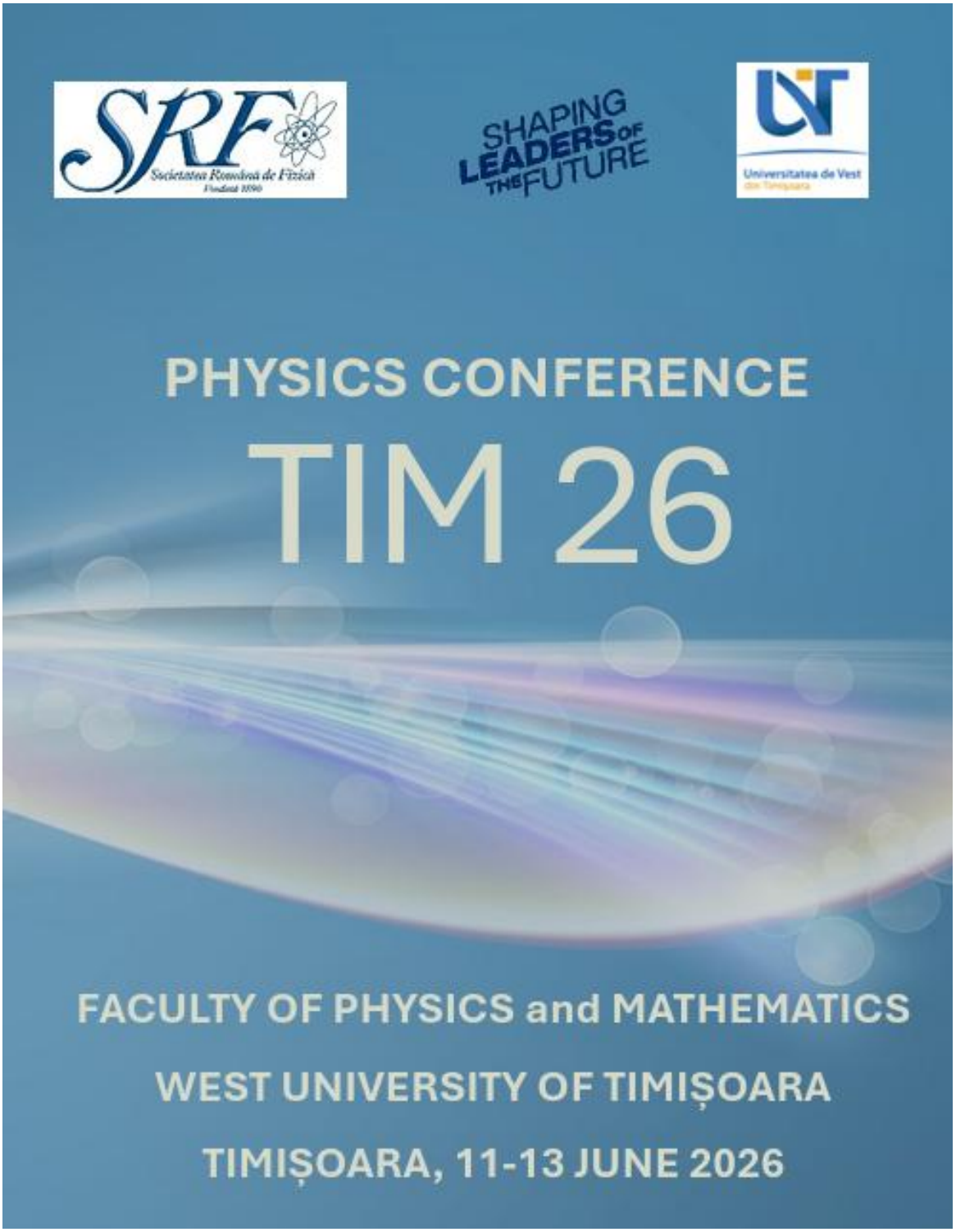


ABSTRACT BOOKLET

Contents

PL-01 5
PL-02 6
PL-03 7
PL-04 8
PL-05 10
PL-06 11
TCP-O01 13
TCP-O02 14
TCP-O03 15
TCP-O04 16
TCP-O05 17
TCP-O06 18
TCP-O07 19
TCP-O08 20
TCP-O09 21
TCP-O10 22
TCP-O11 23
TCP-O12 24
TCP-O13 25
TCP-O14 26
TCP-O15 27
TCP-O16 28
TCP-O17 29
TCP-O18 30
TCP-O19 31
TCP-O20 32
TCP-P01 33
TCP-P02 34
TCP-P03 35
TCP-P04 36
CMP-O01 38
CMP-P01 39
CMP-P02 40
CMP-P03 41
CMP-P04 42
CMP-P05 43
CMP-P06 44
CMP-P07 45
CMP-P08 46
CMP-P09 47
CMP-P10 48

CMP-P11 49
API-O01 51
AIP-O02 52
API-O03 53
API-O04 54
API-O05 55
API-P01 56
API-P02 57
API-P03 58
API-P04 59
API-P05 60
API-P06 61
API-P07 62
API-P08 63
API-P09 64
API-P10 65
API-P11 66
API-P12 67
API-P13 68
API-P14 69
API-P15 70
API-P16 71
API-P17 72
API-P18 73
EP-O01 75
EP-O02 76
EP-P01 77
EP-P02 78
EP-P03 79
EP-P04 81

PLENARY PRESENTATIONS

PL-01

ATMOSPHERIC PRESSURE PLASMAS: FUNDAMENTALS AND EMERGING APPLICATIONS

Ionut Topala[1], Ilarion Mihaila[2], Ioana Cristina Gerber[2], Valentin Pohoata[1]

[1]*Faculty of Physics, Iasi Plasma Advanced Research Center (IPARC), Alexandru Ioan Cuza University of Iasi, Blvd. Carol I, No. 11, 700506 - Iasi, Romania*
[2]*Integrated Center of Environmental Science Studies in the North-Eastern Development Region, Blvd. Carol I, No. 11, 700506 - Iasi, Alexandru Ioan Cuza University of Iași, Romania*

Atmospheric pressure plasma (APP) sources generate transient or stationary plasmas for diverse applications. Atmospheric pressure plasma sources are classified by thermal equilibrium (LTE, arcs/torches vs. non-LTE, barrier discharge/jets/corona/RF/microwave discharges), geometry, gas (air, He, Ar, N_2,), electrical excitation, and stationary vs. transient operation. In weakly ionized plasmas, charge-neutral interactions dominate, with electron-impact as key processes (excitation, dissociation, ionization) in the volume and at soft interfaces; thus, controlling the electron density and composition of working gas are among critical operational factors. Variations in design and operation explain the variations in reported results. In this context, plasma diagnosis plays a dominant role by enabling real-time monitoring of key parameters like electron density, reactive species concentrations, and temperature in atmospheric pressure plasma sources, ensuring reproducible and optimized use.

Over the past half-century, these applications of these plasma sources have evolved from thermal types for propulsion, cutting, welding, and material deposition to non-thermal configurations that process heat-sensitive materials, including biological architectures and living organisms. Nowadays they stand out as versatile options, easily integrated into production lines or used for specific tasks. For example, to enter medical markets, select plasma devices underwent multi-year clinical studies for wound healing and disinfection, emphasizing reproducible, safe operation and efficient biological responses. Results are now promising also for biomedical engineering, veterinary medicine, food science and agriculture. Direct treatment applies plasma to a target, delivering short-lived species, UV, electric fields, and heat instantly, while indirect treatment use plasma effluent or plasma treated liquids (e.g. water, alcohols, cell culture media), then uses the solution on inaccessible sites, relying on molecules such us H_2O_2, NO_3^-, NO_2^-. Synergies often make plasma more effective than individual agents.

In summary, atmospheric pressure plasma sources offer compact, room-temperature, pulsed free-radical chemistry, ideal for local treatments in life sciences and targeted chemical processes for surface treatment of materials, thin films deposition, environmental applications or chemical synthesis. Their effects follow a "key-lock" principle: tailor the atmospheric pressure plasma source to deliver specific active agents for targeted applications.

Future advancements in automation, machine learning, and control of plasma parameters and chemistry will turn products based on atmospheric pressure plasma technologies in reliable solution on various markets. By enabling real-time optimization of reactive species delivery, gas mixtures, and treatment dosages, these technologies ensure reproducibility and standardized use at large scale. This integration promises to accelerate market entry for medical devices, as well as for agricultural, environmental and materials science processes, transforming Atmospheric pressure plasma sources into a mainstream, scalable solution across industry.

Keywords: atmospheric pressure plasma, plasma parameters, diagnosis, applications.

PL-02

SAHARAN DUST AND PHOTOVOLTAIC ENERGY PRODUCTION IN EUROPE

György Varga[1,2]

[1]*HUN-REN Research Centre for Astronomy and Earth Sciences, Budaörsi út 45, Budapest, Hungary*
[2]*Research Institute of Biomolecular and Chemical Engineering, University of Pannonia, Veszprém, Hungary*

Saharan Dust Events (SDEs) increasingly affect atmospheric radiation and photovoltaic (PV) energy production across Europe. While the Mediterranean region remains the primary European hotspot of Saharan dust transport, Central Europe, and so Hungary, has become increasingly exposed in recent years. This is particularly important because Hungary currently has one of the world's highest shares of PV-based electricity generation within its national electricity mix, making the energy sector highly sensitive to aerosol-related atmospheric processes.

This study investigates the effects of Saharan dust intrusions on solar irradiance, cloud properties, and PV performance over Hungary, with a broader comparison to Mediterranean countries. National-scale PV production statistics are combined with MERRA-2, CAMS, and MODIS datasets for the 2019–2025 period to analyze both the direct radiative attenuation effect of mineral dust and the indirect aerosol-cloud interaction pathways associated with dust outbreaks.

The results show that the dominant PV losses are frequently linked not only to direct dust extinction, but also to dust-induced changes in cloud microphysics. In particular, enhanced cirrus formation during dust events substantially increases atmospheric extinction and modifies the partitioning between direct and diffuse radiation. During severe dust outbreaks, PV performance ratio may decrease from typical fair-weather values above 75% to below 50%.

The strongest aerosol-cloud interaction signals are identified during the transitional seasons, especially spring, when thermodynamic conditions favor heterogeneous ice nucleation on mineral dust particles. Similar responses are observed across Mediterranean countries, although the intensity of the impacts varies regionally. The findings highlight the importance of incorporating aerosol-cloud interaction processes and real-time dust information into operational PV forecasting systems to improve renewable energy reliability and energy security under increasingly dusty climatic conditions.

The research was funded by the Sustainable Development and Technologies National Programme of the Hungarian Academy of Sciences (FFT NP FTA).

Keywords: Saharan dust, photovoltaic energy, climate change.

PL-03

FROM JET QUENCHING TO QGP TOMOGRAPHY: INFERRING BULK PROPERTIES WITH HIGH-PT THEORY AND DATA

Magdalena Djordjevic

Institute of Physics Belgrade, Pregrevica 118, 11080 Belgrade, Serbia

The quark-gluon plasma is one of the most intriguing forms of matter produced in the laboratory, yet some of its basic properties remain difficult to determine precisely. In particular, the temperature dependence of its transport properties is still not fully constrained by traditional low-pT observables alone.

In this talk, I will discuss how high-pT hadrons and jets can be used asprobes of the evolving QGP medium. Since these probes are produced early and lose energy while traversing the plasma, their suppression patterns carry information about the temperature profiles and space-time evolution of the medium. I will show how this idea is implemented within our DREENA framework, and how combining low-pT and high-pT data within a Bayesian inference approach can improve the extraction of bulk QGP properties.

PL-04

KONDO COMPENSATION AND QUANTUM CRITICALITY IN SUPERCONDUCTING AND FRACTIONALIZED SYSTEMS

Cătălin Paşcu Moca

Department of Physics, University of Oradea, Oradea, Romania
Department of Theoretical Physics, Budapest University of Technology and Economics, Budapest, Hungary

Magnetic impurities in superconductors give rise to rich quantum many-body phenomena, governed by the interplay between Kondo screening and superconducting pairing. In a conventional metal, an embedded impurity spin is screened by the Kondo effect, forming an extended correlation cloud. In an s-wave superconductor, however, the impurity gives rise to Yu-Shiba-Rusinov (YSR) states, and a quantum phase transition occurs between screened and unscreened phases when the superconducting gap Δ exceeds the Kondo temperature T_K. We show that the Kondo cloud persists in both phases, albeit with only partial screening in the unscreened regime. The concept of Kondo compensation is introduced as a universal measure of cloud integrity, directly related to the impurity's g-factor, which can be probed experimentally via bias spectroscopy.

Beyond conventional metals and superconductors, we investigate the impact of a pseudogap density of states, $\rho(\omega) \sim |\omega|^{\varepsilon}$, on Kondo screening. In the generic absence of particle-hole symmetry, increasing the exchange coupling j drives a quantum phase transition from a partially screened doublet state to a fully screened many-body ground state. At the critical coupling j_c, the Kondo compensation follows a scaling law, $\kappa(j<j_c) = 1 - g(j)$, with the local g-factor vanishing as $g \sim |j - j\_c|^{\beta}$. Combining perturbative drone fermion techniques with non-perturbative NRG computations, we determine the critical exponent $\beta(\varepsilon)$, revealing a non-monotonic dependence on ε. These results establish that the Kondo cloud forms continuously in the presence of a weak pseudogap as the phase transition is approached.

For a larger impurity spin S=1, partial screening leads to an underscreened Kondo effect, giving rise to an additional quantum phase transition between a partially screened doublet state and an unscreened triplet state as Δ/T_K increases. We demonstrate that the Kondo compensation exhibits a universal jump at this transition, vanishing deep in the unscreened phase while approaching 1/2 in the partially screened regime. Spin-spin correlation functions reveal an oscillatory behavior with a short-distance power-law decay and a long-distance exponential suppression governed by the superconducting correlation length ξ_Δ. These properties are further explored via spectral function calculations, employing numerical renormalization group (NRG) and density matrix renormalization group (DMRG) methods.

Finally, we extend these concepts to one-dimensional superconductors with fractionalized excitations. In such systems, conduction electrons split into gapless charge and gapped spin modes, with the impurity coupling exclusively to spin degrees of freedom. This interaction drives a local quantum phase transition and gives rise to the “fractionalized Shiba state.” The impurity-induced tunneling spectrum exhibits universal power-law scaling, with an exponent of -1/2 at half-filling due to gapless charge fluctuations forming a Luttinger liquid. At finite temperatures, spectral features remain universal at the critical point. These findings provide new insights into impurity physics in exotic superconducting environments.

Our results unify diverse aspects of Kondo screening, quantum phase transitions, and impurity physics in superconducting, and fractionalized systems, offering novel experimental signatures and theoretical insights into strongly correlated quantum matter.

Keywords: Kondo physics, DMRG, NRG, renormalization group

References:

[1] H. Shiba, Classical spins in superconductors, Progress of theoretical Physics 40, 435 (1968).
[2] A. Rusinov, Theory of gapless superconductivity in alloys containing paramagnetic impurities, Sov. Phys. JETP 29, 1101 (1969).
[3] A. O. Gogolin, A. A. Nersesyan, and A. M. Tsvelik, Bosonization and Strongly Correlated Systems (Cambridge University Press, Cambridge, 1998).
[4] T. Giamarchi, Quantum Physics in One Dimension (Oxford University Press, Oxford, 2004).
[5] C. P. Moca, C.Hajdu, B. Dora, G. Zarand, Spectral Properties of Fractionalized Shiba States, Phys. Rev. Lett. **135**, 126502 (2025)
[6] Csanád Hajdú, Cătălin Paşcu Moca, Balázs Dóra, Ireneusz Weymann, Gergely Zaránd, Kondo Compensation in a Pseudogap Phase: a Renormalization Group Study, Physical Review B 111, 155125 (2025)

PL-05

PLASMONIC NANOPLATFORMS: FROM BIOSENSING TO CANCER THERANOSTICS

Monica Focsan [1,2]

[1] *Biomolecular Physics Department, Faculty of Physics, Babes-Bolyai University, 1 M. Kogalniceanu Street, 400084, Cluj-Napoca, Romania*
[2] *Nanobiophotonics and Laser Microspectroscopy Centre, Interdisciplinary Research Institute on Bio-Nano-Sciences, Babes-Bolyai University, 42 Treboniu Laurian Street, 400271, Cluj-Napoca, Romania*

Plasmonic nanomaterials have emerged as powerful multifunctional platforms for advanced biosensing, molecular imaging and cancer theranostics due to their remarkable optical and photothermal properties [1]. This plenary lecture will provide an overview of recent advances in the development of plasmonic and hybrid nanoplatforms for biomedical applications, with a particular focus on surface-enhanced Raman scattering (SERS), localized surface plasmon resonance (LSPR), Metal-enhanced Fluorescence (MEF)-based biosensing, and image-guided cancer therapy. Efforts have been directed toward the rational engineering of metallic and hybrid nanostructures with controlled optical responses, enhanced biocompatibility, and integrated diagnostic and therapeutic functionalities. The presentation will highlight the design of multifunctional nanoplatforms based on gold nanostructures, and photoactive nanosystems for ultrasensitive biomolecular detection and photothermal/photodynamic therapeutic approaches. Special attention will be devoted to plasmonic nanoparticles capable of efficient light-to-heat conversion, controlled nanoscale heating, and enhanced spectroscopic performance, enabling precise and minimally invasive therapeutic strategies [2,3].

Finally, the lecture will address current challenges and future perspectives in translating plasmonic nanotechnologies toward clinical oncology, including reproducibility, scalability, nano(bio)interactions, and the development of smart nanoplatforms for precision medicine.

Keywords: gold nanoparticles, biosensing, photothermal therapy, nanomedicine

References:

[1] A.M. Craciun, S. Astilean, M. Focsan, M. Lamy de la Chapelle, *TrAC, Trends Anal. Chem.,* **180** 117913 (2024).
[2] O. Raducu, R. Borlan, A. Holca, A.-M. Craciun, S. Tripon, O. Soritau, G. Chereches, D. Maniu, S. Astilean, M. Lamy de la Chapelle, M. Focsan, *Colloids Surf. B Biointerfaces*, **262,** 115476 (2026).
[3] A. Holca, R. Borlan, A. Campu, S. Dragan, M. Muntean, A.-M. Craciun, A. Sesarman, M. Banciu, S. Astilean, M. Lamy de la Chapelle, M. Focsan, *ACS Appl. Nano Mater*., **8** 19796–19809 (2025).

PL-06

EXPERIMENTAL AND PHENOMENOLOGICAL INVESTIGATIONS OF FEMTOSCOPIC CORRELATIONS IN RELATIVISTIC NUCLEAR COLLISIONS

Daniel Kincses[1]

[1]*ELTE Eötvös Loránd University, Pázmány Péter sétány 1/A, H-1117 Budapest, Hungary*

Femtoscopy, the sub-field of nuclear and particle physics encompassing quantum-statistical correlation measurements on the femtometer scale, is at the forefront of investigations since the discovery of the strongly interacting Quark-Gluon-Plasma (QGP) at the Relativistic Heavy Ion Collider (RHIC). The vast amount of data collected by the STAR experiment during the second phase of the Beam Energy Scan program of RHIC opens up unique opportunities to study strongly interacting matter. Although femtoscopic correlations have been widely studied during the last two decades of QGP research, there are still many open questions and interesting new directions to be explored. In this talk, novel precision approaches to femtoscopic correlation studies will be presented, simultaneously in phenomenological investigations of high-energy collisions and in experimental measurements at RHIC. Extracting the shape of femtoscopic source distributions from different model frameworks can provide the basis for direct comparison with current and future experimental data from low to high baryon densities. These model comparisons could shed light on interesting questions of in-medium effects and hadronic interactions, critical behavior, and nuclear structure and deformation effects.

Keywords: heavy-ion physics, femtoscopy, quantum-statistical correlations

THEORETICAL AND COMPUTATIONAL PHYSICS
(TCP)

TCP-O01

INTERACTION VERTICES BETWEEN WEYL AND ELECTROMAGNETIC FIELDS: FOUR VERSUS SIX SPACETIME DIMENSIONS

Eugen-Mihaita Cioroianu[1] and Stefan-Sabin Manolescu[1]

[1]*University of Craiova, 13 A.I. Cuza Str., Craiova, 200585, Romania*

The paper focuses on the consistent couplings that can be added to a free theory describing the superposition of the linearized Weyl and Abelian 1-form actions. The problem is addressed using the deformation technique applied to the solution of the classical master equation associated with the initial free theory, in both four and six spacetime dimensions. It is shown that, within the standard minimal set of working hypotheses—which, with respect to the derivative order, imposes an upper bound of four on the number of derivatives appearing in the interacting Lagrangian—the results are independent of the spacetime dimension. By contrast, if the framework of hypotheses is enlarged by allowing interaction vertices with at most six spacetime derivatives in $D = 6$, the resulting interacting theory exhibits a much richer structure of cross-couplings than in $D = 4$, characterized by the presence of arbitrary free parameters.

Keywords: Weyl gravity, gauge fields, consistent interactions, local BRST cohomology.

References:

[1] E.M. Cioroianu, S.S. Manolescu, *Symmetry* **18(5)**, 860 (2026).
[2] G. Barnich, M. Henneaux, Phys. Lett. B **311**, 123 (1993).
[3] G. Barnich, F. Brandt, M. Henneaux, Phys. Rep. **338**, 439 (2000).
[4] E.S. Fradkin, A.A. Tseytlin, Phys. Rept. **119**, 233 (1985).

TCP-O02

ON THE FADDEEV-JACKIW-DIRAC APPROACH OF VARIOUS ABELIAN FORMS

Sabin-Stefan Manolescu[1] and Eugen-Mihaita Cioroianu[1]

[1]*University of Craiova, Department of Physics, University of Craiova, 13 A.I. Cuza Str., Craiova, 200585, Romania*

The paper aims to identify the phase space and its symplectic and coisotropic physical subspace for various Abelian forms. The procedure uses a combined Faddeev-Jackiw and Dirac method that exhibits the phase space, the physical co-isotropic subspace, and the underlying symplectic structure.

Keywords: gauge fields, Faddeev-Jackiw method, canonical analysis, Abelian forms.

References:

[1] E.M. Cioroianu, S.S. Manolescu, *Symmetry* **17(11)**, 1953 (2025).
[2] F. Faddeev, R. Jackiw, *Phys. Rev. Lett.* **69**, 1962—1694 (1988).
[3] J. Govaerts, *Int. J. Mod. Phys. A* **18**, 3625—3640 (1990).
[4] J. Barcelos-Neto, C. Wotzasek, *Int. J. Mod. Phys. A* **7**, 4981—5003 (1992).

TCP-O03

VIELBEIN LATTICE BOLTZMANN FOR FLUID FLOWS ON SPHERICAL SURFACES

Victor E. Ambruș[1], Elisa Bellantoni[2,3,4], **Sergiu Busuioc**[1], Alessandro Gabbana[5,6,7], Federico Toschi[8,9]

[1]Department of Physics, West University of Timișoara, Bd. Vasile Pârvan 4, Timișoara 300223, Romania [2]Computation-based Science and Technology Research Center, The Cyprus Institute, 2121 Nicosia, Cyprus [3]Department of Physics & INFN, Tor Vergata University of Rome, 00133 Rome, Italy
[4]LTCI, Télécom Paris, IP Paris, 91120 Palaiseau, France
[5]CCS-2 Computational Physics and Methods, Los Alamos National Laboratory, Los Alamos, 87545, USA [6]Center for Nonlinear Studies (CNLS), Los Alamos National Laboratory, Los Alamos, 87545, USA [7]Università di Ferrara and INFN-Ferrara, I-44122 Ferrara, Italy
[8]Department of Applied Physics and Science Education, Eindhoven University of Technology, The Netherlands
[9]CNR-IAC, I-00185 Rome, Italy

Fluid flows on curved surfaces arise in atmospheric dynamics, biological membranes, and thin liquid films. In this paper [1], we develop a lattice Boltzmann scheme based on the Vielbein formalism for fluid flows on spherical surfaces. The Vielbein vector field encodes the geometry of the manifold, allowing the velocity space to be treated as in flat Cartesian space. The resulting Boltzmann equation exhibits inertial forces that keep fluid particles on the spherical surface, computed via projection onto Hermite polynomials. Since exact streaming is not feasible due to the point-dependent advection velocity in the polar coordinate θ, we employ finite-difference schemes with carefully formulated pole boundary conditions.

We validate the implementation against analytical solutions for sound and shear wave propagation derived in this work, and further demonstrate the robustness of the scheme by simulating an axisymmetric shock wave and corotating vortex pairs, the latter showing qualitative agreement with the reference simulations of Ref. [2].

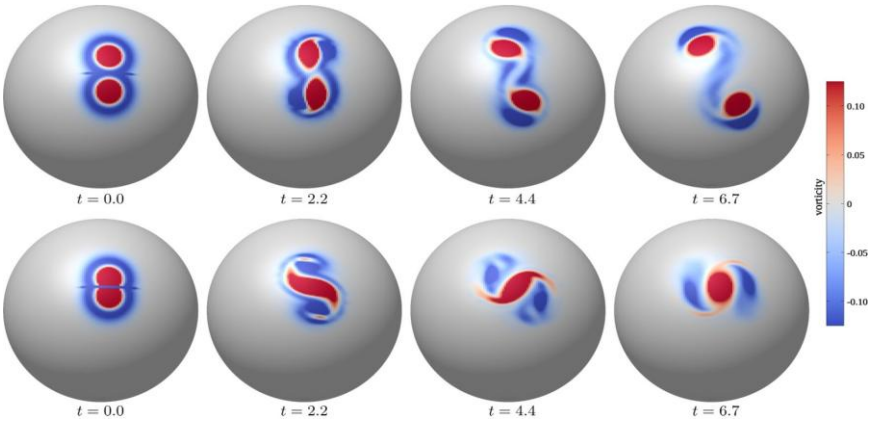


Figure 1: Temporal evolutions of the vorticity field for corotating vortex pairs.

Keywords: Lattice-Boltzmann methods, Shear waves, Shock waves, Sound waves
References:

[1] Ambruş,V.E., Bellantoni,E., Busuioc,S., Gabbana, A., and Toschi, F., Vielbein Lattice Boltzmann approach for fluid flows on spherical surfaces, *Physical Review Fluids*,***10***(12), 124901.(2025).

[2] Yang, Y. Li, and J. Kim, A practical finite difference scheme for the Navier-Stokes equation on curved surfaces in R3 , *J. Comput. Phys.* **411**, 109403 (2020).

TCP-O04

CAUSAL DIRAC FERMIONS IN FINITE ROTATING CYLINDERS

Matteo Buzzegoli[1] and Victor Ambrus[1]

[1]*Department of Physics, West University of Timisoara,*
Bd. Vasile Parvan 4, Timisoara 300223, Romania

Understanding finite-volume corrections and macroscopic quantum phenomena under rotation, such as the axial and helical vortical effects, is crucial for describing the rapidly evolving, rotating quark-gluon plasma (QGP) generated in relativistic heavy-ion collisions. In this talk, we investigate the thermal states of free Dirac fermions within a rigidly rotating cylinder of finite vertical and radial extent. In rotating quantum systems, the introduction of a boundary is essential to maintain causality and prevent unphysical divergences away from the rotation axis. However, introducing sharp corners into the geometry introduces major complications. We explore this by evaluating the impact of boundary conditions (BCs) on the cylinder's top and bottom "lids," contrasting the full MIT bag BCs against an alternative "hybrid" approach that pairs radial MIT BCs with periodic BCs along the vertical axis.

Crucially, we evaluate how these boundary choices interact with pseudo-gauge transformations. While pseudo-gauges (such as the Canonical and Belinfante formulations) are traditionally assumed to be equivalent in unbounded spaces, we demonstrate their non-equivalence under finite-volume constraints. We find that the standard MIT bag BCs tightly restrict lid parameters, breaking translational and chiral symmetry while producing boundary-dependent current profiles. In contrast, the proposed hybrid BCs preserve a constant longitudinal axial flux. This study underscores how the interplay between boundary topography and pseudo-gauge selection fundamentally determines the conservation laws and macroscopic properties of finite, rotating subatomic systems.

Keywords: Thermal field theory, Boundary conditions, Rotation, Quark-gluon plasma.

TCP-O05

LSSM STUDY OF MIXED-SYMMETRY STATES IN ^{50,52,54,56,58}CR

Emanuela Boicu[1,2] and Nadia Tsoneva[2]

[1] *Faculty of Physics, University of Bucharest, 405 Atomiştilor, P.O. Box MG11, 077125 Bucharest-Măgurele, Romania*
[2] *Extreme Light Infrastructure-Nuclear Physics (ELI-NP)/Horia Hulubei National Institute for Physics and Nuclear Engineering (IFIN-HH), 077125 Bucharest-Magurele, Romania*

One interest of nuclear structure physics is to understand the mechanisms by which complex nuclear structures emerge from the interactions between protons and neutrons. A good probe is the study of nuclear states that are sensitive to proton-neutron degrees of freedom [1]. The asymmetry between protons and neutrons leads to the appearance of mixed symmetry (ms) states, first predicted theoretically by the IBM-2 model [2] and later discovered experimentally [3].

Theoretical investigations were carried out within the Large-Scale Shell Model (LSSM), with special attention given to 1+ and 2+ states in ^{50,52,54,56,58}Cr in search of evidence of ms states. For the 1^+ states the transitions studied were B(M1; $0_1^+ \rightarrow 1_i^+$), and the orbital and spin-flip contributions to the total reduced transition probabilities were calculated. For 2^+ states, both B(M1; $2_i^+ \rightarrow 2_1^+$) and B(E2; $2_i^+ \rightarrow 0_{g.s.}^+$) were calculated, as the first 2^+ms state is expected to show a weak transition to ground state and a strong transition to the first 2_1^+ state.

The fp model space was used with three different effective interactions, kb3g [4], gx1a [5], fpd6 [6]. To compare the theoretical results of B(M1) transition probability with the experimental data, an effective spin factor of $g_s^{eff} = 0.8$ was used.

A concentration of M1 strength with a strong orbital character was found at the 3 MeV energy range, supporting the existence of 1^+mixed-symmetry states in Chromium.

Keywords: Chromium, Large Scale Shell Model, Mixed symmetry states.

References:

[1] N. Pietralla, P. von Brentano, A.F.Lisetskiy, *Prog. Part. Nucl. Phys.* **60**, 225-282 (2008).
[2] A. Arima, F. Iachello, *Annals of Physics* **111**, 201-238 (1978).
[3] D. Bohle, A. Richter, W. Steffen, A.E.L. Dieperink, N. Lo Iudice, F. Palumbo, O. Scholten, *Phys. Lett. B* **137,** 27-31 (1984).
[4] A. Poves, J. Sanchez-Solano, E. Caurier, F. Nowacki, *Nucl Phys A* **694**, 157-198 (2001).
[5] M. Honma, T. Otsuka, B. A. Brown, T. Mizusaki, *Eur. Phys. J. A* **25**, 499-502 (2005).
[6] W. A. Richter, M.G. Van Der Merwe, R.E. Julies, B.A. Brown, *Nucl. Phys. A* **523**, 325-353 (1991).

TCP-O06

QUANTUM EFFECTS IN DENSE ATOMIC SYSTEMS VIA THERMAL RESERVOIR

Mihai A. Macovei

Institute of Applied Physics, Moldova State University, Chișinău, Moldova

Light-matter interactions have been always attracted a considerable attention because of various feasible applications. In this regard, here, we shall report our recent results obtained in a dense sample consisting from N two-level emitters mutually interacting via their environmental thermal reservoir. We demonstrated that this complex multi-atom system exhibits a variety of interesting effects for stronger dipole-dipole interactions among the involved two-level radiators. As a first result, we report that the established thermal equilibrium depends on the dipole-dipole coupling strengths - which is not the case for weaker inter-particle interactions. The second result is that the spontaneously scattered photons in these processes possesses quantum features, namely, the sub-Poissonian photon statistics [1].

The second part of the presentation focuses on the presence or absence of interconnections between the dipole-blockade effect and the spatial photon interference phenomena for a small sample of spatially arranged two-level emitters interacting through the thermostat [2]. Crucial differences occur between an extended or Dicke-like small atomic ensemble.

Keywords: Collective effects, Dicke model, Quantum features.

References:

[1] M. A. Macovei, Phys. Rev. A. **110**, 023712 (2024).
[2] A. Rotari, and M. A. Macovei, **arXiv:2602.18269** (2026).

TCP-O07

PRODUCTION RATE FOR POLARIZED DILEPTONS

Moulindu Kundu[1], Aritra Bandyopadhyay[2,1], Victor E Ambruș[1]

[1]*West University of Timișoara, Bd. Vasile Pârvan 4, Timișoara, Romania*
[2]*University of Wrocław, Pl. Maxa Borna 9, Wrocław, Poland*

Dileptons (lepton-antilepton pair) are considered to be an important observable, in the context of studying the characteristics of quark gluon plasma (QGP). Historically the Dilepton Production Rate (DPR) is expressed in terms of the thermal expectation value of the current-current correlator [1] or the imaginary part of the photon self-energy [2]. Evaluation of DPR involves contraction of two rank-2 tensors: the Photonic Tensor (PT) and the Leptonic Tensor (LT). To account explicitly for individual polarization states, we express the rate as a function of the local rest frame lepton and antilepton spin vector [3].

We find that lepton–antilepton pairs with opposite spin orientations are produced more abundantly than pairs with aligned spins. This asymmetry in the production rates becomes increasingly pronounced with increasing lepton mass. Even though our formalism defines the spin vector only for massive particles, we show that the massless limit for the rate can be taken smoothly.

Keywords: dilepton production rate, spin-polarization, quark gluon plasma.

References:

[1] D. McLerran and T. Toimela, *Phys. Rev. D* 31, 545 (1985).
[2] H. A. Weldon, *Phys. Rev. D* 42, 2384 (1990).
[3] C. Itzykson and J.-B. Zuber, Quantum Field Theory (McGraw-Hill, New York, 1980), Sec. 2-2-1.

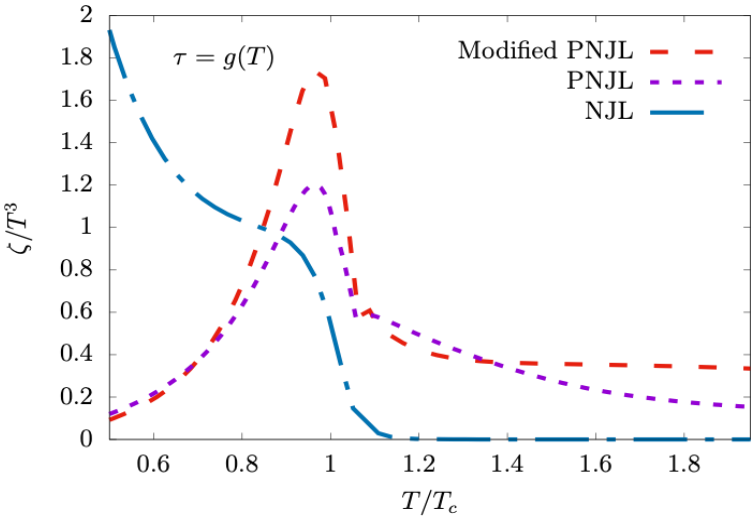
TCP-O08

EFFECTIVE QCD MODEL WITH CONSISTENT QUASI-GLUON TREATMENT

Pracheta Singha[1], Chowdhury Aminul Islam[2], Rajarshi Ray[3], Munshi G. Mustafa[4]

[1]*Department of physics, West university of Timisoara, Bd. Vasile Pârvan 4, Timişoara 300223, România*
[2]*Department of Physics, Aliah University, II-A/27, Action Area II, Newtown, Kolkata-700160, India*
[3]*Department of Physics, Bose Institute, 93/1, A. P. C Road, Kolkata - 700009, India*
[4]*Department of Physics, Murshidabad University, 11, Police Reserve Road, Berhampore 742101, India*

We propose a quasi-particle effective model framework that consistently describes QCD thermodynamics for a two flavor system. In this work we have coupled a quasi-gluon model with background Polyakov loop to the chiral effective model setup. In terms of quasiparticles this model incorporates dynamical properties for both quark and gluon degrees of freedom where confinement properties are realised through background Polyakov loop. Past efforts in this direction were hindered due to the unphysical behavior of the thermodynamic quantities below the deconfinement temperature, as reported in Ref.[1]. In this work we have pointed out that these physical inconsistencies are the artefacts of using the saddle point approximation. Employing an alternative approach proposed in Ref. [2] for yang-Mills description, we have obtained physically consistent results throughout the complete relevant temperature range. The main advantage of this effective model is that one can obtain the thermal quasi-gluon distribution with background Polyakov loop. This enables us to explicitly study the gluonic contribution to various interaction properties of the strongly interacting medium. As an illustrative example, in this work, we have discussed the transport coefficients of shear and bulk viscosity extracted within this model framework and compared it with the outcome from the usual 2 flavor NJL and PNJL model.



Keywords: quasi-particle model, QGP thermodynamics, transport coefficients.

References:

[1] C. Sasaki and K. Redlich, Phys. Rev. D86, 014007(2012), arXiv:1204.4330 [hep-ph].
[2] C. A. Islam, M. G. Mustafa, R. Ray, and P. Singha, Phys. Rev. D 106, 054002 (2022), arXiv:2109.13321[hep-ph].

TCP-O09

DERIVATION OF THE CFL STABILITY CONDITION IN QUASI-3D GEOMETRY

Rareș Iovănescu[1,2] and Cătălin M. Ticoș[1,2]

[1] *Doctoral School of Laser and Accelerator Engineering and Applications of the National University of Science and Technology Politehnica Bucharest, Bucharest, Romania*
[2]*Extreme Light Infrastructure–Nuclear Physics (ELI-NP), IFIN-HH, 30 Reactorului Street, 077125 Magurele, Romania*

We present an analytical derivation of the Courant–Friedrichs–Lewy (CFL) condition in quasi-3D geometry with azimuthal Fourier decomposition. A von Neumann stability analysis is performed for Maxwell's equations discretized in cylindrical coordinates, without using further approximations. The CFL condition is obtained by imposing the spectral radius of the time-update operator of the mapping of ($\mathbf{E}^n$, $\mathbf{B}^{n-1/2}$) to ($\mathbf{E}^{n+1}$, $\mathbf{B}^{n+1/2}$) to be less than or equal to one.

The condition must satisfy the most restrictive modes, which occur when $k_x\Delta x = \pi$ and $k_r\Delta r = \pi$, which is the boundary of the first Brillouin zone. Due to the complexity of the resulting expressions, which involve solving a cubic equation, we wrote a Python code that performs these calculations and provides the exact time step at the CFL limit by inserting the spatial grid steps and the azimuthal Fourier modes. We discuss in the end how this compares to other formulas, including the one used by the Smilei PIC code.

The CFL stability condition is widely used in laser-plasma modelling with PIC simulations and other time-stepping numerical algorithms.

Keywords: CFL, quasi-3D, cylindrical coordinates.

TCP-O10

MOMENT OF INERTIA OF A SELF-INTERACTING SCALAR FIELD

Aleksandar Gecic,[1] **Victor E. Ambruș**,[1] Kenji Fukushima[2]

[1]*Department of Physics, West University of Timișoara, Bd. Vasile Pârvan 4, Timișoara 300223, Romania*
[2]*Department of Physics, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan*

Since the measurement of persistent polarization of Lambda hyperons in non-central heavy-ion collisions [1], systems under rotation have become one of the workhorses to study quantum effects in macroscopic systems. Recently, lattice QCD results revealed that the quark-gluon plasma can exhibit a negative moment of inertia [2]. Effective model calculations performed in the mean-field limit fail to reproduce this behavior [3]. Recent work employing the Fock-Schwinger proper-time method reported a negative moment of inertia for a self-interacting scalar field [4]. In this work, we revisit this model using the traditional methods of finite-temperature perturbation theory. Our conclusion is that, up to $\lambda^{3/2}$, the moment of inertia density is simply equal to the enthalpy density multiplied by the square of the distance to the rotation axis, $I = (\varepsilon + P)\, r^2$.

Keywords: Thermal field theory, Self-interacting scalar field, Moment of inertia.

References:

[1] STAR, Nature **548** (2017) 62. DOI: 10.1038/nature23004,
[2] V. V. Braguta, M. N. Chernodub, I. E. Kudrov, A. A. Roenko, D. A. Sychev, Phys. Rev. D **110** (2024) 014511. DOI: 10.1103/PhysRevD.110.014511.
[3] P. Singha, S. Busuioc, V. E. Ambruș, M. N. Chernodub, Phys. Rev. D **112** (2025) 094031. DOI: 10.1103/knn8-sv3k.
[4] E. Siri, N. Sadooghi, Phys. Rev. D **110** (2024) 036016. DOI: 10.1103/PhysRevD.110.036016.

TCP-O11

SPATIAL PHOTON INTERFERENCE SCATTERED BY THREE ATOMS IN THERMAL FIELD

Arthur Rotari[1] and Mihai A. Macovei[1]

[1]*Institute of Applied Physics, Moldova State University, Academiei str. 5, Chisinau, Moldova*

We shall report our results on the steady-state quantum behaviors of three dipole–dipole coupled two-level emitters positioned at the vertices of an equilateral triangle and interacting with a thermal reservoir, see Figure (1). In this respect, we derived analytical results for the populations of the collective three-atom eigenstates, together with second- and third-order spatial photon correlation functions of the spontaneously scattered electromagnetic field. Our analysis shows that the system, when driven incoherently via the environment, generates single-photon emission streams characterized by sub-Poissonian photon statistics. Although this behavior can resemble dipole–dipole blockade physics in the regime of interatomic separations smaller than the emission wavelength, we demonstrate that its true origin is rooted in the interaction between the symmetrically arranged emitters and the surrounding thermal bath. In contrast, at larger separations, the observed effect is dominated by higher-order spatial interference phenomena [1].

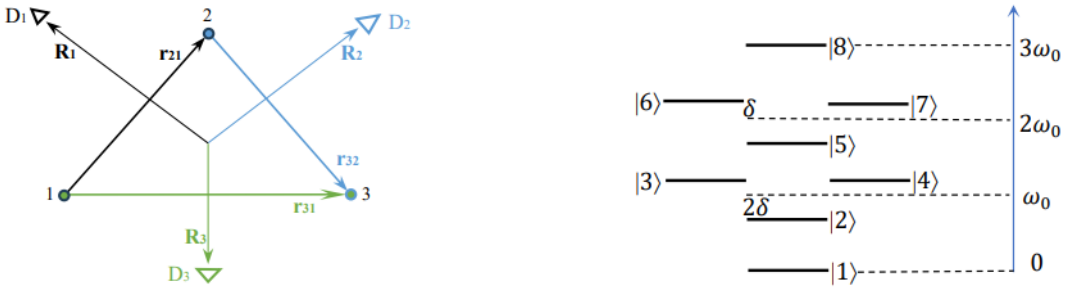


Figure 1: The geometric and Dicke's energy levels configurations.

Keywords: dipole-dipole interactions, two-level emitters, photon statistics.

References:

[1] A. Rotari, and M. A. Macovei, http://arxiv.org/abs/2602.18269 (submitted, 2026).

TCP-O12

ABOUT TWO-FIELD COSMOLOGICAL PERTURBATIONS

Dragoljub D. Dimitrijević[1], Goran Djordjević[1], Milan Milošević[1], Marko Stojanović[2]

[1]*Faculty of Sciences and Mathematics, University of Niš, Serbia*
[2]*Faculty of Medicine, University of Niš, Serbia*

We study cosmological perturbations of the two real scalar fields model. In the so-called non-canonical models the action contains a modified kinetic term of the form [1]

$$S = \frac{1}{2}\int d^4x\sqrt{-g}\left(M_{PL}^2 R - P(\Phi^I, X) - 2W(\Phi^I)\right) \quad (1)$$

where M_{PL}^2 is reduced Planck mass, $I = 1,2$, $W(\Phi^I)$ is two-field potential and $P(\Phi^I, X)$ is some function of the kinetic term X [2]

$$X = G_{IJ}(\Phi^I) g^{\mu\nu}\partial_\mu\Phi^I\partial_\nu\Phi^J, \quad (2)$$

where $G_{IJ}(\Phi^I)$ are components of a (two-dimensional) field space metric $\hat{G}$. When $G_{IJ}(\Phi^I) = \delta_{IJ}$ the model is called canonical, otherwise it is called non-canonical.

We start from one scalar field with the DBI-type Lagrangian, which is of non-canonical form [3]

$$L = -V(\Phi^1)\sqrt{1 + g^{\mu\nu}\partial_\mu\Phi^1\partial_\nu\Phi^1}, \quad (3)$$

and extend the model by introducing an auxiliary real scalar field Φ^2. The second field does not carry any dynamics, and the equation of motion for the first field will not change. Finally, we promote the second field to be dynamical, adding its kinetic term, bringing the model to the form (1).

Keywords: two-field model, cosmological perturbations.

References:

[1] D. Langlois and S. Renaux-Petel, *JCAP* **0804**, 017 (2008).
[2] C.M. Peterson and M. Tegmark, *Physical Review D*, **83(2)**:023522 (2011).
[3] D. Dimitrijevic, M. Dimitrijevic, G. Djordjevic, and M. Milosevic, *AIP Conference Proceedings* **2071**, 020008 (2019).

TCP-O13

DISSOCIATIVE RECOMBINATION AS AN EXOENERGETIC PATHWAY

Felix-Iosif Iacob[1]

[1]*West University of Timişoara, Bvd. Vasile Pârvan nr. 4*

Dissociative recombination (DR) is a fundamental plasma process in which a molecular cation captures an electron, forms a transient excited neutral state, and subsequently dissociates into neutral fragments.

The study discusses the broader implications of ion-mediated dissociation cycles for renewable-energy concepts and plasma-assisted chemistry. While the overall thermodynamic cycle remains constrained by irreversible losses and equilibrium requirements, dissociative recombination represents an efficient natural mechanism for transforming stored ionization energy into thermal and radiative outputs. These findings highlight the importance of DR in the Earth's ionosphere and suggest that solar-driven plasma chemistry may provide useful pathways for future atmospheric-energy and plasma-processing applications.

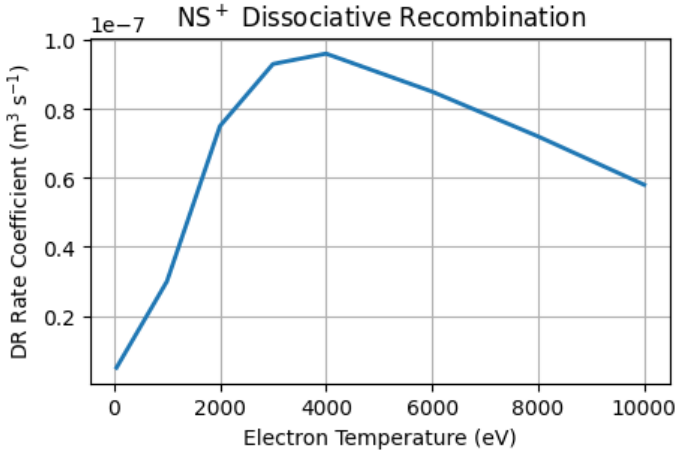


Figure 1: ***Dissociative rate coefficients with electron impact energy***

Keywords: Dissociative recombination, rate coefficients, energetic cicle.

References:

[1] Tennyson, J. (2010). Electron–molecule collision calculations using the R-matrix method. Physics Reports, 491(2–3), 29–76. https://doi.org/10.1016/j.physrep.2010.02.001

[2] Iacob, F., Meltzer, T., Mezei, J. Z., Schneider, I. F., & Tennyson, J. (2022). Study of bound and resonant states of NS molecule in the R-matrix approach. Journal of Physics B: Atomic, Molecular and Optical Physics, 55(23), 235201. doi.org

TCP-O14

Z0 BOSON PRODUCTION AND UNDERLYING-EVENT OBSERVABLES IN PROTON–PROTON COLLISIONS AT √s = 13 TeV

Roxana Mocanu[1,2], Alexandru Jipa[1], Florin Maciuc[2]

[1]*Faculty of Physics, University of Bucharest, Magurele, Romania*
[2]*Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH)*

This work presents a study of Z⁰-boson production and the associated underlying-event (UE) observables in proton–proton collisions at √s = 13 TeV. We use Monte Carlo generated event samples, and in some cases, we compare generator estimations to LHC and other actual measurements. Simulation samples are generated with PYTHIA 8.3 [1], Herwig 7.2 [2] and Sherpa 2.2.16 [3], using leading-order (LO) configurations and, alternatively, next-to-leading order (NLO) approaches obtained through the POWHEG method [4] for PYTHIA and Herwig and the MC@NLO [5] matching scheme for Sherpa.

The comparison of LO and NLO generator configurations is used to follow how the event description changes when higher-order approximation and matching is introduced. We compare the measurements of Z0 production observables or, alternatively, some of the UE-observables, with the corresponding generator estimates when the hardest QCD process in the proton-proton event is approximated at LO or NLO. Besides comparison to measurements, we also compare some observable-estimates between the three generators (at LO and NLO) to get a preliminary estimate of possible generator/theoretical uncertainty.

The study is carried out in fiducial regions corresponding to the LHCb (forward-rapidity) and CMS (central-rapidity) detector acceptances. UE activity is characterized by separating final-state charged particles into Toward, Transverse and Away regions with respect to the Z-boson direction, and by evaluating charged-particle multiplicity densities and scalar ΣpT densities per ΔηΔ(Δφ) as functions of pT(Z). Charged-hadron spectra, hadron-yield ratios, and Z⁰-boson kinematic distributions are also considered. The analysis and all distributions are displayed and analysed using a ROOT-based framework. Results are compared with published measurements from the LHCb and CMS collaborations [6,7], together with UE and hadron-ratio measurements available from HEPData and from LHCb, ALICE, CMS, ATLAS and STAR collaborations.

Keywords: event generators, Drell–Yan, Z boson, underlying event

References:

[1] C. Bierlich et al., A comprehensive guide to the physics and usage of PYTHIA 8.3, SciPost Phys. Codebases 8 (2022), arXiv:2203.11601 [hep-ph]
[2] J. Bellm et al., Herwig 7.2 release note, Eur. Phys. J. C 80 (2020) 452, arXiv:1912.06509 [hep-ph]
[3] E. Bothmann et al., Event generation with Sherpa 2.2, SciPost Phys. 7 (2019) 034, arXiv:1905.09127 [hep-ph]
[4] S. Frixione, B.R. Webber, Matching NLO QCD computations and parton shower simulations, JHEP 06 (2002), arXiv:hep-ph/0204244
[5] F. Höche, F. Krauss, M. Schönherr, F. Siegert, W+n-jet predictions with MC@NLO in Sherpa, Phys. Rev. Lett. 110 (2013), arXiv:1201.5882 [hep-ph]
[6] R. Aaij et al. (LHCb Collaboration), Precision measurement of forward Z boson production in proton-proton collisions at √s = 13 TeV, JHEP 07 (2022) 026, arXiv:2112.07458 [hep-ex]
[7] A. M. Sirunyan et al. (CMS Collaboration), Measurement of differential Z boson production cross sections in proton-proton collisions at √s = 13 TeV, JHEP 12 (2019) 061, arXiv:1909.04133 [hep-ex]

TCP-O15

CHIRAL SYMMETRY BREAKING AND INHOMOGENEOUS PHASES IN THERMAL ANTI-DE SITTER SPACETIME

Sergio Morales Tejera[1]

[1]*Department of Physics, West University of Timisoara, Bd. Vasile Parvan 4, Timisoara 300223, Romania*

We study the spontaneous breaking of chiral symmetry in an AdS spacetime at finite temperature using the quark-meson model. The condensate σ is typically inhomogeneous in AdS and is determined from the differential gap equation. We demonstrate that there are no free integration constants in the regular solutions to the differential equation and find that the solution to the boundary value problem is unique. We find that chiral symmetry is always broken close to the AdS boundary. We construct the phase diagram of the system as a function of the AdS curvature and temperature. These two parameters have opposing effects: temperature tends to restore chiral symmetry, whereas negative curvature favors its spontaneous breaking. We also consider how the phase diagram is modified when the Hawking-Page phase transition is taken into account.

Keywords: chiral symmetry breaking, anti-de sitter

TCP-O16

STRONGLY INTERACTING MATTER UNDER IMAGINARY ROTATION

Tudor Păturleanu[1,2], Victor Ambrus[1], Lehel Csillag[3,4]

[1]*Department of Physics, West University of Timisoara, Bd. Vasile Parvan 4, 300223 Timisoara, Romania*
[2]*Department of Physics, Institut Denis Poisson, CNRS UMR 7013, Universite de Tours, Universite d'Orleans, Parc de Grandmont, 37200 Tours, France*
[3]*Department of Physics, Babes,-Bolyai University, Kogalniceanu Street, 400084 Cluj-Napoca, Romania*
[4]*Department of Mathematics and Computer Science, Transilvania University of Brasov, 500091 Brasov, Romania*

Lattice QCD simulations that include real rotation encounter the sign problem, which can be circumvented by introducing an imaginary angular velocity. To enable direct comparison with such simulations, theoretical models must be formulated in the context of imaginary rotation. This motivates our current work, in which we study interacting quark matter within the linear sigma model subjected to an imaginary angular velocity, $\Omega = i\Omega_I$. We analyze the resulting thermodynamic properties and plot the corresponding phase diagram. Fractalization, the property of thermal expectation values to have a Thomae-like dependence [1], established for free, massless fermions in [2], also appears for interacting, massive fermions. The contribution that survives at large distances away from the rotation axis or at high temperatures, referred to as fractal, displays ninionic statistics [3]. This generalized statistics emerges for matter rotating with an imaginary rational frequency $\nu = \beta\Omega_I/2\pi = p/q$ and interpolates between fermionic and bosonic behavior, controlled by the parameter $k = p + q$, affecting the phase diagram, as in Figure 1. On the rotation axis, three regimes emerge depending on the rational frequency ν: a crossover region, a region exhibiting first-order transitions, and a regime where phase transitions disappear entirely.

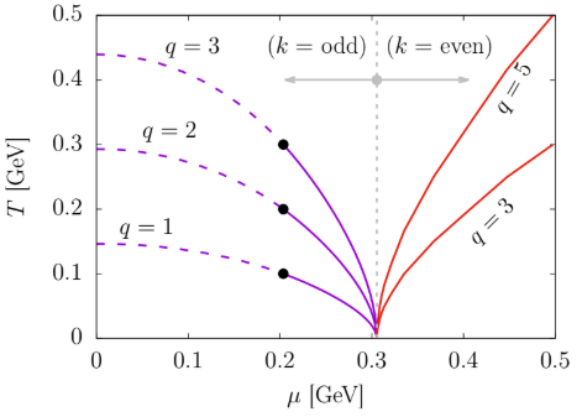


Figure 1: Phase diagram for matter under imaginary rotation, infinitely far away from the rotation axis

Keywords: linear sigma model with imaginary rotation, fractalization, massive Dirac fermions

References

[1] V. E. Ambrus, , M. Chernodub, Phys. Rev. D **108** (2023) 085016.
[2] T. Păturleanu et al., "Dirac fermions under imaginary rotation," Phys. Rev. D **111** (2025), 116004.
[3] M. N. Chernodub, arXiv:2210.05651 [quant-ph].

TCP-O17

GRAVITY MODEL WITH ADDITIONAL NONLOCAL TERM $(R-4\Lambda)\mathcal{F}(\Box)(R-4\Lambda)$

Jelena Stankovic[1]

[1]*Faculty of Education, University of Belgrade, Kraljice Natalije 43,11000 Belgrade, Serbia*

Although very successful, the general theory of relativity is not a complete theory of gravity and there are many attempts to modify it. One of very promising directions of research is nonlocal modified gravity. Nonlocal gravity models that have attracted much attention are given by action

$$S=\frac{1}{16\pi G}\int_M \sqrt{-g}\,\big(R-2\Lambda+P(R)\,\mathcal{F}(\Box)\,Q(R)\big)d^4x,$$

where M is a pseudo-Riemannian manifold of signature (1,3) with metric $g_{\mu\nu}$, Λ is the cosmological constant, P(R) and Q(R) are some differentiable functions of the Ricci scalar R, $\mathcal{F}(\Box)=\sum_{n=1}^{+\infty} f_n\,\Box^n$ and $\Box=\nabla_\mu\nabla^\mu=\frac{1}{\sqrt{-g}}\partial_\mu\big(\sqrt{-g}g^{\mu\nu}\,\partial_\nu\big)$ is the corresponding d'Alembert-Beltrami operator. We consider here the nonlocal model $(P(R)=Q(R)=R-4\Lambda)$ (see [1]) which is given by the following action:

$$S=\frac{1}{16\pi G}\int_M \sqrt{-g}\,(R-2\Lambda+(R-4\Lambda)\mathcal{F}(\Box)(R-4\Lambda))d^4x.$$

To solve the corresponding equations of motion, we first look for a solution of the eigenvalue problem $(R-4\Lambda)=q(R-4\Lambda)$. We found two exact cosmological solutions in flat space $a_1(t)=A\,t^{\frac{1}{2}}\,e^{\frac{\Lambda}{4}t^2}$ and $a_2(t)=Ae^{\Lambda t^2}$. The first solution mimics an interplay between dark energy and radiation. The second solution is a nonsingular bounce one and an even function of cosmic time. In this talk we also consider cosmological solutions with scale factors of the forms $a(t)=\left(\alpha e^{\lambda t}+\beta e^{-\lambda t}\right)^\gamma$ and $a(t)=(\alpha\cos\lambda t+\beta\sin\lambda t)^\gamma$ and find some solutions in nonflat space. Used nonlocal gravity dynamics can change background topology.

This talk is based on joint work with Ivan Dimitrijevic, Branko Dragovich, and Zoran Rakic.

Keywords: modified gravity, nonlocal gravity, cosmological solutions.

References:

[1] I. Dimitrijevic, B. Dragovich, Z. Rakic, J. Stankovic, Symmetry, 14, 3 (2022).

TCP-O18

NUMERICAL STUDY INTO THE INFLUENCE OF VISCOSITY, SEED DIAMETER AND SEED ROTATION ON THE MELT CONVECTION FOR BORATE CRYSTALS GROWN IN A CZOCHRALSKI FURNACE

Dragos Tatomirescu[1], Alexandra Popescu[1], Daniel Vizman[1]

[1]*Faculty of Physics and Mathematics, West University of Timisoara, 300223 Timisoara, Romania*

Recently, Yb^{3+}-doped ceramic laser materials have attracted an increasing amount of academic attention owing to their good thermal and mechanical properties [1,2]. Also, these materials have the potential to substitute Nd^{3+} based laser materials in commercial high-power continuous and mode-locking laser systems operating in the 1 μm range [3]. Furthermore, a new, cheap, reliable and safe growth process for the flux growth of RE_2O_3 (RE =Y,Lu) single crystals from borate solution with comparable laser properties has emerged, emphasising the need for their study [4].

In oder to determine a few of the lesser known physical material properties of the borate solutions involved in these flux growths, our numerical investigations are focused on studying their effects on the melt convection. For this purpose, 2D global numerical simulations were performed using ElmerFEM to determine the thermal field in the whole geometry. The temperature boundary conditions thus obtained were implemented in 3D simulations using the STHAMAS3D software. The computational domain used for the 3D simulations is shown in Figure 1. Three parameters that can have a significant influence on the melt convection (melt viscosity, crystal seed diameter and crystal seed rotation rate) were varied and their effects were studied.

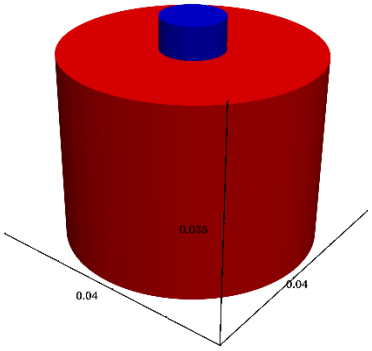


Figure 1: Schematic representation of the numerical domain used in the local 3D simulation (melt – red, crystal – blue)

Keywords: numerical modeling, heat transfer, thermal gradient.

References:

[1] M. Chaika et al., Opt. Mater. 101 (2020) 109774
[2] O. V. Palashov et al., Materials 14 (2021) 3944
[3] R. N. Maksimov et al., Phys. Status Solidi 217 (2020) 1900883
[4] P. Veber et al., CrystEngComm 13 (2011) 5220

Acknowledgment
This work is funded by European Commission within the framework of the National Recovery and Resilience Plan (PNRR) through the ESCARGOT project entitled “Enhanced Single Crystal Applications and Research in the Growth of new Optical rare earth-based compounds for sustainable and efficient Technologies” (n°: 760080/23.05.2023).

TCP-O19

ENVIRONMENTAL EFFECTS ON A DUBLE QUANTUM DOT PLACED ON A MECHANICAL RESONATOR

Arthur Rotari, Alexandr Cudreașov, Irina Cebotari, **Victor Ceban**,

Institute of Applied Physics, Moldova State University, Chișinău, Moldova

The quantum dynamics of an open quantum system made of a double quantum dot placed on a mechanical resonator has been investigated. The effect of thermal environment on the quantum system has been described by considering a phonon and a photon thermal reservoir. The phonon reservoir interacts with the mechanical resonator and has a damping and pumping effect on the resonator. The photon reservoir intraband interaction with the double quantum dot does not implicitly introduce any effects to its dynamics. However, when considering the electron tunnelling effect between the two sides of the quantum dot, we show that an incoherent pumping effect and a spontaneous emission effect occur as long as the electron is allowed to tunnel between the two sides of the double quantum dot. We present here the influence of the phonon and photon thermal environment on the quantum dynamics of the considered quantum system.

Keywords: double-quantum-dot, optomechanics, open quantum systems

TCP-O20

SPIN POLARIZATION DYNAMICS FOR LONGITUDINALLY EXPANDING FLUIDS

Matteo Buzzegoli, Alexander Gecic, **Rajeev Singh**

Department of Physics, West University of Timisoara, 300223, Timisoara, Romania

In heavy-ion collisions spin polarization measurements reveal information about properties of the quark-gluon plasma (QGP), such as its vorticity, shear flow, and temperature gradients. Current predictions assumes that spin degrees of freedom relax to equilibrium and reproduces reasonably well the experimental data. These predictions typically utilize 3+1D hydrodynamic simulations based on the Belinfante energy-momentum tensor and a vanishing spin tensor.

In this talk, I introduce an alternative approach where spin reach equilibrium after a finite time and after uses a symmetric energy-momentum tensor with an associated non-vanishing conserved spin tensor. In this framework, spin polarization is only governed by the spin potential, the space-time evolution of which can be described by perfect-fluid spin hydrodynamics. This method enables the study of spin polarization within 1+1D hydrodynamic flows, facilitating a deeper understanding of its experimental signatures.

By employing an analytical non-boost-invariant flow and physically motivated initial conditions for the spin potential, I present the solutions of ideal spin hydrodynamics and I investigate the transverse-momentum, azimuthal angle, and rapidity dependence of the mean spin polarization vector for Lambda hyperons in Au+Au collisions at 200 GeV. I compare the results with experimental observations and discuss how a quantitative agreement is obtained introducing a model for the transverse flow.

TCP-P01

DISSIPATIVE CAT-STATE STABILIZATION IN A KERR OSCILLATOR: PHASE DIAGRAMS AND DARK STATES

Gabriel Pascu[1]

[1]*Faculty of Physics and Mathematics, West University of Timişoara, 4 Vasile Pârvan Ave., 300223 Timişoara, Romania*

Dissipative cat-state stabilization in a single-mode Kerr oscillator is investigated through a numerical framework. Engineered dissipation is used as a resource for preparing and stabilizing nonclassical oscillator states, rather than being treated only as a source of decoherence. The work focuses on how Kerr nonlinearity, coherent driving, and dissipative channels shape the emergence of cat-like regimes and parity-related structure.

Numerical simulations are performed with the Lindblad master equation in a truncated Fock basis, using QuTiP. The resulting phase diagrams are used to qualitatively identify different regimes through complementary diagnostics. The approach is relevant for reservoir engineering, bosonic qubits, cat-code quantum error correction, and the pedagogical visualization of nonclassical states, with applications in quantum technologies.

Keywords: Kerr oscillator, dissipative cat states, reservoir engineering.

References:

[1] M. Mirrahimi, Z. Leghtas, V. V. Albert, S. Touzard, R. J. Schoelkopf, L. Jiang, M. H. Devoret, *New J. Phys.* **16**, 045014 (2014).
[2] Z. Leghtas, S. Touzard, I. M. Pop, A. Kou, B. Vlastakis, A. Petrenko, K. M. Sliwa, A. Narla, S. Shankar, M. J. Hatridge, M. Reagor, L. Frunzio, R. J. Schoelkopf, M. Mirrahimi, M. H. Devoret, *Science* **347**, 853-857 (2015).
[3] S. Puri, S. Boutin, A. Blais, *npj Quantum Inf.* **3**, 18 (2017).
[4] A. Grimm, N. E. Frattini, S. Puri, S. O. Mundhada, S. Touzard, M. Mirrahimi, S. M. Girvin, S. Shankar, M. H. Devoret, *Nature* **584**, 205-209 (2020).

TCP-P02

DENSITY FUNCTIONAL THEORY STUDY OF THE PHOTOCATALYTIC DEGRADATION OF PENICILLIN BY NANOCRYSTALLINE TiO_2

Corneliu I. Oprea[1], Robert M. Solomon[2], Mihai A. Gîrțu[1,*]

[1]*Faculty of Applied Sciences and Engineering, Ovidius University of Constanța, 900527 Constanța, Romania*
[2]*Faculty of Physics-Doctoral School, University of Bucharest, 077125 Bucharest, Romania*
[*]*Author to whom correspondence should be addressed.*

A promising route for removing antibiotics such as penicillin from wastewater is photocatalytic degradation under UV irradiation using TiO_2 nanoparticles. However, the microscopic mechanisms governing the initial degradation steps remain poorly understood. In particular, it is still unclear whether degradation preferentially occurs in solution or upon adsorption on the oxide surface, and which molecular sites are most vulnerable to attack in solution compared to those activated on the catalyst. In this work, we introduce a unified density functional theory approach that treats penicillin V (phenoxymethylpenicillin) consistently, both isolated in solution and adsorbed on an anatase TiO_2 nanocluster, enabling a direct comparison between solution-phase and surface-mediated degradation pathways. Within this framework, we analyze the adsorption configurations, energy-level alignment, charge-transfer pathways, UV-Vis absorption properties, local reactivity descriptors, and the initial steps leading to bond breaking. The results show that the direct photoexcitation of PenV followed by electron transfer to the oxide is less likely, due to the high energy of the pollutant's excited states. In contrast, degradation initiated by the transfer of photogenerated holes from the catalyst to the adsorbed antibiotic appears more probable, driven by the smaller energetic offset and by the hybridization between molecular and oxide states. Overall, adsorption on the oxide surface appears to be more conducive to degradation, with the carbon atom in the β-lactam ring consistently identified as a susceptible site for attack across different environments.

Keywords: photocatalytic degradation; antibiotic pollutants; titanium dioxide; nanoclusters; density functional theory.

TCP-P03

OPTIMIZATION OF THERMAL GRADIENTS AND STRESS IN KTB3F10 CRYSTAL GROWTH USING NUMERICAL MODELLING

Turc Alex-Florin[1], Dragoș Tatomirescu[1], Daniel Vizman[1]

[1]*Faculty of Physics and Mathematics, West University of Timișoara, 300223 Timișoara, Romania*

Materials with a crystalline structure are a core component for optical or optoelectronic devices. Among these materials, single crystals with a cubic structure attract special attention for optics and photonics [1]. For lasers operating in ultraviolet and infrared spectral regions, a magneto-optical material, such as KTb_3F_{10} (KTF), is desired due to the properties it exhibits high optical homogeneity, reduced thermal lensing, a wide transmittance range and weak thermally induced depolarization effect [2]. Optimization of crystal growth process is a key issue in order to control the quality of the KTF crystals.

By utilizing the open-source software ElmerFEM [3], which was developed by CSC in collaboration with Finnish universities, we modeled the thermal distribution, gradients and stress that a KTF crystal would experience in a Bridgman installation containing four different heaters. In order to achieve high-purity KTF crystals, we need a region with a small temperature gradient where the crystal cools down and enters its annealing stages [1]. The goal of our paper was to compute the required heater power on each of the four different heating zones, starting from an experimental thermal profile, in order to reach an optimal temperature gradient for the growth of high-purity crystals.

Keywords: KTb_3F_{10} crystal, numerical modelling, Bridgman installation, crystal growth

References:

[1] D. N. Karimov, I. I. Buchinskaya, N. A. Arkharova, A. G. Ivanova, A. G. Savelyev, N. I. Sorokin, P. A. Popov, Crystals 11, 285 (2021).

[2] Z. Zhang, Z. Wu, Z. Zhang, L. Su, A. Wu, Y. Li, J. Lan, Magnetochemistry 9, 41 (2023).

[3] M. Malinen, P. Råback, in Multiscale Modelling Methods for Applications in Material Science, pp. 101-113 (2013).

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

TCP-P04

TWO DIPOLE-DIPOLE INTERACTING EMITTERS IN A MODERATELY STRONG LASER FIELD

A. S. Cudreasov [1] and M. A. Macovei [1]

[1] *Institutul de Fizică Aplicată, Unviersitatea de Stat din Moldova, Academiei 5, MD-2028 Chișinău, Moldova*

The resonance fluorescence features of an ensemble of two closely packed and moderately laser-driven two-level emitters under non-resonant conditions are investigated. The regime of choice is the Dicke limit, when the distance between any two-level emitters is smaller than their emission wavelength, such that the dipole-dipole interactions are not negligible anymore. Under the secular approximation, the collective resonance fluorescence spectrum consists of 5 spectral lines, of which 4 are sidebands symmetrically located around the generalized Rabi frequency with respect to the central peak line, and are distinguishable if the dipole-dipole coupling strength is larger than the collective spontaneous decay rate [1]. Thus, it becomes possible for the emitter number within the ensemble to be measured from the spontaneously scattered collective resonance fluorescence spectrum.

Keywords: two-level emitters, cooperative resonance fluorescence, Dicke limit, dressed states, dipole-dipole interaction, detuning, generalized Rabi frequency, master equation, secular approximation, Mollow spectrum.

References:

[1] A. S. Cudreasov, P. Bardetski, and M. A. Macovei, "Two Dipole-Dipole Interacting Emitters in a Moderately Strong Laser Field," in 7th International Conference on Nanotechnologies and Biomedical Engineering, ICNBME 2025, IFMBE Proceedings, vol. 134, edited by V. Sontea, I. Tiginyanu, and S. Railean, Springer, Cham, pp. 49–55 (2025). doi:10.1007/978-3-032-06494-3_6

CONDENSED MATTER PHYSICS (CMP)

CMP-O01

CRYSTAL GROWTH AND CHARACTERIZATION OF KTB_3F_{10} SINGLE CRYSTAL

Maximilian Mangra[1], Kesavan Venkatachalam[1], Grégory Gadret[2], Maria Poienar[3], Gabriel Buse[3], Marius Ștef[1], Daniel Vizman[1], Carla Schornig[1], Daniel Rytz[4], Maximilian Șipoș[1], Philippe Veber[1,3]

[1]*Faculty of Physics, Crystal growth laboratory, West University of Timisoara (Romania)*
[2]*Laboratoire Interdisciplinaire Carnot de Bourgogne (ICB), DIJON Cedex – France*
[3]*Institute for Advanced Environmental Research (ICAM), West University of Timisoara (Romania)*
[4]*BREVALOR Sàrl, 1669 Les Sciernes, Switzerland*

Magneto-optical materials are essential components in optical isolators based on the Faraday effect, and they play a critical role in high-power solid-state laser systems. In particular, terbium-based single crystals offer several advantages, including a wide optical transparency range, low absorption, and high thermal stability. They also operate effectively across the ultraviolet (UV), visible (VIS), and near-infrared (NIR) spectral regions.

Among these materials, KTF (KTb_3F_{10}) crystals are especially attractive because they exhibit low nonlinear refractive indices and small thermo-optic coefficients, while still providing Verdet constants comparable to those of TGG—the most widely used magneto-optic crystal in industry. However, unlike TGG, KTF melts incongruently, making its crystal growth significantly more challenging.

This presentation covers the growth of KTb_3F_{10} single crystals using the Bridgman method, along with their structural characterization by XRD and Laue techniques, their spectroscopic properties, and the measured Verdet constants.

Keywords: KTF, magneto-optic, single crystal

References:

*[1]. Kesavan Venkatachalam, Philippe Veber *, Gabriel Buse, Maximilian Mangra, Daniel Vizman, Matias Velazquez (2026). *SINGLE CRYSTALS FOR MAGNETO-OPTICAL APPLICATIONS IN UV-VIS-NIR*, pp. 82-94. https://doi.org/10.26524/royal.305.4*

[2]. W. Schlichting, K. Stevens, G. Foundos, A. Payne, Commercializing potassium terbium fluoride, KTF (KTb3F10) faraday crystals for high laser power optical isolator applications, Proc. SPIE 10448 [Optifab 2017] 104481N

CMP-P01

DISLOCATIONS IN Tm AND Yb DOUBLE-DOPED CaF_2 CRYSTALS

Francisc Bader[1], Carla Schornig[1], Gabriel Buse[2], Marius Stef[1]

[1]West University of Timisoara, Faculty of Physics and Mathematics, Crystal Growth Laboratory, Timișoara, Romania
[2]West University of Timisoara, Institute for Advanced Environmental Research, Timișoara, Romania

Rare earth doped fluoride crystals are materials with great potential in the field of lasers and photonics due to their characteristic emission bands in the UV, visible and near-infrared spectral regions [1,2]. Crystalline imperfections can influence the optical and laser performance; thus, the study of dislocations is important because the dislocation density is a measure of the crystal quality [3,4].

Several concentrations of Tm and Tb double-doped CaF_2 crystals have been grown using the conventional Bridgman method. The colourless and transparent crystals were obtained in graphite crucibles under vacuum (~10^{-1} Pa) using a shaped graphite furnace [1,2].

In this work we investigate the etch pit morphology and the dislocation density of CaF_2 crystals double-doped with various concentrations of TmF_3 and TbF_3 using the chemical etching method [5]. The method consists of immersing a cleaved sample in 4N HCl at 60°C for 5 minutes. Small etch pits are developed at the emergence points of the dislocations. The etch pits have pyramidal/triangular shapes. The dislocation density depends on the rare earth concentration.

Keywords: Calcium fluoride crystals, Defects, Rare earths, Thulium, Terbium.

References:

[1] C. Schornig, M. Stef, G. Buse, M. Poienar, P. Veber, D. Vizman, *Spectroscopic Properties of TmF_3-Doped CaF_2 Crystals*, Materials **17**, 4965 (2024).
[2] I. Bodea, M. Stef, C. Schornig, G. Buse, P. Veber, D. Vizman, *Spectroscopic Properties of Tb^{3+} Ions in TbF_3-Doped CaF_2 Crystals*, Materials **19**, 801 (2026).
[3] I. Nicoara, M. Stef, A. Pruna, *Growth of YbF_3-doped CaF_2 crystals and characterization of Yb^{3+}/Yb^{2+} conversion*, J. Crystal Growth **310**, 1470–1475 (2008).
[4] I. Nicoara, M. Stef, *Growth and Characterization of Doped CaF_2 Crystals*, in Modern Aspects of Bulk Crystal and Thin Film Preparation, chapter 4, pp. 71–96 (2012).
[5] S. Amelinckx, *The direct observation of dislocations*, Academic Press, N.Y., (1964).

CMP-P02

X-RAY RADIATION EFFECTS ON THULIUM-DOPED CAF_2 AND BAF_2 SINGLE CRYSTALS

Gabriel Buşe[1], Maria Poienar[1], Marius Stef[2], Carla Zeicu[2], Philippe Veber[1,2], Mathieu Duttine[3], Daniel Vizman[2]

[1] *West University of Timisoara, Institute for Advanced Environmental Research, Timişoara, Romania*
[2] *West University of Timisoara, Faculty of Physics, Crystal Growth Laboratory, Timişoara, Romania*
[3] *University of Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, F-33600 Pessac, France*

Thulium-doped alkaline-earth fluorides are prominent candidates for laser, dosimetry and optoelectronic applications due to their low phonon energies and broad transparency [1-2]. In this study, CaF_2 and BaF_2 crystals with varying TmF_3 concentrations were grown via the vertical Bridgman-Stockbarger method [3]. Room-temperature X-ray irradiation was employed to investigate charge conversion processes from Tm^{3+} to Tm^{2+}. Samples of CaF_2: x mol% TmF_3 (x=0,1, 1 and 5) and BaF_2: x mol% TmF_3 (x=0,5, 1 and 5) single crystal were studied before and following 1h, 2h, 3h and 4h of X-Ray irradiation [4]. Non-irradiated CaF_2 display existing Tm^{2+} features, while BaF_2 initially exhibited only Tm^{3+} signatures. Post-irradiation analysis revealed a significant enhancement of Tm^{2+} absorption bands in both hosts, confirming an efficient Tm^{2+} to Tm^{3+} reduction process. Luminescence spectroscopy analysis further elucidates the impact of ionizing radiation [4]. Influence of dopant concentration on the room absorption and emission spectra was also investigated. These findings provide important insights into the radiation-matter interactions of thulium-doped fluorides for their use in advanced radiation detection systems or for solid state based materials.

Keywords: X-Ray irradiation, optical absorption, charge conversion, fluorides.

References:

[1] Kaminskii, A. A., 1996. Crystalline Lasers: Physical Processes and Operating Schemes (CRC Press). https://doi.org/10.1201/ 9781003067962.
[2] Hahn, D., 2014. Calcium fluoride and barium fluoride crystals in optics. Opt. Photonik 9, 45–8. https://doi.org/10.1002/opph.201400066.
[3] Nicoara, D., Nicoara, I., 1988. An improved Bridgman-Stockbarger crystal-grown system. Mater. Sci. Eng. A 102, L1–L5. https://doi.org/10.1016/0025-5416(88)90584-8.
[4] Gabriel Buse et al, submitted to publication in Radiation Physics and Chemistry, No. RPC-S-26-01292.

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

CMP-P03

GREEN SYNTHESIS OF GRAPHENE QDS FOR LATERAL FLOW ASSAY

C. Mihailescu[1,2], I. Mihalache[1], O. Brincoveanu[1], V. Tucureanu[1], A. T. Stiolica[3]

[1]National Institute for Research and Development in Microtechnologies, IMT-Bucharest, Romania
[2]Doctoral School, University of Medicine and Pharmacy, Craiova, Romania
[3]Department of Pharmaceutical Marketing and Management, University of Medicine and Pharmacy, Craiova, Romania

This study presents the properties of graphene quantum dots designed for the rapid testing of cardiac biomarkers[1]. The synthesis was carried out using green tea extract as a sustainable and eco-friendly precursor for the synthesis of graphene QDs via hydrothermal route, without the need for toxic reducing and capping agents, passivizing chemicals or harmful organic solvents.

The rich content of bioactive compounds naturally present in green tea, including polyphenol, catechins, carbohydrates and other organic compounds contribute significantly to the carbon precursor pool while also acting as stabilizing and surface-passivizing agents during the formation of GQDs[2].

The synthesized graphene QDs were purified and characterized through structural, compositional, and optical analyses. TEM investigations confirmed the formation of nanoscale carbon-based structures, while fluorescence measurements revealed strong emission properties suitable for optical detection applications. Preliminary compositional investigations also highlighted the presence of bioactive polyphenolic compounds associated with the synthesized nanostructures. Further compositional analyses are being performed to evaluate the contribution of carbohydrate-derived species to the carbonization process.

In order to evaluate their applicability in biosensing systems, preliminary liquid-phase sandwich immunoreaction assays targeting troponin complexes were performed, demonstrating the feasibility of using plant-derived GQDs as fluorescent labels for future LFIA platform development[3].

Keywords: quantum dots, green synthesis, carbohydrates.

References:

[1] A. C. Mirica, D. Stan, I. C. Chelcea, C. M. Mihailescu, A. Ofiteru and L. A. Bocancia-Mateescu, Front. Bioeng. Biotechnol. 10, 922772 (2022).
[2] H. Opoku, J. Ren, X. Zhou, P. Zhang, S. Tang, D. Dang, L. Edman, and J. Wang, Nano Research 18, 4 (2025).
[3] P. Dubey, RSC Advances 15, 46079–46151 (2025).

Acknowledgements: This work was supported by the Ministry of Education and Research under project number PN-IV-P2-2.1-TE-2023-1953.

CMP-P04

SIMULTANEOUS RECOVERY OF NUTRIENTS AND HYDROGEN VIA ELECTROCONCENTRATION

Anil Dhanda[1], Lakshmi Pathi Thulluru[2], Shamik Chowdhury[3], Makarand M. Ghangrekar[1], Corina Macarie[1], Ionel Balcu[1], Doru Buzatu[1], Narcis Duteanu[1], Paula Sfirloaga[1]

[1]National Institute for Research and Development in Electrochemistry and Condensed Matter, Dr. A.P. Podeanu street, No. 144, 300569, Timisoara, Romania
[2]School of Environmental Science and Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India
[3]School of Water Resources, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India

As the global shift toward circular economy accelerates, recovering nutrients and energy from waste streams has become increasingly critical. Worldwide population growth, which is projected to reach 10 billion by 2064, is driving unprecedented demand for sustainable nutrient management solutions 1. Conventional fertilizer production relies on energy-intensive ammonia synthesis and finite phosphate rock reserves, which faces significant environmental and geopolitical challenges 2. This investigation explores electroconcentration (EC) as a strategy for recovering multiple nutrients and hydrogen (H_2) from hydrolyzed urine under continuous operation. The system achieved high removal and recovery efficiencies for key ions: 79.87% for NH_4^+, 75–88% for Na^+, K^+, and Cl^-, and over 50% for PO_4^{3-} and SO_4^{2-}, with up-concentration factors ranging from 3.3 to 5.4. A peak NH_4^+-N concentration of 24.6 g/L was obtained in the concentrate. Simultaneously, H_2 was recovered at 5.40 m3/m3·d, offering an energy offset of 4.42 kWh/kg N recovered. The system maintained stable performance over 168 h of continuous operation. These results highlight EC as a viable platform for integrated nutrient and energy recovery, offering strong potential for decentralized wastewater treatment and circular resource management.

Keywords: Electroconcentration; Hydrogen recovery; Ion transport; Nutrients recovery; Novel membrane process; Urine valorization.

References:
[1] S. E. Vollset, et al., The Lancet 396, 1285–1306 (2020).
[2] C. X. Chen, et al., Science of The Total Environment 946, 174174 (2024).

Acknowledgements: This work was supported by the CF 39/28.07.2023, PNRR-III-C9-2023 I8: „Selective resource recovery from kitchen waste by integrated Dark Fermentation-Microbial electrolysis cell and ion substitution electrodialysis" project.

CMP-P05

JUDD-OFELT ANALYSIS OF TB^{3+} IONS DOPED IN CAF_2 CRYSTALS

Marius Stef[1], Irinuca Bodea[1], Carla Schornig[1], Gabriel Buse[2], Philippe Veber[1,2], Maria Poienar[2], Daniel Vizman[1]

[1] *West University of Timisoara, Faculty of Physics, Crystal Growth Laboratory, Timişoara, Romania*
[2] *West University of Timisoara, Institute for Advanced Environmental Research, Timişoara, Romania*

Rare-earth-doped fluoride crystals represent a class of advanced photonic materials due to their low phonon energy and high radiative efficiency. In this work, we report a comprehensive spectroscopic investigation of Tb^{3+} ions in CaF_2 single crystals doped with 1, 5 and 10 mol% TbF_3, grown by the vertical Bridgman technique. The study combines optical absorption, Judd–Ofelt (J–O) analysis, steady-state and time-resolved photoluminescence, quantum efficiency evaluation, and emission cross-section calculations in order to elucidate the concentration-dependent optical behavior [1,2].

The absorption spectra exhibit well-defined 4*f*–4*f* transitions characteristic of Tb^{3+} ions, with intensities increasing proportionally with dopant concentration, confirming homogeneous incorporation in the fluorite lattice. The J–O analysis yields intensity parameters (Ω_2, Ω_4, Ω_6) typical for fluoride hosts, indicating a predominantly ionic environment and enabling reliable determination of radiative transition probabilities and lifetimes. The emission spectra are dominated by the intense green transition $^5D_4 \rightarrow {}^7F_5$, while the absence of $^5D_3$ emission is attributed to efficient cross-relaxation processes that funnel excitation energy toward the $^5D_4$ level.

Time-resolved measurements reveal millisecond-scale lifetimes (~4.4–6.7 ms), consistent with the low multiphonon relaxation rates in CaF_2. The internal quantum efficiency increases significantly with Tb^{3+} concentration, from 31.4% (1 mol%) to ~74% (10 mol%), without evidence of strong concentration quenching. Chromaticity analysis confirms stable green emission across all samples. Furthermore, emission cross-section and gain calculations indicate enhanced optical amplification potential, with the highest gain observed for the orange transition at high doping levels [2]

These results demonstrate that CaF_2:Tb^{3+} single crystals combine high quantum efficiency, long lifetimes, and stable emission characteristics, making them promising candidates for visible photonic applications, including solid-state lighting and laser-related devices.

Keywords: Fluoride single crystals, Terbium doping, Bridgman technique.

References:
[1] I. Bodea *et al.*, Materials (Basel). **19**, 801 (2026)
[2] M. Stef *et al.*, Opt. Mater. (Amst). **169**, 117689 (2026)

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

CMP-P06

EFFECT OF RAPID THERMAL PROCESSING ON SURFACE WETTABILITY OF VERTICAL GRAPHENE NANOSHEETS

Alina Matei, Octavian-Gabriel Simionescu, Cristina Pachiu,
Oana Brîncoveanu, Vasilica Țucureanu

National Institute for Research and Development in Microtehnologies (IMT-Bucharest),
Erou Iancu Nicolae Street, 126A, 077190, Bucharest, Romania

Vertical graphene nanosheets (VGN) are three-dimensional (3D) nanoscale structures composed of thin sheets oriented perpendicular to the substrate. Due to the fundamental properties of graphene-based materials, such as high thermal and electrical conductivity, chemical stability, large specific area, and high carrier mobility at room temperature, vertically aligned (VG) graphene structures have found applications in a variety of fields. However, due to their limited wettability and poor interaction with electrolytes, the intrinsic hydrophobicity of VG films limits their applicability in the development of electrochemical or biomedical devices. Generally, the modification of vertical graphene is achieved through chemical functionalization and plasma treatments to optimize its surface, chemical, and electronic properties. In this context, the present study aims to use rapid thermal annealing (RTA) to modify the wetting properties of graphene grown via plasma-enhanced chemical vapor deposition (PECVD) on a SiO_2/Si substrate. The possibility of improving surface properties by removing defects and free radicals, as well as modifying the wettability of graphene was investigated, by applying RTA treatment at 400 °C for 180 sec. in an inert gas atmosphere. Fourier transform infrared (FTIR) and Raman spectroscopy were used to analyze the samples before and after RTA treatment to obtain additional information regarding the presence of defects and surface functional groups, the degree of order/disorder, and the sp^2/sp^3 hybridization ratio. The morphology of vertical graphene was investigated using SEM microscopy, allowing for detailed observation of the orientation and arrangement of the graphene sheets. The hydrophobic or hydrophilic nature of vertical graphene was assessed by measuring the contact angle of a water droplet to determine its surface wettability. The results suggest that RTA treatment is effective for modifying the graphene surface under relatively moderate thermal conditions.

Keywords: rapid thermal annealing, RTA, vertical graphene sheets, hydrophilic character.

References:

[1] J. Prekodravac, Z. Markovic, S. Jovanovic, M. Budimir, D. Peruško, I. Holclajtner-Antunovic, V. Pavlovic, Z. Syrgiannis, A. Bonasera, B. Todorovic-Markovic, *Synthetic Metals*, **209**, 461–467 (2015)

Acknowledgments:
This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-0417 (BioYDetect Contract no. 30TE/2025), within PNCDI IV. Also, this work was supported by the Core Program within the National Research Development and Innovation Plan 2022–2027, carried out with the support of MCID, project No. 2307 (μNanoEl).

CMP-P07

STRUCTURAL PROPERTIES OF RARE EARTH (TM/YB) CO-DOPED CAF_2 AND BAF_2 FLUORIDE SINGLE CRYSTALS

Marian Petrică Bertici[1], Maria Poienar[2], Gabriel Buşe[2], Marius Ştef[1], Carla Zeicu[1], Philippe Veber[1,2], Daniel Vizman[1,2]

[1] *Physics Faculty, West University of Timişoara, Bvd. Vasile Pârvan, No.4, Timişoara, România*
[2] *ICAM, West University of Timişoara, Bvd. Vasile Pârvan, No.4, Timişoara, România*

In recent years, rare-earth (RE) ions doped fluoride MF_2 materials, with M = Ca or Ba, have attracted strong interest for applications such as optical windows, lenses, laser host materials or scintillators [1,2] owing to their low phonon energy, broadband transmission and large bandgap energies. These MF_2 fluoride matrices crystallize in a cubic structure within the Fm-3m space group, where each M^{2+} cation is surrounded by eight F^- ions [3]. When RE ions replace M^{2+} sites, charge neutrality is maintained by interstitial fluorine ions (F^-_i), leading to isolated centers of tetragonal (C_{4v}), trigonal (C_{3v}) or cubic (O_h) site symmetry at low dopant concentrations, and more complex defect clusters at higher concentrations [4,5]. The significant difference in host cationic radii between Ca^{2+} (r = 1.14 Å) and Ba^{2+} (r = 1.49 Å) produces distinct lattice responses upon doping, directly influencing the unit cell parameter and the local symmetry of the incorporated RE ions.

In this study, CaF_2 and BaF_2 single crystals co-doped with 0.1 mol% TmF_3 and three YbF_3 concentrations (0.05, 0.1 and 1 mol%) were grown by the vertical Bridgman-Stockbarger technique in spectral-pure graphite crucibles under vacuum, with a pulling rate of 4 mm/h [6]. The crystalline structure of all samples was investigated by X-ray powder diffraction, confirming the single-phase cubic Fm-3m structure for all compositions. The calculated lattice parameters were found to vary systematically with the Yb concentration in both host matrices, reflecting the incorporation of RE ions and the associated interstitial F^-_i compensators into the crystal lattice. The structural results are correlated with room temperature absorption spectroscopy measurements in order to establish relationships between the lattice modifications induced by co-doping and the optical properties of the Tm/Yb co-doped CaF_2 and BaF_2 crystals.

Keywords: Rare-Earth co-doping; X-ray diffraction; lattice parameter; site symmetry.

References:

[1] D. Hahn, *Opt. Photonik* **9**, 45–48 (2014).
[2] G. Buse, E. Preda, M. Stef, I. Nicoara, *Phys. Scr.* **83**, 025604 (2011).
[3] W.P. Davey, *Phys. Rev.* **19**, 248 (1922).
[4] R.A. Catlow, *J. Phys. C Solid State Phys.* **9**, 1845–1856 (1976).
[5] J.-P.R. Wells, T. Dean, R.J. Reeves, *J. Lumin.* **96**, 239–248 (2002).
[6] I. Nicoara, M. Stef, G. Buse, A. Racu, *J. Cryst. Growth* **547**, 125817 (2020).

Acknowledgement: The authors acknowledge the PN-IV-P6-6.1-CoEx-2024-0154 project, "Centrul de Cercetare de Excelență pentru o Eficiență Înaltă în Utilizarea Energiei".

CMP-P08

DOWNSHIFTING AND UP-CONVERSION LUMINESCENCE IN RE-DOPED TELLURITE OXYCHLORIDE GLASSES

Petr Kostka[1,2], Roman Yatskiv[3], Petr Vařák[3,4], David Le Coq[5], Lousiane Verger[5], Ondrej Bošák[6], Olga Procházková[2], Jiří Zavadil[2]

[1]*Laboratory of Inorganic Materials, Institute of Rock Structure and Mechanics, Czech Academy of Sciences, V Holešovičkách 41, 182 09 Prague 8, Czech Republic*
[2]*Laboratory of Inorganic Materials, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic*
[3]*Institute of Photonics and Electronics, Czech Academy of Sciences, Chaberská 57, 182 00 Prague 8, Czech Republic*
[4]*Department of Inorganic Chemistry, University of Chemistry and Technology Prague, Technická 5, 166 28 Prague 6, Czech Republic*
[5]*Institut des Sciences Chimiques de Rennes, Université de Rennes, Campus de Beaulieu, 350 42 Rennes Cedex, France*
[6]*Faculty of Materials Science and Technology, Slovak University of Technology, Jána Bottu 25, 917 24 Trnava, Slovakia*

Photoluminescence properties of TeO_2-based oxychloride glasses containing Pb and Bi, doped with Er^{3+}, Er^{3+}/Yb^{3+}, and Ho^{3+} ions, are investigated. The RE-doped samples show characteristic downshifting luminescence from 4f–4f transitions; up-conversion emission was detected in Er^{3+}- and Er^{3+}/Yb^{3+}-doped samples. Photoluminescence intensities vary systematically with dopant concentration across all compositions. The Er^{3+}-doped glasses exhibit green and red emission and a dominant band at 1530 nm, with weaker near-infrared (NIR) transitions. Co-doping with Yb^{3+} enables $Yb^{3+}\rightarrow Er^{3+}$ energy transfer, substantially enhancing both downshifting and up-conversion luminescence. The Ho^{3+}-doped samples show green and NIR emission from Ho^{3+} transitions. Excited-state lifetime measurements provide complementary insight into radiative and non-radiative relaxation pathways. The results indicate that RE-doped $PbCl_2$–$BiO_{3/2}$–TeO_2 glasses are promising for visible and NIR photonic applications, with downshifting and up-conversion emissions suitable for optical temperature sensing and related optical technologies.

Keywords: Tellurite glasses, Rare-earth doping, Photoluminescence, Up-conversion emission, temperature sensing.

Acknowledgement:
The work was supported by the Czech Science Foundation (project 25-15635S).

CMP-P09

THERMALLY-ACTIVATED RECONVERSION IN RARE EARTH-DOPED FLUORIDE SINGLE CRYSTALS

Maria Poienar[1], Gabriel Buşe[1], Marius Stef[2], Carla Zeicu[2], Philippe Veber[1,2], Daniel Vizman[2]

[1] *West University of Timisoara, Institute for Advanced Environmental Research, Timişoara, Romania*
[2] *West University of Timisoara, Faculty of Physics, Crystal Growth Laboratory, Timişoara, Romania*

Fluoride hosts doped with Rare-Earth (RE) ions present interesting properties for different applications, especially for optical devices [1]. Moreover, in order to study the potential application of these materials in radiation detection, pure and TmF_3-doped calcium and barium fluoride crystals with various dopant concentrations were grown using the vertical Bridgman-Stockbarger method and irradiated at Room Temperature (RT) under continuous X-Ray flux for up to 4 h [2]. The optical measurements on these crystals indicate that the X-Ray irradiation induces the enhancement of Tm^{2+} absorption bands. Thermal annealing in the 100-600°C range was further employed to investigate the mechanisms involved in Tm^{2+} to Tm^{3+} reconversion.

The optical spectroscopy measurements show that a progressive oxidation of Tm^{2+} back to Tm^{3+} is observed with increasing annealing temperature, accompanied by the disappearance of radiation-induced coloration and the recovery of the initial optical transparency. Complete reconversion occurs at approximately 600 °C for CaF_2 and around 300 °C for BaF_2, confirming that the thermal stability of the divalent state is host-dependent. This study provides more details about the radiation-enhanced Tm^{2+} formation and its thermally activated reconversion in alkaline-earth fluoride hosts and contribute to a deeper understanding of radiation–matter interactions in rare-earth-doped fluorides.

Keywords: X-Ray irradiation, annealing, fluorides, charge conversion.

References:
[1] Kaminskii, A. A., 1996. Crystalline Lasers: Physical Processes and Operating Schemes (CRC Press). https://doi.org/10.1201/ 9781003067962.
[2] Gabriel Buse et al, submitted to publication in Radiation Physics and Chemistry, No. RPC-S-26-01292.

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

CMP-P10

EMISSION BEHAVIOR OF TMF_3 - DOPED CAF_2 CRYSTALS

Carla Schornig[1] , Marius Stef[1], Gabriel Buse[2], Philippe Veber[1,2], Maria Poienar[2], Daniel Vizman[1]

[1]*West University of Timisoara, Faculty of Physics, Crystal Growth Laboratory, Timişoara, Romania*
[2] *West University of Timisoara, Institute for Advanced Environmental Research, Timişoara, Romania*
[3]*Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, Villeurbanne, France*
[4] *CETIM, Grand Est, 67305 Schiltigheim, France*

Rare-earth-doped fluoride crystals are widely recognized as efficient photonic materials due to their low phonon energies and favorable spectroscopic properties, which reduce non-radiative relaxation processes and enhance luminescence efficiency [1,2]. Among them, thulium-doped CaF_2 crystals are of particular interest due to their characteristic emission in the UV–visible spectral range. In this work, we investigate the emission properties of Tm^{3+} ions in CaF_2 single crystals doped with 0.1, 1, and 5 mol% TmF_3, grown by the vertical Bridgman method.

The emission spectra were recorded under UV excitation (260 nm and 353 nm), revealing several bands in the UV–visible region associated with characteristic transitions of Tm^{3+} ions. In addition, a distinct emission band around 353 nm is attributed to Tm^{2+} ions, indicating the coexistence of multiple charge states in the as-grown crystals. The luminescence intensity strongly depends on the dopant concentration, with the highest emission observed at the lowest concentration (0.1 mol%), while a significant decrease is observed at higher concentrations, indicating the onset of concentration quenching.

This behavior is attributed to increased non-radiative energy transfer processes, as well as ion-ion interactions and clustering effects at higher dopant concentrations. The results highlight the role of both dopant concentration and charge-state distribution in determining the emission characteristics of CaF_2:TmF_3 crystals, demonstrating their potential for UV-visible photonic applications.

Keywords: Fluoride single crystals, Thulium doping, Bridgman technique.

References:
[1] C. Schornig *et al.*, Materials (Basel). **17**, 4965 (2024)
[2] D.R. Taikar *et al.*, Macromolecular Symposia (Weinheim). **400**, 2100019 (2021)

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

CMP-P11

ENHANCING THE PROPERTIES OF YTTRIUM-BASED PHOSPHORS NANOPARTICLES BY SURFACE SILANIZATION

Vasilica Țucureanu, Oana Brîncoveanu, Cosmin Romanițan,
Adina Boldeiu, Iuliana Mihalache, Alina Matei

National Institute for Research and Development in Microtehnologies (IMT-Bucharest),
Erou Iancu Nicolae Street, 126A, 077190, Bucharest, Romania

Fluorescent materials or phosphors from the yttrium family comprise a class of materials that includes: Y_2O_3, $Y_3Al_5O_{12}$, Y_2O_2S, YPO_4, $Ba_3Y_2(BO_3)_4$, $Ca_3Y(GaO)_3(BO_3)_4$ etc which, through doping with various rare-earths, are widely used in numerous fields, such as solar and fuel cells, optics, microelectronics, displays, biosensor devices, and bioimaging. Phosphors obtained by wet methods have an increased capacity to bind hydroxyl groups to the surface more easily, which can be used to anchor organic chains to reduce the agglomeration tendency and, consequently, to improve the efficiency of light conversion. 3-Amino-propyl-trimethoxysilane (APTES) is an organic molecule that is frequently employed for the surface functionalization of metal oxides. Different approaches are presented for introducing Si-O groups onto the surface of oxide particles, either in the form of SiO_2 or aminosilanes with terminal amine groups, which allows for the modeling of the distance between particles and facilitates the attachment of biomolecules or other nanoparticles. In this paper, we present the steps involved in the precipitation synthesis of yttrium oxide-based phosphor and the influence of process parameters on the silanization step of the luminescent material. The silanization mechanism involves the hydrolysis of the triethoxy groups, followed by the polycondensation of the hydroxyl groups with the hydroxyl groups on the surface of the nanoparticles. To determine whether this molecule can be chemically or physically adsorbed onto the surface, the influence of pH conditions on the anchoring of APTES molecules was analyzed, highlighting the role of acid and base catalysis. A detailed analysis was performed to examine how process parameters influence the structure, morphology and optical characteristics of modified and unmodified phosphors. The zeta potential indicates the presence of positive charges on the phosphor surface, confirming the spectroscopic observations regarding the silanization of phosphor particles in an acidic medium. In the basic catalysis experiment, the formation of a core-shell structure was observed, where the phosphor core is surrounded by SiO_2.

Keywords: phosphor, silanization, fluorescent labels, ceramics, nanomaterials.

References:

[1] V. Țucureanu, O. Brîncoveanu, C. Romanițan, I. Mihalache, A. Matei, *Annals of West University of Timisoara Physics,* **67(2025)**, 59-71 (2025) https://doi.org/10.2478/awutp-2025-0005;
[2] A. Grassi, F. Punzo, G.M. Lombardo, *Computational and Theoretical Chemistry*, **1238**, 114703 (2024) https://doi.org/10.1016/j.comptc.2024.114703.

Acknowledgements
This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS-UEFISCDI, project number PN-IV-P2-2.1-TE-2023-0417 (BioYDetect, Contract no. 30TE/2025), within PNCDI IV.

APPLIED PHYSICS AND INTERDISCIPLINARY (API)

API-O01

REFINEMENT OF LIQUIDUS BEHAVIOR IN AF_2-RICH PART OF AF_2–RF_3 PHASE DIAGRAMS (A=Ca, Ba AND R=Tb, Tm)

Philippe Veber [1,2], Gabriel Buse[2], Marius Stef[1], Carla Schornig[1], Irinuca Bodea[1], Maria Poienar[2], Vincent Motto-Ros[3], Frederic Pelascini[4], Daniel Vizman[1]

[1]*West University of Timisoara, Faculty of Physics, Crystal Growth Laboratory, Timişoara, Romania*
[2] *West University of Timisoara, Institute for Advanced Environmental Research, Timişoara, Romania*
[3]*Université Claude Bernard Lyon 1, CNRS, Institut Lumière Matière, Villeurbanne, France*
[4] *CETIM, Grand Est, 67305 Schiltigheim, France*

Single crystal growth by the Bridgman technique was investigated in AF_2-rich part of AF_2–RF_3 phase diagrams (A=Ca or Ba – R= Tb or Tm) where the initial molar content of rare earth dopants was ranging from 0.1% to 10%. 10-cm-long boules were successfully grown with high optical quality [1-4]. The effective partition coefficients of rare earth cations were calculated for both CaF_2 and BaF_2 matrices through two different methods.

On the one hand, chemical content characterization was carried out with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and Laser-Induced Breakdown Spectroscopy (LIBS). The combination of these two techniques enabled to estimate quantitatively the effective partition coefficients of each selected rare earth cation for the two fluoride matrices. On the other hand, optical absorption measurements were performed on numerous samples taken from across the entire length of the boules. This second optical method, using Beer-Lambert absorption law, made it possible to calculate a new set of effective partition coefficients which were compared to those obtained from chemical characterization. The values of the effective partition coefficients, greater than or less than 1 and therefore affecting the segregation behaviour of the dopants, were then compared to the sign of the slope of liquidus curves in AF_2-rich – RF_3 phase diagrams. The refinement of the AF_2-rich parts of these four systems is presented in the vicinity of the solid-liquid phase transition. A particular attention was paid for locating the molar fraction range of the expected congruent points where liquidus and solidus curves meet at a single point.

Keywords: Fluoride single crystals, Terbium or Thulium doping, Bridgman technique

References:
[1] G. Buse *et al.*, J. Alloys Compd. **1010**, 177784 (2025)
[2] I. Bodea *et al.*, Materials (Basel). **19**, 801 (2026)
[3] M. Stef *et al.*, Opt. Mater. (Amst). **169**, 117689 (2026)
[4] P. Veber *et al.*, Mat. Res. Bull., submitted, (2026)

Acknowledgement: The authors acknowledge the Romania's Recovery and Resilience Plan (PNRR) through the funding of ESCARGOT project n°: 760080/23.05.2023.

AIP-O02

AEROSOL-INDUCED IMPACTS ON THE PV POTENTIAL AND FINANCIAL BANKABILITY OF SOLAR PROJECTS

Robert Blaga and Marius Paulescu

Department of Physics, West University of Timisoara, V. Parvan 4, 300224 Timisoara, Romania

Aerosols are an often-overlooked factor that negatively influence the yield of PV systems. Their source-dependence, spatial homogeneity, and multifaceted impact make them hard to model beyond generic assumptions and a low time-resolution.

In this work, we propose a methodology for assessing the impact of particular aerosol types through the use of parametric clear-sky models and AERONET ground data. Background aerosol level is determined based on the distribution of Ångström exponent and turbidity from measured data. The impact of desert dust and anthropogenic emissions is isolated out in this way.

The aerosol-induced losses in the solar potential and the financial yield of PV systems is assessed at 12 BSRN and AERONET stations. For a model 1MW system, we find 108.92 MWh/m^2/yr losses at Tamanrasset, Algeria due to desert dust, and 226.67 MWh/m^2/yr losses in Xianghe, China, due to secondary aerosols from anthropogenic combustion. The losses represent 5.1% and 11.4% of the clear-sky PV potential at the two stations. The increase due to aerosols in the financial turnover time at the two stations above a nominal 10-year period is estimated to be 6 and 15 months.

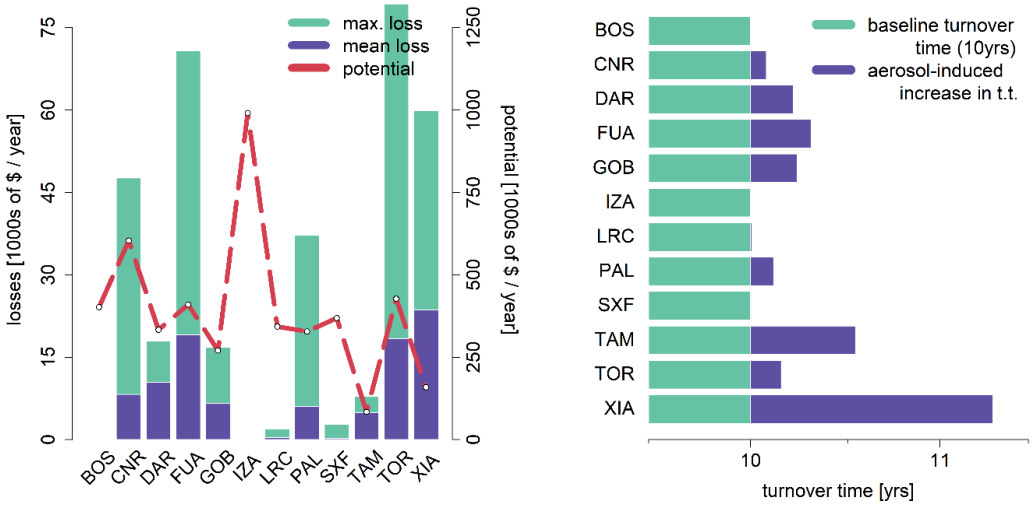


Figure 1: (a) Losses in the PV potential and financial yield and (b) increase in turnover time due to aerosols for a model 1MW PV system at 12 BSRN-AERONET stations.

Keywords: parametric clear-sky model, Ångström turbidity, aerosol baseline

References:

[1] R Blaga, D Calinoiu and M Paulescu. A methodology for realistic estimation of the aerosol impact on the solar potential. *Solar Energy* **271** (2024).

API-O03

A POSSIBLE MATHEMATICAL MODEL FOR PLANT MORPHOLOGY IN RELATION TO GRAVITATION AND LIGHT

Florin Secosan[1], Mihail Lungu[1]

[1] *West University of Timisoara, Faculty of Physics and Mathematics, Timisoara, Romania*

The buds of many plant species and the crowns of many tree species have similar shapes a similarity that suggests the existence of a common mathematical model. There are two methods that can lead to this model: experimental and the theoretical method. The shape of many tree crowns is the result of the combined action of gravitropism and phototropism [1]. The first tropism is of two types: the positive one determines the growth of the roots more or less in the direction of the gravity vector, the negative one has the effect of overcoming gravity in such a way as to benefit from the best possible exposure to sunlight. So, the reaction to light and the need for light constitute the second response of the plant, called phototropism. In the case of buds, both foliar and floral, the initial question does not yet have an answer. The research described in [2] has used a mathematical model inspired by projective geometry that depends on only two parameters, that are geometric and it is not yet known what connection they have with the physical reality of the plant with its local responses to gravity and light. As far as the trees and leaf buds are concerned one can say that at the macro-scale the crown responds gravitropically and phototropically but one does not know to what influences the shape of the buds responds at the micro scale where gravity obviously plays a much too small role and light, before the buds open, does not yet have a measurable effect.

Keywords: Gravitropism, phototropism, fractals, best-fit curves and surfaces, optimization.

References:

[1] Laurent Duchemin, Christophe Eloy, Eric Badel and Bruno Moulia - "Tree crowns grow into self-similar shapes controlled by gravity and light sensing", J. R. Soc. Interface 15: 20170976. http://dx.doi.org/10.1098/rsif.2017.0976

[2] Lawrence Edwards – "The Vortex of Life. Nature's Patterns in Space and Time", Floris Book, 1993, ISBN-10: 0863151485

API-O04

COMPARATIVE STUDY REGARDING EFFECTS OF COLD ATMOSPHERIC PLASMA ON TOMATO AND RED PEPPER SEEDS

Adriana-Florica Bogoşel[1], Mihail Lungu[1], Antoanetta Lungu[2]

[1]*Faculty of Physics, West University of Timisoara, Blvd. V. Parvan 4, 300223 Timisoara, Romania*
[2]*Technical College "E. Ungureanu", P-ta Iancu Huniade 3 Timisoara, Romania*

Cold atmospheric plasma, a non-thermal gas plasma generated at room temperature and atmospheric pressure, is considered a modern non-chemical method with applications in agriculture, due to its ability to modify seeds surface proprieties and stimulate enzymatic activity, based on contained reactive oxygen/nitrogen species. For this comparative study, tomato (*Solanum lycopersicum*) and red pepper seeds (*Capsicum annuum*), collected from local crops, were exposed to cold atmospheric plasma treatment for 1, 2, 3 and 4 minutes, while an untreated control group was maintained for comparison. The results showed that short exposure times (1-2 minutes) improved germination, seedling growth and biomass accumulation in both species. These findings strengthen the possibility of using this non-thermal technology in agriculture in a eco-friendly way to enhance crop performance.

Keywords: cold atmospheric plasma, tomato, red peppers.

References:
[1] R. Milardo. Sustainability, 17(14), 6563 (2025). https://doi.org/10.3390/su17146563
[2] L. Schäfer & A. Herz. *Insects*, 11(6), 357 (2020). https://doi.org/10.3390/insects11060357
[3] N. Nalwa, A. Thakur, A. Vikram, R. Rane, & A. Vaid. *International Journal of Bio-resource and Stress Management*, 8, 535–538 (2017). https://doi.org/10.23910/IJBSM/2017.8.4.1733

API-O05

VERIFICATION OF RADIOTHERAPY DOSE DELIVERY USING TLDS: IMPLEMENTATION OF THE IAEA PROTOCOL

Bianca-Emanuela Nicolescu[1,2], Marius Spunei[1], C.N. Marin[2]

[1]*Oncohelp Association, Ioan Rusu Sirianu, No. 34, Timisoara, Romania*
[2]*Department of Physics, West University of Timisoara, V. Parvan, No. 4, Timisoara, Romania*

In radiotheraphy, the patient safety is the primary objective of the treatment therefore, quality assurance programmes are mandatory and form an essential component of clinical practice, ensuring the accuracy, consistency, and reliability of delivered doses. The aim of this paper is to explore the application of thermoluminescent dosimeter (TLD) irradiation as a validation approach for the accuracy of dose delivery in radiotherapy, in accordance with the International Atomic Energy Agency (IAEA) protocols [1].

In this study the measurements were performed on a TrueBeam linear accelerator and carried out for three different beam energies: 6 MV, 6 FFF, and 10 MV. The methodology employed requires that measurements be performed along the beam central axis at a depth of 10 cm in a water phantom, using a 10 × 10 cm² reference field. These measurements involve irradiating the TLDs with a prescribed dose of 200 cGy, with the corresponding monitor units calculated accordingly.

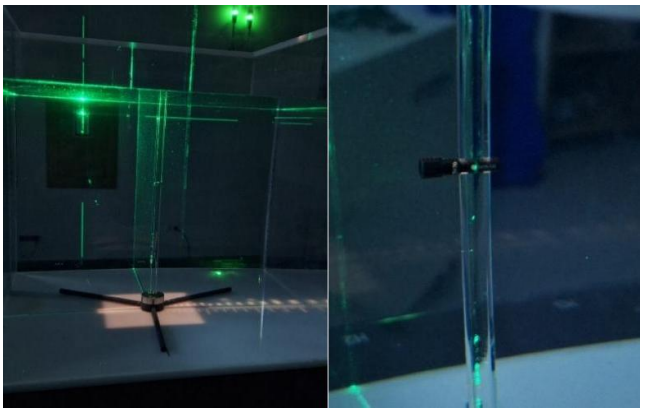


Figure 1: TLD holder placed in the 1D water phantom (left), TLD inserted in the holder (right)

After irradiating the TLDs with the three beam energies available on the TrueBeam system, the results were sent to the IAEA Dosimetry Laboratory in Vienna for independent verification. The outcomes demonstrated good agreement between the measured and reference doses for all three energies, remaining within the acceptable tolerance limits.

Keywords: TLD, IAEA, Quality Assurance, TrueBeam, Dose, Dosimetry.

References:

[1] E.P. Podgorsak, Radiation Oncology Physics: A Handbook for Teachers and Students, 440-447 (2005).

API-P01

ESTIMATION OF DIRECT NORMAL IRRADIANCE FROM ATMOSPHERIC PARAMETERS

Anamaria-Giulia Goilean, Marius Paulescu

Faculty of Physics, West University of Timisoara, Romania

Direct normal irradiance (DNI) is the dominant component in the estimation of global horizontal irradiance (GHI) under clear-sky conditions. At the same time, the estimation of DNI itself has practical relevance for the design and operation of concentrating solar systems.

DNI is a quantity that is rarely measured at radiometric stations. As an alternative, empirical, semi-empirical, and parametric models are used to estimate DNI [1]. The accuracy of these models depends on the input parameters and calibration.

This paper proposes a parametric model for estimating DNI. The innovative features of the proposed model include novel derived model equations and a dedicated calibration of atmospheric transmittance. The model has a physical basis in the spectral solar irradiance radiative transfer code SMARTS2 [2] and is empirically calibrated using measured data from the global BSRN network [3]. Preliminary results indicate that the model performance is high and comparable to that of the best-performing models in its class. The simplicity of the proposed model provides a substantial advantage in practical applications.

Keywords: solar irradiance, direct normal irradiance, clear-sky.

References:

[1] Paulescu E, Paulescu M, *A new clear sky solar irradiance model*, Renewable Energy 179 (2021) 2094–2103.
[2] C.A. Gueymard, SMARTS2 A simple model of the atmospheric radiative
transfer of sunshine: algorithms and performance assessment, in: Florida
Solar Energy Center Rep. FSEC-PF-270-95, 1995 [accessed May 2026], https://
www.nrel.gov/grid/solar-resource/smarts.html.
[3] Baseline Surface Radiation Network. https://bsrn.awi.de/ [accessed May 2026].

API-P02

SOFTWARE PLATFORM FOR GANGLIOSIDE IMS-MS DATA ANALYSIS

Roxana Biricioiu[1,2], Raluca Ica[2,3] , Mirela Sârbu[2], Sorin Nădăban[3], Alina Zamfir[1,2,4]

[1]*Faculty of Physics, West University of Timişoara, Timişoara, Romania*
[2]*National Institute for Research and Development in Electrochemistry and Condensed Matter, Timişoara, Romania*
[3]*Department of Mathematics and Computer Science, Faculty of Exact Sciences, Aurel Vlaicu University of Arad, Arad, Romania*
[4]*Department of Technical and Natural Sciences, Faculty of Food Engineering, Tourism and Environmental Protection, Aurel Vlaicu University of Arad, Arad, Romania*

Introduction: Gangliosides are sialylated glycosphingolipids abundantly expressed in the central nervous system and are regarded as tumor associated antigens and candidate biomarkers in brain tumors [1]. However, comprehensive ganglioside profiling remains challenging due to pronounced molecular diversity and extensive isomerism. In this context, ion mobility mass spectrometry (IMS MS) provides enhanced separation prior to mass analysis, but the resulting datasets are highly complex and require dedicated computational tools for efficient gangliosidomic interpretation.

Methods: Native gangliosides from human brain tissues, including healthy brain tissue and primary brain tumors, were analyzed by IMS MS in negative ion mode. Based on these data, we developed GIMSoft, a software tool for automated interpretation of IMS resolved ganglioside spectra. The current implementation enables feature detection, charge state recognition, neutral mass calculation, and molecular class assignment using accurate mass matching constrained by biosynthetic rules, with outputs prepared for integration into a comparative structural database.

Results: IMS-MS enabled efficient separation of complex ganglioside mixtures from healthy brain tissue and primary brain tumors, significantly reducing spectral overlap. GIMSoft automatically processes IMS-resolved features using *m/z* and charge state information to estimate neutral masses and assign candidate ganglioside classes based on biosynthetic constraints. Current developments focus on integrating MS/MS fragmentation analysis for improved structural annotation, with future extensions targeting machine learning (ML) and artificial intelligence (AI) assisted interpretation of complex gangliosidomic datasets.

Conclusions: This study demonstrates the feasibility of automated molecular class assignment of gangliosides from IMS MS data using a dedicated software approach. GIMSoft integrates accurate mass and charge state information with biosynthetically constrained compositional rules, enabling efficient interpretation of complex datasets and supporting future integration of MS MS and ML assisted spectral analysis.

Keywords: Ion Mobility Mass Spectrometry, Ganglioside profiling, Computational spectral analysis

References:

[1] MR Biricioiu, M Sarbu, R Ica, Ž Vukelić, S Kalanj-Bognar, AD Zamfir. Advances in Mass Spectrometry of Gangliosides Expressed in Brain Cancers. *Int J Mol Sci*. 1335 (2024)

API-P03

MEMBRANES MADE OF HONEY, GELATIN, SILVER MICROPARTICLES AND INJECTABLE WATER: THE INFLUENCE OF SILVER MICROPARTICLES ON ELECTRICAL AND ELASTIC PROPERTIES POTENTIALLY USABLE IN DENTISTRY

Andrei Mihai Gavrilovici[1], Mircea Eugen Anitas[2,3,4], Ioan Bica[2,5], Mădălin Bunoiu[5], Gabriel Pascu[5] and Liviu Chirigiu[6]

[1]Department of Prosthodontics, Faculty of Dental Medicine, University of Medicine and Pharmacy Victor Babeș, 9 Revoluției 1989 Ave., 300070 Timișoara, Romania
[2]Department of Physics, Faculty of Sciences, University of Craiova, 13 A. I. Cuza Str., 200585 Craiova, Romania
[3]Joint Institute for Nuclear Research, 6 Joliot-Curie Str., 141980 Dubna, Moscow Region, Russian Federation
[4]Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH), 30 Reactorului Str., 077125 Măgurele, Ilfov, Romania
[5]Faculty of Physics and Mathematics, West University of Timișoara, 4 Vasile Pârvan Ave., 300223 Timișoara, Romania
[6]University of Medicine and Pharmacy of Craiova, 2 Petru Rareș Str., 200349 Craiova, Romania

In guided tissue regeneration (GTR), biocompatible membranes play an essential role. For this purpose, four membranes are prepared, which contain honey, gelatin particles, injectable water and different amounts of silver microparticles. The work details the method of preparation of the samples, and their characterization by determination of the main electrical and mechanical characteristics of membranes, potentially useful in guided tissue regeneration therapies.

Keywords: bio-membranes, honey, gelatin, injectable water, electrical and elastic characteristics.

References:
[1] A. M. Gavrilovici, M. M. C. Fabricky, M. C. Manole, D. Onisei, D. C. Vlad, I. Bica, M.-L. Negruțiu, *Rom. J. Oral Rehabil.* **17**, 879-887 (2025).
[2] M. Hung, K. Sanders, A. Deshpande, R. Trivedi, C. Schwartz, A. Mohajeri, *Appl. Sci.* **15**, 1145 (2025).
[3] D. Wang, X. Zhou, H. Cao, H. Zhang, D. Wang, J. Guo, J. Wang, *Front. Mater.* **10**, 1220420 (2023).
[4] W.-S. Liu, Y. Liu, J. Gao, H. Zheng, Z.-M. Lu, M. Li, Int. J. *Nanomedicine* **18**, 385-411 (2023).
[5] J.-Y. Peng, M. G. Botelho, J. P. Matinlinna, *J. Dent.* **40**, 531-541 (2012).
[6] T. Bruna, F. Maldonado-Bravo, P. Jara, N. Caro, *Int. J. Mol. Sci.* **22**, 7202 (2021).

API-P04

MULTI-ANALYTICAL INVESTIGATION OF SUSPECTED METEORITIC ROCK SAMPLES FROM LUDEȘTI AREA, DAMBOVITA COUNTY, ROMANIA

Anca-Irina Gheboianu[1], Cristina-Mihaela Nicolescu[1], Marius Bumbac[2], Dragoș-Viorel Brezoi[3], Aurora-Anca Poinescu[3], Simona Mihai[1], Florin-Matei Constantin[4]

[1] *Institute of Multidisciplinary Research for Science and Technology, Valahia University of Târgoviște, 13 Sinaia Alley, 130004 Târgoviște, Romania*
[2] *Faculty of Sciences and Arts, Valahia University of Târgoviște, 13 Sinaia Alley, 130004 Târgoviște, Romania*
[3] *Faculty of Materials Science and Mechanics, Valahia University of Târgoviște, 13 Sinaia Alley, Târgoviște, Romania*
[4] *Valea Mare Secondary School, Dâmbovița, Romania*

The rock samples collected from the Ludești area, Dâmbovița County, Romania, where unusual rock fragments were previously observed, were investigated through a multidisciplinary analytical approach including X-ray diffraction (XRD), wavelength-dispersive X-ray fluorescence spectroscopy (WDXRF), density measurements, and nanoindentation analysis. The study aimed to characterize the mineralogical, chemical, physical, and micromechanical properties of the samples to evaluate their possible relationship with meteoritic or unusual geological materials [1].

The XRD analysis revealed a complex silicate-rich mineralogical composition, with phases such as quartz, epidote, ferro-actinolite, olivine, and kalsilite [2]. This assemblage indicates a heterogeneous structure and suggests that the investigated materials may have experienced complex formation or alteration processes. WDXRF measurements, performed both on different sample surfaces and on homogenized powdered material, showed that the samples are mainly composed of SiO_2, Al_2O_3, CaO, and Fe_2O_3, accompanied by lower amounts of MgO, TiO_2, MnO, and several trace elements. The observed differences between the analyzed areas highlight the compositional variability of the samples. The measured density values, ranging from approximately 2.56 to 3.07 g/cm³, provide important preliminary information for comparison with both terrestrial rocks and known meteoritic materials.

Although these values do not allow a definitive attribution to a meteoritic origin at this stage, they help narrow the range of possible interpretations and indicate that further complementary analyses are necessary. Nanoindentation measurements also revealed local variations in micro-hardness and Young's modulus, most likely associated with differences in compactness, porosity, mineral distribution, and surface roughness. The most compact sample showed the most consistent mechanical response, with average values of approximately 2.23 GPa for micro-hardness and 49.13 GPa for Young's modulus.

Overall, the results obtained provide a valuable first-level characterization of the Ludești rock samples and establish a useful analytical framework for investigating geological materials of uncertain origin. While the data collected so far do not provide conclusive evidence for confirming or excluding a meteoritic origin, they highlight several mineralogical, chemical, and physical features that justify further investigation using complementary techniques or comparison with reference meteorite databases. Thus, this study represents an important preliminary step toward understanding the nature and possible origin of these unusual rock fragments.

Keywords: XRD; WDXRF; nanoindentation; mineralogical characterization

References:

[1] R.J., Macke, D.T Britt, and G.J. Consolmagno, *Meteoritics & Planetary Science*, 46: 311-326. https://doi.org/10.1111/j.1945-5100.2010.01155.x , (2011)
[2] A. Ludwig, *Acta Physica Polonica A*, Vol.100, No.5, (2001)

API-P05

DEVELOPING FUNCTIONALIZED POLYETHYLENE-BASED MATERIALS BY LEVERAGING RESIDUAL PLANT BIOMASS HYDROLYSIS TO INTRODUCE NEW FUNCTIONALITIES

Marius Bumbac[1], Cristina Mihaela Nicolescu[2], Anca Irina Gheboianu[2], Ion Valentin Gurgu[2], Cosmin Stefan Gherghinoiu[3], Germano Craia[3], Bogdan-Catalin Serban[4], Octavian Buiu[4]

[1]Valahia University of Târgoviște, Faculty of Sciences and Arts, Sciences and Advanced Technologies Department, Aleea Sinaia, nr 13, 130004, Târgoviște, Dâmbovița, Romania
[2]Valahia University of Târgoviște, Institute of Multidisciplinary Research for Science Technology, Aleea Sinaia, nr 13, 130004, Târgoviște, Dâmbovița, Romania
[3]KIK Compounds SRL, Strada W, complex UPS Dragomiresti, Dumbrava, Dambovita, Romania
[4]National Institute for Research and Development in Microtechnologies, IMT-Bucharest, 126 A Str. Erou Iancu Nicolae, 077190, Voluntari, Ilfov, Romania

The development of functional polyethylene-based composites remains an important challenge because polyethylene is chemically inert, hydrophobic, and resistant to biodegradation [1,2]. In this work, a practical strategy is proposed for obtaining functionalized polyethylene materials by incorporating plant biomass into the polymer matrix, followed by controlled hydrolysis and post-treatment functionalization. The concept is based on using biomass as an internal source of reactive biopolymer-derived compounds, such as polysaccharides, proteins, peptides, lipids, and other hydrolysis products, which can introduce new chemical and interfacial functionalities into an otherwise non-polar polymer system.

The first stage of the approach involves the preparation of polyethylene/biomass composites with good dispersion of the biomass phase in the polymer matrix. Subsequent hydrolysis is expected to partially degrade the biomass components, generating functional groups such as hydroxyl, carboxyl, amino, or carbonyl groups. The efficiency of hydrolysis and the structural evolution of the composite was evaluated using complementary characterization techniques. FTIR and XRF spectroscopy were used to identify newly formed functional groups and chemical interactions. XRD was applied to evaluate changes in crystalline organization. Differential scanning calorimetry (DSC) was used to assess how biomass incorporation, hydrolysis, and subsequent functionalization affect the properties of polyethylene matrix in the temperature range 30 - 250ºC. The proposed materials may be suitable for several applications, such as adsorbents for wastewater treatment, antimicrobial packaging, controlled-release coatings, and responsive sensing materials. Overall, the proposed approach provides a promising route for transforming polyethylene-based composites into multifunctional materials with improved interfacial reactivity and application-specific performance.

Keywords: functionalized materials, plant biomass, biomass hydrolysis, functionalized polyethylene.

References:

[1] J., Aniśko, P., Kosmela, J., Cichocka, J., Andrzejewski, M. Barczewski, *Materials*, *17*(19), 4825 (2024).
[2] B. A., Alshammari, A. M., Alenad, F. S., Al-Mubaddel, A. G., Alharbi, A. S., Al-Shehri, H. A., Albalwi, Mourad, A. H. I. *Polymers*, *14*(16), 3427, (2022).

Acknowledgments
This work was supported by a grant funded by the Ministry of Education and Research – UEFISCDI, Contract no: 38PTE/2025, project code: PN-IV-P7.1-PTE-2024-0653.

API-P06

EFFICIENT PHOTODETECTOR BASED ON ITO/SIC SCHOTTKY JUNCTION

I. Mihalache[1], R. Pascu[1], G. Pristavu[2], C. Romanitan[1]

[1]National Institute for Research and Development in Microtechnologies, IMT-Bucharest, Romania
[2]National University of Science and Technology Politehnica Bucharest, Splaiul Independenței 313, Bucharest, Romania

Schottky-based photodetectors have demonstrated enhanced responsivity, lower dark current and faster rise–decay dynamics[1]. Owing to these advantages, such architectures have emerged as promising candidates in next-generation optoelectronic systems. The Schottky junctions significantly improves device operation by enabling efficient separation and transport of photogenerated electron–hole pairs at the metal/semiconductor interface.

In this study, Schottky photodiodes of 600µm diameter were designed and fabricated using n-type SiC wafer with an epitaxial layer having a doping concentration around 10^{16} cm^{-3} and a highly doped substrate (10^{18} cm^{-3}). The ITO/4H-SIC Schottky junction was fabricated with 200 nm of sputter-deposited indium tin oxide thin film, followed by thermal annealing for 30 minutes in Ar environment at different temperatures. A control sample with a non-annealed Schottky contact, was also analyzed.

The structure operated as self-powered photodetector. The current-time performances of ITO/SiC Schottky diodes were evaluated at 0, –5 and –10V reverse voltages and the response and recovery times were further assessed. The highest photodetection performance was observed under 330 nm irradiation, where the device responsivity reached 2.7 A/W at zero bias and increased further to 3.20 A/W at −10 V applied bias.

Keywords: Schottky junction, photodiode, 4H-SiC

References:

[1] C.V. Prasad, P. Dharmaiah, G.H. Lee et al., Mater. Today Adv. 28, 100662 (2025).

Acknowledgements: This work was supported by the Ministry of Education and Research under project numbers PN-IV-P2-2.1-TE-2023-1740 and PN-IV-P2-2.1-TE-2023-1953.

API-P07

RECOVERY OF ANALOG SEISMIC SIGNALS: A COMPARATIVE ANALYSIS OF *mb* ESTIMATES FROM A NUCLEAR TEST

Rău Adina[1], Lungu Mihail[2], Popa Mihaela[3], Radulian Mircea[1,3,4]

[1]*National Institute for Earth Physics, Măgurele, Romania*
[2] *West University of Timisoara, Faculty of Physics, Timisoara, Romania*
[3] *Academy of Romanian Scientists, Bucharest, Romania*
[4] *Romanian Academy, Bucharest, Romania*

This paper explores the viability of processing analogue seismograms using modern vectorization techniques to retrieve precise seismological information from historical records. The methodology involves high-resolution scanning of the analogue seismogram and its subsequent processing using the specialized software Web Plot Digitizer [2]. We exemplify the procedure for a well-documented event: a peaceful nuclear test operated on 24.10.1979 in western Kazakhstan, with a catalogue magnitude of mb 5.8 [1], recorded by two stations in western Romania.

The main stage of the research consisted in converting the analogue signal into digital format (vectorization) [3], followed by the calculation of the body-wave magnitude (mb). We obtained a mb magnitude value of 5.7. The difference from the catalogue magnitude is 0.1 units. This small difference validates the workflow and the accuracy of the software used in processing and interpreting the waveforms of the analysed event.

In conclusion, the success of this experiment confirms that analogue data, after converting into digital format, can be successfully integrated into future data analyses using advanced processing techniques.

This work establishes the framework for future research focused on refining processing techniques to reevaluate source parameters for local earthquakes recorded in Romania. By bridging historical archives with modern analytical methods, this approach contributes to a more comprehensive understanding of regional seismicity and better characterizing seismic hazard.

Keywords: vectorization, legacy seismic data, waveform recovery

References:

[1] Oancea V., Kung Y.L., Murphy J.R., Piraino P., Given J.W., Waveforms from Nuclear Explosions (WFNE) Repository, Pure and Applied Geophysics, https://doi.org/10.1007/s00024-024-03536-7, (2024)

[2] Rohatgi A., WebPlotDigitizer, https://automeris.io/WebPlotDigitizer, Version 4.2, April 2019, email:ankitrohatgi@hotmail.com, San Francisco, California, USA.

[3] Paulescu D., Rogozea M., Popa M., Radulian M. – *Digitized database of old seismograms recorder in Romania*, Acta Geophysica, vol. 64, pp. 963-977, DOI: 10.1515/acgeo-2016-0039, 2016

API-P08

AN INTEGRAL MODEL FOR ERYTHEMAL UV DOSE ON TILTED SURFACES

Andrea-Florina Codrean, Madalin Octavian Bunoiu, Marius Paulescu

Faculty of Physics and mathematics, West University of Timisoara, V. Parvan 4, 300223 Timisoara, Romania

Ultraviolet (UV) radiation has significant effects on human skin, ranging from beneficial to harmful outcomes. The erythemal UV dose is defined as the biologically effective dose responsible for skin reddening. It is commonly expressed in standard erythema doses (SED) and interpreted relative to threshold levels such as the minimal erythema dose (MED). This dose depends on atmospheric conditions and the orientation of the receiving surface. Direct measurement, however, remains challenging in practice. As an alternative, modeling approaches provide a viable solution for UV erythemal dose estimation [].

In this work, we propose a model for estimating erythemal UV dose on oriented surfaces using atmospheric parameters as inputs. The main novelties of the approach are the mathematical formulation of the model for a horizontal plane and the introduction of a new transposition equation. This equation is used to convert the estimated dose from a horizontal surface to a tilted surface. Preliminary results indicate that the model represents a good compromise between accuracy and simplicity.

The proposed approach offers a practical tool for assessing UV exposure in applications related to public health, environmental monitoring, and solar radiation studies.

Keywords: UV radiation; Erythema; Transposition model

References:

[1] R. L. McKenzie, R. M. Lucas. *Sci. Rep.* **8**, 13805 (2018).
[2] S. Teggi, S. Costanzini, F. Despini et al. (2026). https://doi.org/10.1038/s41598-026-40878-9.

API-P09

ELECTRICAL AND DIELECTRIC PROPERTIES OF ZnO-BaO-V2O5 GLASSES

Ondrej Bošák [1], Marian Kubliha [1], Tina Tasheva [2], Stanislav Minárik [1], Petr Kostka [3]

[1] *Faculty of Materials Science and Technology, Slovak University of Technology, Bottova 25, 917 24 Trnava, Slovakia, ondrej.bosak@stuba.sk*
[2] *University of Chemical Technology and Metallurgy Faculty of Metallurgy and Materials Science, Department of Silicate Technologies, 8 Kliment Ohridski blvd, Sofia 1797, Bulgaria*
[3] *Laboratory of Inorganic Materials, joint workplace of the University of Chemistry and Technology Prague and the Institute of Rock Structure and Mechanics of the CAS, V Holešovičkách 41, 182 09 Prague 8, Czech Republic*

In semiconducting vanadium oxide–based glasses (V_2O_5), modifications of the glass network occur with the addition of ZnO. Increasing the ZnO content leads to the formation of new structural units, which in turn influence the physical properties of the glass. From the perspective of potential applications, measurements of the electrical and dielectric properties can provide valuable insights into both the material characteristics and the associated structural changes.

Glasses with composition of materials xZnO-(35-x) BaO-65 V2O5 where x = 0, 1, 3, 5, 7, 10, 15, 20 were prepared by using a conventional melt-quenching method. Measurements of DC conductivity, complex permittivity, impedance and complex electrical modulus showed that the gradual exchange of ZnO with BaO has a significant impact on the measured values of electrical and dielectric properties. In a direct electric field, the measured DC conductivity values are significantly dependent on the composition and reach a maximum at around 5% ZnO. From the point of view dielectric properties study, measurements show several mechanisms of dielectric relaxation. It is manifested in the impedance spectra by deformation of measured curve and greater complexity of the equivalent circuit. Measurements of the complex electric modulus, whose frequency dependences of the imaginary part can be separated into two maxima, have proven to be a very suitable tool for a more detailed analysis of dielectric relaxation.

Keywords: vanadium oxide–based glasses, electrical conductivity, impedance spectra.

Acknowledgement: This work was supported by the Slovak Research and Development Agency under the contract No. APVV SK-BG-23-0014, Bulgarian National Science Fund under the contract No KP-06-Slovakia/1 P. Kostka acknowledges the support of the Czech Science Foundation (Project No. 25-15635S).

API-P10

MODELING CLEAR-SKY SOLAR UV IRRADIANCE: A PARAMETRIC APPROACH

George Stirban[1] and Eugenia Paulescu[1]

[1]*Faculty of Physics and Mathematics, West University of Timisoara, V. Parvan 4, 300223 Timisoara, Romania*

Surface solar ultraviolet (UV) radiation is an important component of shortwave solar radiation, playing a significant role in atmospheric and climate processes. Reliable records of surface UV irradiance are essential for numerous environmental and solar-energy applications; however, high-quality ground-based UV measurements remain limited worldwide.

This study proposes a novel broadband physical parameterization for estimating clear-sky surface solar UV irradiance. The approach is developed using the SMARTS2 spectral radiative transfer model [1] and relies on an interdependent integration scheme [2] that derives broadband UV irradiance from spectrally resolved shortwave radiation.

The proposed model is validated against high-quality observations from the Baseline Surface Radiation Network (BSRN) and compared with an established parameterization. Results demonstrate improved accuracy and enhanced stability, highlighting the potential of the proposed method for reliable UV irradiance estimation under clear-sky conditions.

Keywords: global UV irradiance, clear sky, parametric model.

References:

[1] C.A.,Gueymard, SMARTS2 A Simple Model of the Atmospheric Radiative Transfer of Sunshine: algorithms and performance assessment. In: Florida Solar Energy Center Rep. FSEC-PF-270-95 (1995).

[2] J.A., Ruiz-Arias, Spectral integration of clear-sky atmospheric transmittance: review and worldwide performance, *Renew. Sustain. Energy Rev*., 161, 112302, (2022).

API-P11

VALIDATION OF SATELLITE-DERIVED SOLAR IRRADIANCE AND SUNSHINE DURATION AGAINST GROUND MEASUREMENTS IN TIMIȘOARA, ROMANIA

Jordan Ciucea[1], Sergiu-Mihai Hategan[1,2], Andreea Sabadus[1], Marius Paulescu[1]

[1]Faculty of Physics and Mathematics, West University of Timisoara, Romania
[2]Institute for Advanced Environmental Research, West University of Timisoara, Romania

Accurate solar irradiance data are essential for climate monitoring and solar energy applications. Satellite-derived products such as the Copernicus Atmosphere Monitoring Service (CAMS) radiation dataset [1] and the CM SAF Surface Solar Radiation Dataset SARAH-3 [2] provide spatially continuous irradiance estimates over Europe, but their performance at specific locations remains dependent on local climate conditions and requires validation against ground-based measurements.

This study evaluates the accuracy of CAMS and SARAH-3 global horizontal irradiance (GHI) and sunshine duration (SD) estimates at Timișoara, Romania, a location representative of the Pannonian Plain climate. Ground measurements of GHI and sunshine duration were collected over several years using a high-quality pyranometer Kipp & Zonen SMP-10 (class A, ISO9060:2018) and other relevant parameters were measured using a Delta-T Devices automatic WS-GP2 weather station. Satellite-derived GHI and SD are compared against ground observations using standard statistical metrics including normalized mean bias error (nMBE), normalized root mean square error (nRMSE), and correlation coefficient. The analysis is stratified by season and sky condition to identify systematic dependencies in satellite product performance.

The results are expected to contribute to the growing body of validation literature for satellite-derived solar radiation products in southeastern Europe, a region that remains underrepresented relative to western and central Europe.

Keywords: solar irradiance, satellite-derived data, sunshine duration.

References:

[1] M. Schroedter-Homscheidt, A. Arola, N. Killius, M. Lefèvre, L. Saboret, W. Wandji, L. Wald, E. Wey, *22nd SolarPACES Conference Proceedings* (2016).
[2] U. Pfeifroth, J. Drücke, S. Kothe, J. Trentmann, M. Schröder, R. Hollmann, *Earth System Science Data*, **16**, 5243–5265 (2024)

API-P12

DYNAMIC MECHANICAL ANALYSIS OF PULSED LASER BUTT-WELDED WIRES

Dragos Valsan[1], Corneliu Craciunescu[1], Aurel Ercuta[2], Mădălin Bunoiu[2], Gabriel Pascu[2] and Cristian-Radu Ivan[2,3]

[1]*Materials and Manufacturing Engineering Department, Politehnica University Timişoara, 1 Mihai Viteazu Ave., 300222 Timişoara, Romania*
[2]*Faculty of Physics and Mathematics, West University of Timişoara, 4 Vasile Pârvan Ave., 300223 Timişoara, Romania*
[3]*Institute for Advanced Environmental Research (ICAM), West University of Timişoara, 4C Oituz Str., 300086 Timişoara, Romania*

Dynamic mechanical analysis (DMA) was employed as a sensitive technique to characterize phase transformations in NiTi shape memory alloy wires. Wires with a diameter of 0.3 mm were investigated during heating and cooling in both the as-received condition and after butt welding, with the aim of assessing the influence of welding on the martensitic transformation. This reversible transformation occurs between martensite and austenite over a temperature range specific to the alloy.

The results indicate that welding induces localized compositional changes, which significantly affect the dynamic mechanical response and cannot be reliably predicted through compositional analysis alone. In contrast to the single transformation peak observed in the as-received state, two distinct transformation peaks were identified after welding, suggesting a modification of transformation behavior. These findings demonstrate the capability of DMA to detect subtle changes in phase transformation characteristics and highlight the importance of controlling welding parameters to tailor the functional response of NiTi shape memory alloy wires.

.

Keywords: laser welding, shape memory alloys, surface topography.

References:

[1] R. M. Buzdugan, N. Farbas, C. M. Crăciunescu, *Adv. Mater. Res.* **1111**, 240-245 (2015).
[2] Y. Liu, J. Van Humbeeck, R. Stalmans, L. Delaey, *J. Alloys Compd.* **247**, 115-121 (1997).

API-P13

SURFACE TOPOGRAPHY AND COMPOSITIONAL EFFECTS IN ND:YAG SPOTS OF SEVERAL SHAPE MEMORY ALLOYS

Dragos Valsan[1], Corneliu Craciunescu[1], Aurel Ercuta[2], Mădălin Bunoiu[2], Gabriel Pascu[2] and Cristian-Radu Ivan[2,3]

[1]*Materials and Manufacturing Engineering Department, Politehnica University Timişoara, 1 Mihai Viteazu Ave., 300222 Timişoara, Romania*
[2]*Faculty of Physics and Mathematics, West University of Timişoara, 4 Vasile Pârvan Ave., 300223 Timişoara, Romania*
[3]*Institute for Advanced Environmental Research (ICAM), West University of Timişoara, 4C Oituz Str., 300086 Timişoara, Romania*

A wide range of shape memory alloys (SMAs) have been developed for diverse applications. In addition to the shape memory effect, these materials exhibit a broad spectrum of functional properties - such as ferromagnetism, high-temperature capability, and superelasticity - depending on their chemical composition. Alongside the expansion of SMA applications, increasing attention has been directed toward welding technologies, which are essential for enabling both simple and complex structural designs. In this study, SMAs belonging to different compositional alloy systems were subjected to Nd:YAG laser irradiation to investigate laser-induced modifications in surface topography and chemical composition. This work represents a preliminary step towards identification and optimization of suitable welding parameters. Surface and compositional changes were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX), with particular emphasis on the influence of laser processing parameters during spot generation. The effect of spot overlap on compositional variation was also systematically examined. Furthermore, cross-sectional analyses were conducted to evaluate compositional redistribution within the laser-induced molten pool, with specific attention given to elemental evaporation resulting from vaporization during laser processing. Possible segregation phenomena were analyzed as part of an initial assessment of the weldability of less commonly used SMAs and their potential application beyond conventional operating regimes.

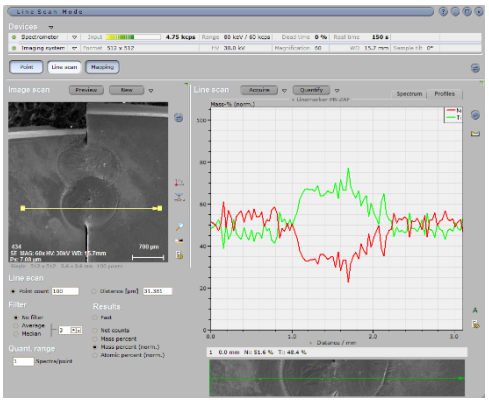


Figure 1: Linear compositional analysis across NiTi plates spot welded by Nd:YAG pulsed laser

Keywords: laser welding, laser processing, shape memory alloys, compositional changes, surface topography.

References:

[1] J. P. Oliveira, N. Schell, N. Zhou, L. Wood, O. Benafan, *Mater. Des.* **162**, 229-234 (2019).
[2] C. Y. Zhou, C. X. Lin, L. L. Liu, *Appl. Mech. Mater.* **37-38**, 1364-1367 (2010).

API-P14

ELECTRICAL PROPERTIES OF $(Na_2S)_{0.75}((In_2S_3)_{0.6}(Sb_2S_3)_{0.6})_{0.25}$

Ondrej Bošák [1], Marian Kubliha [1], Vladimír Labaš[1], Zoé Barbotin [2], David Le Coq [2], Louisiane Verger [2]

[1]*Faculty of Materials Science and Technology, Slovak University of Technology, Bottova 25, 917 24 Trnava, Slovakia, ondrej.bosak@stuba.sk*
[2]*Université de Rennes, CNRS, ISCR-UMR 6226, F-35000 Rennes, France*

Inorganic sodium based solid-state batteries seem to be an alternative to Li technologies for various applications due to their low cost, Na availability, increased safety, and high energy density. Solid electrolyte with Na - ionic conductivity is a key component of it. This research is focused on sulfide-based solid electrolytes, due to their mechanical properties, which provide good contact at the electrolyte/electrode interfaces, low grain boundary resistance, and higher ionic conductivity compared to their oxide counterparts.

Syntheses of new glassy or crystalline materials (Na2S)0.75((In2S3)0.6(Sb2S3)0.6)0.25 conducting sodium ions were done was prepared by mechanochemical method. DC and AC electrical conductivity, impedance and modular spectrometry were performed in inert conditions to evaluate the temperature and frequency dependences. A more detailed analysis using impedance spectra measurements and the proposed equivalent circuit confirmed the existence of several independent influences and higher complexity of investigated glasses.

Keywords: special glasses, electrical conductivity, impedance spectra.

Acknowledgement: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-22-0146 and APVV SK-FR-24-0004.

API-P15

ACE DATA AND THE SOLAR DATA ANALYSIS BY THE QUANTUM SPECTRAL MODEL

Diana-R. Radnef-Constantin[1], Liliana Preda[2], Mark Rushton[3], Agnetha Mocanu[4], Dumitru Popescu[5], Valentin I. Niculescu[6]

[1,3]Institutul Astronomic Al Academiei Romane, 5 Cutitul De Argint Street, Bucuresti, Ro-040557, Romania
[2]Universitatea Politehnica Bucuresti, 313 Splaiul Independentei Street, Bucuresti, Ro-060042, Romania
[3]Universitatea Hyperion Bucuresti, 169 Calarasilor Street, Bucuresti, Romania
[5]ISMMA, 13 Calea 13 Septembrie Street, Bucuresti, Ro-050711, Romania
[6]INFLPR, 409 Atomistilor Street, Magurele, Ro-077125, Romania

We work in frame of the quantum spectral model (QS-Model) for H-I spectrum [1]. The model is applied to the Brackett-Humphreys spectral series to theoretically establish the width of the multiplets and the wavelength position of the maximum of the spectral line in fine structure approximation [1-3] which gives the location of the multiplet lines. After that the results are validated using NIST database for which there are available data, i.e. for multiplets Brackett_1-2 and Pfund_1. Then we compare these results to data from ACE for these common multiplets (existing in both NIST/ACE databases). The QS-Model is applied to the rest of the multiplets in ACE and we make an estimate of the multiplet width and the position of the maximum peak in the spectral composition of the ACE multiplets. Futher, using this model, we perform an analysis of data in this range for solar observations that relate to the hydrogen spectral series in both the Bohr and fine structure approximations. Conclusions are given regarding the quality of solar spectral data.

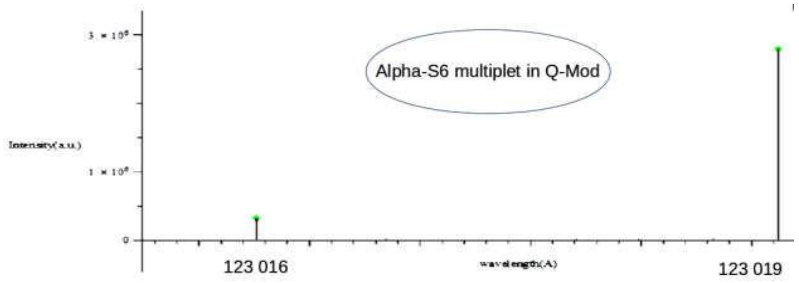


Figure 1: A plot of H-I α-multiplet edges in fine structure approximation for the sixth spectral series in (λ,I)-space.

References:

[1] D. Constantin, L. Preda, M. Rushton, FAST THEOREMS TO IDENTIFY THEMULTIPLET PEAKS AND THE LINK TO THE FACTOR EQUIVALENT TO RYDBERG'S CONSTANT FOR H-I, U.P.B. Sci. Bull., Series A, Vol. 85, Iss. 4, (2023)

[2] D. Constantin, L. Preda, M. Rushton, Hydrogen-like atoms and spectra: special quantum states and maximum relative intensity line of its multiplet, *UPB Sci. Bull.* **85**, 1, (2023), 167–176.

[3] D. R. Constantin, L. Preda, The Estimation of Humphreys A-Multiplet Spectral Composition for H-I Spectrum Using Maximumlocalisation-Spectral-Model. (2024) https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4744616

Acknowledgments: We thank to our colaborator Valentin I. Niculescu which will pay the fee for our participation to the TIM2026 Conference, Timisoara, June, 2026.

API-P16

NUMERICAL AND ANALYTICAL RESULTS FOR THE PULSATORY LIPOSOME

Diana-R. Radnef-Constantin[1], Dumitru Popescu[2], Agnetha A. Mocanu[3], Valentin I. Niculescu[4]

[1]*Institutul Astronomic Al Academiei Romane, 5 Cutitul De Argint Street, Bucuresti, Ro-040557, Romania*

[2]*ISMMA, 13 Calea 13 Septembrie Street, Bucuresti, Ro-050711, Romania*

[3]*Universitatea Hyperion Bucuresti, 169 Calarasilor Street, Bucuresti, Romania*

[4]*INFLPR, 409 Atomistilor Street, Magurele, Ro-077125, Romania*

In this work, we consider a special and interesting bionic object - the pulsatory liposome, which are an unilamellar liposome (lipid vesicle) filled with aqueous solution of osmotic solute. This is introduced in a hypotonic aqueous medium of large dimensions and, due to osmosis process, it has a dynamic and cyclic evolution. The swelling of the liposome during a cycle is described by a differential equation. The liposome relaxind and all the processes which contribute to the liposome relaxing and its coming back to the initial size (pore evolution and internal solution delivery) are described by three differential equations. For each cycle this set of differential equatios may be integrated using numerical and analytical methods [1-5]. The pulsatory liposome can be likened to a biophysical engine. We discuss the results obtained by both methods.

Key words: Pulsatory liposome, biophysical engine, liposome activity life.

References

[1] Popescu, D.; Popescu, A. G.; Journal of Theoretical Biology, 254, pp. 515-519, (**2008).**
[2] Popescu, D.; Popescu, A. G.; *Pulsatory Liposome: A possible biotechnological device. In Liposomes* - Recent Advances, New Perspectives and Applications, IntechOpen Ed. Rajeev K. Tyagi. 6 , 85, **(2023).**
[3] Constantin, D. R.; Popescu, D.; Romanian Journal of Physics. ,vol. 69, no. 1-2, (**2024)**.
[4] Popescu, D.; Radnef-Constantin, D. R.; Rom. Rep. Phys. **77**, 602, **(2025).**
[5] Radnef-Constantin, D. R.; Popescu, D.; Macromolecular Symposia, (**2025).**

Acknowledgement: We thank to our colaborator Valentin I. Niculescu which will pay the fee for our participation to the TIM2026 Conference, Timisoara, June, 2026.

API-P17

INTERMOLECULAR INTERACTIONS IN BINARY AND TERNARY SOLUTIONS OF ERYTHROSIN B (FOOD ADDITIVE E127)

Patricia-Liliana Vieru, Georgiana-Maria Stanciu, Dan-Gheorghe Dimitriu

Faculty of Physics, Alexandru Ioan Cuza University of Iasi, 11 Carol I Blvd., RO-700506, Iasi, Romania

Erythrosin B is a synthetic dye based on iodine (disodium salt of 2,4,5,7-tetraiodofluorescein), derived from petroleum and belonging to the class of xanthene dyes. It is known in the food industry as additive E127 or Red No. 3. Being a red-pink dye, it is used as food colorant, hair colorant, cosmetics and some industrial colorings. In the Unites States, the use of erythrosine B in cosmetics, topical drugs and some foods have been banned since 1990, while its use in all foods and ingested drugs has been banned from 2025. In Canada, erythrosine B is not considered a health risk, while in Europe it is allowed only in the processing of cherries, pet foods and toothpaste.

Here, erythrosin B was experimentally investigated in both binary (by using 18 solvents) and ternary (by using binary solvent mixtures water + methanol, water + ethanol and water + 1-propanol) solutions. The recorded spectra highlighted the presence of a visible electronic absorption spectral band around 540 nm. By analyzing the shift of this spectral band in different solvents, the weights of each type of intermolecular interactions, both specific and non-specific (universal), to the total spectral shift were comparatively estimated through different models. Three theoretical models were involved in the comparative analysis of the spectral band shift in ternary solutions, obtained by mixing two solvents in different ratios. The composition of the first solvation shell was estimated, including the ratio of the 1:1 molecular complex formed by the molecules of the two solvents. Also, the statistical cell model allowed the estimation of the difference between the energies of the intermolecular interactions of the type solute – solvent 1 and solute – solvent 2, respectively.

A quantum-mechanical modeling of erythrosine B molecule was performed by using the density functional method B3LYP, together with the basis set 6-311G*, in the frame of Spartan'24 software. Thus, the values of important molecular parameters were obtained, such as the ground state polarizability and electrical dipole moment, polar surface area, partition coefficient, energies of the frontier molecular orbitals (HOMO – highest occupied molecular orbital and LUMO – lowest unoccupied molecular orbital) etc. Also, the modeling provided the maps of the electrostatic charges per atom, electrostatic potential, local ionization potential, density and frontier orbitals.

Keywords: Erythrosin B, solvatochromism, intermolecular interactions.

API-P18

QUANTUM-MECHANICAL MODELING AND SOLVATOCHROMIC STUDY OF CITRIC ACID (FOOD ADDITIVE E330)

Georgiana-Maria Stanciu, Patricia-Liliana Vieru, Dan-Gheorghe Dimitriu

Faculty of Physics, Alexandru Ioan Cuza University of Iasi, 11 Carol I Blvd., RO-700506, Iasi, Romania

Citric acid, known also as sour salt, is an organic compound naturally occurring in citrus fruits, but also in apples, pears, sour cherry, berries, figs, mushrooms, tomatoes, potatoes, lettuce etc. It can be also synthetized from glycerol or through fermentation by mold of sucrose or glucose-containing medium. The citric acid is largely used in food industry for different purposes: flavoring and preservative in food and beverages, enzymatic clarification of fruit juices, prevention of sucrose or glucose crystallization in caramel or honey, acidification in winemaking and brewing (pH adjustment), emulsification of ice creams, stabilization of spices, prevention of enzymatic browning, oxidation inhibition etc. It is also used in pharmaceutical, chemical, cosmetics, textile and metallurgic industry, as well as in agriculture, construction and biomedical engineering. The citric acid is a compound with multiple health benefits: intermediate in the Krebs cycle (release of the energy stored in nutrients), antioxidant and anti-inflammatory agent, it prevents the formation of kidney stones and supports skin health.

The molecular structure of citric acid was optimized by using the density functional method B3LYP, together with the basis set 6-311G*. The modeling was performed for the isolated molecule (in vacuum), but also in different solvents (water, ethanol, dimethyl sulfoxide, dimethyl formamide and diethyl ether), by using the semi-empirical solvation model SM8. This allowed a comparative analysis of important molecular parameters, such as the ground state polarizability and electrical dipole moment, solvation energy, polar surface area or the energies of the frontier molecular orbitals. The maps of the electrostatic charges per atom, electrostatic potential, local ionization potential, density and frontier orbitals were also provided through modeling. The citric acid was experimentally investigated for solvatochromic behavior. The optical spectra were recorded in binary (by using 20 solvents) and ternary (by using the binary solvent mixtures water + methanol, water + ethanol and water + 1-propanol) solutions and the shifts of the electronic absorption spectral band (existing at around 220-260 nm) were analyzed. Important information was obtained, regarding the weight of each type of intermolecular interactions to the total shift of the electronic absorption spectral band, the composition of the first solvation shell of citric acid molecule in ternary solution or the role of the 1:1 molecular complex formed by the molecules of the two solvents, also in the ternary solutions.

Keywords: Citric acid, solvatochromism, quantum-mechanical modeling.

EDUCATIONAL PHYSICS (EP)

EP-O01

A CONNECTION-BASED TEAM TRIVIA FOR PHYSICS TEACHING

Sárközi Zsuzsa[1] and Vörös Alpár István Vita[2]

[1]*Babeş-Bolyai University, Physics Dept. (str. M. Kogălniceanu nr.1, 400084, Cluj-Napoca, Romania)*
[2]*Apáczai Csere János Highschool (str. I.C. Brătianu nr. 26, 400074 Cluj-Napoca, Romania)*

Physics in class is frequently perceived as a body of formulas disconnected from the world the students already know. Standard quiz-based activities address engagement but remain summative: they test recall rather than build understanding. This paper introduces the "Connection Round" for physics as a formative team trivia format that works differently.

Nine questions drawn from diverse domains — physics, history, language, music, everyday culture — share a single hidden theme revealed by a tenth question. Team-members work collaboratively, and because the entire block is scored at the end, finding the connection mid-round allows teams to retroactively unlock earlier answers. The reveal is a genuine insight experience: a sudden recognition that apparently unrelated facts are instances of the same underlying theme. This places the format at the "understand" and "analyse" levels of Bloom's taxonomy rather than the "remember" level characteristic of conventional physics quizzes. It is – in short – a formative trivia.

We present and analyse multiple rounds developed over years for two contexts: university-level rounds (created by MSc students), and one round adapted for a high school physics camp. We examine clue design, suspense arc, and the balance between physics content and cross-domain surprise. A one-week retention measurement from the camp participants (N = 18, 2022) illustrates the difference between analytical and insight-type clues: retention decreased for a direct factual clue and increased 100% for a linguistically concealed insight.

From this analysis we derive design principles for teachers who wish to construct their own rounds for semi-formal contexts or even for class.

Keywords: physics education, formative trivia, team learning.

References:

[1] H.L. Roediger, J.D. Karpicke, The power of testing memory: Basic research and implications for educational practice, *Perspectives on Psychological Science*, **1**(3), 181–210 (2006).
[2] M. Csikszentmihalyi, I. S. Csikszentmihalyi, eds., *Optimal Experience: Psychological studies of flow in consciousness* (Cambridge University Press, New York, 1988)
[3] Á. Bartha, *A nagy fotelkvíz* [The Great Armchair Quiz] (21. Század Kiadó, Budapest, 2022)

EP-O02

LARGE-VOLUME AI-GENERATED PHYSICS EXERCISES BASED ON STUDENT ABILITY AND COGNITION PROFILING

Felicia Ivona Scarlat[1], Alexandra Neagoe[1], Mihaela Carina Raportaru[2], Alexandru Nicolin-Żaczek[2]

[1]*University of Bucharest, Faculty of Physics, 405 Atomiştilor Street, Măgurele, Ilfov, Romania, 077125*
[2]*Institute of Space Science – INFLPR Subsidiary, 409 Atomiştilor Street, Măgurele, Ilfov, Romania, 077125*

Among the current classroom challenges the generation of personalized exercises that match the individual (very diverse) requirements of students ranks quite high, especially in low-resourced environments where such a manual production of differentiated, student-specific, but also curriculum-aligned materials is unrealistic. While the struggle to bridge the conceptual knowledge of the courses with the difficulties of practical pencil-and-paper problems is real, very few efficient solutions have been proposed so far. To this end, using the power of Large Language Models (LLM) that incorporate advanced reasoning features, we propose an AI-assisted problem-generation pipeline that responds to the requirements of most classroom environments, effectively bridging the gap between the very common standardized instruction and the highly-desirable but currently un-available personalized learning.

Our approach integrates two core innovations, namely:

- **Cognitive Profiling:** We developed an ability matrix utilizing seven qualitative metrics – including Visualization, Representation, and Algebraic Manipulation – derived from Polya's problem-solving framework and the Revised Bloom's Taxonomy. This allows for the diagnostic mapping of student difficulties.
- **Tag-Driven Synthesis:** Moving beyond simple profile-based prompting, we implemented a hybrid model that utilizes a "tag bank" of recurring conceptual and procedural patterns extracted from established physics curricula.

By integrating these two elements within a state-of-the-art LLM that has advanced reasoning abilities, we successfully generated scaffolded exercises tailored to three levels of cognitive transfer (low, medium, and high). Our results demonstrate that this framework not only improves the diversity and complexity of AI-generated practice materials but also provides an effective tool for educators. This study offers a practical, high-scalable, AI-assisted blueprint for enhancing procedural fluency and overcoming the "barrier of abstraction" currently identified in Romanian science education.

Keywords: Generative AI, Physics Education, Personalized Learning, Cognitive Profiling, Problem Solving, Kinematics.

References:

[1] IEA, TIMSS 2023 International Results in Mathematics and Science, International Association for the Evaluation of Educational Achievement (2024).
[2]G. Polya, How to Solve It: A New Aspect of Mathematical Method, 2nd ed., Princeton University Press (1957).
[3] L. W. Anderson and D. R. Krathwohl, A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Longman (2001).

EP-P01

AUGMENTED REALITY AND INTERACTIVE SIMULATIONS IN PHYSICS EDUCATION

Antoanetta Lungu[2], Mihail Lungu[1], Adriana-Florica Bogoșel[1,3]

[1]*Faculty of Physics, West University of Timisoara, Blvd. V. Parvan 4, 300223 Timisoara, Romania*
[2]*Technical College "E. Ungureanu", P-ta Iancu Huniade 3 Timisoara, Romania*
[3]*Secondary School no. 30, Aștrilor 13, Timisoara, Romania*

In education, physics teaching often involves complex and abstract concepts that challenge students' ability to develop a deep conceptual understanding. The integration of augmented reality (AR) and interactive simulations offers innovative pedagogical approaches that support active learning and conceptual visualization. This paper investigates the role of these technologies in undergraduate physics instruction, focusing on their effectiveness in improving students' analytical thinking, problem-solving skills, and conceptual understanding. Augmented reality enables the overlay of virtual models onto real-world environments, facilitating the exploration of otherwise inaccessible phenomena, while interactive simulations allow students to dynamically experiment with physical systems under controlled conditions. The study draws on empirical data from university courses, highlighting improvements in student engagement, academic performance, and knowledge retention. In addition, it addresses implementation challenges, including curriculum integration. The results highlight the potential of AR- and simulation-based learning to enrich physics education at the tertiary level and to align teaching practices with the demands of modern scientific training.

Keywords: augmented reality, interactive simulations, higher education, physics teaching.

References:

[1] Squire, K., & Klopfer, E. (2007). *Augmented Reality Simulations on Handheld Computers*. Journal of the Learning Sciences, 16(3), 371–413. https://doi.org/10.1080/10508400701413435

[2] McKagan, S. B., Perkins, K. K., Dubson, M., Malley, C., Reid, S., LeMaster, R., & Wieman, C. E. (2008). *Developing and Researching PhET Simulations for Teaching Quantum Mechanics*. American Journal of Physics, 76(4), 406–417.

[3] Johnson-Glenberg, M. C., Birchfield, D. A., Tolentino, L., & Koziupa, T. (2016). *Enhancing Learning and Engagement through Embodied Interaction within a Mixed Reality Simulation*. Computers & Education, 95, 174–187.

EP-P02

LEARNING PHYSICS THROUGH STEAM EDUCATION IN PRESCHOOL YEARS

Camelia Delia Voicu[1], Anca Irina Gheboianu[2], Cristina Mihaela Nicolescu[3]

[1] *Valahia University of Targoviste, Educational Sciences Department, Lt. Stancu Ion, No. 35*
[2]*Valahia University of Targoviste, ICSTM, Aleea Sinaia Street, No. 13*
[3]*Valahia University of Târgoviște, Institute of Multidisciplinary Research for Science Technology, Aleea Sinaia, nr 13, 130004, Târgoviște, Dâmbovița, Romania*

While it may initially seem early, introducing physics at the preschool level is consistent with the objectives outlined in the early childhood education curriculum. This approach not only encompasses scientific concepts that children can grasp at this age, enhancing their understanding of the environment, but also promotes logical reasoning and scientific knowledge skills essential for interpreting reality. The focus of this research was to analyse the teaching of physics in kindergarten through the perspective of the STEAM approach, investigating various factors related to both the learning environment and the content delivered. An online questionnaire was distributed across the counties of Dâmbovița, Prahova, Ilfov, and Bucharest to collect data. The results revealed that the scientific topics taught are significantly shaped by the learning context and that there is considerable variability in the strategies employed for teaching physics to young children. Furthermore, the research identified the primary challenges faced by teachers when instructing students in physics at the kindergarten level.

Keywords: preschool Physics education, STEAM education, early-age scientific literacy

References:

[1] S.Thulin, A. Jonsson, M. Fridberg, A. Redfors, *International Journal of Early Years Education*, *31*(3), 822–837 (2023). https://doi.org/10.1080/09669760.2021.2010518

[2] C Gur, *International Journal of the Physical Sciences* Vol. 6(4), pp. 939-943, 18 February, 2011

[3] A Redfors, M. Fridberg, A. Jonsson, S. Thulin, *Education Sciences*. 2022, 12, 427. https://doi.org/10.3390/educsci12070427

[4] C.D. Voicu, M.Ampartzaki, Z.Y.Dogan, M. Kalogiannakis. *Early Childhood Edu- cation - Innovative Pedagogical Approaches in the Post-modern Era. IntechOpen. Available at:* http://dx.doi.org/10.5772/intechopen.107886.

EP-P03

INNOVATIVE STEM EDUCATION: A CATALYST FOR YOUTH ENGAGEMENT IN STEM AND SUSTAINABLE DEVELOPMENT

Cristina Mihaela Nicolescu[1], Marius Bumbac[2], Anca Irina Gheboianu[2], Ion Valentin Gurgu[2], Simona Mihai[1], Isabela Elena Cetățoiu, Liviu Olteanu[1], Bogdan-Catalin Serban[3], Octavian Buiu[3], Anca Baciu[4], Zoltan Borsos[4], Georgeta Nan[4]

[1]*Valahia University of Târgoviște, Institute of Multidisciplinary Research for Science Technology, Aleea Sinaia, nr 13, 130004, Târgoviște, Dâmbovița, Romania*
[2]*Valahia University of Târgoviște, Faculty of Sciences and Arts, Sciences and Advanced Technologies Department, Aleea Sinaia, nr 13, 130004, Târgoviște, Dâmbovița, Romania*
[3]*National Institute for Research and Development in Microtechnologies, IMT-Bucharest, 126 A Str. Erou Iancu Nicolae, 077190, Voluntari, Ilfov, Romania*
[4]*Petroleum Gas University of Ploiești, Bd. București nr. 39, Ploiești, 100680, România*

Universities play an increasingly important role in connecting scientific research, education, and societal development, particularly when their activities are aligned with regional needs and community challenges. This paper presents the experience of Valahia University of Târgoviște, Romania, within the *Joy of Science in South Muntenia Region* initiative, an ongoing project designed to stimulate youth interest in science, technology, engineering, and mathematics through experimental discovery, participatory learning, and applied research-based education [1].

The project promotes an innovative STEM education model in which pupils, teachers, university students, and researchers collaborate in the design and implementation of practical scientific activities. Instead of approaching STEM as a set of abstract concepts, the initiative places experimentation, observation, problem-solving, and prototype development at the center of the learning process. Activities such as science-caravans, STEM-competitions, science-weeks, laboratory-demonstrations, and hands-on workshops were organized to create interactive learning environments where young participants could directly explore scientific principles and their practical applications [2-4].

A distinctive feature of the initiative lies in the co-creation of mini-STEM projects related to sustainability and regional development, encompassing both research and educational dimensions. Together with teachers and high-school pupils, the project team developed experimental activities addressing topics such as alternative galvanic cells for energy generation, anthocyanin analysis as a natural indicator system, 3D printing of plastic mechanical devices, energy harvesting through walking, miniature intelligent solar-energy systems, environmental risk analysis using sensors, reducing sugar detection, water testing and purification, smart irrigation systems for plants, composting as a sustainable solution for soil health, and the extraction or evaluation of active principles from aromatic plants. These activities allowed pupils to connect scientific concepts with real-life challenges related to renewable energy, environmental protection, resource efficiency, digital technologies, food analysis, and sustainable agriculture.

The pedagogical approach adopted in the project is based on experiential, participatory, and inquiry-based learning. Through direct involvement in experimental work, pupils were

encouraged to formulate questions, test hypotheses, interpret results, and propose practical solutions. This approach contributed not only to a better understanding of scientific phenomena but also to the development of critical thinking, creativity, teamwork, and communication skills. At the same time, the participation of university students and researchers facilitated knowledge transfer between academic research and pre-university education, strengthening the connection between schools and the university environment [3, 4].

The initiative also supports the development of open educational resources and promotes collaboration between academia, schools, local communities, industry, and public authorities. By grounding STEM education in locally relevant topics such as energy efficiency, waste management, water quality, environmental monitoring, digital fabrication, and sustainable use of biological resources, the project contributes to building a culture of scientific curiosity and civic responsibility among young learners.

Overall, the results demonstrate that universities can act as catalysts for youth engagement in STEM by transforming scientific knowledge into accessible, experimental, and socially relevant educational activities. The *Joy of Science in South Muntenia Region* initiative illustrates how research-based education, co-creation, and hands-on experimentation can support both the formation of future STEM-oriented generations and the broader objectives of sustainable regional development.

Keywords: STEM professions, applied chemistry and physics, innovation in STEM education, regional development

References:

[1] European Commission (2025). *A STEM Education Strategic Plan: Skills for Competitiveness and Innovation*. Brussels: European Commission. Available at: https://commission.europa.eu/topics/competitiveness/union-skills_en (accessed 20 May 2026).

[2] Nicolescu, C.M., Bumbac, M., Buruleanu, C.L., Voicu, C.D., Dunea, D., Alexandrescu, D.C., Bărascu, E., Hossu, A.M., Moise, V. (2025). *Technical competencies for food waste reduction: the importance of innovation in STEM education*. Annals of Food Science and Technology, 26(4), 12 pp.

[3] Șerban, B.-C., Buiu, O., Bumbac, M., Nicolescu, C.-M., Cobianu, C. (2018). *Chemistry – the journey from central science to chemophobia; how should we address this?*. Journal of Science and Arts, 18(4), pp. 1045–1060.

[4] Baciu, A., Ioniță, I., Suditu, M., Nan, G., Ioniță, L. (2024). *Experimental study on the impact of educational resources on learning effectiveness in STEM subjects*. Journal of Educational Sciences & Psychology, 14(2), pp. 26–34.

Acknowledgements:

This research was funded through the project *Joy of Science in South-Muntenia Region (BUSTING)* - PN-IV-P10-SS-SC-2024-0142, Contract no. 10SSSC/2025, financed by Romanian Ministry of Education and Research.

EP-P04

PERSONALIZED AI-GENERATED PHYSICS EXERCISES BASED ON STUDENT ABILITY AND COGNITION PROFILING

Alexandra Neagoe[1], Felicia Ivona Scarlat[1], Mihaela Carina Raportaru[2], Alexandru Nicolin-Żaczek[2]

[1]*University of Bucharest, Faculty of Physics, 405 Atomiştilor Street, Măgurele, Ilfov, Romania, 077125*
[2]*Institute of Space Science – INFLPR Subsidiary, 409 Atomiştilor Street, Măgurele, Ilfov, Romania, 077125*

Personalized practice is central to developing procedural fluency in physics, but the manual production of differentiated, curriculum-aligned exercises is difficult to scale for a normal-sized classroom. Motivated by the evidence that many students struggle when moving from conceptual knowledge to paper-and-pencil applications [1], this paper proposes an AI-assisted framework for generating personalized kinematics exercises that match the cognitive-ability profile of each learner. The model combines Polya's problem-solving stages [2] with the Revised Bloom's Taxonomy [3] to define seven diagnostic dimensions: task understanding, visualization, representation, equation building, computation, units and conversions, and algebraic manipulation. A synthetic dataset of 20 student profiles was created by assigning low, medium or high difficulty levels to these dimensions and deriving an overall problem-solving profile. Two generation phases were compared. In Phase I, the AI generated exercises directly from the student profile; the resulting tasks were useful for scaffolding but often too simple and insufficiently diverse. In Phase II, a tag-driven layer was added: 24 Romanian ninth-grade kinematics problems were solved and annotated for recurring conceptual and procedural tags, then these tags were recombined with student profiles to generate a 30-item adaptive worksheet. The final output organized practice into three transfer levels: low scaffold, medium transfer and high transfer. The proposed framework therefore moves beyond generic problem construction toward a structured diagnostic-generation pipeline that properly accounts for student cognition, curriculum content and task complexity. Its main contribution is a scalable method for producing differentiated physics practice problems that can support classroom remediation, extension work and increased student autonomy in Romanian physics education.

Keywords: Generative AI, Physics Education, Personalized Learning, Cognitive Profiling, Problem Solving, Kinematics.

References:

[1] IEA, TIMSS 2023 International Results in Mathematics and Science, International Association for the Evaluation of Educational Achievement (2024).
[2]G. Polya, How to Solve It: A New Aspect of Mathematical Method, 2nd ed., Princeton University Press (1957).
[3] L. W. Anderson and D. R. Krathwohl, A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Longman (2001).

List of participants

Victor E Ambrus
Mircea Eugen Anitas
Anca Baciu
Francisc Bader
Ionel Balcu
Aritra Bandyopadhyay
Zoé Barbotin
Elisa Bellantoni
Marian Petrica Bertici
Ioan Bica
Roxana Biricioiu
Robert Blaga
Adiana-Florica Bogosel
Emanuela Boicu
Irinuca Boldea
Adina Boldeiu
Zoltan Borsos
Ondrej Bošák
Dragos-Viorel Brezoi
Oana Brincoveanu
Octavian Buiu
Marius Bumbac
Madalin Octavian Bunoiu
Gabriel Buse
Sergiu Busuioc
Doru Buzatu
Matteo Buzzegoli
Victor Ceban
Irina Cebotari
Isabela Elena Cetatoiu
Liviu Chirigiu
Aminul Islam Chowdhury
Shamik Chowdhury
Eugen-Mihaita Cioroianu
Jordan Ciucea
Andrea-Florina Codrean
Florin-Matei Constantin
Corneliu Craciunescu
Germano Craia
Lehel Csillag
Alexandr Cudreasov
Anil Dhanda
Dragoljub D Dimitijevic
Magdalena Djordjevic
Goran Djordjevic
Dan-Gheorghe Dumitru
Narcis Duteanu
Mathieu Duttine
Aurel Ercuta
Monica Focsan
Kenji Fukushima
Alessandro Gabbana
Gregory Gadret
Andrei Mihai Gavrilovici
Aleksandar Gecic
Ioana Cristina Gerber
Makarand M. Ghangrekar
Anca-Irina Gheboianu
Cosmin Stefan Gherghinoiu
Mihai A Girtu
Anamaria-Giulia Goilean
Ion Valentin Gurgu
Sergiu-Mihai Hategan
Felix-Iosif Iacob
Raluca Ica
Rares Iovanescu
Cristian-Radu Ivan
Alexandru Jipa
Daniel Kincses
Petr Kostka
Marian Kubliha
Moulindu Kundu
Vladimir Labaš
David Le Coq
Mihail Lungu
Antoanetta Lungu
Corina Macarie
Florin Maciuc

Mihai A Macovei
Maximilian Mangra
Stefan-Sabin Manolescu
C.N. Marin
Alina Matei
Simona Mihai
Ilarion Mihaila
C. Mihailescu
Iuliana Mihalache
Milan Milošević
Stanislav Minárik
Roxana Mocanu
Agnetha Mocanu
Sergio Morales Tejera
Vincent Motto-Ros
Mustafa Munshi
Sorin Nadaban
Georgeta Nan
Alexandra Neagoe
Bianca-Emanuela Nicolescu
Cristina-Mihaela Nicolescu
Alexandru Nicolin-Żaczek
Valentin I. Niculescu
Liviu Oltean
Corneliu I Oprea
Cristina Pachiu
Gabriel Pascu
R. Pascu
Catalin Pascu Moca
Tudor Patuleanu
Marius Paulescu
Eugenia Paulescu
Frederic Pelascini
Valentin Pohoata
Maria Poienar
Aurora-Anca Poinescu
Mihaela Popa
Alexandra Popescu
Dumitru Popescu
Liliana Preda
G. Pristavu
Olga Procházková
Diana-R. Radnef-Constantin
Mircea Radulian
Ray Rajarshi
Mihaela Carina Raportaru
Adina Rau
Cosmin Romanitan
Arthur Rotari
Mark Rushton
Daniel Rytz
Andreea Sabadus
Mirela Sarbu
Zsuzsa Sárközi
Felicia Ivona Scarlat
Carla Schornig
Florin Secosan
Bogdan-Catalin Serban
Paula Sfirloaga
Octavian-Gabriel Simionescu
Rajeev Singh
Pracheta Singha
Maximilian Sipos
Robert M Solomon
Marius Spunei
Georgiana-Maria Stanciu
Jelena Stankovic
Marius Stef
A.T. Stiolica
George Stirban
Marko Stojanović
Tina Tasheva
Dragos Tatomirescu
Lakshmi Pathi Thulluru
Catalin M Ticos
Ionut Topala
Federico Toschi
Nadia Tsoneva
Vasilica Tucureanu
Alex-Florin Turc
Dragos Valsan
Petr Vařák
György Varga
Philippe Veber

Kesavan Venkatachalam
Lousiane Verger
Patricia-Liliana Vieru
Daniel Vizman
Camelia Delia Voicu
Alpár István Vita Vörös
Roman Yatskiv
Alina Zamfir
Jiří Zavadil
Carla Zeicu