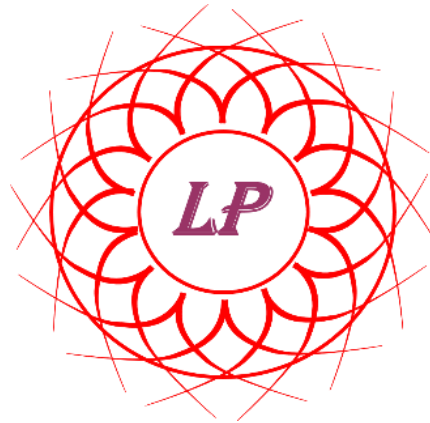


September 16-19, 2025

Yerevan, Ashtarak, Armenia



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Laser Physics 2025

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The Conference is organized in the framework of the International Year of Quantum Science and Technology (IYQ) 2025, declared by UNESCO for the celebration of the major milestone, the 100th anniversary of the development of quantum mechanics



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Abstracts of Plenary Reports

Plenary Report

**Using Optical Nanofibers as a Link for Rydberg Atom-Based
Quantum Networks**

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Optical trapping has revolutionised our ability to trap and manipulate tiny particles, from atoms to cells, providing many new research avenues across several areas of science. The optical tweezers, as an example platform, have provided us with invaluable insights into particle dynamics. One promising alternative to the conventional optical tweezers is that of optical nanofibers - ultrathin fibres with a diameter smaller than the wavelength of the propagating light. For these nanofibers, the light is very tightly bound in the radial direction, giving rise to a very high intensity evanescent field beyond the fiber's surface.

Experimental setups involving optical nanofibers are relatively simple, with a very small physical footprint, thereby providing "lab-on-chip" type applications. For cold atoms, the nanofibers are minimally invasive for the magneto-optical trap performance, while also providing an efficient communication channel for directly sending light to or collecting light from the atoms. Optical nanofibers have been shown to be excellent platforms for exploring features such as chiral atom-light interactions and waveguide quantum electrodynamics.

In our work, we have explored how Rydberg excitation via an optical nanofiber can be achieved [1,2] and how the power requirements are significantly reduced compared to free-space experiments. We will discuss recent progress and future plans for this topic in relation to quantum networks and Rydberg atom trapping.

References

- [1] K.S. Rajasree, T. Ray, K. Karlsson, J.L. Everett, and S. Nic Chormaic, *Phys. Rev. Res.*, **2**, 012038(R) (2020).
- [2] A. Vylegzhanin, D.J. Brown, A. Raj, D.F. Kornovan, J.L. Everett, E. Brion, J. Robert, and S. Nic Chormaic, *Optica Quant.*, **16** (2023).

Plenary Report

Quantum Light and Fluids: Applications in Photonic Simulation and Annealing

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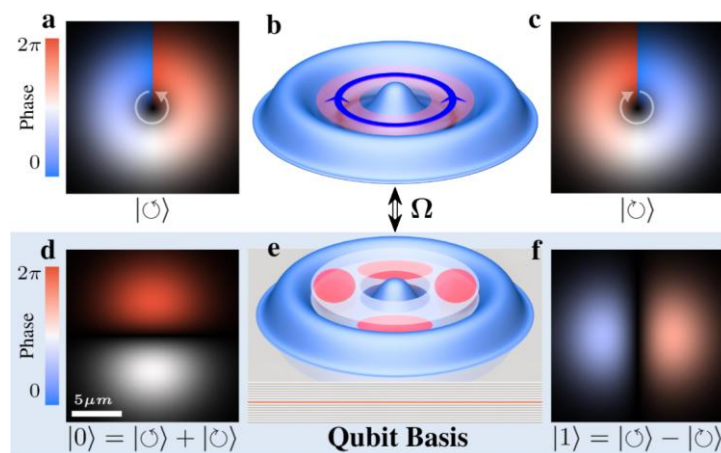
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Exciton-polaritons are hybrid light-matter quasi-particles resulting from the strong coupling of semiconductor excitons and microcavity photons. Being bosons, polaritons can exhibit macroscopic spatial coherence and form out-of-equilibrium condensates exhibiting superfluid behavior when pumped above threshold. A promising recent theoretical proposal for a polaritonic qubit utilizes a split-ring polariton-condensate in an annular ring, involving quantized circular currents [1,2]. This system relies on the formation of vortices in superfluids arising from the quantization of circulation, where the phase accumulation around a supercurrent loop can only take discrete values. Closely related physics governs the principles of operation of superconducting flux or phase qubits involving superconducting loops interrupted by a Josephson junction.

Here we show that, under appropriate conditions, optically trapped out-of-equilibrium polariton condensates can populate two well-characterized states corresponding to the clockwise and counterclockwise circulating currents. We demonstrate coherent coupling between these states, due to the partial reflection of the circulating superfluid from a weakly disordered laser potential or an external control laser beam, while simultaneously maintaining long coherence times. We can control the coupling and thereby the energy splitting between the two eigenmodes of the system. Inspired by the theoretical proposal to realise qubit analogs and quantum computing with two-mode BECs [4], we formally identify the two polaritonic eigenmodes with the basis states of a qubit. Supplemented with controllable coupling between individual polaritonic qubits, such systems hold great potential for simulating a subset of quantum algorithms that do not rely on entanglement.



References

- [1] Y. Xue, et al., *Phys. Rev. Res.*, **3**, 013099 (2021).
- [2] A. Kavokin, et al., *Nat. Rev. Phys.*, **4**, 435 (2022).
- [3] J. Barrat, et al., *Science Advances*, **10**, eado4042 (2024).
- [4] T. Byrnes, K. Wen, and Y. Yamamoto, *Phys. Rev. A*, **85**, 040306(R) (2012).

Plenary Report

Making Statistics Work: Quantum Engines in Ultracold Gases

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Heat engines convert thermal energy into mechanical work and have been extensively studied in the classical and quantum regimes. In the quantum domain, however, nonclassical forms of statistics exist, which are distinct from classical Boltzmann distributions, and which can also be harnessed to generate work in cyclic engine protocols.

In this presentation, I will introduce the concept of the Pauli engine: a novel quantum many-body engine powered by the energy difference between fermionic and bosonic ultracold particle ensembles, arising from the Pauli exclusion principle. The distinct quantum statistics lead to a redistribution of population across energy levels, enabling engine cycles that replace traditional heat strokes in the quantum Otto cycle. This concept has recently been realized experimentally in the BEC-BCS crossover regime of an ultracold gas setup [1].

Building on this idea, I will also present several concepts for hybrid quantum-classical engines in ultracold gases, where a change in quantum statistics is implemented either during the adiabatic work strokes or the isochoric heat strokes. While the Pauli engine alone demonstrated high efficiency, I will show that combining quantum and classical effects can further enhance both efficiency and work output [2].

Our work introduces a foundational concept within the emerging area of quantum technologies and offers insights into the concepts of energy in quantum many-body systems.

References

- [1] J. Koch, K. Menon, E. Cuestas, *et al.*, *Nature*, **621**, 723 (2023).
- [2] K. Menon, Th. Busch, and T. Fogarty, arXiv preprint arXiv:2503.19341 (2025).

Plenary Report

Quantum Gates and Simulations with Rydberg Atoms

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Neutral atoms in arrays of microtraps excited by lasers to strongly interacting Rydberg states represent a highly versatile system for quantum simulations of many-body physics and quantum information processing. Using frequency-chirped laser pulses, the atoms can be transferred to antiferromagnetic-like states of Rydberg excitations, and the preparation fidelity of such states can be accurately estimated using an effective Landau-Zener theory for the adiabatic ground and first excited states of the interacting many-body system [1]. Based on this protocol, we developed an efficient method to realize fast quantum gates between distant atomic qubits connected by an array of atoms that play the role of a quantum bus [2]. Upon exciting and de-exciting the atoms in the array under the blockage of nearest neighbors, depending on the state of the qubits, the system acquires a conditional geometric π -phase, while the dynamical phase cancels exactly, even when the atomic positions are disordered but nearly frozen in time. We have explored both adiabatic transfer with smooth pulses and non-adiabatic transfer using optimized pulses, leading to even faster gates with higher fidelities. The same protocol can be adapted to implement multiqubit gates with atoms arranged in star-graph configurations [3], where the intermediate state of Rydberg excitations corresponds to the solution of the maximum independent set problem for the Ising model. Our results will thus facilitate connectivity and enable larger circuit depths in neutral atoms quantum computers.

References

- [1] A.F. Tzortzakakis et al., *Phys. Rev. A*, **106**, 063302 (2022).
- [2] G. Doultinos, D. Petrosyan, *Phys. Rev. Res.*, **7**, 023246 (2025).
- [3] A. Delakouras, G. Doultinos, D. Petrosyan, (2025).

Plenary Report

**Multimodal Non-Linear Optical Microscopy for Tissue
Characterization and Diagnostics**

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During the years across the new millennium, a plethora of microscopic and spectroscopic label-free non-invasive optical modalities have been developed and successfully applied to the characterization of biological tissues. Among these, Non-linear Optical (NLO) microscopy techniques have undergone an impressive growth because of the advantages offered in comparison to both wide-field and confocal microscopy, such as optical sectioning capability, reduced photo-damage/photo-toxicity, lower scattering and high penetration depth into biological tissues, thanks to the use of near-infrared laser wavelengths. Among NLO microscopy techniques, Two-Photon excited Fluorescence (TPF) microscopy provides non-invasive label-free morphological characterization of tissue intrinsic fluorophores, such as NADH and elastin. Second-Harmonic Generation (SHG) microscopy provides structural information by selectively imaging non-centrosymmetric molecular structures, such as fibrillar collagen. The morphological and structural information can be complemented with the molecular information provided by Coherent Anti-Stokes Raman Scattering (CARS) microscopy, a coherent vibrational microscopy technique useful to generate molecular contrast of specific vibrational bands. The combination of these techniques in a multimodal approach within the same microscopic platform allows imaging and characterization of biological tissues without any exogenous probe by providing morphological, structural, and molecular contrast. The method has been successfully applied to various biological tissues in different physiological and pathological conditions, demonstrating its translational potential for diagnostic applications.

Plenary Report

Metal-Enhanced Absorption and Luminescence: Implications of Surface Plasmon Excitation

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Collective electronic excitations in the form of localized surface plasmons lead to a number of interesting phenomena and important applications, surface-enhanced Raman scattering (SERS) being only the most popular of them. Metal nanoparticles in the size regime of tens of nanometers that support this type of electronic motion serve for visible and infrared light as dipole antennas. Being excited, metal nanoparticles not only effectively absorb and scatter irradiated power but also enhance the near field in close proximity to them. Hence, the behavior of any quantum system placed in the vicinity of a metal nanoparticle is radically changed. The corresponding phenomena are called metal-enhanced [1]. Well-studied cases include metal-enhanced absorption and metal-enhanced luminescence. Metal-enhanced chemiluminescence also belongs to this family, although it is due to the increased speed of radiative transition (Purcell effect) rather than to increased absorption in the near field of plasmonic nanoparticles.

Now, we are exploring the role of metal nanoparticles in the enhancement of electrochemiluminescence, a variant of chemiluminescence with better control of time and place where the reaction proceeds. Thus, the enhancement due to the nearby metal nanoparticles, especially, metal nanoparticles supported on a substrate, is higher as compared to ordinary chemiluminescence.

To realize the opportunities provided by metal-enhanced processes, several techniques for metal nanoparticle fabrication and substrate preparation have been explored [3-4].

This study was supported by a grant from the Russian Science Foundation (Project 23-72-00045 <https://rscf.ru/project/23-72-00045/>).

References

- [1] K. Aslan, C.D. Geddes, *Chem. Soc. Rev.*, **38**, 2556 (2009), (DOI: 10.1039/B807498B)
- [2] D.R. Dadadzhyanov, I.A. Gladskikh, M.A. Baranov, et al., *Sens. and Act. B: Chem.*, **333**, 129453 (2021), DOI: 10.1016/j.snb.2021.129453
- [3] I. Nikitin, L.N. Borodina, A.V. Boltenko, et al., *Opt. Mat.*, **160**, 116741, (2025), (DOI: 10.1016/j.optmat.2025.116741)
- [4] A. Ramos-Velazquez, A. Balashov, A. Bondarenko et al., *Opt. and Quant. Elect.*, **57**, 277 (2025), (DOI: 10.1007/s11082-025-08209-w)

Abstracts of Invited Reports

Invited Report

**Entanglement of Identical Particles and the Principle of the
Common Cause**

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Quantum entanglement is a key resource for quantum technologies, but our understanding of it in the important case of identical particles is still incomplete. We will discuss the notion of entanglement, focusing on its roots in the principle of the common cause, a pillar of probabilistic causality. The purpose of this is to provide a framework for understanding the peculiarities of entanglement for identical (massive) particles. We show that entanglement between (massive) identical particles is manifest at the level of single-probability correlations.

Invited Report

Random Lasers with Scale-Free Network Architecture

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Random lasers (RL), which are based on the lasing effect in disordered media, have attracted attention for several decades due to their accessibility and the absence of external cavities [1]. Recently, particular interest has focused on RL with photonic network (PN) materials [2]. It has been demonstrated that the lasing threshold in such materials strongly depends on the graph topology.

Recently, we suggested an RL based on a complex photonic scale-free networks with dissipative tunneling of photons between microcavities (MCs) placed at the nodes and containing two-level quantum systems (TLs) [3]. We have shown that the RL has several remarkable features related to the statistical properties of PN. Among them is the existence of a topologically protected Perron eigenvalue caused by the presence of a strong mean field and the delocalization/localization of radiation modes depending on the probability of coupling between arbitrary MCs. We demonstrated universal non-reciprocal features of photon transmission within the network that stem from non-uniform losses and quantum interference effects occurring at the nodes. We propose a renormalization group hypothesis for the PN to explain in detail the significant spectral features of the random laser [4]. We reveal two scenarios for lasing in the PN described

by a scale-free graph. The first is independent of the tunneling parameter and occurs when the stationary oscillation frequency of the n -th random laser mode is in resonance with the TLS transition frequency. This scenario is reminiscent of lasing in uncoupled MCs and depends on the population inversion. The second lasing scenario is fundamentally different and occurs for non-resonant modes. It is based on dissipative tunneling in the PN and relates to the achievement of the lasing threshold even at a vanishingly small population inversion, due to the redistribution of energy in the network. Based on our findings, we propose a new photonic Ising machine concept that utilizes specific phase properties of photonic modes in an RL for solving NP-hard problems, including network peculiarities, a low threshold, and rapid transition to lasing in a driven-dissipative TLS.

References

- [1] F. Luan, B. Gu, A.S. Gomes, K.T. Yong, S. Wen, P.N. Prasad, *Nano Today*, **10**, 168 (2015).
- [2] M. Gaio, D. Saxena, J. Bertolotti, D. Pisignano, A. Camposeo, R. Sapienza, *Nature Communications*, **10**, 226 (2019).
- [3] D.V. Tsarev, E.S. Morugin, A.P. Alodjants, *JETP Letters*, **120**, 315 (2024).
- [4] D.V. Tsarev, P.V. Zakharenko, A.P. Alodjants, *submitted to Phys. Rev. A* (2025).

Invited Report

Doppler-Free Spectroscopy of Atoms with Nano-Cells and Applications

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The implemented technique, using homemade nanocells with variable thickness in the range of 40- 3000 nm and filled with alkali metal atomic vapor of cesium, rubidium, potassium, and sodium atoms, made it possible to study:

- 1) High-resolution Doppler-free spectroscopy of alkali atoms [1,2].
- 2) Zeeman and Paschen-Back regimes on hyperfine structure of alkali metal atoms in the presence of magnetic fields of ~ 0.2 -9 kG [3,4].
- 3) Magnetically induced (MI) atomic transitions (about 100 transitions), which have zero intensities in $B=0$, but have large intensity in the presence of a magnetic field [5].
- 4) Study of the Electromagnetically Induced Transparency effect using MI transitions [6].
- 5) Study of the Atom-dielectric surface Van-der-Waals interaction, when the distance between an atom and the surface is less than 100 nm [7].

This work was supported by the Higher Education and Science Committee of RA under project number 1-6/23-I/IPR.

References

- [1] D. Sarkisyan, T. Varzhapetyan, A. Sarkisyan, et al., *Phys. Rev. A*, **69**, 065802 (2004).
- [2] A. Sargsyan, E. Klinger, R. Boudot, D. Sarkisyan, *Opt. Lett.*, **50**, 3229(2025).
- [3] D. Sarkisyan, A. Papoyan, T. Varzhapetyan, et al., *JOSA B*, **22**, 88 (2005).
- [4] A. Sargsyan, G. Hakhumyan, C. Leroy, et al., *Opt. Lett.*, **37**, 1379 (2012).
- [5] A. Sargsyan, E. Klinger, A. Amiryan, D. Sarkisyan, *Physics Letters A*, **539**, 130372 (2025).
- [6] A. Sargsyan, E. Klinger, A. Amiryan, D. Sarkisyan, *Physics Letters A*, **434**, 128043 (2022).
- [7] A. Sargsyan, R. Momier, C. Leroy, D. Sarkisyan, *Physics Letters A*, **483**, 129069 (2023).

Invited Report

Application of Photovoltaic Tweezers for Non-invasive Study of *E-coli* Bacteria by Phase-Sensitive Optical Microscopy

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The results of an experimental study of the movement and trapping of Gram-negative Escherichia coli (E. coli) bacteria in broth suspensions by photovoltaic (PV) tweezers are reported. The Fe-doped lithium niobate (LN: Fe) crystal was illuminated by a milliwatt power non-diffracting Bessel beam at 532 nm wavelength, which resulted in the formation of a Bessel-like refractive lattice of 40 μm periodicity inside the crystal and the generation of an alternating PV field $\sim 10^4$ V/cm near the crystal surface. The fabricated chip-scale device operates as a PV tweezers, allowing the trapping and manipulation of micro-and nanoparticles at the crystal surface. In LN: Fe crystals, the PV electric fields are preserved for up to one year, which allows the operation of PV tweezers in the “autonomous” regime. The visualization of the particles was performed using an optical phase-sensitive microscope (OPSM), providing the simultaneous observation of both the refractive lattice rings and trapped objects. PV tweezers were applied for the trapping of dielectric and metal microparticles [1] and extended to the study of the folded DNA molecules [2].

The novelty of this work is the application of PV tweezers combined with OPSM for the

study of living *E-coli* bacteria by focusing on the control of their motility. The sizing of bacteria was performed. The immobilization and trapping of $\sim 95\%$ of bacteria in the area of the recorded hologram ($\sim 2 \text{ mm}^2$) required $\sim 40 \text{ min}$ (Fig.1). The velocity map of bacteria movement in the photovoltaic lattice is constructed. Experiments showed the screening of the negative charge of bacteria by Na^+ counterions present in broth media because of the dissociation of NaCl in the water. The proposed method is non-invasive and enables novel microscopy techniques with inserted chip-scale PV tweezers.

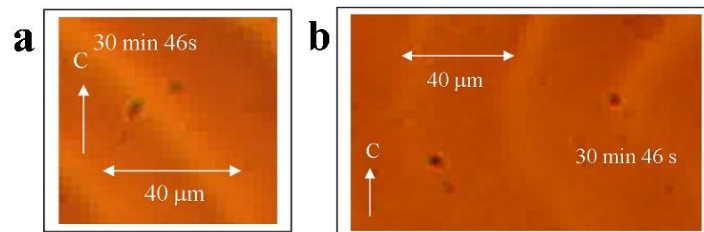


FIGURE 1

References

- [1] L. Tsarukyan, A. Badalyan, R. Hovsepyan, R. Drampyan, *Opt. Las. Techn.*, **139**, 106949 (2021).
- [2] L. Tsarukyan, A. Badalyan, L. Aloyan, Y. Dalyan, R. Drampyan, *Optical Memory & Neural Networks*, **32**(3), S384-S395 (2023).

Invited Report

Fully Transparent Surface Electrodynamic Traps: The Aspects of Preparation and Further Application

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Electrodynamic traps are devices which allow to trap, retain and manipulate charged particles ranging from atomic ions to microparticles without any direct mechanical contact. These traps consist of a set of electrodes to which alternating voltages are applied. As a result of charged particle interaction with the trap electric field, particles literally levitate in an isolated region with the trajectory determined by the power parameters, the environmental and particles parameters, as well as external influences. One possible configuration of traps is the surface electrodynamic trap, which has electrodes located on a substrate. Surface traps are widely used in quantum computing, frequency standards, precision measurement platforms, cold plasma physics research, and, finally, single-particle spectroscopy. In most of these applications, the particles are

exposed to laser irradiation, enabling their state to be manipulated or read. Therefore, an important goal is to develop fully transparent traps that can localize charged particles, ranging from atomic ions to microparticles.

In this study, we developed a fully transparent surface trap with indium-tin oxide (ITO) electrodes. These were deposited on a quartz substrate via magnetron sputtering of an indium-tin target through a contact mask. To maximize the transparency and conductivity of the electrodes, we adjusted the oxygen and argon partial pressures in the chamber and the deposition rate. To enhance the performance of the electrodes, they were post-annealed in an atmosphere. We have demonstrated that this technique allows the production of electrodes with transparency in the visible spectrum of at least 80%, conductivity of around $100 \text{ } \Omega/\text{cm}^2$, a band gap of over 3.5 eV, and tunable properties in the NIR spectral region. Numerical study has shown that the proposed traps allow for retaining the particles in a wide size and mass regions.

In the present work, we also discuss the opportunities provided by the developed traps to the random number generation, gravimetry, chaotic system studying, as well as single particle comprehensive characterization.

This study was supported by the Russian Science Foundation (project 24-79-00225)

Invited Report

On the New Method for the Precise Determination of the Intramolecular Potential Energy Surface on the Basis of Microwave and Submillimeter-Wave Spectra

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A new method for the precise semiempirical determination of the basic parameters (structural parameters and parameters of the intramolecular potential energy surface, PES) of a molecule on the basis of highly accurate experimental data from the microwave and submillimeter-wave regions is suggested. The options and advantages of this method in comparison with the other methods of molecular PES determination are discussed using a diatomic molecule as an appropriate illustration. The HCl molecule is exploited as a suitable example. It is shown with this example that the use of a very limited number (ten for H^{35}Cl and five for D^{35}Cl) of submillimeter-wave line positions allows one to determine the values of the equilibrium rotational parameter, harmonic frequency, and anharmonic coefficients of the third, fourth, and fifth order with accuracy of 0.01%, 0.01%, 0.01%, 2.1%, and 10.1%, respectively, in comparison with the analogous results obtained from extensive infrared studies. Peculiarities of the derived method at

application to the polyatomic molecules are discussed.

The work was supported by the Tomsk Polytechnic University in the frame of the PRIORITY- 2030 project.

Invited Report

Calculations of Magnetic Field Values that Cancel the Transitions of Alkali Atoms

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We analysed π , σ^+ and σ^- transition cancellations between magnetic sublevels of hyperfine structures of alkali-metal isotopes. D_1 line transitions of all isotopes are considered analytically and D_2 line transitions for some isotopes numerically.

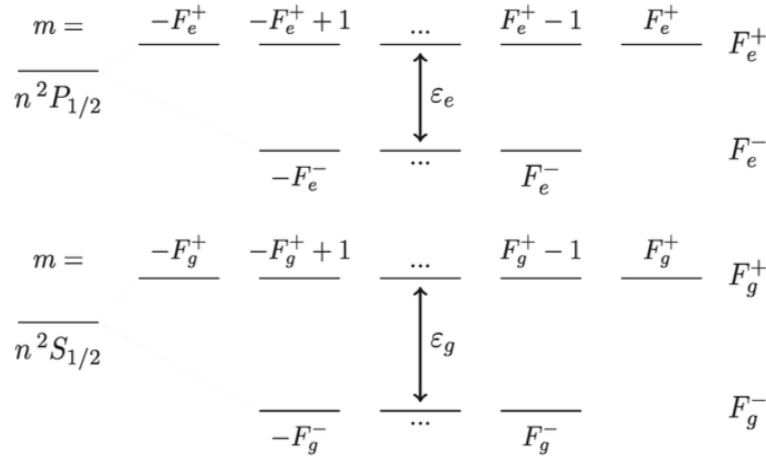


FIGURE 1: D_1 line scheme in a magnetic field. When I is a half-integer quantity

General block Hamiltonian matrices in the presence of a magnetic field are built, eigenvalues and eigenkets describing ground and excited levels are calculated, modified, and unperturbed transfer coefficients as a function of the nuclear spin I , the magnetic quantum number m and the magnetic field magnitude B are defined.

For D_1 line a unique formula for B -field values cancelling transitions is obtained. The accuracy of the B -field values is only limited by the uncertainty of the involved physical quantities.

$$B = -\frac{2m}{\mu_B(1+2I)} \times \frac{2\varepsilon_e\varepsilon_g}{g_g\varepsilon_e + g_e\varepsilon_g}; \quad 0 \leq (-1)^{2I} m \leq I - \frac{1}{2}$$

Isotope	I	F	m	B (G)
²³ Na	3/2	1	-1	153.2007(86)
²³ Na	3/2	2	-1	153.2007(86)
³⁹ K	3/2	1	-1	44.991(10)
³⁹ K	3/2	2	-1	44.991(10)
⁴⁰ K	4	9/2	7/2	190.20(33)
⁴⁰ K	4	7/2	7/2	190.20(33)
⁴⁰ K	4	9/2	5/2	135.85(24)
⁴⁰ K	4	7/2	5/2	135.85(24)
⁴⁰ K	4	9/2	3/2	81.51(15)
⁴⁰ K	4	7/2	3/2	81.51(15)
⁴⁰ K	4	9/2	1/2	27.171(48)
⁴⁰ K	4	7/2	1/2	27.171(48)
⁴¹ K	3/2	1	-1	24.046(95)
⁴¹ K	3/2	2	-1	24.046(95)
⁸⁵ Rb	5/2	2	-2	380.73(13)
⁸⁵ Rb	5/2	3	-2	380.73(13)
⁸⁵ Rb	5/2	2	-1	190.368(66)
⁸⁵ Rb	5/2	3	-1	190.368(66)
⁸⁷ Rb	3/2	1	-1	642.590(76)
⁸⁷ Rb	3/2	2	-1	642.590(76)
¹³³ Cs	7/2	3	-3	1359.237(26)
¹³³ Cs	7/2	4	-3	1359.237(26)
¹³³ Cs	7/2	3	-2	906.158(17)
¹³³ Cs	7/2	4	-2	906.158(17)
¹³³ Cs	7/2	3	-1	453.0790(84)
¹³³ Cs	7/2	4	-1	453.0790(84)

Table 1: *B*-field values cancelling transitions of ²³Na, ³⁹K, ⁴⁰K, ⁴¹K, ⁸⁵Rb, ⁸⁷Rb and ¹³³Cs with uncertainties.

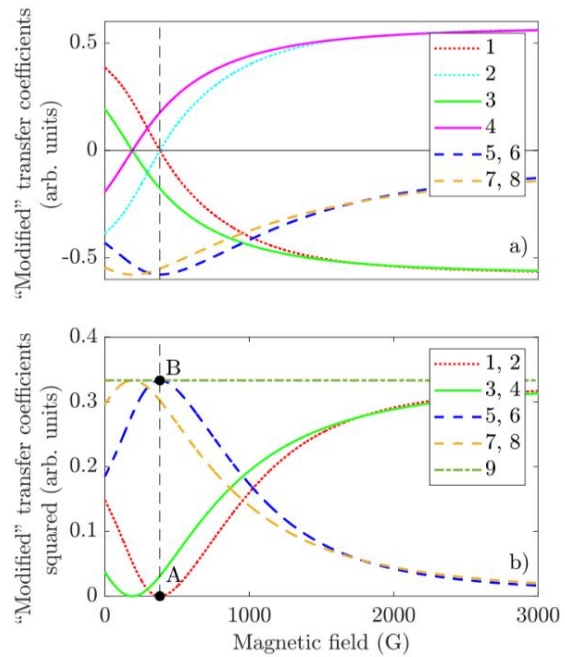


Figure 2: a) ⁸⁵Rb *D*₁ line modified transfer coefficients for *m* = -2 and *m* = -1 π transitions. For this isotope four cancellations exist: 1, 2, 3 and 4. b) Modified transfer coefficients squared for *m* = -3, -2 and -1. The vertical dashed line indicates the value *B* = 380.73 G which corresponds to the cancellation of the transitions 1 and 2 (point A) and coincides with the maximum of transitions 5 and 6 (point B). The maximum of transitions 7 and 8 coincides with the cancellation of the transitions 3 and 4. “Guiding” transition coefficient squared 9 corresponds to *m* = -3.

Invited Report

Resonance Kapitza-Dirac Diffraction of an Atom in a Standing Wave as a Probe of Quantum Superposition Principle

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Examining the methods of recording the quantum state of the atomic translational motion formed by near-resonance Kapitza-Dirac diffraction and atom interferometer, it was concluded that they cannot be accepted as a justification for its superposition nature, as well as the collapse postulate of the measurement. The blocking factor here is that the momentum states are measured at different spatial points, where a direct detection of a superposition state would mean violation of the conservation of energy (or mass), as well

as the corpuscular component in the particle substance due to the de Broglie wave-particle concept.

To clarify the dilemma regarding the nature of the translational motion and the nature of the measurement of the state, we have proposed and analyzed a method of laser probe spectroscopy for an atomic sample, the number of atoms of which is less than the effective number of discrete momentum states formed by the near-resonance Kapitza-Dirac diffraction. A full coverage of the issue can be obtained by acting on the atomic sample immediately after the standing wave, also by a traveling wave, and performing the spectroscopic measurement of the studied state after the traveling one (such a pattern is shown in [Figure 1](#)). Additional measurements performed after the standing wave are of an auxiliary nature and, naturally, will increase the reliability of the final conclusions both about the superposition nature of the translational motion of the atom and about the process of its measurement.

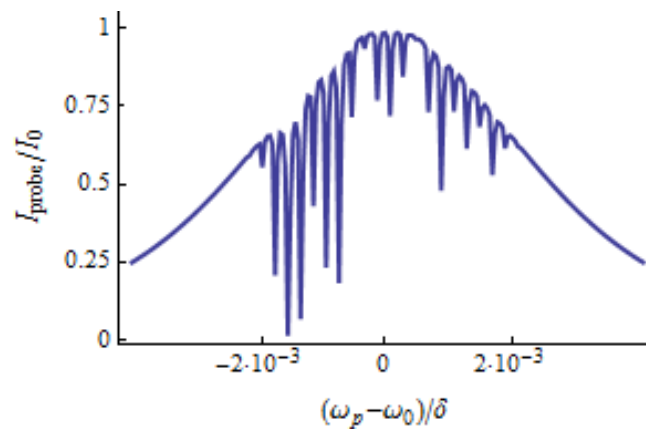


Figure 1: Doppler-sensitive absorption spectrum of an atomic sample subjected to the standing and subsequent traveling waves: Atoms were in a superposition state while the measurement was of “classical”, non-collapse nature.

References

1. V.M. Arutyunyan, A.Zh. Muradyan, Rep. Acad. Sci. Arm. SSR, **60**, 275 (1975).
2. P.J. Martin, P.L. Gould, B.G. Oldaker, et al., *Phys. Rev. A*, **36**, 2495 (1987).

Invited Report

**Doppler-Free Spectroscopy of 6S-7P Atomic Transition Realized by
a Cs Nanocell**

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The features of Doppler-free resonances detected by probing the $6S_{1/2} \rightarrow 7P_{3/2}$ transition of the Cs atom at 456 nm in a nanofabricated vapor cell are presented. The oscillator strength of these transitions intensities is 60 times weaker than that of the Cs 852 nm transition intensities. The Doppler-free resonance using the nanocell (NC) with thickness $L \sim 230$ nm and $L \sim 460$ nm (where L is the thickness between the inner surfaces of the NC's windows), is investigated [1]. For $L \sim 460$ nm, single pass Doppler-free resonances have linewidth < 20 MHz (which are 40 times smaller than the Doppler linewidth of 800 MHz at 170 °C) and are located at the atomic transitions $F_g = 3,4 \rightarrow F_e = 2,3,4,5$ with the correspondence of the amplitudes to their transition intensities. These narrow resonances are of interest for high-resolution spectroscopy and instrumentation, particularly, can serve as a frequency reference tool. For $L < 400$ nm, frequency red shift of the atomic transitions is observed, caused by atom-surface interactions. The C_3 coefficient of the van der Waals effect is measured [1].

This work was supported by the Science Committee of RA, in the frame of project 25RG-1C008.

References

- [1] A.Sargsyan, E. Klinger, R. Boudot, D. Sarkisyan, *Opt. Lett.*, **50**, 3229(2025).

Invited Report

**On the Quantum Motion of a Single Photon in a Nanofiber and its
Decay into Two Entangled Photons**

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To study the wave properties of a single photon with spin in an arbitrary medium, we use modified Yang-Mills equations for Abelian fields within the framework of the gauge

symmetry group $SU(2) \times U(1)$. Using the original system of first-order partial differential equations as an identity, a system of second-order partial differential equations is derived that describes the evolution of the wave state of a single photon in Minkowski space-time with fabrics. Taking into account the obtained system of equations for the motion of a photon in a plane perpendicular to the direction of propagation of the photon, we have derived an equation similar to the equation of a two-dimensional quantum harmonic oscillator with a time-dependent frequency. The work studies elastic and inelastic scattering of light on quantum dots, which are distributed along the direction of photon propagation in a nanolight guide. The mathematical issues arising in solving this problem within the framework of the representation of complex probabilistic processes are studied in detail, including non-trivial geometric problems associated with the emergence of an additional subspace with non-commutative geometry, which allows one to accurately construct mathematical expectations of various parameters of the dynamical system. In particular, the mathematical expectation of the photon wave function was calculated, and its transition to one of the Bell states was constructed in the form of an integral representation.

Invited Report

Double- and Single-Frequency Doppler-Free Spectroscopy of Alkali-Metal Atoms: Applications to Atomic Clocks

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Recently, our group of the Frequency Standards Lab has performed double-frequency Doppler-free spectroscopy of ^{87}Rb atoms [1] in application to compact optical clocks [2,3]. The most interesting results are the narrowest width of the crossover and growth in the amplitude of the peak $F_e=1$ with the two-photon detuning. The first part of the report will be devoted to the explanation of these effects via the analysis of the transition $J_g=1/2 \rightarrow J_e=1/2$ with an arbitrary value of the nucleus spin I .

A way to obtain a Doppler-free resonance unaffected by microwave and Zeeman coherences with the double-frequency technique will be presented in the second part of the report. Its advantages over a conventional approach will be discussed.

The double-frequency spectroscopy requires a bichromatic radiation, which can be obtained by using an external modulator or by efficient microwave current modulation of a diode laser with an extended cavity. The device becomes bulkier. The third part of the report focuses on the theoretical investigation of whether or not monochromatic radiation can be used instead of a bichromatic to provide a resonance with a similar amplitude-to-width ratio.

The authors receive funding from the Russian Science Foundation (grant No. 24-72-10134).

References

- [1] V. L. Velichansky, K. M. Sabakar, A. S. Fedorov, et al., *JETP Letters*, **121**, 602-607 (2025).
- [2] Z. L. Newman, V. Maurice, T. Drake, et al., *Optica*, **6**, 680-685 (2019).
- [3] M. A. Hafiz, G. Coget, E. de Clercq et al., *Optics Letters*, **41**, 2982 (2016).

Invited Report

Scanning Technique for Direct Optical Transmission Imaging of Highly-Scattering Objects

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We present a spatial scanning technique for optical transmission imaging of strongly-scattering objects based on the spatially-selective registration of ballistic photons originating from modulated (pulsed) laser radiation. The registration system counts the number of transmitted pulses at any pixel, forming a grayscale image. By choosing a modulation regime, it is possible to record a real analog image or to outline the contours of image features without the necessity of software image processing. The developed system is tested on a model scattering object (a stack of paper) and a biological object (a human hand). Due to the automatic adjustment of the signal level, realized by the appropriate laser modulation mode, formation of an image with a structure uniformly pronounced across the aperture has been attained, even under conditions of significant changes in background transmission [1].

References

- [1] S. Shmavonyan, A. Khanbekyan, M. Movsisyan, A. Papoyan, “Scanning technique for direct optical transmission imaging of highly-scattering objects”, *Optics and Lasers in Engineering*, v.**184**, 108633 (2025).

Abstracts of Oral Reports

Oral Report

Autofluorescence Lifetime Imaging Probe for Optical Diagnostics of Liver Tumors

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Liver cancer is a global health challenge and its incidence is growing worldwide, with more than 1 million cases per year by 2025. While hepatocellular carcinoma (HCC) is the most common form of liver cancer, hepatic metastases of colorectal carcinoma (CRC) are the natural disease evolution in almost 50% of patients with CRC. For both HCC and CRC liver metastases, surgical resection represents the only chance of long-term survival. In this context, a label-free optical diagnostic and/or surgical guidance tool would be highly suitable to reduce possible positive margins and improve the patient's disease outcome. In this study, we used a custom-made autofluorescence lifetime fiber-based imaging instrumentation [1] to provide real-time discrimination of tumor from perilesional tissues in freshly excised liver samples. The proposed approach allowed discriminating tumor from perilesional tissue, reporting the fluorescence lifetime decay of cellular metabolic markers, i.e., NADH and FAD(H). In particular, we reported about the characterization and delineation of tumor against healthy margin in different clinical cases of gastrointestinal tissues [2], demonstrating the capability of our method. The approach was further validated on a larger statistic by examining around 30 surgical specimens of both HCC and CRC hepatic metastases, demonstrating that this approach is a powerful method for delineating tumor borders as well as for differentiating HCC from CRC metastases to the liver. The obtained results, together with the capability to acquire and process images in real time under bright backgrounds, enable our methodology to be translated into surgical and clinical instrumentation for label-free tissue diagnostics and surgical guidance.

References

- [1] J.L. Lagarto, V. Shcheslavskiy, F.S. Pavone, and R. Cicchi, "Real-time fiber-based fluorescence lifetime imaging with synchronous external illumination: A new path for clinical translation," *J. Biophotonics*, vol. **13**, no. 3, Mar. 2020.
- [2] Suraci D, Baria E, Tirloni L, Lagarto JL, Buccianti S, Agostini C, Pillozzi S, Antonuzzo L, Taddei A, Cicchi R. "Delineation of gastrointestinal tumors biopsies using a

fluorescence lifetime imaging optical fiber probe". *J Biophotonics*,
2024 Jul 16:e202400122

Oral Report

Single- and Collective Microparticles Nonlinear Dynamics in the Hermite-Gauss Optical Beams

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Optical tweezers are widely used for trapping and manipulation of optically transparent micro-sized particles, ranging from geometrically regular dielectric spheres to multilayers system and biological structures. Particles can be retained in the tweezers' optical fields due to the gradient force induced by internal reflection and usually directed towards the maximum intensity. In the simplest case of Gaussian beams, which are the most common in optical tweezers implementations, the gradient force direct to the beam's symmetry axis. In this case particle's dynamics can be described as central force dynamics. The dynamics of dielectric particles in Gaussian beams have been well investigated for spherical particles, as well as for the particles with complex spatial structure. In one hand such a central force dynamic is rather simple to describe but have a lack of control parameters. On the other hand, an additional degree of particle dynamics control can be achieved by using structured optical beams in tweezers. One such configuration of optical beams which provide a new opportunity is Hermite-Gauss beams.

In this study, we present two traps' configurations, which are a passive optical trap based on Hermite-Gauss beams for dielectric microparticles, and the hybrid optical-electrodynamical trap. We numerically calculate the evolution of the nonlinear dynamics of the spherical particles in the described trap configurations. In the present for optical trapping, we consider TEM 01 and TEM 10 modes of Hermite-Gaussian beams. As the electrodynamics trap modulus, we used 5-wire surface traps. In the proposed systems we observe bistable dynamics, related to two maxima distribution of intensity in laser beams. Moreover, the presence of two stable positions in studied non-linear systems led to the transition of particle dynamics to chaos. To comprehensively characterized transition to chaos we calculate the Lyapunov exponents for studied system and generalized it in a non-trivial Lyapunov exponent maps. We also show a new prospective that provide the hybrid traps with Hermite-Gaussian beams for the formation and organization of quasi-Coulomb crystals.

This study was supported by the Russian Science Foundation (project 24-22-20042).

Oral Report

Characterizing Electro-Optic Phase Modulations for Temporal Mode Transformations

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Temporal modes are a framework for quantum information science and technologies. They offer a high-dimensional Hilbert space for information encoding and are well-suited for use in integrated photonics and single-mode fiber networks. Efficient manipulation of temporal modes is required to make this framework viable. Techniques for temporal mode transformations have been developed that allow for control over the individual mode structure, as well as beam-splitter-like transformations between multiple modes. However, no scheme has yet been achieved to perform targeted multi-mode unitary transformations on temporal modes. We present a pathway toward implementing programmable arbitrary unitary transformations on temporal modes using phase-only operations in the form of electro-optic modulation. We present techniques to measure and characterize temporal phase modulations using spectral interferometry. Additionally, we demonstrate the ability to generate and measure arbitrary phase modulations in the time and frequency domains using photonic arbitrary waveform generation.

Oral Report

Thermal Infrared Human Detection with Elliptical Aperture Horn Providing Wide Horizontal Angle of View and Coverage Area

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The work presents a novel miniature technique for human detection with an elliptical aperture horn as a radiation concentrator in the thermal infrared spectrum. The horn focuses radiation from relatively hot objects in the surrounding area into the thermal sensor [1, 2]. The ultimate angle for the ray, obliquely incident on the horn with a wide horizontal apex

angle and directly falling on the output window, is derived by geometric consideration of the problem.

The experiment uses elliptical aperture horns, which are made of metal sheets with a nickel-plated inner surface to ensure complete reflection of the incident beam in the thermal infrared spectrum. The horns' output windows are connected with the input window of the thermal sensors to detect concentrated thermal infrared radiation from the surroundings. The Arduino board and laptop are used to acquire data from the sensor output. A new software program in Python has been developed to register thermal signals from the observing area. The program indicates even small changes (0.04 °C) in the background temperature due to the appearance of hot objects within the field of view of the horn. The concept is developed to indicate temporality alarm switching by analyzing signals from the thermal sensor and Arduino board.

In the experiments, the dependence of the detected signal level on the observation angle of the human at a distance of 6m is registered. We obtain that the horizontal angle of view of the horns is 80 °C, and the detection coverage area is 321.0 m².

References

- [1] A.E. Martirosyan, R.B. Kostanyan, V.A. Martirosyan, *et al.*, *Opt. Eng.* Vol. **63**, 044101 (2024).
- [2] A.E. Martirosyan, P.H. Muzhikyan, V.A. Martirosyan, *et al.*, *Contemp. Phys.* Vol. **60**, pp. 94–100 (2025).

Oral Report

Parametric Resonance and Phase Transitions in the Quadrupole-Trap-Based Nonlinear Levitodynamic System

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Levitodynamics is a rapidly developing and promising field of modern physics. A unique feature of levitodynamical systems is the absence of mechanical contact between a levitated (or trapped) particle and other system elements. In particular, single-charged nano- and microparticles could be trapped and retained in an alternating quadrupole electrical potential. Such a mechanical isolation of a single levitated particle allows it to be a superior system for precision measurements and fundamental research. Although the field of levitodynamical systems is rapidly developing and already finds real-world applications, it is mainly stuck with improving existing experimental techniques and avoiding immersion in

the depth of nonlinear phenomena inevitably present in levitodynamic systems, and actually determining the nature of their behavior.

For example, the motion of a massive charged nano- or microparticle in the alternating electric potential of the trap is rather complex. The energy exchange between different degrees of freedom in the system can lead to resonance effects and phase transitions of particle motion. In addition, the interaction of a massive particle with buffer gas, firstly, leads to viscous drag and energy dissipation, which at high particle velocities takes a nonlinear behavior; secondly, it leads to stochastic behavior in the particle motion, caused by Brownian gas motion. The complexity and diversity of the dynamics in such systems imply a whole set of sensitive dynamical states. Accurate and systematic accounting of nonlinear effects arising in the trapped particle dynamics may allow the development of new approaches to precision sensing and measurement applications.

In this study, we present the results of an investigation into parametric resonance and phase transitions in the dynamics of a silicon dioxide microsphere localized in a quadrupole trap at atmospheric pressure. We show a scenario of resonance effects occurring in particle dynamics at the coincidence of secular and micromotion frequencies of the particle translational oscillations. Consequently, we discuss features of the phase transition in particle motion, which is accompanied by a change in the spectral composition of particle oscillations and a sharp increase in its oscillation amplitude. Notably, the growth in the amplitude of particle oscillations gets stabilized due to the nonlinearity of viscous drag forces, resulting in the formation of a specific limit cycle of particle motion known as an extended orbit. We analyze the conditions of the parametric resonance and the mechanisms of the extended orbit formation that may be utilized for new levitodynamic system-based sensors.

This study was supported by the Russian Science Foundation (project No.24-79-00225).

Oral Report

Metrological Properties of Dual-Frequency Doppler-Free Resonances in ^{87}Rb and ^{85}Rb Atoms

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Today, compact atomic frequency standards operating in the optical range are in demand as clocks, for the development of quantum sensors (magnetometers, gyroscopes), atom cooling applications, and quantum computing. The dual-frequency Doppler-free spectroscopy enables the detection of high-contrast absorption resonances with a favorable signal-to-noise

ratio [1]. The frequency stability of a laser locked to one of these resonances can reach values better than $1 \cdot 10^{-13}$ at 100 s averaging time [2, 3].

Until now, most studies dedicated to this topic have involved Cs atoms. The bichromatic field was generated using an external electro-optic modulator (EOM), which restricts opportunities for miniaturization. In this work, we present new results of dual-frequency Doppler-free spectroscopy applied to ^{87}Rb and ^{85}Rb atoms. The bichromatic field was created by direct modulation of the injection current of an extended-cavity diode laser, so the additional EOM was not needed.

The ratio of the Doppler width to the hyperfine splitting of the excited state in these atoms is larger than 0.6, which allowed observing the crossover resonances for the first time with this technique. It was found that for parallel polarizations of counter-propagating beams, their amplitude significantly increases as compared to the case of orthogonal polarizations. The width of the crossover resonance exceeds the minimum achievable natural linewidth by a factor of 2 to 3. The parameters of eigen resonances have been studied as functions of the two-photon microwave detuning. The low-frequency resonance shows increase of amplitude and becomes twice narrower if microwave field is detuned, while the high-frequency resonance possesses the best characteristics at the exact two-photon resonance. Metrological parameters of six observed resonances were optimized, including proper polarizations orientation, two-photon detuning value, vacuum cell temperature, and laser light intensity determination. Advantages and disadvantages of each resonance are discussed. We consider these results as valuable for the development of a miniature atomic optical frequency standard.

Work is supported by a grant from the Russian Science Foundation №24-72-10134.

References

- [1] M. A. Hafiz *et al.*, *Optics Letters*, **41**, 2982 (2016).
- [2] A. Gushing *et al.*, *JOSA B*, **38**, 3254 (2021).
- [3] A. Gushing *et al.*, *Optics Letters*, **48**, 1526 (2023).

Oral Report

Microwave-Optical Double-Resonance Spectroscopy in a Rubidium Microcell

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One of the precision spectroscopy methods actively used in the study of alkali metal atoms, particularly rubidium, is based on the effect of microwave-optical double resonance [1]. This technique has found special application in quantum sensing, especially for the construction of atomic frequency standards [2]. Moreover, it can be used for visualization of the magnetic field distribution or measurement of microwave radiation power [3].

The spatial resolution of a quantum sensor is determined by the size of its sensitive volume, which can be a cell containing atomic vapors. In the context of quantum sensing, atomic cells with micron-scale thickness are of particular interest. The present work is focused on the investigation of spectral properties of thermal rubidium atomic vapor in a microcell with a thickness less than 90 micrometers using the method of microwave-optical double-resonance spectroscopy.

The measured spectra are compared with those obtained from a centimeter-scale cell. A number of key factors limiting the sensitivity of the microcell in magnetic field measurements have been identified. The main mechanism of spin relaxation of the atomic ensemble is collisions with the cell's walls, which cause the narrowing of the Doppler spectrum of atoms in the microcell compared to the spectrum in the macroscopic cell. It is also shown that the radiation trapping effect leads to the redistribution of optical pumping among atoms of all velocity groups. This process determines the linewidth of the double resonance spectral lines in the microcell. This phenomenon can be used to estimate the number of photon reabsorption events in an optically dense medium, complementing the existing approaches [4].

References

- [1] Demtröder, W. "Optical Pumping and Double-Resonance Techniques", *Laser Spectroscopy*: Vol. 2 Experimental Techniques, 213-257 (2008).
- [2] E. Batori, C. Affolderbach, M. Pellaton, et al., "μpop clock: A microcell atomic clock based on a double-resonance Ramsey scheme", *Phys. Rev. Appl.*, **18**, 054039 (2022).

- [3] Horsley, A. “High resolution field imaging with atomic vapor cells”, Doctoral dissertation, University of Basel (2015).
- [4] N. Mercadier, W. Guerin, M. Chevrollier, and R. Kaiser, “Lévy flights of photons in hot atomic vapours,” *Nat. Phys.*, **5**, 602–605 (2009).

Oral Report

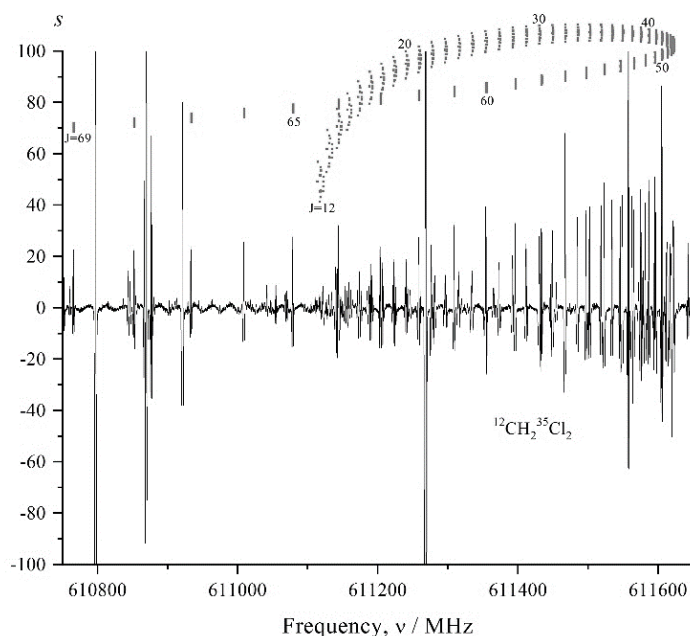
Global Analysis of Quadrupole Hyperfine Structure in Excited Vibrational States of the Methylene Chloride Molecule

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The high-resolution submillimeter wave spectra of the $^{12}\text{CH}_2^{35}\text{Cl}_2$ methylene chloride (six spectra were recorded in different parts of the 0.075 – 1.1 THz spectral region) were analyzed in the frame of Watson’s Hamiltonian in A -reduction and I^r -representation with the use of the SPFIT/SPCAT package of Pickett. The 2368 unresolved lines (including 878 peripheral lines of triplets) with the maximum values of quantum number $J^{\text{max}} = 83$ and $K_a^{\text{max}} = 19$ were assigned in the experimental spectra to the transitions of the ($v_4 = 2$) vibrational state (in general, this spectroscopic structure is due to partially resolved/unresolved Cl quadrupole coupling hyperfine structure of the 29840 individual quadrupole–rotational transitions). The eleven rotational and centrifugal distortion parameters and three nuclear quadrupole coupling parameters obtained from the fit reproduces values of the experimental multiplet centers with the root mean square deviation of 36 kHz and of the experimental peripheral lines of triplets with $d_{\text{rms}} = 47$ kHz. Comparison with the rotational and centrifugal distortion parameters of the ($v_4 = 2$) vibrational state known in the literature is made, and shown that they reproduce the same set of the experimental line positions with d_{rms} that is 130 times worse in comparison with the results of the present study.



The work was supported by the Tomsk Polytechnic University in the frame of the PRIORITY- 2030 project.

Oral Report

Comprehensive Absolute Line Strengths Analysis of the $^{28}\text{SiH}_4$ Octad: The 24 Sub-Bands of the Octad in the Region of $2600\text{--}3400\text{ cm}^{-1}$

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Absolute line strengths of $^{28}\text{SiH}_4$ were measured for the first time with a Bruker Fourier transform infrared spectrometer IFS125HR and analyzed in the $2600\text{--}3400\text{ cm}^{-1}$ region where the eight different bands (twenty-four sub-bands) of the SiH_4 octad are located. The 1300 absolute strengths of lines belonging to the F_2 , F_1 , and E-type sub-bands of the octad ($J^{\text{max}} = 20$) were determined from the fit of the Hartmann–Tran profile to their experimental line shapes and were used then as the initial information in the fit of the effective dipole moment parameters of the octad. The derived set of 19 fitted parameters reproduces 1300 initial absolute line strengths of the $^{28}\text{SiH}_4$ octad with the d_{rms} deviation of 4.6%.

The work was supported by the Tomsk Polytechnic University in the frame of the PRIORITY- 2030 project.

Oral Report

Optical Reservoir Computing with Engineered Structure and Tunable Coupling

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Reservoir Computing (RC) is a computational approach based on a Recurrent Neural Network. There are physical implementations of RC including different Optical RC's [1]. Different reservoir schemes with different structures were explored [2]. We propose an advanced optical scheme using a Liquid Crystal Cell (LCC) with a voltage-controlled scattering as a reservoir.

Liquid Crystal molecules change their orientation inside LCC under different applied voltages. This reorientation leads to a change in scattering and, as a result, the nodes coupling and structure of the reservoir. It adds an additional degree of freedom to the system.

Our experimental results show a gradual transition from dense, Random Gaussian, fully coupled to the identity diagonal uncoupled matrix in a simple retrieval task. In a high scattering case, results were comparable with the results of experiments with a fixed high-scattering media. Steady transformation of a retrieved transmission matrix from a fully coupled (high scattering cases) to an identity uncoupled (low scattering cases) is shown. Besides that, we compared the time predictions of spatiotemporal chaotic datasets obtained from the Kuramoto-Sivashinsky equation, obtained with an optical setup with different reservoir structure and node coupling, to the results of simulations with corresponding parameters. The results show the change in prediction quality for different reservoir structures and coupling. Tuning the reservoir according to the task may lead to better performance.

References

- [1] M. Rafayelyan, J. Dong, Y. Tan, F. Krzakala, S. Gigan, "Large-scale optical reservoir computing for spatiotemporal chaotic systems prediction," *Physical Review X*, **10**(4), 041037 (2020).
- [2] Pathak, Jaideep, et al., "Model-free prediction of large spatiotemporally chaotic systems from data: A reservoir computing approach." *Physical Review Letters*, **120**.2 (2018): 024102.

Oral Report

Polymer-Immobilized Topological Solitons Generated via Low-Intensity Light in Dye-Doped Cholesteric Systems

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In this study, we present a novel method for the low-power optical generation of localized orientation structures in chiral nematic liquid crystals (CNLCs); including well-known cholesteric torons. These structures belong to the class of topological solitons, which hold significant potential as tunable optical elements or components in advanced photonic systems, such as microlens arrays [1] or two-dimensional diffraction gratings [2].

Previous research has established that optical generation of various topological solitons typically requires high-power laser beams (40–110 mW per localized structure) [3,4]. An alternative opto-molecular approach [5], relying on photoactive CNLCs with a light-modulated cholesteric helix, achieved soliton formation at significantly lower power (tens of nanowatts). However, this approach required the use of a specific chiral molecular additive and constant light illumination to sustain the structures.

Our work introduces a simple and versatile approach for the addressable generation of various localized chiral structures, including cholesteric spherulites, using a Gaussian beam with a power of just a few milliwatts. We investigate the formation of these structures under varying beam parameters and in frustrated dye-doped CNLC films, as well as their electric-field-driven evolution. Additionally, we develop a polymerizable CNLC matrix, enabling—for the first time—the stabilization of polymerized topological defect pairs formed under an applied electric field. Crucially, all metastable solitons and non-equilibrium defect structures can be polymerized at any stage without distorting the director field.

The research was supported by the Higher Education and Science Committee of MESCS RA (Research Project №24AA-1C060).

References

- [1] R. Hamdi, G. Petriashvili, G. Lombardo, M.P. De Santo and R. Barberi, *Journal of Applied Physics*, **110**, 074902 (2011).
- [2] P. Ackerman, Z. Qi, I. Smalyukh, *Physical Review E*, **86**, 021703 (2012).
- [3] I.I. Smalyukh, Y. Lansac, N.A. Clark, R.P. Trivedi, *Nature Materials*, **9**, 139 (2010).
- [4] B. Yang and E. Brasselet, *Journal of Optics*, **15**, 044021 (2013).
- [5] C. Loussert, S. Iamsaard, N. Katsonis and E. Brasselet, *Advanced Materials*, **26**, 4242 (2014).

Oral Report

Direct Observation of the Quantum Phase of a Free-Falling Object

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Since Galileo and Newton and all the way to Einstein, the phenomenon of gravitational free fall stood at the very center of the understanding of nature. As quantum mechanics and classical gravity are still not a unified theory, it is important to study the phenomenon of free fall also in the quantum realm. To directly measure gravitational free fall in the quantum domain, namely, to measure the quantum phase of a free-falling object, we realize a novel cold-atom interferometer, the Quantum Galileo Interferometer (QGI), in which one wave packet is levitated and stays static in the laboratory frame while the other is in free fall [1]. QGI is a variant of the Stern-Gerlach interferometer (SGI) [2, 3], which is based on utilizing the force experienced by an atomic spin in an inhomogeneous magnetic field. By creating a superposition of magnetic-sensitive and magnetic-insensitive states, we manage to “hold” one part of the atomic superposition (Rb87) against falling with a magnetic gradient, while another part of the superposition is in free fall. At the end of the interferometric sequence, the two parts of the superposition, i.e., two atomic wave packets, must be precisely overlapped in position, momentum, and shape, which requires precise control of currents in the atom chip, creating the magnetic gradient pulses. The realization of the QGI makes available a new tool for the study of gravity, the quantum equivalence principle, and more generally, the quantum-gravity interface.

References

- [1] O. Dobkowski, B. Trok, P. Skakunenko, *et al.*, preprint arXiv:2502.14535 (2025)
- [2] Y. Margalit *et al.*, *Sci. Adv.*, **7**, 2879 (2021)
- [3] O. Amit *et al.*, *Phys. Rev. Lett.*, **123**, 83601 (2019)

Oral Report

Nanoroughness Induced Antireflectivity in Opaque Systems

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We have studied the specular and diffuse scattering of light from a weakly rough opaque surface. A theory is developed that utilizes new, modified boundary conditions. They significantly change the results both for specular and diffuse scattered intensities. An anti-reflection is predicted in the wavelength region where the light penetration depth into the medium is of the order of the roughness root mean square height. This phenomenon is observed experimentally for nano-roughened Si films in the 300-400 nm region. Angular and polarization dependencies of diffuse scattered (haze) light are revealed. It is shown that the haze is mainly p-dominated and is directed around the surface normal, independent of the incident angle.

References

- [1] V. Gareyan, N. Margaryan, Zh. Gevorgian, *Phys. Rev. A*, **Vol. 110**, 063523, (2024).
- [2] V. Gareyan, Zh. Gevorgian, *Phys. Rev. A*, **Vol. 109**, 013515, (2024).

Oral Report

Third Harmonic Generation as a Monitoring Tool for Precision Glass Processing

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Femtosecond laser processing is a versatile tool, now widely employed in industrial manufacturing, offering exceptional precision across a broad range of materials. Demonstrated applications range from crack-free cutting and drilling [1] to the direct inscription of integrated optics and photonic elements (waveguides, diffraction gratings, phase plates, etc.) [2, 3]. The achievable precision, however, is sensitive to several factors, including laser-system parameters (pulse-energy stability), optics quality (beam profile and aberrations), and environmental conditions (temperature, vibration). This study focuses on

two process-related factors that most directly affect feature fidelity: accurate laser-focus detection (maintaining the beam waist on target), and reliable measurement of the material-modification threshold, which defines the working fluence range required for near-threshold sub-micron processing.

Several techniques with varying performance and application scope have been proposed for precise laser-focus detection, and numerous autofocus systems have been developed on these principles [4]. Most, however, target specialized tasks and are difficult to integrate into microfabrication setups. Here, we discuss and demonstrate on BK7 glass a focus-detection approach that uses the third-harmonic generation (THG) produced by the same femtosecond beam employed for machining. Its advantages and limitations will be presented and compared with those of a conventional confocal-imaging method.

In addition, an in-situ THG-based method will be discussed for determining the material's modification threshold. The results obtained with this approach are compared to values derived from real-time optical-transmission measurements during spatially selective irradiation and from the widely used post-irradiation diameter-regression method of Liu *et al.* [5]. The findings indicate that the THG-based approach delivers higher sensitivity, as even subtle early-stage modifications reduce THG efficiency, enabling the onset of pre-damage processes to be detected and analyzed.

The work was supported by the Higher Education and Science Committee of RA, in the frames of the research project No. 23-2DP-2J002.

References

- [1] K. Mishchik, R. Beuton, O. D. Caulier, *et al.*, *Opt. Express*, **25**(26), 33271 (2017).
- [2] K. Sugioka and Y. Cheng, *Light: Sci. Appl.*, **3**(4), e149 (2014).
- [3] M. Malinauskas, A. Zukauskas, S. Hasegawa, *et al.*, *Light: Sci. Appl.*, **5**(8), e16133 (2016).
- [4] V.H. Dinh, L.P. Hoang, Y.N.T. Vu, *et al.*, *Opt. Lasers Eng.*, **167**, 107625 (2023).
- [5] J.M. Liu, *Opt. Lett.*, **7**, 196 (1982).

Oral Report

Influence of Electric Field on the Graphite Coating of Aluminum Foil

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R.B. Kostanyan

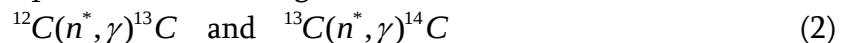
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Due to certain physical and technical properties of aluminum and its alloys, they are widely used in aviation, mechanical engineering, and various electrical devices. However, their use is somewhat limited by the fact that aluminum is prone to corrosion in certain environments. The application of aluminum in the production of supercapacitors is also complicated, as they degrade in alkaline electrolytes. Therefore, to protect aluminum structures from corrosion, carbon-based coatings are applied. These coatings are used due to the chemical inertness and high density of graphite-based materials. They were originally developed for corrosion protection in aqueous salt solutions. This study presents the results of an experimental investigation into the effect of an electric field on the graphite coating of aluminum foil. The experiments were conducted using an electrolyzer filled with regular water as the electrolyte, and aluminum foil samples with graphite coating were used as both the cathode and anode. The electrodes were subjected to electric pulses with steep rise times. When subjected to defined electric field parameters and a 72-hour exposure period, the cathode coating exhibited a loss of integrity. No changes in the coating were detected on the anode surface. A study of the damaged region of the cathode surface, conducted with a scanning electron microscope equipped with an energy-dispersive X-ray microanalysis system, demonstrated that the application of an electric field leads to substantial structural degradation of the graphite coating on the aluminum foil. A physical mechanism for the transformation of carbon in the graphite coating of the cathode is proposed. Naturally occurring elemental carbon has three isotopes. The most common is carbon-12 (^{12}C), followed by the less abundant carbon-13 (^{13}C), and the radioactive isotope carbon-14 (^{14}C), which undergoes spontaneous beta decay to form stable nitrogen-14 (^{14}N) according to the reaction:



where β^- is an electron and $\bar{\nu}$ is an electron antineutrino. Considering the conditions for the formation of quasineutrons (n^*) in electrolyzers, it is reasonable to assume the possible formation of new carbon isotopes via the following reactions:



Thus, the transformation of stable carbon isotopes into radiocarbon according to (2), followed by the decay of radiocarbon into a stable nitrogen isotope via reaction (1), may lead to the degradation of the carbon surface of the cathode.

Abstracts of Poster Reports

Poster Report

Physics-Informed Neural Network Modeling of Spatiotemporal Dynamics in Liquid Crystals via Complex Ginzburg–Landau Equation

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The Complex Ginzburg–Landau (CGL) equation is a paradigmatic model for describing nonlinear spatiotemporal dynamics in extended physical systems, including light–matter interactions in liquid crystals (LCs) [1]. We investigate reorientation dynamics of vertically aligned LC film under the action of applied electric field driven by modulated light (LC light valve) [2]. It captures the behavior of nonequilibrium pattern formation and defect dynamics. In this study, we consider the canonical case of CGL equation yielding a evolution equation

$$\partial_t A = \mu A - \Delta A + |A|^2 A,$$

where $A(x, y, t)$ is the complex field describing LC director distribution, $\mu(x, y, t)$ a bifurcation parameter [2] (Figure 1). In our case, μ is defined as the applied low-frequency electric field dynamically controlled by the spatially modulated light beam [3].

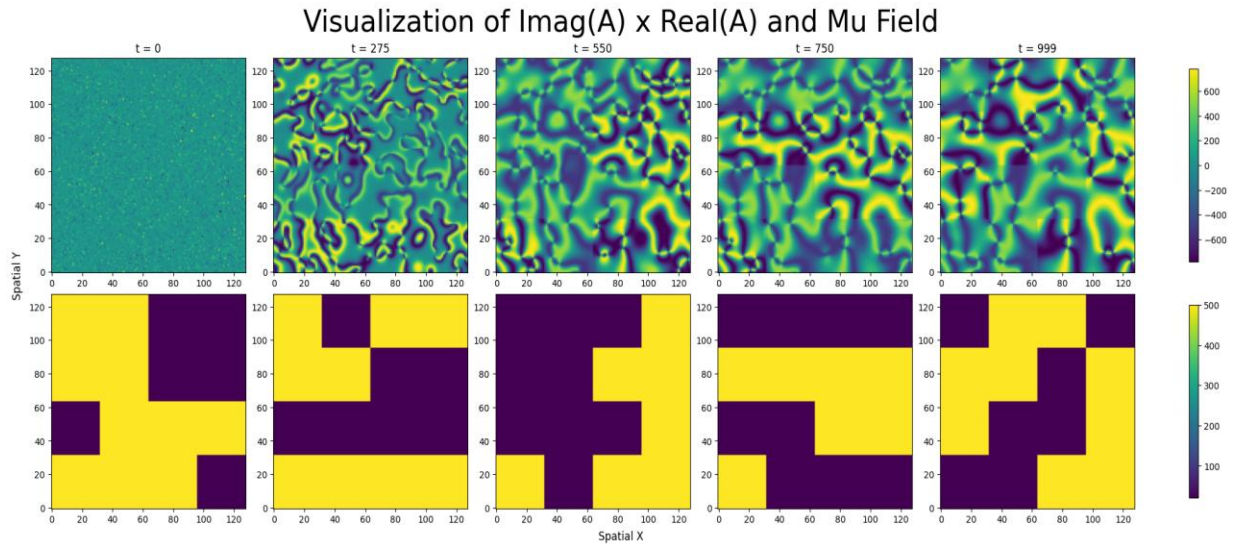


Fig. 1 Spatiotemporal evolution of the complex field interaction $\text{Re}(A) \times \text{Re}(A)$ and the corresponding μ field across selected time frames.

This work introduces a Physics-Informed Neural Network (PINN) framework for modeling liquid crystal system reorientation governed by the CGL equation [4], incorporating a spatiotemporally varying bifurcation parameter μ . By embedding the CGL equation into the

loss function, the model simultaneously infers the system state A and the latent μ field. The method accurately captures nonlinear dynamics and reconstructs μ field. This shows the potential of PINNs for uncovering hidden behavior in optical media and enabling controllable pattern formation in liquid crystal systems.

References

- [1] I.S. Aranson, L. Kramer, *Rev. Mod. Phys.*, **74**, 99 (2002).
- [2] P.J. Aguilera-Rojas, M.G. Clerc, M. Diaz-Zuniga, R. Gajardo-Pizarro, *Physica D*, **476**, 134599 (2025).
- [3] N. Collings, A. R. Pourzand, F.L. Vladimirov, et al., *Appl. Opt.*, **38**, 6184–6189 (1999).
- [4] M. Raissi, P. Perdikaris, G.E. Karniadakis, *J. Comput. Phys.*, **378**, 686 (2019).

Poster Report

Optical Reservoir Computing for Liquid Crystal Dynamics Prediction

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Reservoir Computing (RC) is a computational framework based on large recurrent neural networks with fixed internal weights, offering a powerful and efficient approach to processing spatiotemporal data. Recent advances in Reservoir Computing (RC) have leveraged physical systems, such as light scattering media [1], to accelerate computation and improve energy efficiency. Building on this foundation, we propose a hybrid approach that integrates a Convolutional Neural Network (CNN) encoder with an optical reservoir for the prediction of real-world spatiotemporal dynamics. While prior implementations have primarily focused on synthetic chaotic datasets, such as the Kuramoto-Sivashinsky system [1], our study applies the same optical setup to experimentally measured video data of dynamic patterns in a liquid crystal (LC) cell. The CNN encoder transforms high-dimensional spatial inputs into compact representations suitable for optical processing, which are then temporally predicted using the optical RC. Finally, the predicted states are decoded back into the spatial domain. This architecture demonstrates the feasibility of combining deep learning with physical reservoir computing for real-time forecasting of complex physical systems, and introduces a novel application of optical RC to experimentally derived spatiotemporal chaos.

References

- [1] Dong, J., Rafayelyan, M., Krzakala, F., & Gigan, S. (2019). Optical reservoir computing using multiple light scattering for chaotic systems prediction. *IEEE Journal of Selected Topics in Quantum Electronics*, 26(1), 1–12.
<https://doi.org/10.1109/jstqe.2019.2936281>

Poster Report

Hardware-Software System Based on the MDR-4 Monochromator for Studying Photoelectric Characteristics

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A hardware-software system was developed and successfully used in scientific research for measuring the spectral characteristics of optical materials. The system enables the measurement of key photoelectric characteristics, namely: photoluminescence, the dependence of photosensitivity on the wavelength of the excitation radiation, and the determination of the red boundary of the photoelectric effect.

The system is based on the MDR-4 monochromator and an ADC/DAC board from National Instruments. A software package was developed in the LabView environment, allowing researchers to program the experimental procedure and use the system for both standard and custom measurements. The study presents the results of applying the automated system for measuring the spectral characteristics of a wide-bandgap semiconductor, ZnO, doped with an acceptor impurity.

Despite existing technical solutions for automating photoelectric measurements [1,2,3], there is no ready-made commercial device available on the market for measuring the photoelectric parameters of wide-bandgap semiconductors. The aim of this work is to develop a hardware-software system for scientific research, as well as to design and validate a methodology for measuring the photoelectric properties of semiconductors and heterostructures, specifically: 1) photoelectric characteristics, 2) current-voltage (I-V) characteristics of heterostructures, and 3) photovoltaic characteristics of solar cells. The system offers extensive capabilities for measuring key photoelectric properties, including photoluminescence spectra, current-voltage characteristics under monochromatic illumination, the dependence of photosensitivity on the excitation wavelength, and the determination of the red boundary of the photoelectric effect. As a result, a laboratory prototype was created, which allows for the further commercialization of the obtained results in the form of a device for measuring photoelectric characteristics.

References

- [1] A.L. Filatov, O.A. Byshevsky-Konopko, N.G. Yaremenko, *et al.*, *Instruments and Experimental Techniques* № 1, p. 97 (2022).
- [2] A.V. Balobanov, G.M. Mikheev, *Chemical Physics and Mesoscopy*], **9**, №4, p. 430.
- [3] A.A. Khachaturova, M.N. Nersesyan, O.L. Ayvazyan, *Instruments and Experimental Techniques*, № 2, in print (2025).

Poster Report

Single-Mode Propagation of a THz Pulse in a Waveguide

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Efficient broadband terahertz (THz) waveguides are critical for a wide range of THz applications, including time-domain spectroscopy, high-resolution medical imaging, spaceborne instrumentation, telecommunications, and the development of integrated waveguide circuits.

This work presents a study of the modal composition of THz pulse propagating in a parallel-plate waveguide partially filled with a nonlinear crystal—either lithium niobate (LiNbO₃) or DAST—serving as an efficient optical frequency converter. Unlike traditional excitation methods using coaxial probes or horn antennas, THz pulses are generated remotely via optical rectification in the nonlinear crystal, driven by femtosecond pulses from a Ti:Sapphire laser [1].

Single-mode propagation of the THz pulse ensures a well-defined spatial field confinement, preventing modal dispersion, interference, and consequently signal degradation.

Numerical simulations were carried out using MATCAD and COMSOL to analyze THz propagation in the waveguide. The study demonstrates the possibility of achieving single-mode coupling between the input linearly polarized optical pulse and the THz pulse with an ultra-broad spectral bandwidth of 0.1–2.6 THz. By numerically determining the width and height of the nonlinear crystal for given waveguide dimensions and known dielectric permittivity (ϵ) of the crystal, conditions for single-mode propagation of the THz pulse were achieved. It is also shown that, as the THz frequency increases, a greater portion of the pulse energy is confined within the nonlinear crystal. At the same time, the remainder propagates in the surrounding space.

References

- [1] A.S. Nikoghosyan, V.R. Tadevosyan, G.N., Goltsman, *et al.* // *J. Phys. Conf. Series*. **Vol. 2** 548. 2023. Art. no. 012013. doi: 10.1088/1742-6596/2548/1/012013

Poster Report

Online Learning Framework for Arbitrary Transmission Matrix Engineering

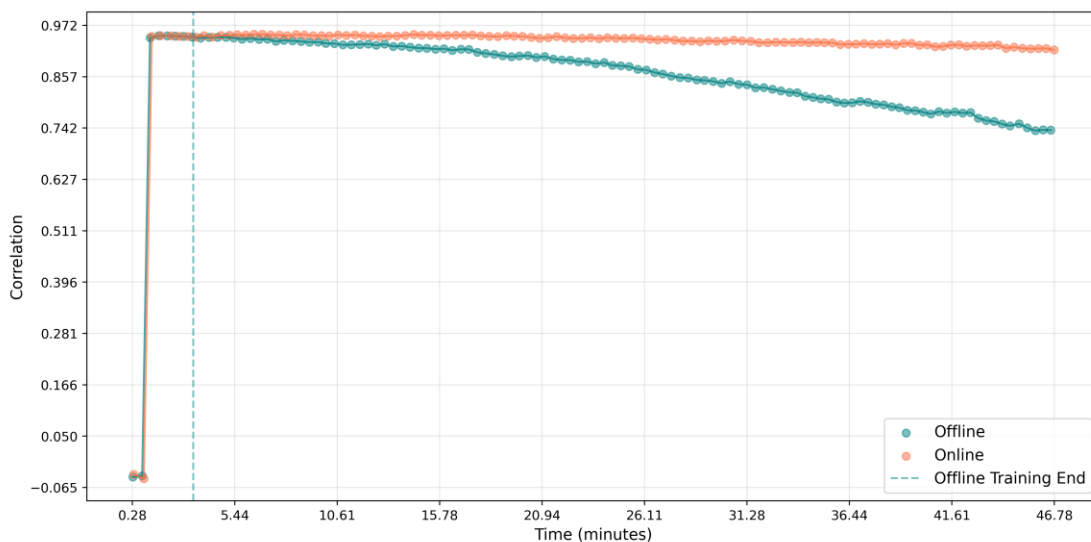
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Getting high-fidelity reconfigurable optical systems, especially in dynamic environments, can be a challenging task. We introduce a new framework that leverages a feedback mechanism with a physical setup and online learning paradigm to continuously engineer a desired transmission matrix and compensate for noise and decorrelation in real-time.

Accurate control of light transmission relies on the measurement and control of the transmission matrix (TM), which maps input to output fields of the pipeline [1]. Environmental fluctuations and system drift perturb the TM, introducing noise and reducing correlations; in such environments, any correctly engineered TM would very soon lose its accuracy if not compensated for the dynamic changes [2]. Conventional methods can design arbitrary TMs by treating complex media as reconfigurable linear operators [3], but they usually demand frequent, disruptive recalibrations when conditions change dynamically. Moreover, such approaches usually do not have direct feedback from the physical setup, resulting in accumulated errors, which degrade the overall fidelity. Our approach closes these gaps by integrating live intensity measurements into a neural-network optimizer that, in online mode, updates the phase pattern on a Spatial Light Modulator (SLM) continuously, without interrupting operation. This continuous feedback loop obtains and maintains a high-fidelity target TM at runtime, automatically correcting for decorrelation and drift.



Our hybrid method reaches and sustains output correlation scores above 95% for around an hour in an unstabilized diffusive environment, whereas the performance of the offline feedbackless approach degrades to around 75%, as it can be seen in the figure above for a case of 8 by 8 random target TM engineering. This framework can have a wide range of applications – including optical communications, optical computing, high-resolution imaging, and secure optical encryption - by providing a reliable and high-quality TM engineering mechanism.

References

- [1] S.M. Popoff, G. Lerosey, R. Carminati, et al., *Phys. Rev. Lett.* **104**, 100601 (2010).
- [2] Z. Li, W. Zhou, Z. Zhou, et al., *Nature Communications*, **15**, 1498 (2024).
- [3] M.W. Matthès, P. del Hougne, J. de Rosny, et al., *Optica*, **6**, 465-472 (2019).

Poster Report

Hopping and Drift Mechanisms of Charge Carrier Transport in CdS:Li Films

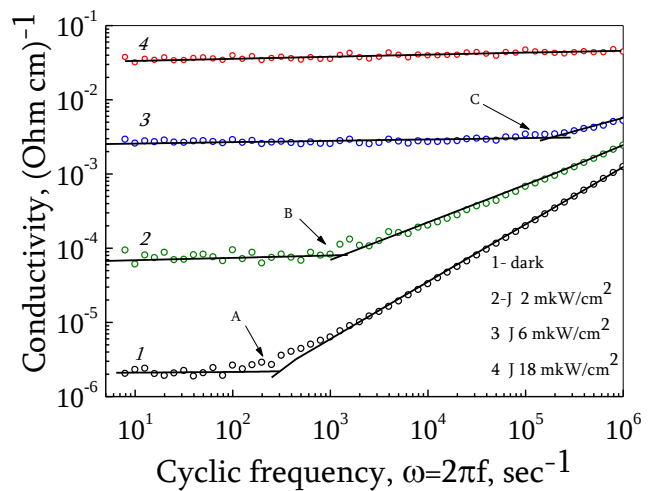
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This work investigates the mechanisms of dark and photoconductivity in CdS:Li films. The experimental data are interpreted using models based on the hopping mechanism of charge carrier transport for dark conductivity and a combination of hopping and drift mechanisms for photoconductivity, depending on the energy of the exciting photon and the intensity of the absorbed light. For photons with energy exceeding the material's band gap, the drift mechanism of charge carrier transport dominates. On the other hand, for photons with energy lower than the band gap, the transport of carriers occurs through the hopping mechanism. These results confirm that the type of transport mechanism depends on both the energy characteristics of the excitation



radiation and the conditions of external illumination. The figure shows the dependence of photoconductivity $\sigma_{ac}(\omega)$ (curves 1–3) and dark conductivity (curve 4) on the frequency ω of the alternating electric field for CdS:Li films. The dark conductivity dependence (curve 1) exhibits an increasing nonlinear character and can be approximated by a power function: $\sigma_{ac}(\omega) = A\omega^s$, where the parameter $s=0.79$. It is assumed that the value of s remains constant across the entire frequency range. This allows us to conclude that the dark conductivity occurs due to quantum mechanical tunneling (QMT) of charge carriers above the Fermi level through the impurity conduction band. Additionally, the presence of so-called crossover points was identified, which mark the frequency ranges where the charge transport mechanism changes. At these frequencies, a transition from a linear to a power-law dependence on the graph $\ln(\sigma)$ from $\ln(\omega)$ is observed.

These results indicate significant changes in the charge carrier transport mechanisms as the frequency of the alternating electric field is varied.

References

- [1] N.R. Aghamalyan, R.K. Hovsepyan, A.R. Poghosyan, and V.G. Lazaryan, “Photodetectors on the base of ZnO thin films”, *Proc. SPIE*, 5560, 235-240, 2004.
- [2] N.R. Aghamalyan, R.K. Hovsepyan, A.R. Poghosyan, B. von Roedern, and E.S. Vardanyan, “Photoelectric and spectral properties of ZnO thin films”, *Journal of Optoelectronics and Advanced Materials*, 9, 1418-1421, 2007.

Poster Report

Coherent Control of Shallow Impurity Quantum States in a Graphene Monolayer by Short Laser Pulses with Quadratic Frequency Chirp

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Coherent laser control of quantum states that include the possibility of coherent transfer of the atomic population into a given quantum state or generation of a given superposition atomic state by laser radiation is an important problem of contemporary science and technology [1]. Different schemes of coherent population transfer and coherent creation of superposition states have been investigated extensively in recent years [2, 3]. In [1], a single laser pulse with linear frequency chirp (FC) in the adiabatic following regime was used for robust transfer of population between two metastable states of a quantum system with [1]-

configuration of working levels. Recently, FC laser pulses were used for coherent control of Landau levels in graphene [4] and of the lowest states of a shallow impurity in a graphene monolayer [5]. The effect of dissipation processes on coherent population transfer and coherence creation between impurity states in a graphene monolayer forming a quantum system of Λ -configuration was studied in [6].

In this work, we apply a short laser pulse with a quadratically chirped carrier frequency (QFC) to a quantum system of a Λ -configuration of energy levels to create an arbitrary coherent superposition of metastable states of the system with a negligible excitation of the system. The case of a single “broadband” laser pulse is considered, when the frequency spectrum of the pulse (without chirp) exceeds the frequency distance between the metastable energy levels of the system. The results obtained are applied to a graphene monolayer. For two metastable states, as in [5, 6], we consider the $1S$ and $2S$ states of a shallow donor impurity in a graphene monolayer with an open energy gap in a perpendicular magnetic field. The energies of two metastable states and the excited state $2P^+$ are calculated using a variational approach in the model of the suggested soft Coulomb potential [7].

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References

- [1] G.P. Djotyan, J.S. Bakos, Zs. Sörlei et al., *Phys. Rev. A*, **70**, 063406 (2004).
- [2] Z Zhang, X Yang, and X Yan, *J. Opt. Soc. Am. B*, **30**, 1017 (2013).
- [3] M. Ndong, G.P. Djotyan, A. Ruschhaupt et al., *J. Phys. B*, **48**, 174007, (2015).
- [4] C. Ding, R. Yu, X. Hao, D. Zhang, *Sci. Rep.*, **8**, 1530 (2018).
- [5] A.P. Djotyan, G.P. Djotyan, and A.A. Avetisyan, *J. of Cont. Phys.*, **59**, 272 (2024).
- [6] A.A. Avetisyan, A.P. Djotyan, G.P. Djotyan et al., *J. of Contemp. Phys.*, **60**, 272 (2024).
- [7] A.P. Djotyan, K. Mouloupoulos, A.A. Avetisyan, *Semi. Sci. Technol.* **40**, 015012 (2025).

Poster Report

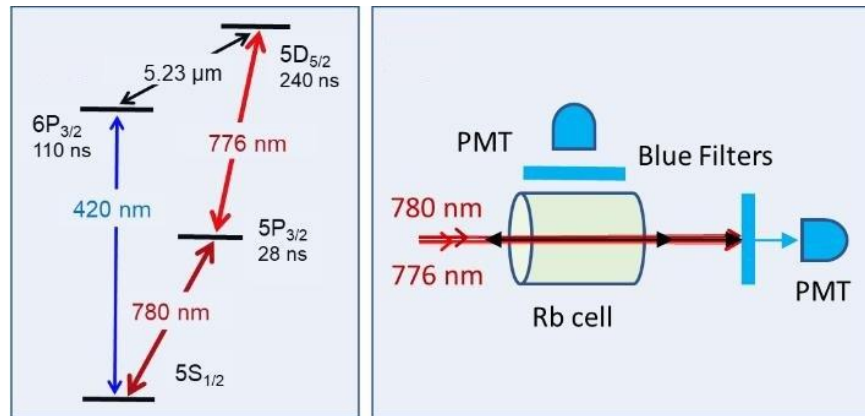
Investigation of Collimated Emission at 420 nm in Rubidium Vapor: Laboratory Model of Atmospheric Phenomena and Coherence Analysis

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We present an experimental realization of collimated blue light generation at 420 nm in rubidium vapor via coherent two-photon excitation. Two continuous-wave diode lasers at 780 nm and 776 nm are used to coherently excite rubidium atoms to the $5D_{5/2}$ level. Under certain conditions, the atoms undergo a dipole-allowed transition to $6P_{3/2}$, emitting infrared radiation at $5.23\ \mu\text{m}$. Through a four-wave mixing process involving the two input laser fields and the generated IR wave, collimated coherent emission at 420 nm is observed.



This emission mechanism is fully coherent, allowing not only spectral control but also the potential transfer of the optical angular momentum of the input beams to the generated light. Such coherence makes this scheme suitable for structured light generation and quantum optics applications. The experimental setup includes Arduino-based active temperature stabilization and Helmholtz coils for magnetic field compensation.

A key objective of the study is to determine the statistical nature of the 420 nm emission. Despite its high directionality, it remains unclear whether this radiation is truly laser-like (coherent) or partially thermal in origin. To address this, we plan to measure the second-order coherence function $g^{(2)}(\tau)$, which represents the normalized autocorrelation of light intensity and characterizes photon statistics.

The experiment serves as a laboratory model for understanding directional emission observed in the Earth's mesosphere, where naturally occurring sodium layers emit light under external excitation. The nature of this collimated atmospheric emission is still under investigation, and its potential laser-like properties remain debated. Our laboratory study provides a controlled platform for emulating such phenomena and for applying quantum-optical diagnostics to determine the coherence of the observed light.

References

- [1] A.M. Akulshin, N. Rahaman, S.A. Suslov, *et al.*, *Opt. Lett.*, **45**, 1822–1825 (2020).

Poster Report

Evolution of Adiabatic States in a Dissipative Three-Level System

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Control and coherent manipulation of quantum systems interacting with laser radiation form the basis for quantum technologies and various quantum applications (see [1–3] and references therein). Adiabatic interactions are of great practical importance, in particular in quantum information science [4]. In this work, necessary and sufficient conditions for the stability of adiabatic states in three-level quantum systems are investigated analytically and numerically. Various possible configurations of three-level systems under exact two-photon resonance are considered.

It is shown that the lifetime of the studied states in all three configurations, in the case of large one-photon detuning, is determined by the dephasing time between levels that are not connected by a dipole transition. The sufficient conditions for the stability of adiabatic states are equivalent to the conditions for adiabatic interaction. Therefore, the lifetime of the so-called b-state is the same as that of the dark state. However, if in the Λ -system, the coherence decay rate γ_c for the dark state and b-state is determined by dephasing rates, while in Ξ - and V-systems, it includes contributions from rapid spontaneous decay processes.

Therefore, although adiabatic states can be realized in all configurations, the interaction time (i.e., stability lifetime) in the Λ -system is typically three orders of magnitude longer than in Ξ - and V-systems. For example, in alkali atoms for Λ -system $\gamma_c \sim 5$ kHz, the lifetime can exceed 100 microseconds. An efficient population transfer through those states is demonstrated, despite relatively long relaxation times. The evolution of adiabatic states for arbitrary values of one-photon detuning has been studied numerically.

References

- [1] S. Van Frank, et al., *Scientific Reports*, **6**(1), 34187. (2016)
- [2] C.P. Koch, et al., *EPJ Quantum Technology*, **9**(1), 19. pp.60 (2022).
- [3] Q. Ansel, et al., *J. of Physics B: Atomic, Molecular and Optical Physics*, **57**, 133001 (2024).
- [4] D. Bluvstein, et al., *Nature*, **626**(7997), 58-65. (2024).

Poster Report

Distribution of Yb Ions in the Lattice of 15%Yb:(Lu,Y)AG Transparent Laser Ceramics with Different Lu/Y Balance

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The 15%Yb: (Y_xLu_{3-x})Al₅O₁₂ ceramics (x = 0, 0.75, 1.5, 2.25, and 3.0), with lattice constants ranging from 11.9160 to 12.0075 Å, are widely studied and highly versatile host materials due to their thermal, optical, and mechanical properties [1]. Based on a modified Strocka's formula [2], and an analysis of the dependence of the lattice constant on the Lu/Y ratio, as well as room temperature absorption spectra (Fig. 1), the distribution of Yb³⁺ ions between the c- and a-sites of the lattice is estimated (Table 1).

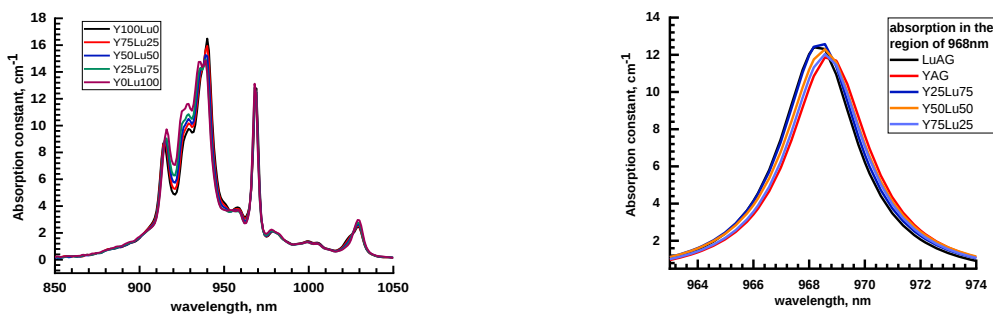


Fig.1 Absorption coefficient of 15%Yb: (Lu,Y)AG crystal at T = 300K.

Table Distribution of Yb³⁺ in the 15%Yb: (Y_xLu_{1-x})₃Al₅O₁₂ lattice

N	Y/Lu ratio	Formula unit	Lattice constant, Å	$\frac{N_c}{N_{Yb}}$, %
1	LuAG	$\{Lu_{2.601}Yb_{0.399}^{(Lu)}\}\{Al_{1.949}Yb_{0.051}\}Al_3O_{12}$,	11.9160	88.7
2	25/75	$\{Y_{0.516}Lu_{2.084}Yb_{0.234}^{(Y)}Yb_{0.166}^{(Lu)}\}\{Al_{1.950}Yb_{0.050}\}Al_3O_{12}$	11.9372	88.9
3	50/50	$\{Y_{1.176}Lu_{1.420}Yb_{0.324}^{(Y)}Yb_{0.080}^{(Lu)}\}\{Al_{1.954}Yb_{0.046}\}Al_3O_{12}$	11.9575	89.8
4	75/25	$\{Y_{1.875}Lu_{0.733}Yb_{0.375}^{(Y)}Yb_{0.017}^{(Lu)}\}\{Al_{1.952}Yb_{0.058}\}Al_3O_{12}$	11.9832	87.1
5	YAG	$\{Y_{2.606}Yb_{0.394}^{(Y)}\}\{Al_{1.944}Yb_{0.056}\}Al_3O_{12}$	12.0075	87.6

References

- [1] A. Pirri, G. Toci, J. Li, et al., *Optics Express*, **24**, No. 16, 17832 (2016)
- [2] G. Demirkhanyan, B. Patrizi, R. Kostanyan, et al., *Sol. State Chem.*, **316**, 123577 (2022)

Poster Report

Growth and Investigation of Tm₃Al₅O₁₂ Garnet Doped with Li⁺ Ions

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The addition of lithium (Li) to crystalline materials leads to significant changes in their physical properties; however, the mechanisms of Li incorporation and charge compensation depend on multiple factors and do not follow strict or universal rules. In this study, thulium aluminum garnet (TmAG) was selected as a model system for investigation. Single crystals of undoped, Li-doped TmAG and Ce:Li-codoped TmAG, and polycrystalline samples doped with Li were synthesized using both the solid-state reaction and melting-solidifying techniques. The lattice parameters of the samples with different Li concentrations (125-600 ppm) were measured and compared with the values calculated from theoretical models [1]. Ultraviolet absorption spectra of TmAG:Li and TmAG:Ce,Li single crystals were also recorded. The experimental results revealed that at least a part of the Li ions occupy crystallographic sites, similar to the behavior observed in Li-doped lutetium aluminum garnet (LuAG:Li) [2]. It is suggested that Li ions are more likely to substitute for Al³⁺ ions.

This work was supported by the State Committee of Science of the Ministry of Education and Science of the Republic of Armenia, project 21AG-1C030.

References

- [1] B. Strocka, P. Holst, W. Tolksdorf, *Philips J. Res.*, **33**, 186 (1978).
- [2] M.V. Derdzian, et al., *CrystEngComm*, **20**, 1520 (2018).

Poster Report

Communication via Light in Free Space

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Free space optics technology is gaining increasing attention as a promising alternative to traditional radio frequency systems [1]. It enables high-speed data transmission without the need for cable infrastructure and offers high signal directivity, making it suitable for applications with strict requirements on security and energy efficiency.

This study aims to provide modeling, development, and engineering of a practical free-space optical communication system for both data transmission and reception. The proposed system operates in the near-infrared spectrum and incorporates advanced optical hardware and software adjustments, allowing a significant reduction of the impact of external noise and interference. In addition, the project includes an analysis of the system's robustness to atmospheric disturbances such as rain, fog, and dust.

The practical implementation of the Free-space optical data transmission system, depending on the communication range and emitter power, demonstrates the ability to operate in a dynamically changing environment and varying weather conditions. Potential applications of this system of optical communication include the remote control of aerial vehicles.

References

- [1] H. Willebrand, B.S. Ghuman, *Free-Space Optics: Enabling Optical Connectivity in Today's Networks*, Sams Publishing, Indianapolis, 2002.

Poster Report

Geometrical Phase Modulation of Microwaves via Liquid Crystals

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In the microwave radiation domain, wavefront modulation has important applications, particularly in the design of reconfigurable antennas, where precise control of phase is crucial [1]. Phase modulation can be achieved using both solid-state and liquid crystal (LC) modulators. The high birefringence and dielectric tunability of liquid crystals make them a promising platform for radio-frequency controlled devices [2, 3].

This project proposes a liquid crystal-based system for geometric phase control of microwave radiation, relying on the phenomena of Bragg reflection and geometric phase (Berry phase). The Bragg reflection phenomenon in chiral systems enables broadband microwave reflection, while the application of geometric phase allows for modulation of the phase of the reflected wave [4-6]. Numerical simulations have demonstrated reflection efficiencies characteristic of Bragg reflection. Geometric phase calculations and experimental implementation with a physical prototype are planned.

References

- [1] Diane Kruse, “The importance of broadband, why this matters”, NEO Connect, 08.2019
- [2] X. Li, Y. Wan, J. Liu, D. Jiang, T. Bai, K. Zhu, J. Zhuang, and W. Wang, “Broadband electronically scanned reflectarray antenna with liquid crystals,” *IEEE Antennas Wireless Propag. Lett.*, vol. **20**, no. 3, pp. 396–400, Mar. 2021, doi:10.1109/LAWP.2021.3051797.
- [3] Franc, O. H. Karabey, G. Rehder, E. Pistono, R. Jakoby, and P. Ferrari, “Compact and broadband millimeter-wave electrically tunable phase shifter combining slow-wave effect with liquid crystal technology,” *IEEE Trans. Microw. Theory Techn.*, vol. **61**, no. 11, pp. 3905–3915, Nov. 2013, doi: 10.1109/TMTT.2013.2282288.
- [4] Ryotaro Ozaki, Shunsuke Hashimura, Shinji Yudate, Kazunori Kadowaki, Hiroyuki Yoshida, And Masanori Ozaki, “Optical properties of selective diffraction from Bragg-Berry cholesteric liquid crystal deflectors “. <https://doi.org/10.1364/OSAC.2.003554>.
- [5] Inge Nys*, Migle Stebryte, Yera Ye. Ussembayev, Jeroen Beeckman, Kristiaan Neyts, “Tilted chiral liquid crystal gratings for efficient large-angle diffraction”, <https://doi.org/10.1002/adom.201901364>.
- [6] Johnson, R., & Peterson, M. (2018). “Simulation of Bragg Diffraction in Liquid Crystals.” *Journal of Applied Physics*.

Poster Report

Optical Control of Umbilical Defects in Liquid Crystals

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Liquid crystal systems support a wide range of spatiotemporal behaviors, from stable defect configurations to highly dynamic, fluctuating states. Controlling these dynamics is of interest both for understanding fundamental nonlinear processes and for enabling new functional applications. In this work, we investigate nematic liquid crystals driven by external fields and modulated using digital micromirror device (DMD)-generated light patterns. This spatially and temporally structured optical forcing allows us to selectively excite, suppress, or reorganize umbilical defects. Our goal is to access regimes where defect proliferation becomes irregular and potentially chaotic, and to develop strategies for stabilizing or steering such behavior. We use amplitude-equation models of Ginzburg–Landau type to interpret how patterned forcing modifies instability thresholds and defect interactions. This approach provides a pathway towards achieving and controlling chaos in soft-matter systems, with potential applications in reconfigurable photonic devices, adaptive optics, and unconventional information processing.

Poster Report

Investigation of Li⁺ Codoped YAlO₃:Ce Scintillation Crystals

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Perovskites with the general formula (Y, Lu, Gd) AlO₃ doped with cerium are promising materials for applications as scintillators and phosphors. The presence of slow components in the decay under high-energy excitation is a disadvantage that reduces their scintillation efficiency, which is related to several factors, including the presence of intrinsic defects acting as traps. The introduction of divalent ions into Ce³⁺-doped garnets accelerates scintillation due to stabilization of Ce⁴⁺ states that compete with other electron traps [1].

Monovalent co-dopants are less efficient in this respect, but in a number of garnets doped with Ce^{3+} and Pr^{3+} ions have shown high efficiency in increasing radiation resistance [2]. Here we study the influence of monovalent Li^+ on optical properties and radiation resistance of the $\text{YAlO}_3\text{:Ce}$ scintillator and its denser analog, mixed $(\text{Lu,Y})\text{AlO}_3\text{:Ce}$.

The studies were performed on un-doped and Ce-doped crystals with a Li concentration of up to 200 ppm. Crystals were grown by the Bridgman method in a reducing atmosphere. Measurements of real composition (EDX), lattice parameters, optical absorption, γ -ray induced absorption (^{60}Co source), and decay under X-ray excitation were performed.

Optical edge shift towards longer wavelengths with increasing Li amount and appearance of an absorption tail extending to 370 nm have been registered in as-received crystals, indicative of conversion of a part of Ce^{3+} into Ce^{4+} [3]. A decrease in absorption coefficient in the 200-260 nm range in un-doped crystals, which is a measure of intrinsic defect density, is registered for low (<70 ppm) Li concentrations. Radiation induced absorption coefficient (after 10 kGy dose) in the range of emission (peaking at 350 nm) lies between 3.3 and 3.9 cm^{-1} with no clear dependence on the Li content. At equivalent cerium content, Li co-doping (35-150 ppm) has shown no noticeable effect on the rise time but slightly increases the amount of delayed luminescence. The paper discusses peculiarities in the behavior of perovskite crystals with double Ce:Li co-doping.

This work was supported by SCS Armenia (project 21AG-1C030).

References

- [1] M. Nikl, K. Kamada, V. Babin, *et al*, *Cryst. Growth Des.* **Vol. 14**, 4827 (2014).
- [2] M. Derdzyan, K. Hovhannesian, I. Ghambaryan, *et al*, *IEEE Transactions on Nuclear Science* **Vol. 14**, 1988 (2025).
- [3] F. Moretti, K. Hovhannesian, M. Derdzyan, *et al*, *ChemPhysChem* **Vol. 18**, 493 (2017).

Poster Report

Hard X-Ray Zernike-Type Phase-Contrast Imaging Based on a Two-Block Crystal System with Parallel Blocks of Equal Thickness

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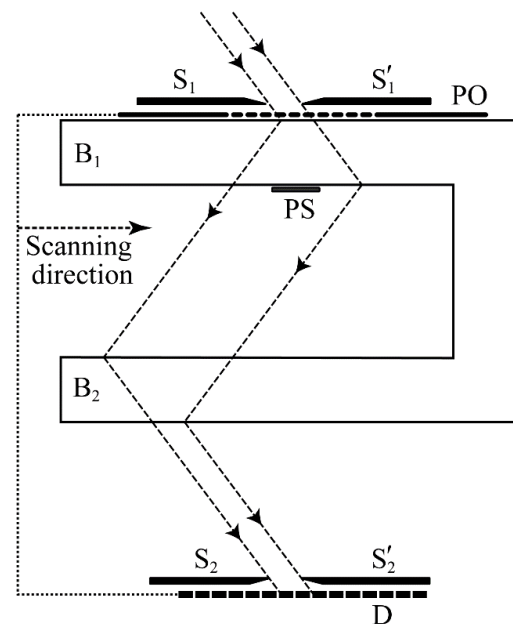
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The possibility of X-ray Zernike-type phase-contrast imaging [1], based on X-ray dynamical diffraction in a two-block crystal system with parallel blocks of equal thickness cut according to the symmetric geometry of Laue diffraction [2–4], is considered.

The schematic diagram of the considered device is shown in the figure. Here, B_1 and B_2 are the blocks of the two-block crystal system, PO is the test phase-object, PS — $\lambda/4$ phase shifter, D — image detector, $S_1S'_1$ and $S_2S'_2$ — scanning slits in front of the phase-object and the detector, respectively.

A coherent X-ray beam with a width of a few tens of μm is transmitted through the test phase-object and falls on the first crystal block. Dynamical diffraction in the crystal block results in spatial separation of X-rays — tilted and non-tilted as they pass through the sample. A $\lambda/4$ phase shifter is arranged in the inter-block space of the two-block crystal system, in the path of the non-tilted rays. Laue diffraction in the second crystal block ensures convergence of rays originating from the same point of the sample. A scanning scheme is used to increase the effective size of the test samples and to reduce background in the image [5].



The numerical simulation of image formation shows an acceptable quality of the registered phase-contrast image.

References

- [1] F. Zernike, *Z. Tech. Physik*, **16**, 454 (1935).
- [2] V. Indenbom, I. Slobodetskii, K. Truni, *Sov. Phys. JETP*, **39**, 542 (1974).
- [3] E. Suvorov, V. Polovinkina, *JETP Lett.*, **20**(5), 145 (1974).
- [4] V. Indenbom, E. Suvorov, I. Slobodetskii, *Sov. Phys. JETP*, **44**, 187 (1976).
- [5] L.A. Haroutunyan, *J. Contemp. Phys.*, **58**, 435 (2023).

Poster Report

Simulation of Electronic Properties of Volcano-Shaped Quantum Rings with Type-II Band Alignment

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Quantum rings (QRs) have shown promise in a variety of applications, both with and without utilizing their topological properties. While their topological features are mainly applied in spintronic and quantum computing devices such as spin qubits and spin-controlled excitonic memory, their geometry and electronic structure also enable use in THz detectors, solar cells, optical polarization devices, and single-photon sources [1].

We conducted a detailed study of the electronic properties of the graded composition. In $\text{As}_{1-x-y}\text{Sb}_x\text{P}_y$ QRs, using experimental shape and size data. The calculations were based on linear composition profiles. They performed using continuum elasticity theory and the eight-band $\mathbf{k}\cdot\mathbf{p}$ model of the SPHInX library [2], which includes the three highest valence bands and the lowest conduction band with spin components.

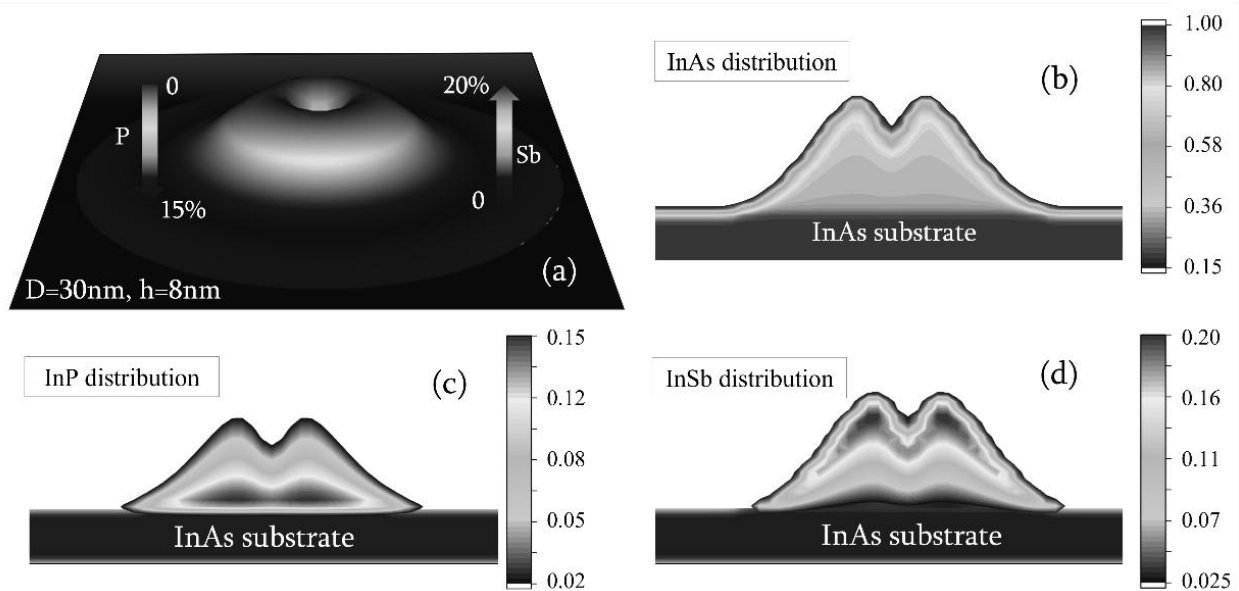


Figure 1: 3D model (a) and its cross-section views of *InAs* (b), *InP* (c), and *InSb* (d) distributions along the central axis of the ring.

The model assumes an ideal volcano-like shape, with Sb content increasing up to 20% at the top and P content up to 15% at the bottom. We calculated the transition energies between the hole ground state and the InAs conduction band edge at 283 K for different ring

geometries. A height variation of just 2 nm significantly alters the absorption spectra, with a blue shift at 4 nm height and a red shift at 8 nm, indicating strong sensitivity of the optical properties to geometric dimensions.

References

- [1] V.M. Fomin, (Ed.) Physics of Quantum Rings. NanoScience and Technology, Springer Cham, 2018
- [2] O. Marquardt, S. Boeck, C. Freysoldt, et al., *Comput. Mater. Sci.*, **95**, 280 (2014)

Poster Report

Light-Driven Antimicrobial Therapy of Cationic Porphyrins

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Antimicrobial photodynamic therapy (APDT) has received significant attention due to its unique ability to kill all currently known classes of microorganisms without inducing antimicrobial resistance [1]. Porphyrins are well-established photosensitizers for PDT-related applications [2]. The present study evaluates water-soluble, cationic porphyrins and their silver-containing analogs as photosensitizers for APDT. Based on preliminary experimental data, the meso-tetra(4-N-allylpyridyl) porphyrin (TAIPyP4) demonstrated superior photodynamic activity, achieving >99% bacterial inactivation of *E. coli* at a porphyrin-to-bacteria concentration ratio of 500:1 under 15 minutes of blue light irradiation (460 nm). At the same concentration, the dark cytotoxicity was measured at approximately 60%. This work provides a reference for the rational design of photosensitizers for antimicrobial applications.

This work was supported by the Science Committee of RA, in the framework of the research project N°25RG-1F179.

References

- [1] M.R. Hamblin, *Curr. Opin. Microbiol.*, **33**, 67–73 (2016).
- [2] O.I. Koifman, T.A. Ageeva, N.S. Kuzmina, et al. *Macroheterocycles*, **15**, 207–304 (2022).

Poster Report

W/La_{0.99}Ce_{0.01}B₆/Mo/Al₂O₃ Thermoelectric Sensor of Single Photon Detector with High System Efficiency at UV Wavelengths

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For various photon-counting applications at UV wavelengths, such as trapped-ion quantum information processing, upper atmosphere lidar studies, UV fluorescence lifetime imaging microscopy, and UV astronomy, single-photon detectors that combine high system efficiency and high count rate are needed. Superconducting nanowire single-photon detectors have achieved significant success over the past two decades for IR photon counting applications. However, little research has been done to improve their performance for wavelengths below 400 nm. It is worth noting that [1] presents a MoSi superconducting detector optimized for 250 and 370 nm, operating at 4.2 K with a detector efficiency of 70 - 80% and timing resolution down to 60 ps FWHM. Previously, we showed that a thermoelectric single-photon detector with a W/La_{0.99}Ce_{0.01}B₆/Mo/Al₂O₃ sensor can efficiently detect already absorbed photons in the near-IR to near-UV region [2]. Here we describe the design of this sensor, which can provide high system efficiency at wavelengths of 55.1, 32.627 and 27.71 nm.

We present the results of computer simulations on heat propagation processes within a sensor consisting of a W absorber, a La_{0.99}Ce_{0.01}B₆ thermoelectric layer, a Mo heat sink, and an Al₂O₃ substrate, following single-photon absorption. Sensors with a square surface area of 1 or 100 μm^2 and a thickness of the absorber, thermoelectric sensor, heat sink, and substrate of 40, 10, 10, and 100 nm, respectively, were considered. The features of heat propagation in the sensor volume after absorption of single photons at operating temperatures of 0.5, 1, and 1.5 K, as well as signal and noise power, were studied in detail. The obtained results and the analysis of the optical spectra of the absorber material, which is tungsten, allow us to state that for the W/La_{0.99}Ce_{0.01}B₆/Mo/Al₂O₃ sensor, system efficiency of up to 78, 96, and 98% can be achieved at a terahertz count rate when registering photons with wavelengths of 55.1, 32.627, and 27.72 nm.

The work was supported by the Higher Education and Science Committee of RA (project No. 1-6/IPR).

References

- [1] E.E. Wollman, V.B. Verma, A.D. Beyer, R.M. Briggs, B. Korzh, J.P. Allmaras, F. Marsili, A.E. Lita, R.P. Mirin, S.W. Nam, and M.D. Shaw. *Optics Express* **25**(22), 26792 (2017).
- [2] A.A. Kuzanyan, V.R. Nikoghosyan, A. Davoyan, A.S. Kuzanyan, *Applied Optics* **64**(9), 1 (2025).

Poster Report

Comparison of Air-Annealing and γ -Ray Irradiation Effects in YAG:Pr and YAG:Pr,Li Scintillation Crystals

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The introduction of small amounts of Li^+ into YAG:Pr and GSAG:Pr crystals is an efficient means of improving radiation resistance due to the reduction of oxygen vacancies [1]. With the introduction of Li^+ into LuYAG:Pr combined with air annealing, the energy resolution and the light yield are improved [2]. As reported, the light yield is increased after air annealing in YAG:Pr crystal; however, it is degraded in the ceramics [3]. Air annealing may eliminate some of the traps but also induce new absorptions associated with valence changes of impurities. Both air-annealing and radiation induced effects differ significantly in crystals grown by different methods using different crucibles and atmospheres. In this work we study the influence of Li^+ guest ions on the behavior of YAG:Pr crystals subjected to air annealing and irradiation.

The studies were performed on a series of YAG:Pr (0.1-0.5 at%) and YAG:Pr(0.1-0.5 at%), Li(40 ppm) crystals grown by the Bridgman method in a reducing atmosphere, using Mo crucibles. Annealing was performed in air at 1200 °C for six hours. The ^{60}Co source with a 1.25 MeV photon energy was used in irradiations.

Influence of crystal composition on the formation of additional absorption after treatments is analyzed on the basis of measured absorption spectra. A broad absorption band (twice lower in intensity in Li-codoped samples) with a tail extending to 400 nm is registered after annealing in all the crystals studied, and its origin is discussed. Induced absorption

coefficients in function of Pr^{3+} concentration in Li-free and Li-codoped crystals, as well as changes in f-f line intensities after both types of treatments, are obtained and compared. To improve scintillation performance, annealing of YAG:Pr, Li is considered more preferable.

This work was supported by the SCS RA (project 21AG-1C030).

References

- [1] M.V. Derdzian, K.L. Hovhannesyan, I.A. Ghambaryan, et al, *IEEE Transactions on Nuclear Science*, **72**, 1988 (2025).
- [2] C. Foster, Y. Wu, L. Stand, et al, *J. Lumin.*, **216**, 116751 (2019).
- [3] M. Witkowski, D. Zhou, W. Drozdowski, et al, *Optical Materials*, **85**, 230 (2018).

Poster Report

Evaluating the Impact of Linear Correction on Spectral Phase Reconstruction

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A method has been developed to reconstruct the spectral phase of ultrashort pulses using the dispersive Fourier transform, offering a simpler alternative to traditional spectral interferometry [1-3]. The method makes use of far fields of dispersion to translate spectral phase information into a measurable temporal domain. The technique is implemented using sum-frequency generation, where the unknown pulse serves as a reference (self-reference). We have experimentally validated this method by directly measuring the spectral phase of several amplitude-modulated pulses.

Experimentally, however, we do not measure the spectral phase itself, but rather the chirp of the ultrashort pulse, which is the derivative of the phase. As expected, when dealing with far fields of dispersion, the chirp data measured has a linear component that needs to be removed for proper analysis. A line was fitted along the registered data and then subtracted from the registered results to accomplish this. In order to determine whether our proposed method of removing the linear component is most optimal, modifications were made to the fitted line with the goal of these modifications being the discovery of a better case of pulse reconstruction.

References

- [1] Y. C. Tong, L. Y. Chan, H. K. Tsang, *Electron. Lett.* **33**, 983 (1997).
- [2] M. Sukiasyan, A. Kutuzyan, *Frontiers in Optics / Laser Science*, paper LW7G.1, (2020).
- [3] M. Sukiasyan, N. Karapetyan, H. Toneyan, *et al.*, *Applied Optics*, **58**, 2817, (2019).

Poster Report

pH-Dependent Structural Transitions in Complementary Telomeric DNA Strands: Competition Between Duplex, G-Quadruplex, and i-Motif States

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Human telomeric DNA regions, as well as promoter regions of oncogenes, are capable of forming not only the canonical B-DNA duplex but also noncanonical four-stranded secondary structures such as G-quadruplexes and i-motifs, which play essential roles in genome regulation and stability [1]. We investigated the conformational behavior of complementary G-rich (TelG) and C-rich (TelC) human telomeric DNA strands, as well as their equimolar mixture, under mildly acidic to neutral pH conditions (5.5, 6.5, and 7.0). Using circular dichroism spectroscopy, UV spectrophotometry, and differential scanning calorimetry, we probed the equilibrium structures and thermal stability of the various conformational states [2].

Our results reveal that TelG forms a G-quadruplex across all pH values studied, while TelC adopts an i-motif only at pH 5.5. At higher pH, the i-motif is destabilized, favoring coil or duplex formation. In equimolar mixtures, the duplex conformation dominates at all pH levels, yet coexisting populations of i-motif and G-quadruplex are observed at lower pH. Notably, the contribution of the i-motif to the system's melting enthalpy diminishes sharply with increasing pH, whereas the duplex shows increasing thermal stability, reaching a maximum at pH 7.0.

These findings provide quantitative insights into the energetic competition among duplex, G-quadruplex, and i-motif structures, and underscore the role of pH in modulating structural transitions in telomeric DNA. Our results are relevant for understanding pH-dependent genomic regulation and for designing therapeutic strategies targeting noncanonical DNA structures.

References

- [1] Tigran V. Chalikian, Lutan Liu, Robert B. Macgregor, *Biophysical Chemistry*, **267**, 106473 (2020).
[2] M.Kh. Badalyan, I.V. Vardanyan, Y.B. Dalyan, et al., *ACS Omega*, **8**, 47051 (2023).

Poster Report

Absorption, Photoluminescence and Raman Spectra of Oxyfluoride Barium Borate Aluminosilicate Glasses Doped by Nd and Er Ions

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The optical properties of pure and neodymium- or erbium-doped oxyfluoride barium borate aluminosilicate glasses BaO/BaF₂-SiO₂-B₂O₃-Al₂O₃, which are of interest from the point of view of their practical application in various fields, such as fiber optics, quantum electronics, and laser devices, were studied. Borosilicate glass (BSG) is a special sort of glass consisting of SiO₂ and B₂O₃. It generally has a lower thermal expansion coefficient value ($3.4 \times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$) than that of soda-lime-silica (SLS) glass, and possesses good chemical resistance, high dielectric strength and a higher softening temperature (800°C) when compared to those of SLS glass. These glasses were doped with Nd and Er ions to study their emission properties.

The chemical composition of the glass was determined by quantitative chemical analysis methods. The results of the chemical analysis are presented in Table 1.

Table 1. Chemical composition of BaO/BaF₂-SiO₂-B₂O₃-Al₂O₃ glasses (in mas %)

Main elements	SiO ₂	Al ₂ O ₃	BaO	B ₂ O ₃	FeO	P ₂ O ₅	Na ₂ O	K ₂ O	F	loi	Sum
Glass	24.54	6.84	53.48	10.153	0.007	0.02	0.28	0.05	1.89	0.24	100

The content of neodymium and erbium oxides in both samples was 2.5 mas%.

Optical absorption and PL spectra were recorded in order to determine the energy of the Stark levels of the Er and Nd ions in the BaO/BaF₂-SiO₂-B₂O₃-Al₂O₃ glasses. To excite the PL of neodymium ions, laser radiation with a wavelength of 808 nm was used, and emission at

three main transitions $^4F_{3/2} \rightarrow ^4I_J$ of neodymium ions was observed at wavelengths of 0.9, 1.06, and 1.33 nm.

A laser with radiation on 980 nm wavelength was used to excite near IR emission of erbium ions at ~ 1550 nm, assigned to $^4I_{13/2} \rightarrow ^4I_{15/2}$ transition.

When neodymium- or erbium-doped glasses were excited by a laser with a wavelength of 473 nm in 90° geometry for Raman spectra, strong PL was observed in the red region, visible to the naked eye in glasses with erbium and slightly weaker in samples with neodymium (apparently due to reabsorption), possibly associated with the emission of the glass network.

Poster Report

Neural Network-Assisted Optimization of Laser Fields for STIRAP in Multilevel Quantum Systems

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In this work, we propose a methodology for optimizing laser control fields to implement STIRAP [1-3] in multilevel quantum systems using a neural network-based approach. Our framework leverages both physics-informed neural networks (PINNs) and traditional optimization methods to achieve optimal control. Using PINNs within the density matrix formalism, we generate time-dependent pulse profiles that guide the system along adiabatic trajectories, while the optimization methods independently fine-tune these pulses. This dual strategy effectively suppresses population leakage and improves transfer fidelity in open quantum systems with relaxation processes.

The framework has been validated on various configurations, including Λ -, M-, and complex multiconnected schemes, demonstrating flexibility and scalability. The results underscore the potential of neural network-based control for efficiently designing population transfer protocols in multilevel quantum systems, and can be extended to a wide range of quantum information tasks.

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References

- [1] Roman Sahakyan, Romik Sargsyan, Edgar Pogosyan, Martin Astsatryan, and Emil Gazazyan, book of abstract, International Conference MMCP 2024 Yerevan, Armenia, October 21–25, 2024
- [2] Ishkhanyan, A. Reverse-Engineered Exact Control of Population Transfer in Lossy Nonlinear Three-State Systems. *Photonics*, **11**, 1007. <https://doi.org/10.3390/photonics11111007> 2024
- [3] E.A. Pogosyan and E.A. Gazazyan, *Optical Memory and Neural Networks*, **32**, 3, pp 396–401. 2023

Poster Report

Single-Transistor-Based Capacitive Memory Cell Built in Li-Doped ZnO Thin Films

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Charge memory cells are widely used as dynamic memory cells (DRAM). A capacitor and a field-effect transistor (FET) are the main elements for a single-transistor and single-capacitor memory element - 1T1C DRAM. It seems promising to use A_2B_6 semiconductors in this capacity, in particular, zinc oxide (ZnO), because their dielectric and electrical properties can be controlled over a wide range by introducing a donor or acceptor impurity [1, 2]. The mechanism of carrier transport in dielectric ZnO films is poorly understood, in particular, in films with low conductivity doped with an acceptor impurity. This work aims to study the mechanism of charge carrier transport in doped ZnO films. The results obtained were used to create a single-transistor and single-capacitor dynamic memory element (1T1C DRAM), in which the zinc oxide film acts as a capacitor dielectric and a FET channel.

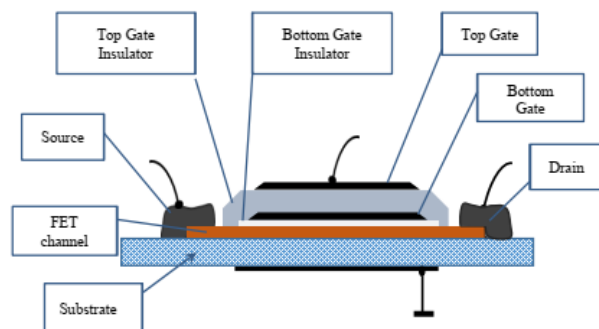


Fig. shows a scheme of FET with a floating gate. Both ZnO (ZnO:Li) and ZnO:Ga were used as FET channel. After deposition, the film was annealed in air to reduce the concentration of oxygen vacancies. Next, the source and drain electrodes were thermally deposited. The bottom gate insulator is a

compensated ZnO:Li semiconductor with minimal conductivity. The bottom gate is a highly conductive ZnO:Ga film. Next, we sputtered an amorphous MgF₂ film as the top gate insulator and a metallic aluminum as the top gate.

The mechanisms of charge carrier transport of undoped and doped ZnO thin films were studied. The frequency dependences of the conductivity were studied and interpreted from the point of view of various mechanisms of polaron conductivity in the framework of the Mott theory of hopping conductivity. The results obtained were used for the creation of the single-transistor capacitive memory elements (1T1C) and field-effect transistors with a floating gate.

References

- [1] N.R. Aghamalyan, R.K. Hovsepyan, A.R. Poghosyan, and V.G. Lazaryan, "Photodetectors on the base of ZnO thin films", *Proc. SPIE*, 5560, 235-240, 2004.
- [2] N.R. Aghamalyan, R.K. Hovsepyan, A.R. Poghosyan, B. von Roedern, and E.S. Vardanyan, "Photoelectric and spectral properties of ZnO thin films", *Journal of Optoelectronics and Advanced Materials*, **9**, 1418-1421, 2007.

Poster Report

Measurement of the Second-Order Coherence and the Nature of a Light Source

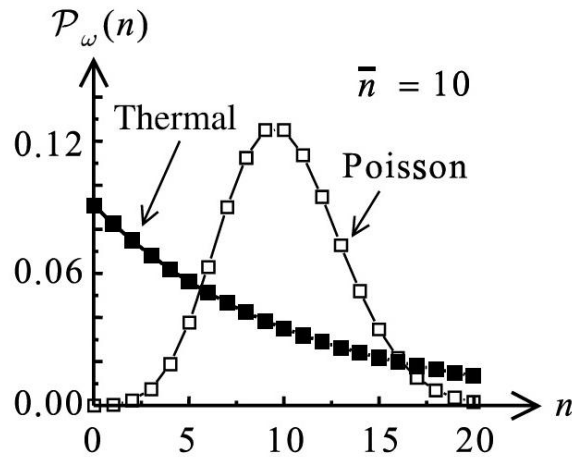
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The scheme of the Hanbury-Brown and Twiss (HBT) experiment for traditional intensity correlations measurement, which reveals intensity fluctuation of an optical field, has laid the foundation for modern quantum optics. Moreover, second-order temporal coherence provides a useful tool for characterizing the basic types of light, including thermal, coherent laser, and single-photon light.

Here, we describe simple experiments to describe photon statistics. We examine the light properties in terms of the coherence time and a second-order coherence function, as determined either by measuring the light intensity as a function of time or via coincidence analysis of a pair of photon detectors.



We aim to investigate the nature of radiation in the case of a two-photon transition on the D2 line of rubidium, as well as to study the behavior of coherent and incoherent radiation at large delay times τ . Special attention is given to analyzing the transition of the autocorrelation function from a value of 2 (typical for thermal sources) to 1 (for coherent sources) as the delay time increases.

References

- [1] Glauber, R. J. (1963). The quantum theory of optical coherence. *Physical Review*, **130**(6), 2529–2539. <https://doi.org/10.1103/PhysRev.130.2529>
- [2] Mandel, L., & Wolf, E. (1965). Coherence properties of optical fields. *Reviews of Modern Physics*, **37**(2), 231–287. <https://doi.org/10.1103/RevModPhys.37.231>
- [3] Hanbury Brown, R. & Twiss, R. Q. (1956). Correlation between photons in two coherent beams of light. *Nature*, **177**, 27–29. <https://doi.org/10.1038/177027a0>

Poster Report

Effects of UV Irradiation on the Electrical and Optical Properties of Ag-doped ZnO Films

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Exposure to UV radiation can modify the band gap or introduce new electronic states in ZnO, resulting in notable variations in its electrical conductivity. These changes can significantly enhance its sensing performance [1], making it suitable for use in UV sensors for

applications such as environmental pollutants monitoring, and offering the potential for highly sensitive detection.

Ag (0.05 at.%) doped ZnO (AgZnO) films were prepared using an e-beam evaporation method and characterized by X-ray diffraction (URD-6) and energy-dispersive X-ray (EDX) microanalysis using an INCA Energy 300 instrument. The optical properties were investigated through transmittance and far-infrared (FIR) reflectance spectroscopy, using Shimadzu UV1800 and Specord M-80 spectrometers. Electrical resistance was measured with a UT612 LCR Meter. Aluminum was used as the electrode material. UV irradiation (≤ 365 nm) was applied using a low-pressure mercury lamp (180 nm–300 nm) with a power density of approximately 0.1 W/cm² for a duration of 84 hours. The results are as follows:

-The band gap of the as-deposited ZnO film was initially 3.260 eV. It increased slightly to 3.265 eV after annealing and remained unchanged under UV irradiation for up to 84 hours. This indicates that the band gap of AgZnO films treated by UV light (≤ 365 nm) exhibits good UV stability.

-FIR reflectance spectra of the ZnO films, recorded in the range of 200 - 4000 cm⁻¹ to identify functional groups, showed a slight increase in reflectance after UV exposure. Additionally, minor absorption features corresponding to OH and CO bonds, initially present in the films, disappeared after 84 hours of irradiation, suggesting the removal of these groups due to prolonged UV exposure.

- Electrical resistance of the ZnO films decreased sharply during the initial stages of UV irradiation (within the first 30 hours), then decreased more gradually up to 84 hours. A reduction in resistance typically reflects an increase in charge carrier concentration (e.g., electrons) or the formation of additional conductive pathways. This behavior is often attributed to structural degradation or the creation of surface oxygen vacancies, which can act as electron donors and enhance conductivity.

References

- [1] Hwai-En Lin, Jeongsoo Hong, Ryosuke Nitta, Yuta Kubota, Yuta Katayanagi, Hajime Wagata, Tetsuo Kishi, Tetsuji Yano, [Tetsuji Yano](#), Nobuhiro Matsushita, *Appl. Surf. Sci* **489**, 135 (2019).

Poster Report

Application of Metal Nanoparticles with Localized Surface Plasmon Resonances for Luminol Chemiluminescence Enhancement

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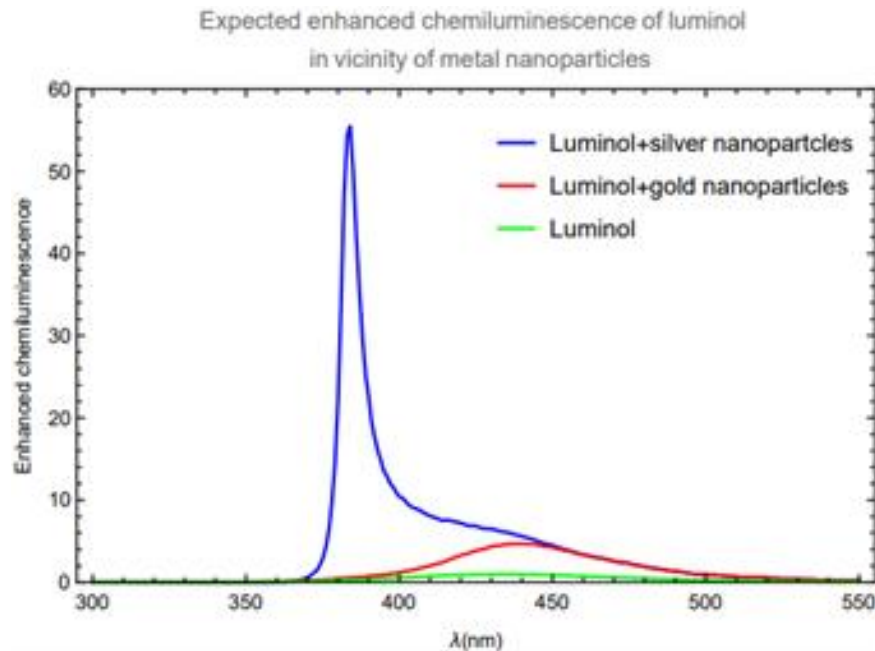
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Chemiluminescence-based sensors do not require an external optical source, which simplifies their design and reduces costs compared to photoluminescence-based devices. Their main limitation is the low emission intensity, hindering the detection of low analyte concentrations. Metallic nanoparticles supporting plasmon resonances are able to enhance chemiluminescence intensity, acting as nanoantennas and, via the Purcell effect, increasing the radiative transition rate and chemiluminescence quantum yield. We calculated the radiation transition rate γ in its dependence on the distance r from the center of a metal sphere of radius a , and permittivity ε .

$$\gamma(r) = \gamma_0 \left| 1 + \frac{2(\varepsilon - 1)}{\varepsilon + 2} \left(\frac{a}{r} \right)^3 \right|^2.$$

Considerable speedup of the radiative transition may be achieved when $\text{Re}(\varepsilon) = -2$ corresponding to excitation of a localized surface plasmon. In this case the chemiluminescence quantum yield grows because radiative transitions win the competition with the nonradiative transitions.



As it is clearly seen in the figure, simultaneously with the quantum yield enhancement, the spectrum of the chemiluminescence changes considerably. This observation gives the possibility to experimentally solve the long-standing problem of the differentiation of chemical and electrodynamical mechanisms' contributions to the metal-enhanced fluorescence. While the former does not change the chemiluminescence spectrum, the latter shifts the chemiluminescence maximum in the direction of the surface plasmon resonance maximum.

Poster Report

Optical Characterization of Atmospheric Aerosols Using a Calitoo Sun-Photometer

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Atmospheric aerosols significantly influence the Earth's radiative balance, air quality, and visibility. This study investigates the optical and physical characteristics of aerosols in Shadegan, a humid city in southwest Iran, using multi-source data including ground-based sun-photometry, PM₁₀ concentrations, satellite observations, and atmospheric transport modeling. A Calitoo handheld sun-photometer was used to retrieve aerosol optical depth (AOD) and angstrom exponent (AE) through spectral measurements at 465, 540, and 619 nm. AOD quantifies the total columnar aerosol loading by measuring the attenuation of solar radiation, while AE provides insight into the aerosol particle size distribution. Measurements were conducted on two contrasting days: a clean day (May 2, 2023) and a dusty day (May 27, 2023). AOD increased from 0.06 to 0.78, while AE dropped from 0.57 to 0.08, indicating the dominance of coarse-mode particles during the dust episode. Complementary observations revealed that horizontal visibility declined sharply from 10 km to 3 km, and PM₁₀ concentrations rose from 68 $\mu\text{g}/\text{m}^3$ (indicating good air quality) to 120 $\mu\text{g}/\text{m}^3$ (classified as unhealthy for sensitive groups). MODIS satellite data from both Terra and Aqua platforms indicated AOD values of 0.10 and 0.26 on the clean day, increasing to 0.80 and 0.65, respectively, on the dusty day. These satellite-derived AODs showed strong correlation with ground-based sun-photometer measurements, with Terra data displaying closer agreement. Furthermore, backward trajectory analysis using the HYSPLIT model indicated that the dust-laden air masses originated from arid regions of Iraq, confirming the transboundary nature of the dust transport. The integration of spectral, in-situ, and remote sensing datasets in this study highlights the importance of a multidimensional approach to aerosol monitoring in complex environments such as Shadegan.

References

- [1] A. Bayat, A. Assar-Enayati, A. Touseh, Validation of Aerosol Optical Depth Measured by CALIOP, MODIS, MISR, and OMI Sensors Using Ground-Based Sun-Photometer in Zanzan Region, *Journal of Applied Researches in Geographical Sciences*, 2021.
- [1] A. Yousefi Kebriya, M. Nadi, E. Afaridegan, Z. Sun, Wetland Shrinking and Dust Pollution in Khuzestan Iran: Insights from Sentinel-5 and MODIS Satellites, *Environmental Monitoring and Assessment*, Vol. 195, Article No. 145 (2023).
- [3] E. Nozaripak, A. Assar-Enayati, A. Bayat, Comparison of Ground-Based Sun-Photometer and MODIS Satellite Data for Aerosol Optical Depth in Zanzan, Iran, Proc. 31st Iranian Conference on Optics & Photonics and 17th Iranian Conference on Photonic Engineering & Technology, Zanzan, Iran (2024).

Poster Report

Magnetically Induced Transparency, Absorption, and Dispersion Characteristics of a Rb-87 Medium in a J-Type Configuration for Weak Magnetic Field Measurement

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We present a theoretical investigation of magnetically induced transparency (MIT), absorption, and dispersion in a weakly excited Rb-87 atomic medium configured in a J-type three-level scheme, aimed at precision weak magnetic field measurement. The system comprises two Zeeman sublevels of the same ground hyperfine state coupled to an excited state via right-circularly polarized light, with both longitudinal and transverse magnetic field components included. Using the Bloch equations under the weak excitation regime, we derive analytical solutions for atomic populations and coherences in stationary, quasi-stationary, and short-pulse regimes. The formalism decouples population and coherence dynamics, enabling exact solutions via eigenvector methods and variation of constants. We identify a bifurcation in the system's oscillatory behavior at zero longitudinal field splitting, marking a transition from single- to dual-mode dynamics. Analytical expressions for the absorption coefficient and dispersion are obtained through $\text{Im}[\rho_{32}]$ and $\text{Re}[\rho_{32}]$, respectively, providing direct relations for magnetic field measurement sensitivity. The results serve as a guide for experimental implementation, offering a framework for detecting MIT and optimizing weak magnetic field sensing in atomic vapors.

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Poster Report

A Quadratic Transformation Identity for the Confluent Heun Function Involving Three Arbitrary Parameters

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We present a new quadratic transformation identity for the confluent Heun function. The transformation represents the confluent Heun function, with three arbitrary parameters of its differential equation, as the product of an exponential pre-factor and an irreducible linear combination of two confluent Heun functions with a quadratic argument and altered parameters. This result is an independent addition to the class of quadratic transformations for the confluent Heun function, distinct from the first identity of this kind reported in *Heliyon* 10, e36535 (2024) [2].

The presented transformation offers significant potential for applications in various fields, particularly in solving problems in quantum mechanics, general relativity, and other areas of mathematical physics. By allowing three parameters, including the accessory parameter q , to vary freely, the identity enhances the versatility of the confluent Heun function for addressing complex mathematical systems.

As the confluent Heun function continues to gain importance in modern theoretical studies, the discovery of new functional identities such as this one is valuable for simplifying intricate equations and expanding analytical methods.

References

- [1] A. Ronveaux, “Heun’s Differential Equations”, Oxford University Press, London, 1995.
- [2] A.M. Ishkhanyan, *Heliyon* **10**, e36535 (2024).

Poster Report

Strong Confinement of a Nanoparticle in a Needle Paul Trap: Towards Matter-Wave Interferometry with Massive Objects

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Quantum mechanics (QM) and General relativity (GR), also known as the theory of gravity, are the two pillars of modern physics. A matter-wave interferometer with a massive particle can test numerous fundamental ideas, including the spatial superposition principle- a foundational concept in QM - in completely new regimes, as well as the interface between QM and GR, e.g., testing the quantization of gravity [1]. Consequently, there exists an intensive effort to realize such an interferometer. While several paths are being pursued, we focus on utilizing nanodiamonds (NDs) as our particle, and a spin embedded in the nanodiamond together with Stern-Gerlach forces, to achieve a closed loop in space-time. There is a growing community of groups pursuing this path [2]. Recently, our group published a series of preprints, each dedicated to a specific building block of our future ND matter-wave interferometer [3-9].

In this report, we present the experimental results of the strong confinement of a levitated particle, which is crucial for angular confinement, precise positioning, and advantageous for deep cooling. We designed a needle Paul trap with a controllable distance between the electrodes, giving rise to a strong electric gradient. By combining it with an effective charging method - electrospray - we reach a trap frequency of up to 40 kHz, which is more than twice the state of the art. We believe that the designed trap could become a significant tool in the hands of the community working towards massive matter-wave interferometry.

References

- [1] S. Bose, A. Mazumdar, G. W. Morley *et al.*, *Phys. Rev. Lett.*, vol. **119**, no. 24, p. 240401 (2017)
- [2] S. Bose, A. Mazumdar, R. Penrose *et al.*, CERN ESPP White Paper (submitted March 2025).
- [3] P. Skakunenko, D. Folman, Y. Bar-Haim *et al.*, preprint arXiv: 2508.13723 (2025)
- [4] O. Feldman, B. B. Shultz, M. Muretova *et al.*, preprint arXiv:2508.14687 (2025)
- [5] S. Liran, O. Dobkowski, R. Benjaminov *et al.*, preprint arXiv:2508.15625 (2025)
- [6] M. Muretova, Y. Japha, M. Toros, *et al.*, preprint arXiv: 2508.13723 (2025)
- [7] M. Givon, Y. Bar-Haim, D. Groswasser, *et al.*, preprint arXiv: 2508.13662 (2025)
- [8] R. Benjaminov, S. Liran, O. Dobkowski, *et al.*, preprint arXiv: 2508.14722 (2025)
- [9] N. Levi, O. Feldman, Y. Rosenzweig *et al.*, preprint arXiv: 2508.15504 (2025)

Poster Report

Four-Parametric Generalization of the Second Demkov-Kunike Two-State Model

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We introduce a new time-dependent level-crossing model that describes a quantum two-state system subjected to a constant-amplitude laser field. In this configuration, which presents a four-parametric generalization of the three-parametric second Demkov-Kunike level-crossing model, the frequency detuning changes within a finite range, and the resonance crossing generally occurs asymmetrically in time with respect to the crossing point. The general solution to this problem can be written as a linear combination with arbitrary constant coefficients of two independent generalized hypergeometric functions of Clausen, each of which can be presented as a linear combination of two ordinary hypergeometric functions. We analyze the asymptotes of the solution in terms of the quasi-energies and compute the final transition probability for the scenario where the system starts in the first quasi-energy state.

References

- [1] B.W. Shore, *Manipulating Quantum Structures Using Laser Pulses* (Cambridge University Press, New York, 2011).
- [2] L.D. Landau, "Zur Theorie der Energieübertragung. II", *Phys. Z. Sowjetunion* 2, **46** (1932).
- [3] A.M. Ishkhanyan, T.A. Shahverdyan, T.A. Ishkhanyan, "Thirty-five classes of solutions of the quantum time-dependent two-state problem in terms of the general Heun functions", *Eur. Phys. J. D*, **69**, 10 (2015).
- [4] A.M. Ishkhanyan and A.E. Grigoryan, "Fifteen classes of solutions of the quantum two-state problem in terms of the confluent Heun function", *J. Phys. A*, **47**, 465205 (2014).
- [5] A.M. Ishkhanyan, T.A. Shahverdyan, and A.M. Ghazaryan, "Asymmetric version of the second Demkov-Kunike level-crossing model", *Optical Memory and Neural Networks*, **32**, S435–S442 (2023).

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