for the formation of diffraction patterns with primary maxima are derived, where the system is illuminated so that all structural elements oscillate in phase under the influence of the external field. It is demonstrated that, under these conditions, reciprocity exists between the illumination and observation directions in the diffraction problem. The influence of the diffracted field on the source of the external field is also studied.

Based on this analysis, the well–known Laue conditions for the scattering vector are discussed as two distinct conditions imposed on the directions of illumination and observation of maxima.

***E – Mail:** *ashot.khachatrian@gmail.com*

Design Optimization of Proton Radiation Shielding Using PHITS–Based Monte Carlo Simulation with Multilayer Concrete–Iron Barriers

S. Yani[1], W. Rahma[1], T. Sumaryada[1], Endarko[2], F. Haryanto[3], N. Nuraeni[3], D.T. Tai[4*], N. Tamam[5], A. Sulieman[6,7]

[1]*IPB University, Indonesia*

[2]*Institut Teknologi Sepuluh Nopember, Indonesia*

[3]*Institut Teknologi Bandung, Bandung, Indonesia*

[4]*Nguyen Tat Thanh University, Viet Nam.*

[5]*Princess Nourah bint Abdulrahman University, P.O Box 84428, Riyadh 11671, Saudi Arabia.*

[6]*King Saud Bin Abdulaziz University for Health Sciences, Al Ahsa, Saudi Arabia.*

[7]*King Faisal Specialist Hospital & Research Center, Riyadh, Saudi Arabia*

This study aims to evaluate the effectiveness of various shielding configurations in attenuating proton radiation and secondary particles, using Monte Carlo simulations. The focus is on comparing single–layer concrete shields with multilayer combinations involving concrete, iron (Fe), and polyethylene (PE).

Monte Carlo simulations were performed using the PHITS code to model proton radiation transport through different shielding materials and configurations. Proton energies from 50 to 250 MeV were simulated, with varying shield thicknesses, material densities, and source–to–shield distances. Both single–layer (concrete) and multilayer shields (e.g., concrete + Fe, concrete + PE) were analyzed. Output metrics included proton fluence, secondary particle production (photons, neutrons), and flux at the detector. Multilayer shielding configurations significantly outperformed single–layer concrete in attenuating both primary and secondary particles. Specifically, a shield composed of 10 cm concrete ($\rho = 2.3$ g/cm^3) followed by 10 cm iron resulted in near–complete elimination of proton, photon, and neutron flux at the detector for all simulated energies. Proton flux decreased consistently with increased material density and multilayer configurations, especially those including heavy elements like iron.

Multilayer shields incorporating dense materials such as iron provide superior protection against proton radiation and associated secondary particles. These findings support the use of optimized multilayer shielding structures—particularly concrete combined with iron—for improved radiation safety in proton therapy and related facilities.

[*]**E – Mail:** *dttai@ntt.edu.vn*

Artificial Neural Network (NNT) vs Multilinear Regression Models to Predict Naturally Occurring Radioactivity (NORM) in Gold Mining Area in Eastern Sudan

T.E. Adreani[1], I.I. Suliman[2], H. Idriss[2*], A. Sulieman[3], M. Alkhorayef[4], D. Bradley[5,6]

[1]Nuclear and Radiation safety Institute, Sudan Atomic Energy Commission, Khartoum, Sudan
[2]Deanship of Scientific Research, Imam Mohammad Ibn Saud Islamic University, Saudi Arabia
[3]RSD CAMS King Saud University for Health Sciences, Hofuf, Saudi Arabia
[4]DRS CAMS King Saud University, Riyadh, Saudi Arabia
[5]Department of Physics, University of Surrey, Guildford, Surrey GU2 7XH, UK
[6]Sunway University, Centre for Radiation Sciences, Jalan University, 46150, PJ, Malaysia

Regression models and artificial neural networks (ANNs) are among the most commonly employed techniques for predicting the dynamics of natural and industrial phenomena [1]. In eastern Sudan, radioactivity levels in areas affected by gold mining and other industrial activities were forecast using multiple regression and artificial neural networks. We developed multiregression and ANN models using Python scripts on a Linux–based computer. Using the findings of background radiation measurements conducted in an area of naturally occurring radioactive materials (NORM) in Eastern Sudan, we tested and validated the model. The outcomes were contrasted with matching activity concentrations of soil samples determined by HP–Ge gamma spectrometry [2]. The mean and percentage variations between the measured and expected values of 40 K, 232Th, and 238U were analyzed. Artificial neural networks (ANNs) and multilinear regression were employed to estimate the activities of 232Th and 40 K, along with other radiological parameters. These results were compared to those obtained by gamma spectroscopy (GS) measurements. The expected values for radioactivity and radiological parameters were within the uncertainties of the measured values for the models. With an accuracy of up to 96%, the ANN surpassed the linear regression model in predicting radioactivity concentration and other targeted radiological risk indicators using ambient conditions and location coordinates as input. However, ANNs require significantly more computational power than regression models.

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[*]**E – Mail:** *iiidris@imamu.edu.sa*

Monte Carlo Evaluation of Secondary Neutron and Gamma Contributions in Proton Therapy Using GEANT4/GATE

Nguyen Khac Son[1], Duong Thanh Tai[2*], Nissren Tamam[3], Abdelmoneim Sulieman[4,5], David Bradley[6,7]

[1]*Lam Dong General Hospital, 1 Pham Ngoc Thach Str, Ward 6, Da Lat City, Lam Dong, 670000, Viet Nam*
[2]*Nguyen Tat Thanh University, Viet Nam*
[3]*Princess Nourah bint Abdulrahman University, P.O Box 84428, Riyadh 11671, Saudi Arabia*
[4]*King Saud Bin Abdulaziz University for Health Sciences, Al Ahsa, Saudi Arabia*
[5]*King Faisal Specialist Hospital & Research Center, Riyadh, Saudi Arabia*
[6]*Sunway University, No. 5 Jalan Universiti, Bandar Sunway, Subang Jaya, 46150 Petaling Jaya, Selangor, Malaysia*
[7]*University of Surrey, Stag Hill Campus, University Road, Guildford, Surrey GU2 7XH, UK*

In proton therapy, secondary particles such as neutrons and gamma rays are unavoidably produced through nuclear interactions, potentially contributing to out–of–field dose and biological risk. This study aims to evaluate the energy spectra and dose contribution of secondary neutrons and gamma rays generated within a water phantom during proton irradiation using detailed Monte Carlo simulations.

A comprehensive Geant4/GATE simulation was developed to model a clinical proton beam (70–250 MeV) incident on a water–filled Blue Phantom PT geometry. Physics processes were modeled using the QGSP_BIC_HP_EMY list, and particle interactions were recorded using Dose Actor, PhaseSpace Actor, and Digitizer Actor. Secondary particle spectra and deposited energy were analyzed using PDG–based particle classification. The Bragg peak location (R80) was validated against NIST data and prior experimental studies. The R80 values from simulations showed excellent agreement with reference data, with relative deviations within 1.6%. Secondary neutron and gamma yields increased with proton energy, reaching 34.84% and 133.39% of primary protons at 250 MeV, respectively. However, their contribution to deposited energy in the phantom remained minimal, with secondary non–proton particles contributing up to 6.88% of total deposited energy at 250 MeV.

The dose contribution from neutrons and gamma rays was consistently <0.01% across all energies studied. While secondary neutron and gamma production increases with incident proton energy, their direct contribution to in–field dose remains negligible. Nonetheless, their potential biological impact–especially outside the treatment field–warrants further investigation. These findings support ongoing efforts to optimize shielding and assess long–term risks in proton therapy.

[*]**E – Mail:** *dttai@ntt.edu.vn*

Occupational Radiation Exposure in Saudi Arabia's Nuclear Medicine Departments: Assessment, Challenges, and Safety Insights

Mohammed Alkhorayef[1*], Abdelmoneim Sulieman[3], Hassan Salah[3], Omer Mahgoub[4], Nissren Tamam[5], David Bradley[6,7]

[1]Department of Radiological Sciences,
College of Applied Medical Sciences, King Saud University,
P.O Box 10219 Riyadh 11433, Saudi Arabia
[2]Radiological Sciences Department, College of Applied Medical Sciences–Al Ahsa,
King Saud bin Abdulaziz University for Health Sciences,
P.O.Box 2477 Al Ahsa, 31982, Kingdom of Saudi Arabia
[3]INAYA Medical Collage, Nuclear Medicine Department, Riyadh, Saudi Arabia
[4]Department of Radiological Sciences, National Ribat University, Khartoum, Sudan
[5]Princes Nourah Bint Abdulrahman University, College of Sciences,
Physics Department, Riyadh, Saudi Arabia
[6]Applied Physics and Radiation Technologies Group, CCDCU
Sunway University, 5 Jalan UniversitiBandar Sunway, Petaling Jaya, Malaysia, 47500
[7]School of Mathematics and Physics, University of Surrey, Stag Hill,
University Campus, Guildford, United Kingdom, GU2 7XH

This study evaluates occupational radiation exposure among healthcare professionals in nuclear medicine departments in Saudi Arabia over six years. Optically stimulated luminescence (OSL) dosimeters(AL2O3:C) (Nagase Lindauer, LTD (Japan)), was used to quantify the annual effective doses (Hp (10)) for A cohort of 16 workers including nurses (n=3, 18.75%), physicians (n=1, 6.25%), medical physicists (n=3, 18.75%), and technologists (n=9, 56.25%).The overall mean ± SD effective dose per annum was (1.33±0.26) for nurses, (1.72±0.82) for technologists, (1.02±0.09) for medical physicists, and 0.41 for physicians. The current study showed that Results indicate that technologists consistently receive the highest radiation exposure due to their direct involvement in radiopharmaceutical handling and imaging procedures, while medical physicists have the least exposure. The occupational dose is higher compared to the majority of previously published studies. Development of dose reduction strategies by improving the work environment are crucial to reduce the annual effective dose.

[*]**E – Mail:** *mkhorayef@yahoo.co.uk*

Electrical Strength of thin Dielectrical Layers and their Presentation by the Density of the Probability Distribution Function

A.M. Sedrakyan[1*], N.Z. Grigoryan[2], E.W. Kurghinyan[2], S.S. Alaverdyan[2], L.A. Vardanyan[2]

West Ukrainian National University Yerevan Education and Research Institute,
31 Hrachya Acharyan, Yerevan, Republic of Armenia, 00??
[2]National Polytechnic University of Armenia, Institute of Energy and Electrical Engineering
105 Vahan Teryan St., Yrevan, Republic of Armenia, 0009.

The probabilistic appearance of the dependence of the breakdown voltage (electrical strength) of a dielectric located between the circles of a capacitor on the thickness in homogeneous and inhomogeneous fields for dielectric layers in the range from 0.1 mm to atomic thickness is considered. The results of already known experiments and an analytical view of the probability density of their distribution applied to the presentations of the probability integral and its averaging have been used in the work. There are a lot of problems when it becomes necessary to deal with bodies of elementary dimensions (here we consider elementary sizes from 0.1 mm to 10^{-7} mm). Therefore, there is a need to study the deviations of the corresponding physical quantities and the presentation of values and views for use in the micro range. To conduct a similar study of the corresponding physical value in this paper, let's introduce a probabilistic distribution function, the notion of its average value, and investigate the probabilistic deviation of the corresponding physical values. Our task is to introduce a probabilistic density distribution function p (E_i) corresponding to a physical value (for example, the electrical strength E_i) at each point (at least 10^{-7} mm) of every elementary volume, so that the physical value for that volume is defined as:

$$\overline{E_0} = \frac{\int_{E_0-\Delta E}^{E_0+\Delta E} \rho_{(Ei),} Ei \, dEi}{\int_{E_0-\Delta Ei}^{E_0+\Delta E} \rho_{(Ei)} dEi},$$

where E_0 is the probable value of the electrical strength; ΔE – the possible deviation from electrical strength.

*E – Mail: *asedrakyan.phys@gmail.com*

The Study of Single Crystals α–$LiIO_3$ Doped with L–Alanine and Glycine

A.A. Danghyan*, **R.P. Sukiasyan, R.A. Apreyan, L.S. Bezhanova, N.S. Gharibyan, A.K. Atanesyan**

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

In this study, the effect of doping the amino acids L–Alanine (L–Ala) and Glycine (Gly) on α–$LiIO_3$ single crystal were presented. Previously have reported by us on improving the properties of α–$LiIO_3$ crystal doped with L–arginine (L–Arg) and L–nitroarginine (L–NNA) [1]. Bulk crystals were grown both from solutions doped with different quantities (3 mol/% and 5 mol/%) of L–Ala and Gly and from pure solution of α–$LiIO_3$. These grown crystals were studied by single–crystal X–ray diffraction, second harmonic generation, IR and UV–Vis spectroscopy methods. The XRD data of pure and doped crystals are in good agreement with the reported literature values of pure α–$LiIO_3$ [2], indicating that doping with L–Ala and Gly does not violate the parameters of the crystal lattice. However, the presence of L–Ala and Gly in α–$LiIO_3$ crystal can be identified due to IR spectra. From the grown crystals, 1 mm plates were cut with planes perpendicular to the z and y axes, and their UV–VIS spectra were recorded. In the range of 340–800 nm, pure α–$LiIO_3$ (z) crystals exhibit lower transmittance compared to α–$LiIO_3$: Gly (z) and higher compared to α–$LiIO_3$: L–Ala (z) crystals. This trend holds true for both 3 mol/% and 5 mol/% dopant concentrations. In the case of plates cut perpendicular to the y–axis, no observed improvement in transmittance is noted within the same range. When doped with Gly the optical quality of the crystals was improved and growth rate was increased. The second harmonic generation activity of the crystals α–$LiIO_3$ grown with L–Ala and Gly dopants is higher than that of pure α–$LiIO_3$.

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* **E – Mail:** *d.astghik94@gmail.com*

Establishing National Diagnostic Reference Levels (NDRLs) for Nuclear Medicine in Saudi Arabia

A. Alsugair[2], N. Alaboudi[1], F. Alothaim[1*], A. Almutairi[5], A. Almosabahi[3], A. Aldosari[3], S. Albahiti[4], Y. Alkadhi[2], B. Moftah[2], M. Alshabanah[2], S. Aldelaijan[2], N. Alnaimy[5], M. Alhashem[5], A. Alkhalifa[6], A. Algeer[7], A. Alkhadra[8], A. Alomrani[9], M. Alkhorayef[10], M. Ghrawi[1], A. Almansour[1], A. Alswayed[1], A. Aldalaan[1]

[1]*The Saudi Food and Drug Authority SFDA – Riyadh, KSA*
[2]*King Faisal Specialist Hospital & Research Centre – Riyadh, KSA*
[3]*Ministry of Health – Riyadh, KSA*
[4]*King Abdulaziz University Hospital – Jeddah, KSA*
[5]*King Fahad Specialist Hospital – Dammam, KSA*
[6]*Prince Sultan Military Medical City – Riyadh, KSA*
[7]*Armed Forces Medical Services – Riyadh, KSA*
[8]*Dr. Sulaiman Al Habib Hospital – Riyadh, KSA*
[9]*National Guard Hospital – Riyadh, KSA*
[10]*King Saud University – Riyadh, KSA*

The Saudi Food & Drug Authority (SFDA) has led the first governmental initiative to establish the Saudi National Diagnostic Reference Levels (NDRLs) in the Kingdom of Saudi Arabia. This is to promote dose optimization in alignment with international guidance as well as the SFDA strategic objectives. The SFDA previously published the Saudi NDRLs for various imaging modalities, including CT, general X–ray, and mammography. Now, the SFDA is extending the Saudi NDRLs to include nuclear medicine. The SFDA has established the NDRLs in nuclear medicine for commonly performed protocols, which include bone imaging, myocardial perfusion imaging, thyroid imaging, renal imaging, and tumor imaging. This will maximize diagnostic effectiveness while minimizing unnecessary radiation exposure in nuclear medicine.

To develop these reference levels, the SFDA collaborated with leading hospitals across the Kingdom to collect real data on commonly performed nuclear medicine procedures. Administered activities were gathered for key protocols such as bone scans, myocardial perfusion imaging, thyroid imaging, renal scans, and tumor imaging. The NDRLs were set as the 75th percentile of the hospitals' median dose distribution.

[*]**E – Mail:** *faatheem@sfda.gov.sa*

The result showed considerable variation in the administered doses across all participating hospitals, highlighting the value of establishing national reference levels. The resulting Saudi NDRLs provide a localized benchmark that supports dose optimization while considering regional clinical practices.

This extension to the Saudi NDRLs advocates for dose optimization in nuclear medicine. In the future, the SFDA will consider establishing NDRLs for additional imaging modalities. This will significantly advance the regulatory framework for medical imaging in the kingdom, promoting continuous quality improvement and national standards for radiation safety and medical imaging.

Investigation of Surface Properties of Graphene Layers using Fractal Analysis

H. V. Vasilyan*, H. I. Badalyan, T. V. Ohanyan, S. J. Sedrakyan, E. Aleksanyan, N. B. Margaryan

A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers, Yerevan, Republic of Armenia, 0036

Graphene was synthesized via an efficient, low–temperature liquid–phase exfoliation technique and then characterized using a suite of analytical methods. Raman spectroscopy provided insight into its structural features and the effects of subsequent thermal treatment on defect signatures and residual impurities. Atomic force microscopy revealed a fractal surface topology with an average roughness of approximately 0.33 nm. By computing fractal dimensions from the AFM data, we derived a theoretical surface potential of 370 meV, which aligns within 8 % of the 400 meV measured experimentally by the Kelvin probe method. These results underscore the power of fractal analysis for accurately probing graphene's surface morphology and electronic behavior.

The research was supported by The Higher Education and Science Committee of MESCS RA (Research project **Nº24 24LCG–1C015**)

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* **E – Mail:** *harutvasilyan2004@gmail.com*

Proton Irradiation Effects on Infrared and Structural Properties of Graphene for Space Applications

T.V. Ohanyan*, **H.I. Badalyan, H.V. Vasilyan, S.J. Sedrakyan, E. Aleksanyan, N.B. Margaryan**

A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers, Yerevan, Republic of Armenia, 0036

Graphene's outstanding physical characteristics—most notably its ultralight weight—make it an ideal candidate for space based technologies. Yet, the effects of proton irradiation, a prevalent factor in the space environment, on both its structural integrity and functional performance have not been fully characterized. In this work, we examine how 15.5 MeV proton beams alter liquid phase exfoliated graphene, with particular attention to its infrared absorption features and microscopic structure. Our results show that organic contaminants and functional groups picked up during exfoliation raise graphene's Fermi level, thereby inhibiting infrared absorption via the Pauli blocking mechanism. When exposed to proton fluences up to 1×10^{15} protons/cm^2, these adsorbates are effectively stripped away, removing the Pauli blocking effect and restoring the material's infrared response. These findings enhance our understanding of graphene's behavior under proton bombardment and support its future deployment in space-borne thermal coatings, electronic systems, and optical devices.

The research was supported by the Higher Education and Science Committee of MESCS RA (Research project **№ 24LCG–1C015**).

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***E – Mail:** *tigran.ohanyan@aanl.am*

Possibility of Visualization of Phase–Contrast X–ray Image of Polymer Substances Using an X–ray Interferometer

S.N. Noreyan[1], V.R. Kocharyan[1], V.V. Margaryan[1*], V.N. Aghabekyan[1], T.H. Eyramjyan[2], H.G. Margaryan[1], A.M. Mamyan[1], H.R. Drmeyan[1]

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

The paper proposes a new method for visualizing phase–contrast images of polymeric substances using an X–ray interferometer, which makes it possible to determine some of their properties. In particular, based on a three–crystal (two–beam) interferometer, the refractive index and density of polymers were determined by analyzing changes in interference (moiré) patterns. A special device (phase modulator) was prepared and tested to measure the phase change when it is placed in one of the interfering beams. It is shown that the presence of a sample in one of the interfering beams creates shifts in the moiré pattern fringes relative to the fringes obtained in the absence of a sample. The influence of changing the phase relationship of interfering coherent beams on the interference pattern was investigated. The phase shift was determined experimentally and the unit decrement of the refractive index of the sample was calculated. A special device was designed and tested, which allows to change the radius of a cylindrical polymer wire by stretching it. Changing the interference (moiré) patterns and the corresponding reflexes of the diffracted beams in the interferometer leads to the visualization of a phase–contrast image of the polymer cord, which allows its diameter to be determined with great accuracy.

[*]**E – Mail:** *mar.vardan84@gmail.com*

Mechanisms of Influence of Ionizing Radiation on Phospholipid Bilayer

H.G. Badalyan*, A.A. Avetisyan

Department of General Physics, Institute of Physics, Yerevan State University,
1, Alex Manoogian St., Yerevan, Republic of Armenia, 0025

As a result of the research, it has been established that the direct target of IR is the dipole fragments of phospholipid molecules. Under the influence of the electrical component of the electromagnetic field, the dipole heads rotate about a certain axis along the orbit, since they are connected to the hydrocarbon tails with one of its end. Since H^+ positive charge rotates in a certain orbit, a rotational (magnetic) moment is induced, which already is subject to the influence of the magnetic component of the electromagnetic field. As a result of the influence of both components, the dipolar fragment of the phospholipid molecule changes the angle relative to the surface of the bilayer [1], which leads to a change in the strength of the electrostatic interaction, and, consequently, to the imbalance between electrostatic and van der Waals forces. Due to the imbalance, the structure of the bilayer and, consequently, their biophysical properties are changed.

The second possible mechanism for the action of electromagnetic waves on the phospholipid bilayer can occur through the formation of peroxides, lipids and other radicals, which result in peroxide and lipid oxidation of the hydrocarbon hydrophobic component of the phospholipid molecule. As a result, van der Waals forces of attraction change, and the balance between electrostatic and van der Waals interactions is disturbed. Such changes can lead to a change in the membrane structure and its permeability. Radicals formed during peroxide oxidation were recorded by the method of chemiluminescence detection

The third proposed mechanism and the object of the influence of IR influence, which has a secondary nature of the influence, is the pre membrane water that is structured at the interface between the two liquid–solid phases and has a pentagonal structure, in which counterions are distributed. IR affect both structured water and the distribution of counterions, as a result of which the forces of electrostatic repulsion between dipole fragments change, and as a result the balance of forces between electrostatic and van der Waals interactions is disturbed.

These three mechanisms act in combination or separately, depending on the parameters and the profile of the IR.

***E – Mail:** *hbadal@ysu.am*

The Theoretical and Experimental Study of L–Arginine Sulfates and L–Nitroarginine Sulfosalicylate Crystals

N. S. Gharibyan[1*], M. Sahakyan[2], T. Bednarchuk[2], A.A. Danghyan[1], S.A. Ter–Balyants[1], A.K. Atanesyan[1], R.P. Sukiasyan[1]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia
25 Hr. Nersisyan Str., Yerevan, Republic of Armenia, 0014
[2]*Institute of Low Temperature and Structure Research, Polish Academy of Sciences,*
ul. Okólna 2, 50–422 Wrocław, Poland

The subjects of the present study are L–arginine sulfates (LAS·2H_2O & LAS) and L–nitroarginine sulfosalicylate (L–NNA·SSA). The thermal properties, vibrational spectra, UV–Vis transmittance spectrum and second harmonic generation activity were experimental studied. The crystal and molecular structure of crystals were determined by the single–crystal X–ray diffraction method. The optimized lattice parameters of the crystal structures of L–NNA·2SSA and L–arginine sulfate (LAS) are presented in Table, together with their experimental values. Thus, the optimized unit cell volume was reduced by 6.24% for L–NNA·SSA, 9.9% for LAS·2H_2O and 5.02% for LAS crystal. As well as, theoretically obtained optical properties are consistent with the experimental ones. In particular, the absorption spectrum of LAS·2H_2O decreases rapidly at low energy regions, which agrees well with the transmittance spectrum of LAS, suggesting a dielectric nature of both materials. Moreover, the bands originating from the orbital electrons of oxygen (O), nitrogen (N) and carbon (C) are responsible for the formation of energy gaps of about 2.9 eV for L–NNA·SSA, 4.2 eV for LAS·2H_2O and 4.6 eV for LAS crystals, highlighting their dielectric properties.

Experimental and theoretical lattice parameters of L–NNA·SSA, LAS·2H_2O and LAS crystals

Lattice parameters	L–NNA·SSA (sp. gr. $P2_12_12_1$)		LAS (sp. gr. $P2_12_12$)		LAS·2H_2O (sp. gr. $P2_1$)	
	Exp.	Theor.	Exp.	Theor.	Exp.	Theor.
a (Å)	13.26100	12.99463	10.51180	10.33604	8.0895(16)	7.60348(33)
b (Å)	15.38600	14.84202	21.18610	20.78662	7.0417(14)	6.9690(30)
c (Å)	17.83200	17.68802	10.11650	9.96028	12.146(2)	11.84296(2)
α= β= γ (°)	90	90	90	90	90, β=91.07	90
Volume (Å^3)	3638.3(3)	3411.4(3)	2252.9(9)	2139.9(8)	691.7(2)	623.2(2)

This work is supported by the Ministry of science and education RA, projects No. 24WS–1C022 and NAS RA within the framework of the ‘’Young Scientists’ Support Program’’ No. 24–YSIP–030.

[*]**E – Mail:** *nellygharibyan50@gmail.com*

Optimization of Calibration Factors and Recovery Coefficients for Lu–177 SPECT/CT Using Phantoms

Mohammed Alkhorayef[1*], Meshari A Alnaaimi[2], Mousa A Alduaij[2], Abdelmoneim Sulieman[3], David Bradley[4,5]

[1]Department of Radiological Sciences,
College of Applied Medical Sciences, King Saud University,
P.O Box 10219 Riyadh 11433, Saudi Arabia
[2]Nuclear Medicine Unit, Kuwait Cancer Control Centre, Shuwaikh, Kuwait;
[3]Radiological Sciences Department, College of Applied Medical Sciences– Al Ahsa, King Saud bin Abdulaziz University for Health Sciences,
P.O. Box 2477 Al Ahsa, 31982, Kingdom of Saudi Arabia
[4]Applied Physics and Radiation Technologies Group, CCDCU Sunway University,
5 Jalan UniversitiBandar Sunway, Petaling Jaya, Malaysia, 47500
[5] School of Mathematics and Physics, University of Surrey,
Stag Hill, University Campus, Guildford, United Kingdom, GU2 7XH

Accurate quantification of Lu–177 uptake in radionuclide therapy requires precise calibration of SPECT/CT systems. This study aimed to determine calibration factors (CF) and recovery coefficients (RC) using Jaszczak and NEMA Image Quality phantoms under standardized acquisition and reconstruction protocols. Lu–177 SPECT/CT was performed with a dual–energy window protocol: main photopeak (208 keV ± 10%) and scatter correction windows (±5%). The Jaszczak phantom provided CF values, while the NEMA Image Quality phantom assessed RC across varying sphere–to–background concentration ratios. SPECT acquisition employed MELP collimators with 60 projections (10s/projection, 128x128 matrix, and zoom 1.0). Reconstruction utilized hybrid recon (5i, 16ss) with resolution recovery, scatter correction, and attenuation correction. The CF derived from the Jaszczak phantom was [10.6: 10.8 CPS/MBq]. RC varied significantly with sphere size, highlighting the dependence of quantification accuracy on spatial resolution. Scatter correction and resolution recovery were critical for improving RC for smaller spheres (<10 mm). This study establishes robust calibration and recovery protocols for Lu–177 SPECT/CT imaging, facilitating enhanced accuracy in dosimetry calculations. The use of optimized energy windows and advanced reconstruction algorithms significantly impacts quantification reliability. These findings strongly advocate for the standardization of Lu–177 imaging protocols, underscoring their crucial role in clinical applications.

[*]**E – Mail:** *mkhorayef@yahoo.co.uk*

On Similarity of X–ray Diffraction Patterns Formed in a 3–block Defocused Interferometer and a Bi–crystal System of Narrow Air Gap

H.R. Drmeyan[1], S.A. Mkhitaryan[1*], S.N. Noreyan[1], V.N. Aghabekyan[1], S.B. Dabagov[2,3]

[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]*INFN Laboratori Nazionali di Frascati*
Via E. Fermi 54, Frascati, Italy, 00044
[3]*National Research Nuclear University Moscow Engineering Physics Institute*
31Kashirskoe hwy., Moscow, Russian Federation, 115409

The results of studies of fine structures of X–ray diffraction patterns formed in the X–ray 3–block defocused (violated ideal geometry) interferometers and a new method to record these structures are presented in this work. To implement this method, a monolithic 4–block X–ray diffraction system is proposed and successfully applied, in which the first 3 blocks are thin and set up a 3–block interferometer of a violated ideal geometry, while the additional thick 4th block is in a reflection position. It is shown that fine structures of X–ray interference patterns obtained from 3–block interferometers of violated ideal geometry are also detected when the splitter and mirror blocks are thin and the analyzer is thick. The formation of interference patterns as families of parallel stripes (lines) in a plane perpendicular to the diffraction vector has been experimentally proved for X–ray 3–block interferometers of violated geometry. The additional 4th thick block is revealed to be responsible only for increasing the pattern's linear size in the scattering plane without changing the pattern qualitatively and introducing new information into it. It is experimentally shown that fine structures of X–ray diffraction patterns are also revealed in bi–crystal systems with a non–diffracting zone (narrow air gap), which is also confirmed by the use of an additional 3rd thick block. It also proved the identity of fine structures of X–ray diffraction patterns observed in a 3–block defocused interferometer and a bi–crystal system of a narrow air gap.

[*]**E – Mail:** *sammkhitar@yahoo.com*

Alternative Methods of Obtaining a Medical Radioisotope ^{111}In

T.M. Bakhshiyan[1,2*], G.H. Hovhannisyan[2]

[1]*Institute of Applied Problems of Physics*
of the National Academy of Sciences of the Republic of Armenia,
25 Hrachya Nersisyan, Yerevan, Armenia, 0014
[2]*Yerevan State University, 1 Alex Manoogian Str., Yerevan, Republic of Armenia, 0025*

Given the growing prospects for the widespread use of isotopes in nuclear medicine, such as in SPECT/CT and PET/CT diagnostics, functional imaging, targeted therapies, etc., the number of methods for isotope production continues to grow. Since the second half of the 20th century, scientists worldwide have been searching for inexpensive, simple, and reliable methods to produce indium-111 (^{111}In) with high radiochemical and chemical purity. Each production method has its own advantages and limitations. In this review, we analyze the available routes for obtaining ^{111}In, comparing our experimental results with published data. The aim of this analysis is to study alternative methods for obtaining the ^{111}In isotope and to compare them with common methods, such as proton-induced reactions on cadmium isotopes and alpha-induced reactions on gold isotopes.

In our experiments, we investigated nuclear reactions on enriched tin targets induced by protons and photons, taking advantage of the availability of a compact medical cyclotron and a linear electron accelerator in Yerevan. A stack of enriched (63.2%) ^{114}Sn foils was irradiated using an 18 MeV proton beam provided by the IBA Cyclone18/18 cyclotron. The cross sections for the ^{114}Sn(p,α)^{111}In reaction were measured using the stacked-foil activation technique. This method allows for the determination of excitation functions at multiple proton energies simultaneously, under identical irradiation conditions. Additionally, an enriched (92.6%) ^{112}Sn target was irradiated at the LUE-75 linear electron accelerator of the A. Alikhanian National Science Laboratory at the bremsstrahlung endpoint energy $E_{\gamma max}$ = 55 MeV. The cross section per equivalent quantum for reaction ^{112}Sn(γ,x)^{111}In, have been measured via the method of activation and off-line γ-ray spectrometric technique.

Our research allows us to conclude that it is possible to use the photonuclear method for the production of ^{111}In if the proton beam is not available.

[*] **E – Mail:** *tiruhibakh@gmail.com*

Making Perovskite Solar Cells in Regular (n−i−p) architecture

A. Arestakyan[1*], E. Aleksanyan[1], V. Harutyunyan[1], A. Badalyan[1,2], N. Grigoryan, A. Papikyan, H. Yeritsyan, A. Martirosyan

[1] *A.I. Alikhanyan National Science Laboratory (Yerevan Physics Institute), 2 Alikhanyan Brothers, Yerevan, Republic of Armenia, 0036*

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

Perovskite solar cells (PSCs) have emerged at the forefront of contemporary photovoltaic research as one of the most promising next-generation technologies, owing to their potential to deliver high power conversion efficiencies (PCEs) at comparatively low manufacturing costs. Over the past decade, this class of solar energy materials has demonstrated a remarkable advancement, both in terms of material innovation and device engineering. Notably, within a relatively short span, laboratory-scale PSC prototypes have achieved certified efficiencies surpassing 27%, positioning them in direct competition with long-established photovoltaic materials such as crystalline silicon, GaAs and cadmium telluride (CdTe). This progress has been driven by intensive global research efforts aimed at optimizing compositional engineering, interfacial modification, and deposition methodologies. Nevertheless, despite the widespread academic interest in this field, the reproducibility of high-efficiency PSCs remains a significant bottleneck. Only a limited number of research laboratories worldwide have demonstrated the consistent fabrication of devices exceeding the 20% efficiency threshold under standard testing conditions.

Present work addresses the challenges of standardization and procedural transparency by delineating detailed fabrication protocols for PSCs based on the regular n−i−p structure. Our objective is to furnish a comprehensive, methodologically rigorous account of each stage in the device preparation process, encompassing material selection, substrate treatment, layer deposition, annealing regimes, and characterization techniques. Establishing improved reporting standards and shared fabrication practices may serve as a catalyst for accelerating both the technological maturation of perovskite photovoltaics and the broader expansion of their application in sustainable energy systems.

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[*] **E – Mail:** *arevik.arestakyan@yerphi.am*

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