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TIM 22

PHYSICS CONFERENCE

Abstract booklet

**FACULTY OF PHYSICS
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23-25 November 2022

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23-25 November 2022
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CM-O06	<u>APPLICATION OF THE Cr³⁺ IONS FOR OPTICAL THERMOMETRY - A REVIEW</u> E.C.C. Kiss , M. Piasecki, M.G. Brik

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API-I02	<u>USING ADVANCED TECHNOLOGIES TO PROCESS DATA GIVEN BY A PM SENSOR</u> M.T. Udristoiu , A. Dudáš, A. Michalíková, J. Škrinárová, J. Raganová, M. Hruška, M. Spodniaková Pfefferová, J. Raykova, H. Yldizhan, I. Petrisor, I. Buligiu, D. Stoyanova, E. Yilmaz
API-O01	<u>ESTIMATION OF PM10 POLLUTION LEVEL FOR 2021 IN FIVE MAJOR ROMANIAN CITIES USING INDEPENDENT AIR QUALITY MONITORING NETWORK DATA</u> L. Velea, M.T. Udristoiu , S. Puiu, R. Motisan
API-O02	<u>HYPERTHERMIA WITH NANOPARTICLES IN THE FORM OF FERRITES</u> Ardeleanu Helmina , Iordana Astefanoaiei, Dorina-Emilia Creanga
API-O03	<u>THE OUTCOME OF BREAST CANCER RADIOTHERAPY AS A FUNCTION OF SETUP ERRORS</u> Ioana-Claudia Costin , Loredana G. Marcu
API-O04	<u>ION METROLOGY DEVELOPMENTS FOR EXTREME LIGHT INFRASTRUCTURE</u> Michael Ehret , G. Gatti, L. Volpe, D. Ursescu
API-O05	<u>HIGH VACUUM VAPOR-PHASE PROTON EXCHANGE LINBO3 OPTICAL WAVEGUIDES WITH HIGH-INDEX CONTRAST</u> Mihnea-Raoul Sandu , L. Hrostea, A. P. Rambu, F. Doutre, V. Tiron, S. Tascu
API-O06	<u>HIGH CONTROL AND REPRODUCIBILITY OF INDEX CONTRAST OF LITHIUM NIOBATE WAVEGUIDES FABRICATED BY HIGH VACUUM PROTON EXCHANGE</u> Laura Hrostea , M. R. Sandu, A. P. Rambu, S. Tascu
API-O07	<u>PM MODELLING THROUGH LAND-USE REGRESSION IN TIMIȘOARA, ROMANIA</u> Robert Blaga



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TC-P02	<u>STATISTICS OF MOON SURFACE CRATERS</u> T.-G. Dumitru, R. Solomon, A.I. Nicolin
TC-P03	<u>PRODUCTION OF Z BOSONS AND ELECTRON-POSITRON PAIR IN DE SITTER UNIVERSE</u> Cosmin Crucean and Diana Dumitrele
TC-P04	<u>WAITING TIMES DISTRIBUTIONS IN CRIPTOCURRENCY EXCHANGE RATES</u> T.-G. Dumitru, A.I. Nicolin and E.G. Spanakis
TC-P05	<u>LAYERED PLANAR TARGETS FOR THE PRODUCTION OF GAMMA BEAMS USING HIGH-POWER LASERS</u> S. Micluța-Campeanu, D. Doria, A.I. Nicolin
TC-P06	<u>DISTRIBUTION OF WAITING TIMES FOR AVERAGE SEA LEVELS IN TRIESTE HARBOR</u> G.T. Pană and A.I. Nicolin
TC-P07	<u>NUMERICAL MODELING OF ULTRA HIGH INTENSITY LASER ION ACCELERATION AND GAMMA PRODUCTION FROM OVERDENSE COS^2 PROFILE ARGON GAS JETS</u> Dragos Tatomirescu

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CM-P02	<u>DISLOCATIONS IN PbF_2 DOPED BaF_2 CRYSTALS</u> Marius Stef, Gabriel Buse , Carla Schornig and Maria Poienar
CM-P03	<u>STUDY OF COBALT PHOSPHATES: SYNTHESIS AND THERMAL PROPERTIES</u> Maria Poienar , Gabriel Buse, Paula Sfirloaga, Daniel Vizman, Marius Stef, Anamaria Dabici and Paulina Vlazan

APPLIED PHYSICS AND INTERDISCIPLINARITY

-Poster presentations-

API-P01	<u>ELECTRICAL AND DIELECTRIC PROPERTIES OF ZINC LEAD TELLURITE GLASSES WITH LEAD IN VARIOUS FORM</u> Ondrej Bošák , Petr Kostka, Marian Kubliha, Svetlana Lukic-Petrovic, Goran Štrbac, David Le Coq, Stanislav Minarik
API-P02	<u>PREPARATION AND LUMINESCENCE PROPERTIES OF Pr-DOPED HEAVY METAL OXIDE GLASSES BY ION IMPLANTATION</u> Marian Kubliha , Petr Kostka, Roman Yatskiv, Laurent Calvez, David Le Coq, Pavol Noga, Vladimir Labaš, Ondrej Bošák
API-P03	<u>THE PRESENCE OF HEAVY METALS IN DENTAL CARIES, PERMANENT TEETH, COMING FROM A POLLUTED WORK ENVIRONMENT</u> Marius Belc, Semaghiul Birghila, Nicoleta Matei, Mihaela Maris
API-P04	<u>ANALYSIS AND CALIBRATION OF GFS SOLAR IRRADIATION FORECASTS FOR TIMISOARA</u> Sergiu-Mihai Hategan and Marius Paulescu
API-P05	<u>STRUCTURAL AND MORPHOLOGICAL INVESTIGATIONS OF MOSAICS FROM BANLOC CASTLE (ROMANIA)</u> Alina Moşiu, Lorena Iancu, Ramona Marina Grigorescu, Anca Irina Gheboianu, Sofia Slamnoiu-Teodorescu, Rodica-P1mariana Ion, Marius Moşoarcă
API-P06	<u>IDENTIFICATION OF ANTROPHIC ACTIVITY INTERFERENCE IN THE SEISMIC CATALOGUE FOR BANAT REGION</u> Adina Vanciu Rau, Raluca Dinescu, Mircea Radulian, Mihail Lungu
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API-P08	<u>PROFILING PARTICLES OF SAHARA DUST SETTLED IN ROMANIA BY A SIMPLIFIED DYNAMIC LIGHT SCATTERING PROCEDURE AND CENTRIFUGATION</u> Chicea Dan and Olaru Sorin
API-P09	<u>STRUCTURAL INVESTIGATION OF $x(\text{V}_2\text{O}_5) \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}]$ AND $x\text{V}_2\text{O}_5 \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{CaO}]$ GLASS SYSTEMS BY RAMAN SPECTROSCOPY</u> D. Racolta , M. Balasoiu, C. Andronache, L. Mihaly-Cozmata, A.V. Rogachev, O.L. Orelovich, V.V. Sikolenko
API-P10	<u>EYEBALLS SCATTERED IRRADIATION DOSES INDUCED IN A X-RAYS TREATMENT</u> Nicola Cristina Madalina
API-P11	<u>THE IMPACT OF ACCURATE PARAMETERS ESTIMATION OF A SOLAR CELL ON PV MODULE PERFORMANCE ASSESSMENT</u> Andreea Sabadus and Marius Paulescu
API-P12	<u>STRUCTURE ORGANIZATION OF SILICONE-RUBBER BASED MAGNETIC AND MAGNETORHEOLOGICAL ELASTOMERS REVEALED BY MEANS SANS AND NEUTRON DEPOLARIZATION METHODS</u> M. Balasoiu, O. M. Bunoiu, V.T. Lebedev, S.V. Kozhevnikov, L. Almasy, Yu.V. Nikitenko, A.I. Kuklin, I. Bica
API-P13	<u>STUDY OF ELECTRICAL PROPERTIES OF SOME ORGANIC TERNARY BLENDS THIN FILMS FOR PHOTOVOLTAIC APPLICATIONS</u> Laura Hrostea and Liviu Leontie

API-P14	<u>A NUMERICAL ANALYSIS OF PARTICLE HANDLING BY STANDING ACOUSTIC AND DIELECTROPHORETIC FIELDS</u> G.D. Lascu , D.M. Bălăţeanu, M. Lungu and A. Neculae
API-P15	<u>STATISTICS OF MUSICAL NOTES</u> I. Stanciu, A. Stancea, A.I. Nicolin
API-P16	<u>FORECASTING THE SUNSPOT NUMBER BY USING ARTIFICIAL INTELLIGENCE TECHNIQUES</u> Remus Boata
API-P17	<u>A HYBRID METHOD FOR MODELING SOLAR IRRADIATION IN TIMISOARA</u> Remus Boata
API-P18	<u>MAGNETICALLY ACTIVE COMPOSITES WITH RELATIVELY GIANT DIELECTRIC PERMITTIVITY</u> Madalin Bunoiu, Maria Balasoiu, Gabriel Pascu , Liviu Chirigiu, Gabriela Iacobescu and Ioan Bica

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EP-O02	<u>NEW EXPERIENCES AND FACTS IN MULTIMEDIA TEACHING OF COSMOLOGY, ASTROPHYSICS AND SPACE TECHNOLOGY TO STUDENTS FROM ALL FIELDS</u> Dumitru N. Vulcanov
EP-O03	<u>SOME MODERN METHODS RELATED TO ADVANCED TECHNOLOGIES IN TEACHING STEM SPECIALISTS</u> Zh. Raykova, D. Stoyanova, Mihaela T. Udristioiu , H. Yidizhan, J. Raganova, E. Yilmaz, I. Petrisor, I. Buligiu, S.C. Sararu, M. Hruska, M. Spodniakova-Pfefferova
EP-O04	<u>THE IMPACT OF BOTH REAL AND VIRTUAL LABORATORY ON PRACTICAL SKILLS DEVELOPMENT FOR EDUCATION IN PHYSICS</u> Ralph Alexandru Erdelyi and Dana Craciun
EP-O05	<u>INFLUENȚA CLASEI OGLINDITE (FLIPPED CLASSROOM) ASUPRA ELEVILOR DE LICEU LA ORA DE FIZICĂ</u> Maria-Roxana Biricioiu, Dana Crăciun
EP-O06	<u>PARTICULARITĂȚI ALE UTILIZĂRII TIC ÎN ACTIVITATEA DIDACTICĂ LA DISCIPLINA FIZICĂ</u> Baba Sanda, M. Ilie, Dana Crăciun
EP-O07	<u>ÎNVĂȚAREA FIZICII PRIN INVESTIGAȚIE</u> Lăcătușu Violeta Eugenia

- Poster presentations -

EP-P01	<u>METHODS USED FOR THE PURPOSE OF MOTIVATING THE STUDY OF PHYSICS AT THE LEVEL OF THE EDUCATIONAL UNIT</u> Antoanetta Corina Lungu, Adina Daniela Mioc
EP-P02	<u>UNDERSTANDING THE FORMATION OF SHOCK WAVES THROUGH THE NUMERICAL SOLUTION OF BURGERS' EQUATION</u> D. Costache, A.I. Nicolin
EP-P03	<u>THE IMPORTANCE OF PHYSICS EDUCATION IN A MODERN SOCIETY</u> Kortye Claudia
EP-P04	<u>UTILIZAREA APLICAȚIILOR DE TIP "SITE BUILDER" ÎN PREDAREA ȘI ÎNVĂȚAREA FIZICII</u> Ramona Humeniuc



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CONFERENCE ABSTRACTS

TCP - Plenary presentation

SPIN, POLARIZATION AND COORDINATE OPERATORS OF MASSIVE DIRAC'S FERMIONS

Ion I. Cotaescu

West University of Timisoara

It is shown that the components of Pryce's spin operator of Dirac's theory are $SU(2)$ generators of a representation carried by the space of Pauli's spinors determining the polarization of the plane wave solutions of Dirac's equation. These operators are conserved via Noether theorem such that new conserved polarization operators can be defined for various polarizations. The corresponding one-particle operators of quantum theory are derived showing how these are related to the isometry generators of the massive Dirac fermions of any polarization, including momentum-dependent ones. In this manner, the problem of separating conserved spin and orbital angular momentum operators is solved naturally. Moreover, the operator proposed by Pryce as mass-center coordinate is studied showing that after quantization this becomes in fact the dipole one-particle operator.

Keywords: Dirac theory, spin operator, coordinate operator, isometry generators, QFT, one-particle operators.

References:

[1] I.I. Cotaescu, arXiv: 2206.13911

CMP - Plenary presentation

QUANTUM QUENCH AND CHARGE OSCILLATIONS IN THE SU(3) HUBBARD MODEL

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We introduce the notion of non-Abelian tensors, and use them to construct a general non-Abelian time evolving block decimation (NA-TEBD) scheme that uses an arbitrary number of Abelian and non-Abelian symmetries. Our approach increases the speed and memory storage efficiency of matrix product state based computations by several orders of magnitudes, and makes large bond dimensions accessible even on simple desktop architectures. We use it to study post-quench dynamics in the repulsive SU(3) Hubbard model, and to determine the time evolution of various local operators and correlation functions efficiently. Interactions turn algebraic charge relaxation into exponential, and suppress coherent quantum oscillations rapidly.

Keywords: Quantum quench, TEBD, Hubbard model.

References:

[1] Cătălin Pașcu Moca, Miklós Antal Werner, Örs Legeza, Tomaž Prosen, Márton Kormos, and Gergely Zaránd, Phys. Rev. B 105, 195144 (2022)

[2] Miklós Antal Werner, Cătălin Pașcu Moca, Örs Legeza, and Gergely Zaránd Phys. Rev. B 102, 155108 (2022)

CMP - Plenary presentation

**MICROMAGNETIC DESIGN OF SKYRMIONIC MATERIALS AND CHIRAL
MAGNETIC CONFIGURATIONS IN PATTERNED NANOSTRUCTURES FOR
NEUROMORPHIC AND QUBIT APPLICATIONS**

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We tackle the problematics of magnetic skyrmions, nanometer-size vortex-like swirling topological defects in the magnetization texture [1] within a multiple scale modelling framework. Using *ab-initio* tools [2], we calculated and analyzed the anatomy of the magnetic anisotropy, the Dzyaloshinskii–Moriya asymmetric exchange (DMI) and their response to a gating electric field, in some multi-layered heterostructures, designed to provide electric field tunable perpendicular magnetization and sizeable DMI, as requested for skyrmion occurrence. Micromagnetic simulations in nanometer-size disks [3] allowed us to extract phase diagrams of materials parameters and corresponding magnetic textures classified according to their topological charge. From the phase diagrams we identified the suitable range of magnetic anisotropy, DMI and saturation magnetization allowing either to stabilize skyrmionic ground states or to write them using the spin-transfer torque of a pulsed perpendicular current. We further illustrate manipulation strategies of the skyrmions' core polarization and chirality via electric fields. Analysis of different contributions to the total magnetic energy density point out critical issues influencing the skyrmions' stability. Finally, we discuss experimental issues related to the choice of materials or the design of novel magnetic materials compatible with skyrmionic applications in classic, neuromorphic and quantum information technologies.

Keywords: skyrmions, nanomaterials, micromagnetism.

References:

- [1] A. Fert et al, *Nature Reviews Materials* **2**, 17031 (2017).
- [2] P. Blaha et al, *J. Chem. Phys.* **152**, 074101 (2020).
- [3] A. Vansteenkiste et al, *AIP Advances* **4**, 107133 (2014).

TCP - Plenary presentation

**THE HIGGS BOSON: DISCOVERY, CURRENT STATUS
AND FUTURE PLANS**

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The ‘Standard Model’, the theory describing the microscopic behaviour of elementary particles, provides an accurate description of the force of electromagnetism, the weak nuclear force and the strong nuclear force. Based on the principle of ‘gauge symmetry’, the Standard Model (SM) has achieved exceptionally high agreement between theoretical predictions and experimental measurements.

The most impressive discoveries made at CERN were the massive W and Z gauge bosons in 1983 and the subsequent discovery in 2012 of the Higgs boson, the final particle of the model to be confirmed.

Despite its success, the SM cannot describe all observed phenomena, indicating the need for new ideas such as supersymmetry.

I will present the current status of the measurements dedicated to Higgs boson production and its intrinsic properties.

In the second part of my talk will discuss the near future plans and long-term perspective for accurate Higgs boson characterization.



Figure 1: 4 July 2022, Anniversary of the discovery of the Higgs boson.

Keywords: Higgs boson, Standard Model, Large Hadron Collider, Future Circular Collider.

References:

[1] 4 July 2022, Anniversary of the discovery of the Higgs boson
<https://home.cern/events/anniversary-discovery-higgs-boson>

API - Plenary presentation

MECHANOELASTIC MODEL FOR SPIN-CROSSOVER MOLECULAR MAGNETS

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Spin crossover (SC) molecular magnets, extensively studied due to their potential applications in thermal and pressure sensors, optical displays, actuators or in data storage, are inorganic compounds commutable between two states with different optical, volume, magnetic and vibrational properties: the low spin state (LS) and the high spin state (HS). The commutation between the states can be triggered by temperature, pressure, light irradiation or magnetic field. In this paper we use the mechano-elastic model, based on the idea that the difference of molecular volumes between the two states is at the origin of elastic interactions [1, 2], in order to discuss recent experimental data in spin crossover materials, such the elastic step after photoexcitation, the thermal behavior of the SC nanoparticles on a surface, or the same state molecules cluster formation [3] (Figure 1). The simulations were performed for open boundaries 2D and 3D samples, composed of individual molecules linked by springs, which stand for elastic interactions, and the evolution of the system has been followed by Monte-Carlo or Molecular Dynamics approaches.

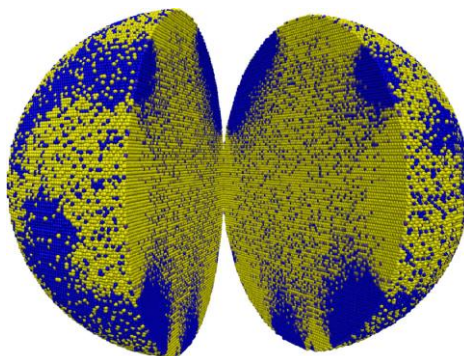


Figure 1 HS molecules cluster formation for a large sphere (1 million SC molecules) from several points on the surface. HS molecules: blue, LS molecules: yellow

Keywords: molecular magnets, elastic model, Monte Carlo simulations.

References:

- [1] C. Enachescu, L. Stoleriu, Lorenc, E. Collet et al., *Phys. Rev. B*, **95**, 224107 (2017), *Phys. Rev. B*, **96**, 614105 (2017), *Phys. Rev. B* (2022), in press
- [2] R. Bertoni, M. Lorenc, L. Stoleriu, C. Enachescu et al., *Nature Mat*, **15**, 606 (2016)
- [3] A. I. Popa, L. Stoleriu, C. Enachescu, *J. Appl. Phys*, 129, 131101 (2021)



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EP - Plenary presentation

OPPORTUNITIES IN PHYSICS AND PHYSICS EDUCATION IN THE BALKAN REGION

Radu Constantinescu

TCP - Invited presentation

TOWARD OBJECT ORIENTED BAYESIAN TWO-RULE AUTOMATIC ADAPTIVE QUADRATURE

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The QUADPACK subroutine package [1] for solving the Riemann integrals (RI), implemented in all the major computing libraries worldwide, shows as weak feature the *fragility* of its automatic decisions driving the path to the solution.

The Bayesian two-rule automatic adaptive quadrature (B2AAQ) [2], while keeping the perennial QUADPACK qualities, implements an integrand adapted chain of automatic decisions resulting in *robust*, *reliable*, and *efficient* solutions. Essentially, B2AAQ builds up the numerical solution through a gradual development of a partition of the integration domain $[a,b]$ into finite integration ranges. Their distribution is driven by Bayesian inferences on the integrand conditioning, following from locally resolved integrand properties over the knots of the spanning AAQ rule evaluation component. The details of the evolving partition critically depend on the user provided *a priori* information on the integration domain $[a,b]$ and on the occurrence of isolated ill-conditioned features of the integrand function over it.

The B2AAQ solution may be built up either as a *general single subrange decision tree* (allowing for the existence of 25 classes of root inputs) or as a *forest of general subrange decision trees*. A forest always includes two lateral subrange trees, allowing together for 40 classes of tree root inputs. A number of 16 classes of tree root inputs are possible for each of the $K-1$ ($K > 1$) *inner* subrange trees, if present.

The characterization of the tree root inputs is elementary, without asking for expert assessment of the RI properties, as assumed by the QUADPACK package.

Keywords: automatic adaptive quadrature, QUADPACK package, Bayesian two-rule automatic adaptive quadrature, numerical integration, Riemann integrals.

References:

- [1] R. Piessens, E. de Doncker-Kapenga, C.W. Ueberhuber, D.K. Kahaner, QUADPACK, *a subroutine package for automatic integration*, Springer, Berlin, (1983).
- [2] Gh. Adam and S. Adam, EPJ Web of Conferences **226**, 01001, 8 pp. (2020)
<https://doi.org/10.1051/epjconf/202022601001>

TCP - Invited presentation

Dedicated to Prof. Ion I. Cotăescu, on his 80th anniversary

**A POWERFUL TOOL FOR PARTICLE PHYSICS: THE GENERALIZED GAUGE MODEL
 $SU(3)_c \otimes SU(n)_L \otimes U(1)_Y$**

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In this paper we argue that, by simply further working out—within the renormalization paradigm—the Cotăescu theoretical method [1] of solving generalized $SU(3)_c \otimes SU(n)_L \otimes U(1)_Y$ gauge models, one obtains [2,3] several phenomenological predictions such as: the true quantization of both the electric and weak charges for all the particles allowed by these models, as well as the precise number of 3 fermion generations observed in nature, a plausible mass spectrum and a promising framework for implementing mass-generating mechanisms for the neutrino sector.

Keywords: generalized gauge models, electric and weak charges quantization, mass spectrum.

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TCP - Oral presentation

**QUANTUM EFFECTS RELATED TO TOROIDAL DIPOLE MOMENTS
AND THE POSSIBILITY OF OBSERVING THEM**

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Toroidal multipoles are a new class of electromagnetic multipoles that were originally discovered in the context of parity violation in nuclear reactions. Nowadays, the toroidal dipole (the lowest order term) is studied in systems at all scales, from particle physics, to solid state systems and metamaterials. While in most experimental setups for metamaterials the toroidal dipole can be treated classically [1,2], we have introduced its quantum treatment using a toroidal dipole operator of the form [3,4]:

$$\hat{T}_i \equiv \frac{1}{10 m_p} \sum_{j=1}^3 (x_i x_j - 2r^2 \delta_{ij}) \hat{p}_j \quad (1)$$

with i and j cartesian indices, m_p is the mass of the particle and \hat{p}_j is the momentum operator.

The properties of this operator were studied for a thin film shaped into a torus surface. While it was found to be an observable, handling it poses some problems due to its eigenfunctions not being normalizable. After essentially performing a renormalization, we found out that the values the toroidal dipole takes should be quantized. Considering the coupling with the electromagnetic field $\hat{H}_I \equiv -\mu_0 q (\vec{j} + \vec{\dot{D}}) \cdot \hat{\vec{T}}$ we estimated the energy separation that could be expected as well as its dependence on the size and scale of the system.

Keywords: toroidal moments, quantum mechanics, metamaterials.

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TCP - Oral presentation

SUPER-EXCITED STATES OF NS RELEVANT FOR ELECTRON/NS⁺ COLLISIONS

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The NS⁺ cation was recently discovered in the interstellar medium [1]. The e⁻/NS⁺ collisions play a major role in its kinetics. We have just completed a preliminary study of these processes. In a first step, the R-matrix method was employed to *ab-initio* calculate the relevant Feshbach resonances of NS, their autoionization widths and the major NS Rydberg series [2]. Subsequently, we found the asymptotic limits for these states of the neutral molecule. The following step is to use these data to compute the collision cross-sections by applying the Multichannel Quantum Defect Theory (MQDT) [3,4]. Figure 1. shows the closest to ion Rydberg potential curve and two dissociation potential curves along with their dissociation limit.

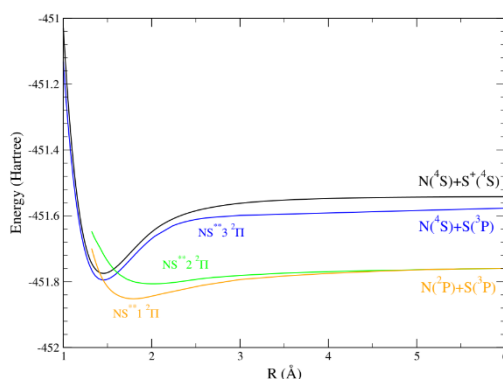


Figure 1: Potential energy curves for NS⁺ (top, black), a Rydberg state (below, blue) and two dissociative states (green and orange) of NS in the case of ²Π symmetry.

Keywords: Rydberg states, resonances, R-matrix, collision quantum dynamics.

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TCP - Oral presentation

UNIVERSAL DECAY LAW FOR α -DECAY WITH SCREENING CORRECTION

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A new empirical formula for the α -decay half-lives is obtained from the generalization of the electrostatic interaction with the inclusion of a screening effect [1, 2]. The screening is modeled through the analytical form of the Hulthen potential. The obtained formula recovers the universal decay law when screening is absent. Numerical applications are performed for the assertion of the impact of the screening effect on the reproduction of data for heavy and superheavy nuclei and for generating predictions for exotic nuclei.

Keywords: half-lives, alpha decay, screening effect.

References:

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TCP - Oral presentation

LATTICE BOLTZMANN MODEL FOR DENSE GAS FLOWS

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The Boltzmann equation becomes invalid as the size of gas molecules is comparable with the average intermolecular distance. A better description is provided by the Enskog collision operator[1], which takes into account the finite size of gas molecules. This extension implies non-local collisions as well as an increase in collision frequency, making it computationally expensive to solve. An approximation of the Enskog collision operator is used in this work to develop a quadrature-based Lattice Boltzmann scheme for non-ideal monatomic dense gases[2]. The kinetic model is shown to be able to tackle non-equilibrium flows of dense gases in problems such as shock wave propagation. The results are compared systematically with the more accurate but computationally intensive particle method of solving the Enskog equation. The Shakhov model [3] is implemented in order to fine-tune the Prandtl number. The present model is shown to have good accuracy for small to moderate denseness of the fluid (proportional to the reduced density), as shown in Fig. 1, and due to the efficiency in terms of computational time, it is suitable for practical applications.

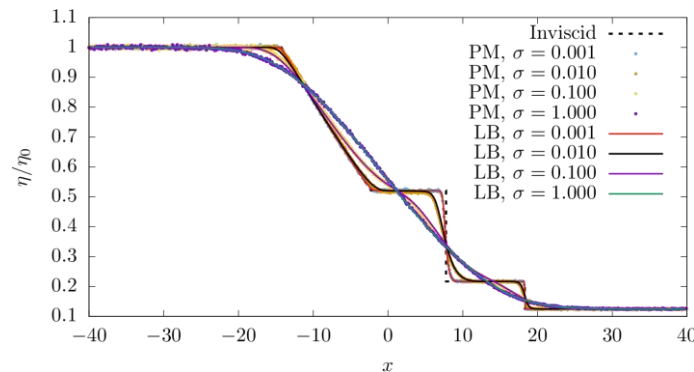


Figure 1: Reduced density η/η_0 for different values of the molecular diameter σ , obtained using Lattice Boltzmann (LB) and the particle method (PM).

Keywords: Kinetic theory, Lattice Boltzmann, Shock wave propagation, Dense gas.

References:

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TCP - Oral presentation

MEASUREMENT-INDUCED NONLOCALITY FOR OBSERVERS NEAR A BLACK HOLE

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We present a systematic and complementary study of quantum correlations near a black hole by considering the measurement-induced nonlocality (MIN). The quantum measure of interest is discussed on the same footing for the fermionic, bosonic and mixed fermion-boson modes in relation to the Hawking radiation. The obtained results show that in the infinite Hawking temperature limit, the physically accessible correlations does not vanish only in the fermionic case. However, the higher frequency modes can sustain correlations for the finite Hawking temperature, with mixed system being more sensitive towards increase of the fermionic frequencies than the bosonic ones. Since the MIN for the latter modes quickly diminishes, the increased frequency may be a way to maintain nonlocal correlations for the scenarios at the finite Hawking temperature.

Keywords: black holes, nonlocality, quantum information.

TCP - Oral presentation

ATTRACTORS FOR FLOW OBSERVABLES IN 2+1D BJORKEN FLOW

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We examine the capabilities of second-order Israel-Stewart-type hydrodynamics to capture the early-time behaviour of the quark-gluon plasma fireball created in heavy-ion collisions. We point out that at very early times, the dynamics of the fireball is governed by the local 0+1-D Bjorken flow attractor due to the rapid expansion along the longitudinal direction. Discrepancies between hydrodynamics and kinetic theory in this far-from equilibrium regime leads to disagreement at the level of late-time observables, such as elliptic flow. We show that rescaling the initial energy-density profile for hydrodynamics accounts for such discrepancies, restoring agreement with kinetic theory for large opacities (small shear viscosity / large system size / high energy).

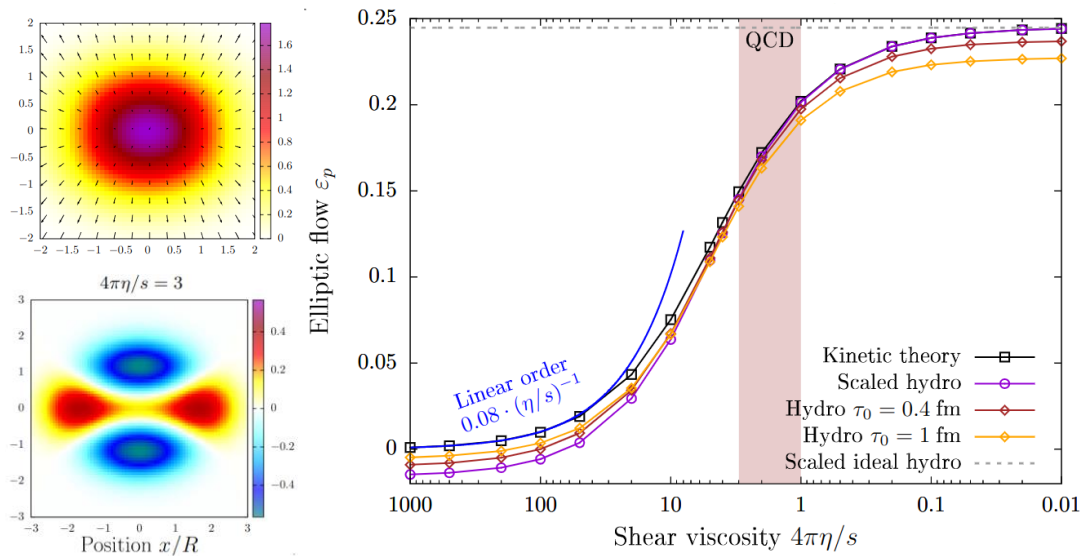


Figure 1: (left) Transverse profile of the fireball with shear viscosity to entropy density ratio $4\pi\eta/s=3$, of size R , at time $\tau=R$: (top) energy density; (bottom) transverse anisotropy $T^{xx}-T^{yy}$. (right) Shear viscosity-dependence of the elliptic flow coefficient ϵ_p obtained using various models.

Keywords: Bjorken flow, Attractors, Elliptic flow, Quark-gluon plasma, Heavy-ion collisions

TCP - Oral presentation

DESCRIPTION OF THE WOBBLING MOTION THROUGH A BOSON METHOD

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Wobbling motion, a clear signature of triaxiality in nuclei, is described through a new boson approach with the help of the Bargmann representation. Indeed, by making an expansion of the angular momentum components, one can reach a Schrödinger equation for the initial Hamiltonian that has a fully separated kinetic term. For a certain value of the total angular momentum, the potential energy shows three minima and two of them are degenerate. A chiral-like character is identified in the deepest points. Construction of the phase diagrams, which show the stability of the wobbling character is also made through a classical analysis. The theoretical model that is obtained is tested for the nucleus ^{135}Pr , where a good agreement with experimental data is achieved for the energy spectrum.

Keywords: boson expansion, wobbling, triaxiality, phase diagrams

References:

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TCP - Oral presentation

**INVESTIGATION OF GAMMA PHOTON SOURCES USING
NEAR-CRITICAL DENSITY TARGETS TOWARDS
THE OPTIMIZATION OF THE LINEAR BREIT-WHEELER PROCESS**

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At the interaction between an ultra-high intensity laser pulse ($I > 10^{22}$ W/cm²) with matter, the electrons will be accelerated up to ultra-relativistic velocities and will emit a copious amount of synchrotron gamma photons. Studies on various absorption mechanisms using different target configurations, showed a conversion efficiency of the laser energy to gamma photons from 15% [1] up to 35% [2]. For even higher intensities ($I > 10^{24}$ W/cm²), the emitted gamma photons can interact with the laser field and create electron-positron pairs by the nonlinear Breit-Wheeler (BW) process [3].

Our main goal is to investigate the high energy synchrotron radiation emitted by electrons in the laser-plasma interaction, eventually leading to production of electron-positron pairs via the linear and nonlinear BW processes. Through 2D Particle-in-Cell (PIC) simulations using SMILEI [4], we studied the case of an ultra-high intensity laser pulse interacting with a near critical density target. In optimal configuration for the maximum conversion efficiency of the laser energy to gamma photons [5], we investigated the pair production by the nonlinear BW process. Considering the interaction between two identical gamma beams [6-7] (prior produced in the laser-plasma interaction) at a distance of 0.1 cm and at different collision angles, we analyzed the total number of pairs produced and their collimation by the linear BW process.

Keywords: ultra-high intensity regime, high energy photons, electron-positron pair creation.

References:

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TCP - Oral presentation

CYLINDER QUANTUM FIELD THEORIES AT SMALL COUPLING

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We show that any 2D scalar field theory compactified on a cylinder and with a Fourier expandable potential V is equivalent, in the small coupling limit, to a 1D theory involving a massless particle in a potential V and an infinite tower of free massive Kaluza-Klein (KK) modes.

Moving slightly away from the deep IR region has the effect of switching on interactions between the zero mode and the KK modes, whose strength is controlled by powers of the coupling, hence making the interactions increasingly suppressed. We take the notable example of Liouville field theory and, starting from its worldline version, we compute the torus (one-loop) partition function perturbatively in the coupling constant. The partition function at leading order is invariant under a T-duality transformation that maps the radius of the cylinder to its inverse and rescales it by the square of the Schwinger parameter of the cylinder. We show that this behavior is a universal feature of cylinder QFTs.

Keywords: Quantum Field Theory, Compactifications, Liouville theory, T-duality.

CMP - Invited presentation

ANALYSIS OF THE SURFACE LAYER OF BIOACTIVE GLASS BEFORE AND AFTER THE IN VITRO TEST IN A SIMULATED BODY FLUID – RAMAN MICROSCOPE

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Introduction

Bioglasses are among the most intensively studied materials, which could be widely used in modern medical practice due to their ease of design and specific (e.g. chemical, antibacterial or bioactive) properties. Researchers are still looking for new materials for more effective modifications and explanations of the processes at the bioactive glass surface when it is in contact with physiological fluids. After implantation into a human body, bioactive glass forms a biologically active layer of hydroxyapatite (HA) on the implant's surface, which chemically resembles the mineral composition of bones and teeth. The other property of bioactive glass is expected to occur is degradation in natural body fluids, especially when bathing in (Simulated Body Fluid - SBF). The bioactivity of the glass significantly depends on a composition of a material and its dispersion. Bioactive glasses, especially magnetic bioactive glasses, deserve a special place in health care as they can be used in the process of cell separation or as a contrast agent in magnetic resonance imaging [1-2].

Experimental

Series of Bioglass® samples doped with different amounts of Fe₂O₃ were obtained in the modified sol-gel method as given by Fure and his collaborators [3]. The glasses were prepared using citric acid as the catalyst. The samples were characterized with X-ray diffraction, Differential Scanning Calorimetry- DSC, Infrared Spectroscopy – IR, Raman Spectroscopy, Scanning Electron Microscopy - SEM, Energy Dispersive Spectroscopy – EDS, ICP-MS Analysis. The bioactivity of the samples was tested by in vitro immersion in artificial plasma SBF, which was synthesized according to the receipt of Kokubo [4]. The samples and the SBF solution were checked after 6 h, 24 h, 1 week and 2 weeks in the solution. – all samples are bioactive regardless of the concentration of iron ions.

Results and Discussion

SEM analysis showed that the greater the addition of Fe in the glass, the more porous the sample becomes. The mass degradation in SBF develops relatively fast - about 35-47% of the glass was degraded within two weeks, it should be remembered that it was observed change in the mass of the sample is the resultant the result of two processes: the degradation of the material and the associated transfer of ions into solution, and the reverse process, the transfer of other ions from solution to samples and HA/HAC (HAC – hydroxyapatite carbonate) formation. Raman spectra and FT-IR spectra confirm the formation of HA/HAC, additionally Raman spectroscopy imaging technique was used to check the distribution of the HA/HAC on the sample's surface and verify a below-surface penetration of HA/HAC. It was found that the depth distribution profile strongly depends on the amount of a dopant.

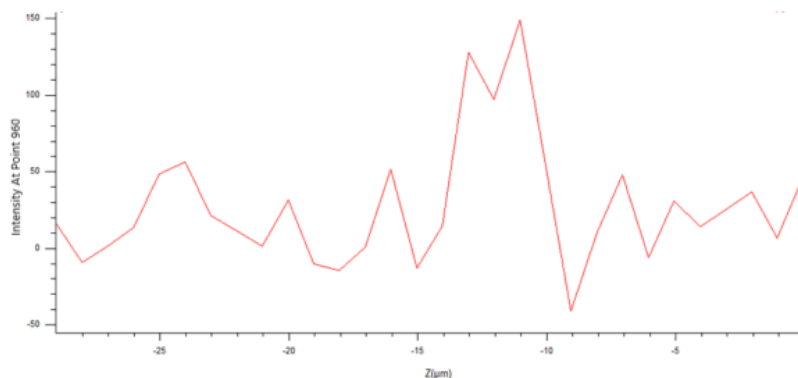


Figure 1: Analysis of the intensity of the Raman shift signal by energy 960 cm^{-1} ; tested material - glass with 2.0% Fe admixture - changes in the depth function.

Conclusions

- All the glasses obtained are bioactive because after being immersed in SBF, HA is produced on their surface.
- An increase in Fe ions content leads to smaller glass grains with a more spherical shape.
- HA content under the sample surface is higher than on the surface.
- HA was found not only on the surface of the sample but also under the surface.
- Raman spectroscopy is a sufficient tool to verify the presence of hydroxyapatite on the surface, and in particular to observe its distribution in the tested material.

Keywords: : Bioglass[®], Fe dopant, Raman mapping.

References:

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CMP - Oral presentation

LINEAR RESPONSE THEORY FOR NON-HERMITIAN SYSTEMS

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Linear response theory provides a general framework to describe the leading order effects on observables of physical systems due to small time-dependent perturbations. We perform an extension of the theory to the realm of quantum systems described by non-Hermitian Hamiltonians. It is shown that the time-dependence of the expectation of an observable in the latter case is described by a generalized Kubo formula which characterizes cases when either the unperturbed system and the perturbation, or both are non-Hermitian.

We discuss two applications of the linear response theory. First we derive a finite optical conductivity for tachyons in one-dimensions. These are hypothetical particles moving faster than the speed of light. They can however be simulated in optical lattices or cold atom systems as excitations moving faster than some intrinsic velocity in the experiment such as the Fermi velocity. Second we discuss the density-density response of a Hermitian Fermi gas subjected to a non-Hermitian perturbation, and show the absence of Friedel oscillations.

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CMP - Oral presentation

**COOPERATIVITY IN MIXED SPIN CROSSOVER MOLECULAR MAGNETS
ANALYZED THROUGH A MECHANOELASTIC MODEL**

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Spin crossover (SC) compounds are molecular magnets with two stable states in thermodynamic competition: the diamagnetic low spin (LS) state stable at low temperatures and the paramagnetic high spin (HS) state, seen as future candidates for memory devices. The difference in the volume of atoms in HS and LS states leads to elastic interactions. If these are large enough, they determine hysteresis phenomena and cooperative self-accelerated relaxations. In order to analyze the cooperativity of a mixed crystal, the neat compound can be diluted by adding magnetically inert dopants (such as Ni or Zn) [1]. The behavior can be analyzed within the mechanoelastic model [2], in which the SC atoms are rigid spheres, linked through springs.

Here, we study the behavior of $\text{Co}(\text{bpy})_3[\text{LiCr}(\text{ox})_3]$ spin crossover compound by doping it with inert Ni atoms. By using the mechanoelastic approach, we anticipate the effect of Ni concentration on the cooperativity of the crystal during the thermal transition and we demonstrate that the experimental incomplete transition – large number of LS molecules at high temperatures - are due to interactions between Ni lattice and Co molecules. In addition, we show the dependence of HS cluster sizes on the dopants concentration.

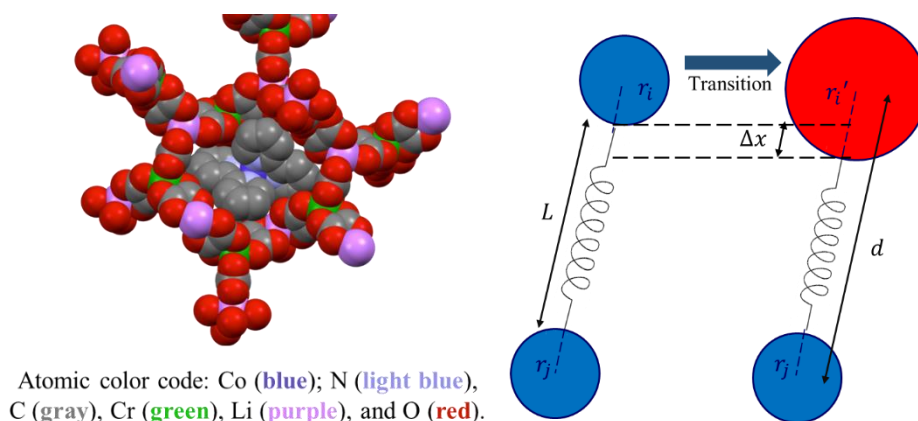


Figure 1: The space-filling model representation of a crystal molecule (left) and the representation of a spin transition through the mechanoelastic model (right)

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CMP - Oral presentation

LONG-RANGED CU-BASED ORDER AT CUPRATE/MANGANITE INTERFACE

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We present a resonant inelastic and elastic X-ray scattering (RIXS/REXS) study of epitaxial $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}/\text{Nd}_{1-x}(\text{Ca}_{1-y}\text{Sr}_y)_x\text{MnO}_3$ heterostructures (NYN). We show that the Copper charge density wave (Cu-CDW) order of the near optimally doped $\text{YBa}_2\text{Cu}_3\text{O}_7$ layers can be strongly modified via the hole doping and tolerance factor of $\text{Nd}_{1-x}(\text{Ca}_{1-y}\text{Sr}_y)_x\text{MnO}_3$, i.e. by changing x and y .

At $x=0.35$ we observe a quasi-2D Cu-CDW order with $d_{x^2-y^2}$ orbital character that resembles the one that is commonly found in strongly underdoped bulk YBCO. The strength of the corresponding Bragg peak at $Q_{\parallel} \approx 0.3$ r.l.u. gets strongly enhanced as the tolerance factor of the manganite layers¹ is decreased and its CE-type antiferromagnetic and charge/orbital ordered (COO) is reinforced¹.

Upon increasing the hole doping of the manganite layers to $x=0.5$, we observe a new kind of Cu-CDW order which has a much smaller wave vector of $Q_{\parallel} \approx 0.1$ r.l.u., a larger correlation length of about 40nm, and a different orbital character, i.e. d_{z^2} rather than $d_{x^2-y^2}$, than the one commonly found in the bulk cuprates².

The origin of this new Cu- d_{z^2} charge order is not yet understood, but seems to be rooted in the particular properties of the cuprate/manganite interface. The RIXS and additional X-ray absorption spectroscopy data provide evidence for an important role of the orbital reconstruction of the Cu-ions at the interface with the manganite and a related transfer of electrons from the manganite to the cuprate.

While further studies are required to fully understand the interfacial coupling mechanism(s), the possibility of tuning the Cu-CDW holds great prospects for studying its relationship with high-Tc superconductors and hopefully, for future quantum devices

Keywords: charge order, high-Tc superconductor, manganite.

References:

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CMP - Oral presentation

ON THE MODELING OF MICROWAVE FERROFLUIDIC ABSORBERS

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Originally designed as rocket fuel, ferrofluids have become well known for rheological applications [1], magnetic seals [2], heat transfer fluids [3] and cancer treatment by magnetic hyperthermia of tissues [4]. Since ferrofluids are functional materials characterized by magnetic, electric as well as liquid properties, they can be embedded in silicon rubber or in flexible plastic bags of various shapes, in order to obtain so called microwave absorber meta-skins.

The talk focuses on the analysis of theoretical models that describe the frequency dependence of the complex magnetic permeability and complex dielectric permittivity, by comparison with measurements made on a ferrofluid with magnetite particles dispersed in kerosene. The analysis is extended to the comparison of theoretical and experimental results of the characteristic parameters of microwave electromagnetic absorbers.

The conclusion of the study is that the existing theoretical models can be applied for the design of microwave ferrofluidic absorbers, with some corrections of the model parameters, as resulted from experimental findings.

Keywords: ferrofluid, complex magnetic permeability, complex dielectric permittivity, microwave absorber.

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CMP - Oral presentation

KINETICS OF EXCITON LUMINESCENCE OF LAYERED MOSE₂ AND MOS₂ CRYSTALS INTERCALATED WITH HALOGEN MOLECULES

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Being indirect bandgap semiconductors, bulk Transition Metals Dichalcogenides TMD single crystals, in contrast to monolayers, do not possess luminescent properties [1]. The situation changes when halogen molecules intercalate into the van der Waals (vdW) gap of these layered compounds [2]. These molecules are embedded in the quasi-tetrahedral voids of the vdW gap, forming neutral centres, with properties similar to isoelectronic impurities that provide efficient radiative recombination in some indirect-gap semiconductors.

In this work, we present the results of a study of the kinetic of bound excitons photoluminescence (PL) in bulk MoSe₂:I₂ and MoS₂:Cl₂ crystals. The optical excitation of the samples was provided using CW and pulsed radiation of frequency doubled YAG:Nd⁺³ lasers ($\lambda=532\text{nm}$). The temperature dependences of steady-state PL spectra and integral intensity, as well as of the radiative decay time constant $\tau_R(T)$ were investigated in the range 10-70 K.

The experimental results were fitted by theoretical curves calculated within the framework of the model assuming, that the population of exciton levels corresponds to the conditions of thermodynamic equilibrium. This model well describes similar experimental results, including $\tau_R(T)$, obtained for MoS₂:Cl₂, however, turned out to be inadequate for describing the explicit non-monotonic behaviour of the $\tau_R(T)$ dependence observed for MoSe₂:I₂ in the temperature range of 30-50. It is shown that the observed nonmonotonicity arises at temperatures when thermal dissociation of the short-lived exciton state *B* with higher energy, which is closer by $\Delta_{AB}=5.6\text{ meV}$ to the valence band, than the state *A*. Therefore, in the absence of thermodynamic equilibrium, the contribution of the long-lived state *A* to the probability of radiative recombination increases (i.e., the PL decay kinetics slows down), which leads to the nonmonotonic behaviour of the dependence $\tau_R(T)$.

In the case of MoS₂:Cl₂ crystals, the interval between the lowest two exciton states *A* and *B* is only $\Delta_{AB}=1.8\text{ meV}$, which is three times less than in MoSe₂:I₂. With an increase in temperature, at $kT > 3\text{ meV}$, the long-lived exciton state *A* and the short-lived *B* dissociate almost simultaneously, and therefore the observed dependence $\tau_R(T)$ has a monotonic behaviour.

Based on the analysis of the temperature dependences of the spectral shape and the integral intensity of the steady-state PL, as well as of its temporal characteristics, the lifetimes of the exciton states have been determined and the processes of radiativeless recombination that lead to the thermal PL quenching in the studied layered materials.

Authors acknowledge financial support provided by the Moldovan Agency for Research and Development (Agreement No. 20.80009.5007.19).

Keywords: 2D - TMDs, bound excitons, photoluminescence.

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CMP - Oral presentation

APPLICATION OF THE Cr³⁺ IONS FOR OPTICAL THERMOMETRY - A REVIEW

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In recent years, optical thermometry and materials that have a certain potential to become optical thermometers have been fully researched for their possible applications both in medicine and biology, as well as in heavy industry such as superconducting magnets, aerospace or of crystallography. Generally optical thermometry is based on systematic and reversible changes of certain spectroscopic properties (ratio of intensities of two emission peaks, emission lifetime, full width at half maximum etc) with temperature. In particular, when biological and medical applications are concerned, the emission used for temperature sensing should be confined within one of the near-infrared biological windows, where light has its maximum depth of penetration. One of the most widely used methods to detect temperature by using emission spectroscopy is Fluorescence Intensity Ratio (FIR), which involves a change in the relative intensities of two radiative transitions, either from rare earth ions or transition metal doped materials. The greatest potential for such a technique is given by the Cr³⁺ ion, which, thanks to favorable relative position of its energy levels, 2E, 4T₂ (two emitting states) and 4A₂ (the ground state), is characterised by a good absolute and relative sensitivity, regardless of the nature or crystalline form of the host in which it is located, whether it is a mono-crystal of α-Al₂O₃ [1], a poly-crystal of ZnGa₂O₄ [2], or a perovskite of CaHfO₃ [3], regardless of the application possibilities of the resulting material (biological and medical for the former two materials, or industrial cryology for the latter material). The last study is important, together with the one about LaGaO₃:Nd³⁺ [4], because they open the way to new studies related to the doping of different perovskites with chromium to create new thermometric materials in the future that are more efficient and more precise.

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API - Invited presentation

ON THE DESTRUCTION RATES OF HYDROCARBON DUST IN INTERSTELLAR MEDIUM

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Various plasma laboratory astrophysics experiments are employed for carbon dust analogues deposition, i.e. hydrogenated amorphous carbon (HAC or a-C:H) samples, in order to match the astrophysical observations and related processes such as processing in space for the 3.4 μm band carriers in diffuse and dense dust clouds [1,2]. In order to obtain information on dust processing in space, laboratory astrophysics experiments are performed, usually employing energetic particles (UV photons, electrons or ions) and irradiation under vacuum conditions.

The present work will review our results on HACs energetic processing, using H^+ , C^+ and Si^+ at 3 MV TandatronTM accelerator from “Horia Hulubei” National Institute for Physics and Nuclear Engineering, aiming to revise the effects of analogues’ morphology and density on the 3.4 μm band intensity drop. Hydrogen recombination model and the phenomenological exponential decay fitting function are used to extract destruction cross section by cosmic-rays in the diffuse ISM, using the 1 MeV monoenergetic proton approximation. The characteristic times for CH bond destruction are compared with the dynamical times of diffuse regions and dense clouds. The results allow us to group the literature results into two families: data that support the scenario of unlikely aliphatic CH bonds destruction by cosmic rays and data that support a possible aliphatic CH bonds destruction by cosmic rays.

Keywords: interstellar dust analogues, aliphatic content, destruction rates.

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API - Invited presentation

USING ADVANCED TECHNOLOGIES TO PROCESS DATA GIVEN BY A PM SENSOR

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Air pollution represents a major problem for many cities around the world. Particulate matter pollution affects population's health and environment [1]. This study aims to make some predictions for particulate matter concentrations by applying techniques of artificial intelligence [2-3] for a set of data given by a particulate matter sensor, between September 14, 2021 and October 1, 2022. The sensor is placed in Craiova city, Romania and measures three meteorological parameters (temperature, pressure, relative humidity) and three particulate matter concentrations.

The aim of this study is to apply methods like linear and polynomial regression to find correlations between variables, decision trees/random forest as optimization techniques for the values estimation. Reached results can be used for estimation of air pollution in the area without a need for sensor. This, expanded to a network of sensors, can be used as important estimator for whole regions.

Keywords: air pollution forecasting, sensor, data, correlations, artificial intelligence.

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API - Oral presentation

ESTIMATION OF PM10 POLLUTION LEVEL FOR 2021 IN FIVE MAJOR ROMANIAN CITIES USING INDEPENDENT AIR QUALITY MONITORING NETWORK DATA

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Air pollution with PM10 affects human health and environment [1]. We present a short synthesis of PM10 pollution levels at annual scale for the five most populated cities in Romania, namely Bucuresti, Iasi, Cluj-Napoca, Timisoara and Constanta, for the year 2021. To this end, we use data from the independent air quality monitoring network URADMONITOR (<https://www.uradmonitor.com/>). The sensors providing the data are located close to the city centers (Bucharest, Timisoara, Constanta), residential areas (Cluj-Napoca) and in an industrial area (Iasi).

We employ five indicators related to daily average concentration level of PM10, relevant at annual level, as defined by European Environment Agency. The indices highlight the annual mean, number of days with exceedance of threshold values, maximum daily value as well as 50% and 90.4% percentiles based on mean daily PM10 levels along the year.

Keywords: particulate matter, air pollution, sensors, Romania.

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API - Oral presentation

HYPERTHERMIA WITH NANOPARTICLES IN THE FORM OF FERRITES

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In the treatment of cancer, one of the most promising therapies is hyperthermia based on magnetic nanoparticles such as small oxides of iron and other metals [1]. In our study we focused on the synthesis of ferric nanoparticles with different concentrations of cobalt due to the appropriate magnetic properties [2], optimal heating, for their use in the treatment of tumors as shown by preliminary experimental and theoretical studies [3]. Their stabilization in aqueous solution was achieved by coating with perchloric acid. The results of the microstructural and magnetic investigations indicated that the presence of cobalt influences the characteristics of the nanoparticles obtained by us in the laboratory, this is in accordance with the data from the specialized literature. At the same time, based on the magnetic properties, we developed a mathematical model focused on the quantitative description of the temperature distribution using the areas of the hysteresis loops for the three types of magnetic nanoparticles synthesized by us. The comparative discussion of the solutions of the basic equation in the applied mathematical model was done according to the cobalt content and taking into account the assumptions underlying this proposed model. Further development of our research will consider new cobalt ferrite nanoparticles with new cobalt contents and different organic coatings to contribute to their biocompatibility and stability in aqueous suspensions – as required by administration in living organisms.

Keywords: magnetic nanoparticles, magnetic hyperthermia, modeling of the temperature field.

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THE OUTCOME OF BREAST CANCER RADIOTHERAPY AS A FUNCTION OF SETUP ERRORS

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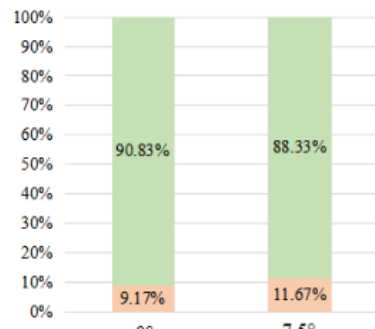
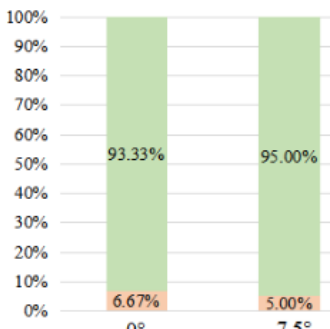
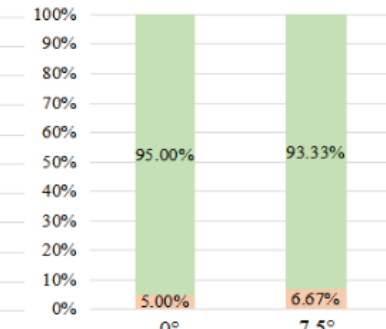
For an effective radiotherapy treatment, the reproducibility of patient position is mandatory. The purpose of this work is to assess the effect of breast board inclination on target and organs at risk (OARs) dosimetry under systematic (Σ) and random (σ) errors during conformal as well as intensity modulated radiotherapy techniques.

Three groups of patients positioned in supine were evaluated: group A immobilized on 7.5° inclination, group B immobilized on 0° inclination and group C which was immobilized on both inclinations (0° and 7.5°). Three sets of treatment plans were completed for all patients (3DCRT, IMRT and VMAT techniques) using conventional dose prescription (50Gy in 25 fractions) and error simulations were performed on Monaco 5.51.10 treatment planning system.

Regarding target volume dosimetry, the study showed that under systematic errors the values are more striking than under random errors (table 1). For group C positioned on both boards' inclination, the mean target coverage for 3DCRT, IMRT and VMAT under random errors reached 95% of the prescribed dose. Also, according to the percentage of OARs numbers exceeding dose constrains, the OARs were well protected for modulated techniques (table 1).

Evaluating the impact setup errors have on target coverage and dose constrains for organs at risk can improve the outcome of radiotherapy. Furthermore, managing the factors that influence the setup position, leads to a more personalized treatment.

Table 1. Setup error influence on target and OARs dosimetry (target coverage values <95% of prescribed dose due to systematic errors highlighted in grey)

Target coverage (Gy)								
Group	A (7.5°)		B (0°)		C(0°)		C (7.5°)	
Setup errors	Σ	σ	Σ	σ	Σ	σ	Σ	σ
3DCRT	46.56	47.54	47.12	47.65	47.32	47.66	46.85	47.69
IMRT	48.10	47.71	47.74	48.07	47.58	47.98	47.25	47.98
VMAT	46.66	47.49	48.07	48.25	47.83	48.06	47.37	48.13
OARs (%)								
3DCRT			IMRT			VMAT		
% OARs exceeding limits			% OARs exceeding limits			% OARs exceeding limits		
% OARs below dose limits			% OARs below dose limits			% OARs below dose limits		
								
0°			0°			0°		
7.5°			7.5°			7.5°		

API - Oral presentation

ION METROLOGY DEVELOPMENTS FOR EXTREME LIGHT INFRASTRUCTURE

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We present results from the ongoing IMPULSE project (Integrated Management and reliable oPerations for User-based Laser Scientific Excellence, EU H2020 GA 871161) efforts towards metrology standardization of primary and secondary laser driven sources. We will give an overview of the standardization of metrology for laser plasma experiments, laser sources, and laser based secondary sources contributed by CLPU, Spain.

The pan-european character of the project is emphasized with an insight to contributions from the Spanish Pulsed Laser Centre (CLPU) [1-5]. We will shed light on a selection of sources as well as possible application cases for future beamtime applicants. High power lasers are presented as primary sources, secondary sources include (a) low divergence charged particle beam sources, especially electron sources accessing energies of 100ds of MeV and proton sources for highest energies of the order of 10s of MeV, and (b) sources of strong electromagnetic pulses of the kV/m.

Keywords: extreme light infrastructure, secondary sources, high energy density,

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API - Oral presentation

HIGH VACUUM VAPOR-PHASE PROTON EXCHANGE LiNbO₃ OPTICAL WAVEGUIDES WITH HIGH-INDEX CONTRAST

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Highly confining waveguides ($\Delta n_e > 0.1$) and low propagation losses have been fabricated in lithium niobate (LN) by a new process called High Vacuum Vapor-phase Proton Exchange (HiVac-VPE) [1]. Index contrast and propagation losses of HiVac-VPE channel waveguides are investigated in view of telecom applications. The results recommend HiVac-VPE as very promising technique for fabricating efficient nonlinear photonic integrated circuits in LN crystals. The impact of high vacuum on the optical features of the waveguides and reproducibility of the process were tested by producing, in same conditions, more than fifty waveguides. HiVac-VPE process was performed on Z-cut LN optical grade samples in a hermetically sealed hourglass tube for different exchange durations $t(h)$. The tube is pumped down to a pressure as low as $p = 3.4 \times 10^{-5}$ mbar. This very low pressure is imperative in order to diminish as much as possible any traces of water from the proton exchange container. In order to reconstruct the index profile of the planar waveguides, the effective indices of the propagation modes have been measured using a standard two-prisms coupling set-up at $\lambda = 633$ nm [2]. The measured effective indices N_{eff} of TM guided modes allow us to reconstruct the index profiles of waveguides fabricated for different exchange durations. Propagation losses in the HiVac-VPE channel waveguides have been measured by using the Fabry-Pérot cavity technique [3] obtaining around 3.5 ± 0.1 dB/cm.

Acknowledgements: This work was supported by a grant of the Romanian Ministry of Education and Research, CNCS—UEFISCDI, Project number PN-III-P4-ID-PCE-2020-0239, Contract number PCE 142/2021, within PNCDI III.

Keywords: Index profiles, Proton Exchange, LiNbO₃ waveguides.

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API - Oral presentation

HIGH CONTROL AND REPRODUCIBILITY OF INDEX CONTRAST OF LITHIUM NIOBATE WAVEGUIDES FABRICATED BY HIGH VACUUM PROTON EXCHANGE

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The study validates the excellent control and reproducibility of the index contrast and index profile of optical waveguides fabricated on Z-cut lithium niobate (LN) substrates by High Vacuum Proton Exchange (HiVacPE) technique [1]. Proton exchange processes in high and low-vacuum conditions were performed in a hermetically sealed hourglass tube, using 16 g of Benzoic Acid (BA) and Lithium Benzoate (LB) powder mixture as proton source, in a concentration of $\rho_{LB}=2.60\pm0.05\%$. The working pressure conditions were set to be: $p_{HiVacPE}=3.5\times10^{-5}$ mbar for the tubes destined to HiVacPE process [1] and $p_{LoVacPE}=3.5$ mbar for LoVacPE process respectively [2]. In order to verify over the time the reproducibility of each process, at random moments during one year, twenty samples (ten pairs) were fabricated by using the mentioned conditions. In order to reconstruct the index profiles of the planar waveguides, the effective indices of the propagation modes have been measured using a standard two-prisms coupling set-up at $\lambda=633$ nm and the effective indices N_{eff} of TM guided modes as well as the values of mode depths were calculated by IWKB. Performing HiVacPE technique, the waveguides show an exponentially decreasing index profiles with low values of the index contrast distributed in a very narrow range of $\pm0.01\times10^{-2}$ around the mean value of $\Delta n_e=2.34\times10^{-2}$. On contrary, the index profile of LoVacPE waveguides presents a mix of a step and a gradient profile with high values of the index contrast distributed in a large range of $\pm1\times10^{-2}$ around the mean value of $\Delta n_e=10.4\times10^{-2}$. So, there is an improvement of index contrast reproducibility of two orders of magnitude.

Keywords: lithium niobate waveguide, high vacuum proton exchange, index contrast.

Acknowledgements: This work was supported by a grant of the Romanian Ministry of Education and Research, CNCS—UEFISCDI, Project number PN-III-P4-ID-PCE-2020-0239, Contract number PCE 142/2021, within PNCDI III.

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API - Oral presentation

PM MODELING THROUGH LAND-USE REGRESSION IN TIMIȘOARA, ROMANIA

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The influence of aerosols on photovoltaic energy conversion is multi-faceted: 1) extinction of the incoming solar beam, 2) damage of the protective casing of the PV cell, 3) deposition on the surface of the cell ('soiling') etc. Thus, the accurate knowledge of the atmospheric aerosol loading is a paramount factor in designing a PV system. In urban settings, due to the point-like nature of pollution sources, the spatio-temporal resolution of commonly available aerosol data is too low for accurate modeling. An alternative route is to model aerosol optical depth (AOD) based on ground-level particulate matter (PM) measurements. The availability of good accuracy, ultra-low cost PM sensors makes such a study feasible.

In this paper, land-use regression models are tested for modelling PM_{2.5} and PM₁₀ levels. Data is collected from two public networks of the local administration of the city of Timișoara, Romania, containing such low-cost PM sensors. The model predictions are tested in various ways, including comparison to measurements from the handful of stations of the government monitoring agency. Daily PM maps for the city are generated at a few selected days, for illustration purposes.

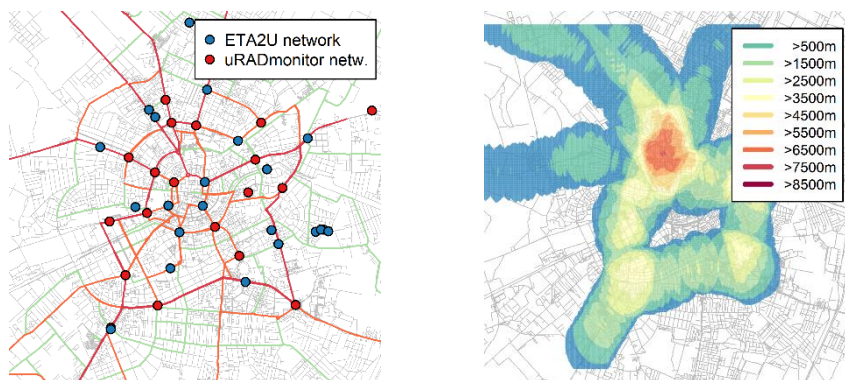


Figure 1: (left) Sensor networks and major roadways. (right) Total road length inside 1km buffer.

Keywords: particulate matter; land use regression; low-cost sensors; PM-to-AOD;

References:

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TCP - Poster presentation

RECONSTRUCTION OF FEMTOSECOND LASER PULSES BY CONVOLUTIONAL NEURAL NETWORKS

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Complete temporal and/or spectral characterization of femtosecond laser pulses can be realized through indirect measurements, like the FROG (Frequency Resolved Optical Gating) [1] technique. FROG uses a delayed replica of the original pulse to record a spectrogram image (trace), from which the amplitude and phase can be recovered by different FROG inversion algorithms [2-3]. The spectrogram image is recorded by measuring the spectrum of the signal originating from the interaction of the two pulses in a non-linear optical medium for varied time-delays. In the present work we present a pulse retrieval (amplitude and phase) method, based on CNNs (convolutional neural networks), which aims to be faster than classical algorithms. CNNs are multi-parametric functions (with powerful feature extraction capabilities) and modern versions may contain hundreds of layers, with many parameters to be optimized. The network we employed in our work is a modified version of the DenseNet neural network [4]. We train the neural network on computationally generated FROG traces, and monitor the error between the original and the retrieved laser fields. The CNN layer parameters are adjusted according to this error. The CNN model is tested by calculating the average reconstruction error on a test set, distinct from the training set. These data sets are generated by two different methods. In the first one we use randomly generated data, while the second method uses an empirical model obtained from the ELI-NP facility at Măgurele. Our results show a good and fast reconstruction of the simulated laser pulses with low values of the reconstruction error on the test set.

This work was supported by a grant of the Romanian National Authority for Scientific Research, NCS-UEFISCDI, project PN-III-P5-ELI-RO, project number ELI_03/01.10.2020.

Keywords: ultrashort laser pulse, convolutional neural network, FROG spectrogram.

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TCP - Poster presentation

STATISTICS OF MOON SURFACE CRATERS

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We present here the results of a computational study on the statistics of moon surface craters using publicly available data published by NASA and a 3D reconstruction of the Moon surface and its main landmarks. Part of these results will be used in the European research project TRUSTEE, funded within the Horizon Programme under Grant Agreement 101070214, to check the functionalities of the TRUSTEE system, particularly the transparent processing of scientific data in a secure-by-design framework.

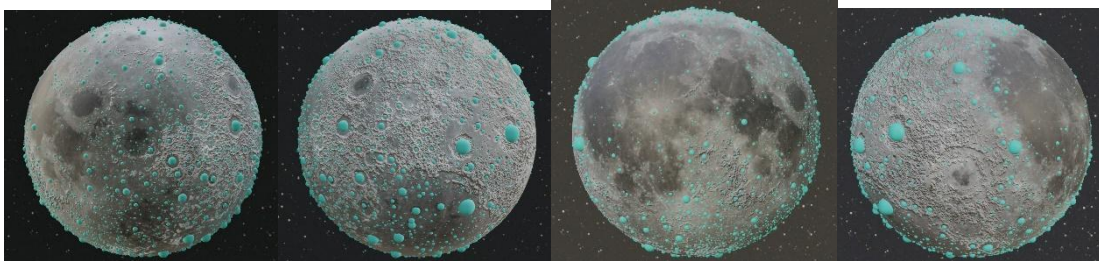


Figure 1: Moon surface craters (marked with blue-dots whose size is proportional to the crater diameter) in a 3D reconstruction of the Moon based on publicly available data from NASA.

The main result of our study is that the distribution of crater diameters is akin to the scale-free distribution so ubiquitous in complex systems, though with notable differences, particularly for small crater diameters.

Keywords: Moon, statistics of surface craters, 3D map

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TCP - Poster presentation

**PRODUCTION OF Z BOSONS AND ELECTRON-POSITRON PAIR IN DE SITTER
UNIVERSE**

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We study the generation of massive fermions and Z bosons from vacuum in the expanding de Sitter universe. Our results are the generalization to the curved geometry of the Weinberg-Salam electro-weak theory for the case of Z boson interaction with leptons. The probability is found to be a quantity that depends on the Hubble parameter and we prove that such perturbative processes are possible only for large expansion regime of the early Universe. The total probability and rate of transition is obtained for the case of large expansion and we use the dimensional regularization for the momenta integrals. In the Minkowski limit we obtain that the probability of particle generation from vacuum is vanishing.

Keywords: de Sitter metric, Z boson, transition amplitude.

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TCP - Poster presentation

**WAITING TIMES DISTRIBUTIONS
 IN CRIPTOCURRENCY EXCHANGE RATES**

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Motivated by the monetization modelling of nonfungible tokens (NFTs) we report here the results of a statistical study of the exchange rates of cryptocurrencies (obtained from cryptodatum.com) using the distribution of waiting times as the main instrument to describe their volatility. Despite the unpredictability of exchange rates, a close study of these distributions reveals a pattern that can be used in the monetization of digital assets whose values are set using a reference cryptocurrency.

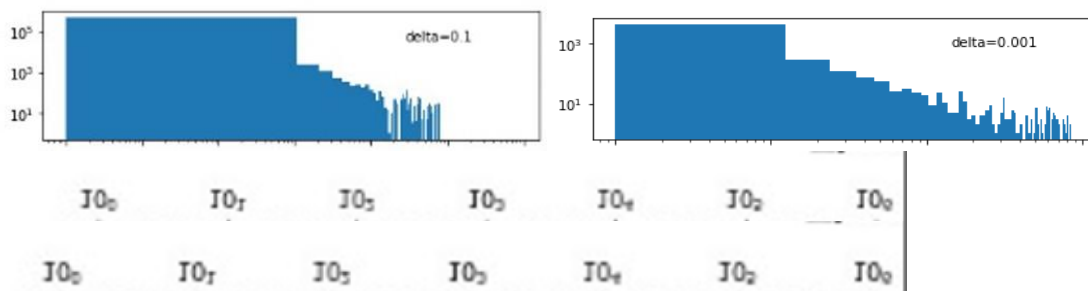


Figure 1: Waiting Times Distributions for ETHEREUM-United States Dollar compared with the distributions for a real currency, EURO-United States Dollar, using the dollar as the main denominator.

Keywords: scale-free distribution, cryptocurrency.

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TCP - Poster presentation

LAYERED PLANAR TARGETS FOR THE PRODUCTION OF GAMMA BEAMS USING HIGH-POWER LASERS

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The generation of strongly confined gamma beams through laser-matter interaction in the ultra-high-power regime can be controlled through the geometrical and structural properties of the targets used to focus the laser on. Considering a parameter regime relevant for the experiments scheduled to take place at Extreme Light Infrastructure – Nuclear Physics, we report here numerical results for planar layered structured. Our 2D and 3D Particle-in-Cell EPOCH simulations show that the layering of planar targets of increased electron densities allows for the generation well-confined gamma beams. Our results complement the existing ones on structured pipe-like targets, which are known to allow for the efficient control of the ensuing two-branched gamma beam through the inner channel radius, suggesting an efficient target geometry that is easier to achieve experimentally.

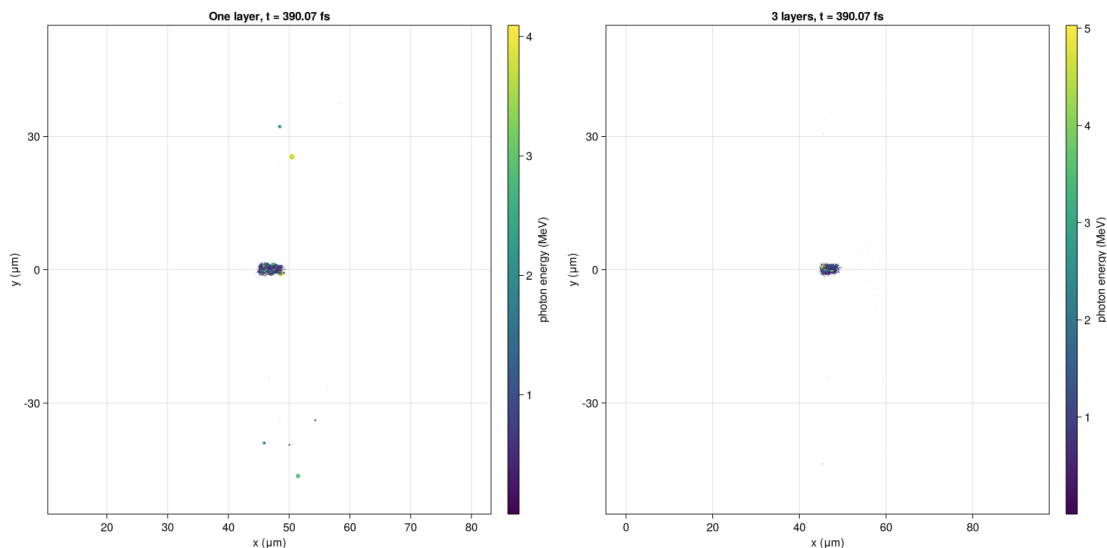


Figure 1: Single-layered vs. triple-layered targets. Layered targets produce better gamma beams because of the reduced noise.

Keywords: PIC simulations, gamma beams, structured targets

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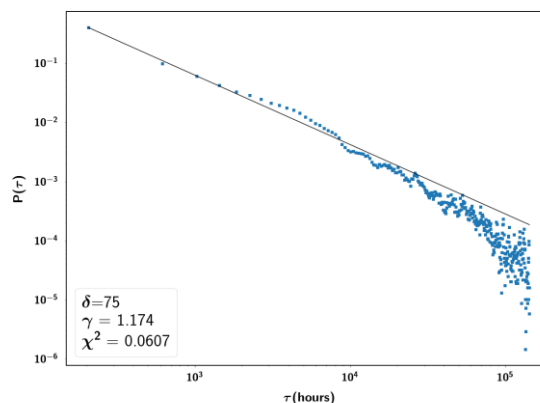
DISTRIBUTION OF WAITING TIMES FOR AVERAGE SEA LEVELS IN TRIESTE HARBOR

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As part of the work within the European Project DANUBIUS-IP [1] on the interoperability of the databases curated by the DANUBIUS-RI partners, we present here the results of some preliminary statistical analyses on the datasets from CNR-ISMAR. Processing the data on the average sea level and the daily temperature in Trieste Harbor, we have found a scale-free-like distribution for the waiting times, *i.e.*, $P(\tau) \sim \tau^{-\gamma}$, where τ is the waiting time and γ is a constant (see Ref. [2]). Waiting times are defined akin to those used for earthquakes, namely τ being the time between an event with a magnitude M and the first subsequent event with a magnitude $M + \delta$. Here M is given by the sea level in cm. The results are quite robust for the average sea level, where the record consists of more than 70000 entries, therefore the statistics are relevant. For the daily temperature the statistical results are less impressive, as the dataset consists of only 7000 entries. The results reported here rely on a thorough data curation which now allows for automatic advanced queries and more complex analyses, in line with the FAIR principles.



Distribution of waiting times for observed hourly sea levels from 01-I-1939 to 31-XII-2018 for $\delta = 75$ cm. It resembles a scale-free distribution with $\gamma = 1.174$

Keywords: average sea level, waiting times, scale-free.

References:

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TCP - Poster presentation

**NUMERICAL MODELING OF ULTRA HIGH INTENSITY LASER ION
ACCELERATION AND GAMMA PRODUCTION FROM OVERDENSE COS^2 PROFILE
ARGON GAS JETS**

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In the past two decades, laser-accelerated ion sources and their applications have been intensely researched due to the increased focus in developing potential laser plasma sources with applications in proton radiography [1], fast ignition [2], hadrontherapy [3], [4], radioisotope production [5] and laboratory astrophysics [6]. Recently, it has been shown through experiments that proton beams with characteristics comparable to those obtained with solid targets can be obtained from gaseous targets [7-10]. By means of Particle-In-Cell simulations (PICLS code [11]), this paper studies in detail the changes in ion and gamma photon output at the interaction between a ultra-high intensity laser and a near-critical Ar gas nozzle. We can ascertain the effects of different peak densities of the gas nozzle on the accelerated particle spectrum features through a parametric study that follows several nozzle peak densities. Furthermore, the gamma photon production is studied for all cases comprised in the study in order to ascertain the feasibility of such targets as secondary sources.

Keywords: laser plasma acceleration, numerical simulation, particle in cell

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CMP - Poster presentation

INVESTIGATIONS OF SOME ELECTROMAGNETIC PROPERTIES IN LOW FREQUENCY FIELD OF THE SILICONE RUBBER/FERROFLUID COMPOSITE

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By mixing a commercial silicone rubber (SR) RTV-530 type, with a kerosene-based ferrofluid (F) with magnetite particle, in different volume fractions ϕ , six composite material samples, were obtained. The samples manufactured in the absence of the magnetic field, H were noted with SRF₀₁, SRF₀₂ and SRF₀₃ and the samples manufactured in the presence of the magnetic field H were noted SRF_{h1}, SRF_{h2} and SRF_{h3}. The investigation of the magnetic and dielectric properties of all samples, was made using the complex impedance measurements in the frequency range (500 Hz - 2 MHz) at room temperature, measuring both the complex magnetic permeability μ and the complex dielectric permittivity ε [1, 2]. The obtained results show that the imaginary component μ'' of the complex magnetic permeability presents a maximum at a frequency f_m that moves to higher values with the increase of the volume fraction ϕ , thus indicating a magnetic relaxation process attributed to Brownian relaxation.

Knowing the measured values of the imaginary component ε'' of complex dielectric permittivity, the frequency dependence of the conductivity $\sigma(f)$, was determined, which respects the Jonscher universal law [3]. The obtained results allowed the determination of the static component σ_{DC} of the conductivity and the evaluation of the energy barrier of electrical conduction process, W_m , which is lower in the case of the samples manufactured in the presence of the magnetic field, in agreement with the σ_{DC} component.

This study is very important in manufacturing composite materials of this type, for their use as magneto-dielectric devices controlled by an outside magnetic field.

Keywords: Ferrofluid, Complex magnetic permeability and permittivity, Electrical conductivity.

References:

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DISLOCATIONS IN PbF₂ DOPED BaF₂ CRYSTALS

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Fluoride crystals doped with Pb²⁺ ions are materials with great potential in the field of lasers due to their high intensity emission bands in the near UV spectral region [1]. Crystalline imperfections can influence the laser performance, thus the study of the dislocations is important because the dislocation density is a measure of the crystal quality.

Three concentrations of PbF₂ -doped BaF₂ crystals have been grown using the conventional Bridgman method. Colorless, transparent crystals were obtained in graphite crucible in vacuum (~10⁻¹ Pa) using a shaped graphite furnace [2].

In this work, we investigate the etch pits morphology and the dislocations density using the chemical etching method [3]. The method consists in immersing a cleaved sample in 2N HCl at 60⁰C for 2 minutes. Small pits are developed at the emergence points of the dislocations. The etch pits have irregular hexagonal shapes as shown in Figure 1. The study performed for the three PbF₂ -doped barium fluoride single crystals indicates that the dislocations density depends on the Pb²⁺ concentration.

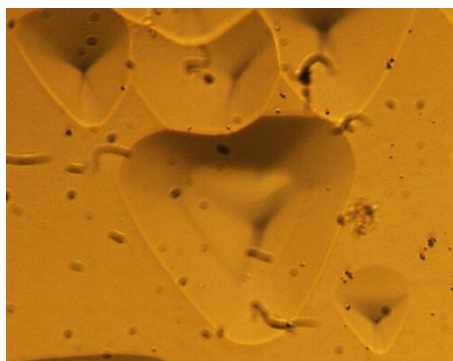


Figure 1: Dislocations in BaF₂ crystal doped with 0.5 mol% PbF₂ - magnification 20X.

Keywords: Barium fluoride crystals, Defects, Dislocations, Lead.

References:

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CMP - Poster presentation

STUDY OF COBALT PHOSPHATES: SYNTHESIS AND THERMAL PROPERTIES

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Cobalt-containing materials are reported as promising materials in life science, for instance, they show great potential for multiple applications such as electrochemical energy storage electrode materials [1], in water-splitting catalysis [2], as O₂-evolution electrocatalysts or O₂-evolution cocatalysts on photocatalysts with high activities [3].

In this work, we report the synthesis of cobalt phosphates (Co-P) nanomaterials (Figure 1 left) and the study of their physical and chemical properties. The thermal stability of these cobalt phosphates is investigated up to higher temperatures (800°C) (Figure 1 right), as this is a very important aspect that has to be taken into consideration in order to use the materials for applications in different areas such as, for example, in electronics, catalysis or batteries. Moreover, special emphasis is devoted to the optical properties of the obtained Co-P materials and the absorption spectra in the UV-Vis-NIR domain will be presented and discussed.

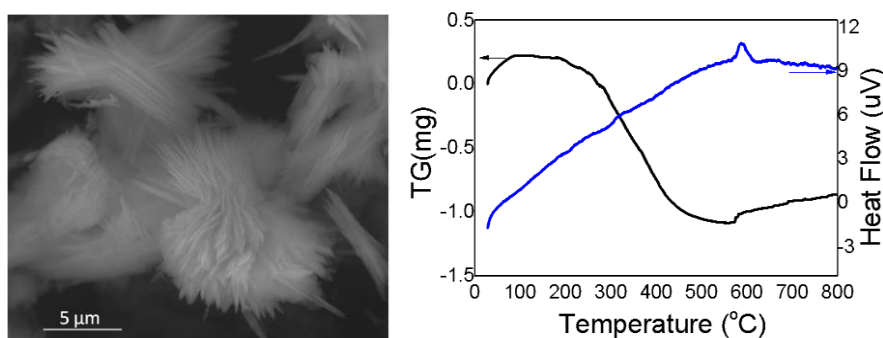


Figure 1: SEM image (left) and thermogravimetric analysis in air atmosphere up to 800 °C (right) for the $\text{Co}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$ material.

Keywords: cobalt phosphates, synthesis, thermal stability, absorption spectra.

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API - Poster presentation

ELECTRICAL AND DIELECTRIC PROPERTIES OF ZINC LEAD TELLURITE GLASSES WITH LEAD IN VARIOUS FORM

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Heavy metal oxide glasses containing lead are typically stable against devitrification upon heating and they have a wide infrared transmittance, up to the wavelength of 8 μm . Influence of the one constituent (PbO , Pb_3O_4 , PbO_2 , PbF_2 , PbBr_2 , PbCl_2 , PbI_2 , $\text{Pb}(\text{NO}_3)_2$ and PbCO_3) on dc conductivity, static permittivity, dielectric relaxation of ternary glasses of the system $70\text{TeO}_2 - 20(\text{Pb in different form}) - 10\text{ZnO}$ is presented and discussed. DC conductivity values at constant temperature changes by 2 orders of magnitude depending on the form used. The conduction activation energy values of these glasses determined in temperature range from 20 to 200 $^\circ\text{C}$ are from 0.94 to 1.08 eV. In the case of the use of halide forms (Br, Cl) and $\text{Pb}(\text{NO}_3)_2$, the values of DC conductivity are the highest and the conduction activation energy increases significantly compared to other forms of Pb. Permittivity of the glasses shows slightly increase with temperature, and significantly increase with decreasing frequency of electric field. The permittivity values at constant temperature and frequency are significantly depending on form of Pb addition.

This work was supported by the Slovak Science Foundations, projects VEGA 1/0144/20, APVV SK-FR-19-0007, and APVV DS-FR-19-0036 P. Kostka acknowledges the Czech Science Foundation – project no. 19-07456S and MEYS – project no. 8X20053. Research is partially supported by the European Union through the European Regional Development Fund (ERDF), the Ministry of Higher Education and Research, the French region of Brittany and Rennes Métropole.

Keywords: heavy metal oxide glasses, electrical conductivity, permittivity

API - Poster presentation

PREPARATION AND LUMINESCENCE PROPERTIES OF Pr-DOPED HEAVY METAL OXIDE GLASSES BY ION IMPLANTATION

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Special glasses based on heavy metal oxides are a group of materials with interesting optoelectronic applications in the mid-infrared range since their low phonon energy is lowered. They also possess a high transparency meaning that after doping with rare earth elements they can exhibit good luminescent properties and are promising materials for fiber amplifiers. Their synthesis is carried out by the melting-quenching process in which peculiar cautions are taken in regards to the solubility of the rare earth element and the tendency to crystallization. The other important point is the selectivity of the used rare earth element in relation with the luminescence spectrum.

The paper presents the procedure of Praseodymium (Pr) doping at 1000 and 2000 wt. ppm by ion implantation into $65\text{Sb}_2\text{O}_3\text{-}25\text{PbCl}_2\text{-}10\text{LiCl}$ and $60\text{PbO-}40\text{Ga}_2\text{O}_3$ glasses prepared by melting-quenching method. The luminescence properties have been determined and influence of Praseodymium (Pr) ion implantation is discussed. The electric conductivity of prepared layers using Van der Pawa method were determined.

This work was supported by the Slovak Science Foundations, projects VEGA 1/0144/20, APVV SK-FR-19-0007, and APVV DS-FR-19-0036. This work also was supported by the European Regional Development Fund under contract No. ITMS2014+: 313011W085. P. Kostka acknowledges the Czech Science Foundation – project no. 19-07456S and MEYS – project no. 8X20053. Research is partially supported by the European Union through the European Regional Development Fund (ERDF), MESRI, the French region of Brittany and Rennes Métropole.

Keywords: Ion implantation, Praseodymium, heavy metal oxide glasses, luminescence

API - Poster presentation

**THE PRESENCE OF HEAVY METALS IN DENTAL CARIES, PERMANENT TEETH,
COMING FROM A POLLUTED WORK ENVIRONMENT**

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INTRODUCTION. Manganese is used in the metallurgical, chemical and ceramic industries and can cause damage to the respiratory system. Chromium, similar to lead, copper and cadmium, is classified by International Agency for Research on Cancer as a factor inducing development of cancer. Exposure to lead and its compounds during both the prenatal and postnatal periods causes damage to the nervous system, renal function or gastrointestinal tract [8,9].

MATERIAL AND METHOD. The paper presents the level of heavy metals contained in the permanent teeth coming from the polluted areas around the city of Constanța. The studied group of teeth: upper and lower molars (crown, root), carious teeth, extracted as unrecoverable. The extracted teeth were immersed in 3% hydrogen peroxide for 24 hours. They were then washed with saline solution and cleaned of any soft tissue residues. The teeth were mechanically polished with abrasive toothpaste. All tooth samples were selected and analyzed separately for crown and root. Only the dentin of the teeth was analyzed. Dental monsters were microwave digested in solution of concentrated HNO₃ 8 ml and concentrated HCl 2 ml. Finally, the solutions were filtered and diluted to 50 ml final volume, and the metal content was determined by graphite atomic absorption spectrometry (GTAAS, model: Contra 800, Analytica Jena Instruments, Germany).

DISCUSSIONS.

Premolars coronal teeth dentine- no dental caries. The average concentration: Ni 4.210 ppm, Cu 6.990 ppm, Co 0.28 ppm, Mn 0.4071 ppm, Cd 0.0347 ppm, Cr 0.6189 ppm, Pb 11.001 ppm. The concentrations of Ni, Co, Mn, Cd are insignificant. The concentrations of Cr, Pb, and Cu are low concentrations.

Premolars coronal teeth dentine, dental caries. The average concentration: Ni 5.110 ppm, Cu 9.190 ppm, Co 0.29 ppm, Mn 0.4171 ppm, Cd 0.5347 ppm, Cr 4.0189 ppm, Pb 15.1010 ppm. The concentrations of Ni, Co, Mn, Cd are insignificant. The concentrations of Cr, Pb, Cd and Cu are high concentrations.

Molars coronal teeth dentine- no dental caries. The concentrations of Ni, Co, Mn, Cd are insignificant. The concentrations of Cr, Pb, and Cu are low concentrations.

Molars coronal teeth dentine- dental caries. Analyzed samples indicated a big difference in dental caries for all samples: Ni 7,103 ppm, Cu 149,796 ppm, Co 0,39 ppm, Mn 1,14536 ppm, Cd 0,4131 ppm, Cr 3,2273 ppm, Pb 14,6640 ppm.

CONCLUSIONS. The results of the study confirm that the risk of exposure to heavy metals and risk of dental caries exposure at cadmium and lead associated with environmental pollution.

Keywords: dental caries, permanent teeth, heavy metals



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API - Poster presentation

ANALYSIS AND CALIBRATION OF GFS SOLAR IRRADIATION FORECASTS FOR TIMISOARA

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The integration of solar power and other types of renewable energy into the electric grid requires accurate forecasts. Thus, solar irradiation forecasts of the available solar resource are useful for the penetration of solar power in the energy mix. For day-ahead forecasts, numerical weather prediction (NWP) models are used the most [1], such as the Global Forecast System (GFS), provided by the National Weather Service of the United States [2]. GFS offers a global forecast for numerous weather parameters, as well as for the downward short-wave radiation flux (DSWRF). The computation is performed with input from the entire data aggregated from various sources, including satellite-derived data. The model is issued daily at 00, 06, 12 and 18 UTC and offers hourly forecasts for the next 120 hours. This paper aims to analyze the GFS model performance in Timisoara, using real-time forecasts from September and October 2022. Also, based on the model's performance a possible calibration to reduce the errors and biases of the GFS forecast is studied.

Keywords: solar radiation forecast, GFS, calibration.

References:

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API - Poster presentation

STRUCTURAL AND MORPHOLOGICAL INVESTIGATIONS OF MOSAICS FROM BANLOC CASTLE (ROMANIA)

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As one of the emblematic historical monuments from Romania, the Banloc complex includes five buildings: the manor, the kitchen, the stall, the hunting pavilion and the house of the housekeeper [1]. The focus aims to investigate the kitchen building, which was fully covered by mosaics (interior and exterior at the window, the last one being from pavement white and red). If by X-ray diffraction (XRD), for interior mosaics have been identified SiO₂, quartz, Calcium Carbonate, Zussmanite, Sodium Aluminum Sulfide in majority, while for exterior mosaic, dolomite, Calcium Carbonate, Quartz, Oskarssonite and Calcium Aluminum Silicide have been determined. All of them are proved by X-ray fluorescence (WDXRF) and FTIR spectra (Figure 1).

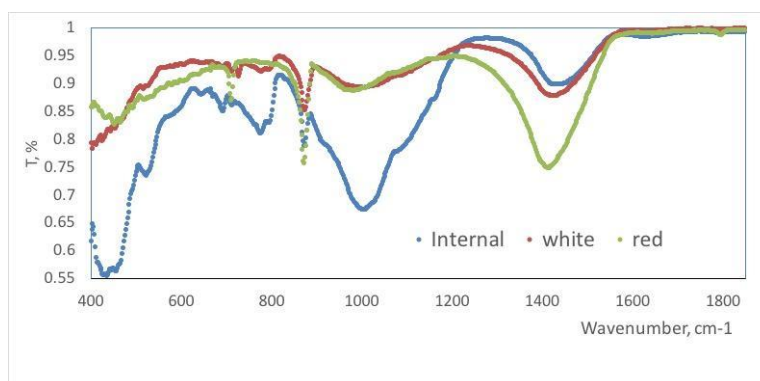


Figure 1. FTIR spectra of the mosaic samples from interior (blue) and exterior (red and green lines)

The morphology has been detected by optical, zoom microscopy, and scanning electron microscopy (SEM), which revealed the colours, fissures, cracks and even holes of these samples due to the time weathering processes, and damages they suffered in time, Figure 2.

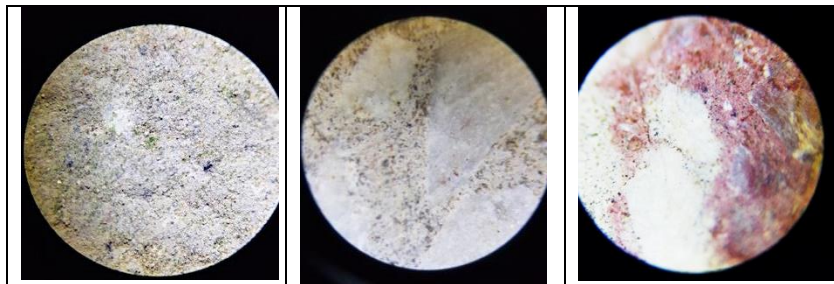


Figure 2: Figures should be numbered and figure captions in italics using font size 10.

Keywords: architecture, historical monument, Banloc

References:

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API - Poster presentation

IDENTIFICATION OF ANTHROPIC ACTIVITY INTERFERENCE IN THE SEISMIC CATALOGUE FOR BANAT REGION

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Banat region is one of the most active zones in terms of crustal seismicity in Romania. Even though the active seismic monitoring started from early XXth century, the data sets got more performant with the development and expansion of the seismic network monitoring in the late 1970's. One particularity regarding seismic data acquisition is that in many cases anthropic activity, such as mining and quarry exploitation, interferes with natural seismicity. Our aim is to bring forward a series of data extracted from the ROMPLUS [1] catalogue updated with data from the catalogue elaborated by Oros for Banat region [2], to identify the anthropic interference. For this we propose a method based on multiple discrimination criteria, such as local time of event occurrence, magnitude, location in respect with the nearest exploitation site, depth and P-wave input analysis (polarity and waveform). Identifying and filtering the anthropic events from the catalogue will result in a better imaging and characterizing of the natural seismic phenomenon in Banat region improving this way the regional seismic hazard assessment.

Keywords: Banat seismic region, Banat seismicity, anthropic activity

References:

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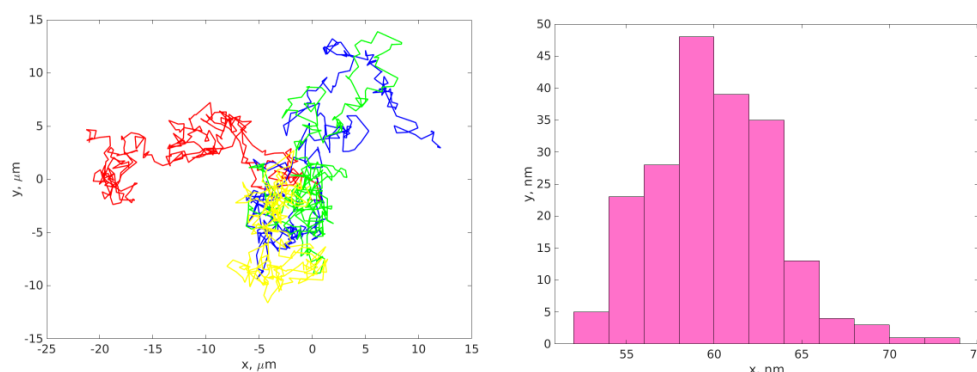
NANOPARTICLES SIZE DISTRIBUTION ASSESSMENT BY DIRECT OPTICAL PARTICLE TRACKING

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Nanotechnology is an innovative field within material science, aiming to manufacture nanostructured materials. The novel properties are caused by the nanometer range size, therefore a size characterization in the early synthesis stages is crucial. However, for such small dimensions, in the range of a few to tens of nanometers, specific techniques are required. Dynamic Light Scattering (DLS) [1] and Atomic Force Microscopy (AFM) are currently used for assessing the size in the above mentioned range. A novel optical method which we name Direct Particle Tracking (DPT) is an alternative that can be used to output the particle size distribution of particles suspended in a carrier fluid. The mean square displacement of each particles is assessed by analyzing a succession of images recorded using an optical microscope with a modified light source. The diffusion coefficient of each particle is computed and here from the diameter of each particle is assessed, followed by the size distribution. The work presents a realistic computer simulation of nanoparticles diffusion to verify the code written for Direct Particle Tracking. The simulated paths of 4 nanoparticles and the DPT assessed diameter distribution of the simulated diffusion of 60 nm diameter Ag nanoparticles are illustrated by the figure below.



The figure reveals that the results are consistent with the diameter used for simulation. The code was used to analyze a recording and

to produce the size distribution of synthesized Ag nanoparticles [2], as well.

Keywords: diffusion computer simulation, direct particle tracking.

References:

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- [2] A. Nicolae-Maranciuc, D. Chicea, L.M. Chicea, *Int. J. Mol. Sci.* **23** 5778 (2022). <https://doi.org/10.3390/ijms23105778>

API - Poster presentation

PROFILING PARTICLES OF SAHARA DUST SETTLED IN ROMANIA BY A SIMPLIFIED DYNAMIC LIGHT SCATTERING PROCEDURE AND CENTRIFUGATION

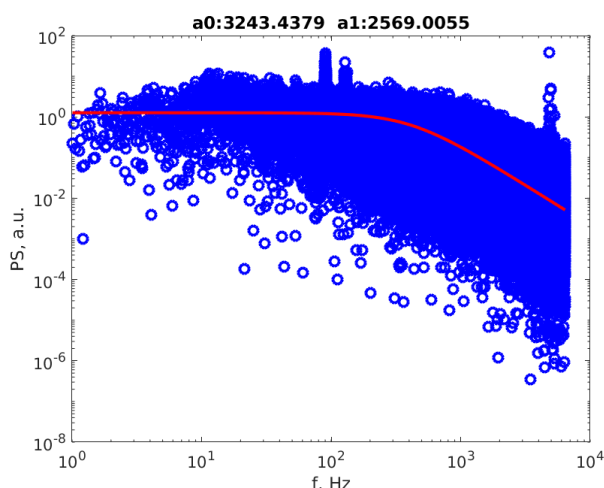
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At the beginning of April 2022 a Saharan dust cloud moved and arrived above Romania's territory, followed by a rain containing the dust particles, which were deposited on objects. Such deposits were sampled and diluted in deionized water, forming a suspension. The particle size was analyzed using Dynamic Light Scattering (DLS). The intensity of the light scattered by a particle is proportional to the 6-th power of the particle radius, therefore the interference field is dominated by the light emitted by the bigger particles in suspension. A centrifuge separation was performed to achieve a separation of the particles by density, followed by a DLS experiment to analyze the size of the particles. The DLS was simple and the DLS time series analysis consisted of assessing the frequency spectrum of the scattered light intensity, also called power spectrum (PS), filtering the PS and fitting the expected Lorentzian line to it to find the parameters here from the average diameter of the suspended particles.

We found that the suspension collected the Sahara dust rain contained bigger organic particles, with an average diameter of 1.78 μm and inorganic sand particles with an average diameter of 117 nm. The figure illustrates the FS (blue dots) and fitted Lorentzian line (red continuous line) for the sand particles. Details regarding the DLS procedure and the parameters used for centrifuge separation are presented in the extended paper.



setup

and

after

Keywords: Saharan dust cloud, DLS, particle sizing.

References:

- [1] D. Chicea, *Sensors*. 3425 **20** (2020), DOI: <https://doi.org/10.3390/s20123425>.
- [2] A. Nicolae-Maranciuc, D. Chicea, L.M. Chicea, *Int. J. Mol. Sci.* **23** 5778 (2022). <https://doi.org/10.3390/ijms23105778>

API - Poster presentation

STRUCTURAL INVESTIGATION OF $x(\text{V}_2\text{O}_5) \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}]$ and $x\text{V}_2\text{O}_5 \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{CaO}]$ GLASS SYSTEMS BY RAMAN SPECTROSCOPY

D. Racolta¹, M. Balasoiu^{2,3,4}, C. Andronache¹, L. Mihaly-Cozmuta¹, A.V. Rogachev^{2,4}, O.L. Orelovich², V.V. Sikolenko²

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Glasses from the systems $x(\text{V}_2\text{O}_5) \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}]$ and $x\text{V}_2\text{O}_5 \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{CaO}]$, with $0 < x \leq 50\text{mol } \%$ were prepared in the same conditions [1, 2] and characterized by Raman spectroscopy. The influence of V_2O_5 content on the structure of $\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}$, and $\text{P}_2\text{O}_5 \cdot \text{CaO}$ glass matrix was followed.

The Raman spectra of $\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}$ and $\text{P}_2\text{O}_5 \cdot \text{CaO}$ glass matrix present absorption bands characteristic to the metaphosphate structure. The main structural units are similar in both glass systems up to 5 mol%.

The addition of V_2O_5 determines the modification of the structure of the studied glasses.

The Raman spectra of $x\text{V}_2\text{O}_5 \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{CaO}]$ present, besides the bands specific for the matrix, some bands assigned to characteristic vibrations of V–O bonds which are evidenced only for high content of V_2O_5 . [3].

With the addition of V_2O_5 , in $x(\text{V}_2\text{O}_5) \cdot (100-x)[\text{P}_2\text{O}_5 \cdot \text{Li}_2\text{O}]$ the bands characteristic to metaphosphate structure are decreasing slowly. In this case the characteristic bands assigned to V–O vibrations were evidenced [4].

Keywords: Phosphate glasses; Raman spectroscopy; Iron ions; Vanadium ions.

References:

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API - Poster presentation

**EYEBALLS SCATTERED IRRADIATION DOSES INDUCED IN A X-RAYS
TREATMENT**

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The purpose of this work is to measure the doses induced by scattering the X-rays used in the treatment of the nasal pyramid, on the eyeballs protected by lead screens.

We report the results of a test experiment in which a T300 device was used as a unit that provides high doses for deep and semi-deep orthovoltage therapy, in the voltage range from 50 to 300 kV. A choice of "soft" spectra is possible for superficial X-ray treatment. An integral part is a networked verification and registration system, RadControl - II, for treatment planning. High voltage and tube current parameter sets can be combined with a choice of seven filters for a total of 20 different beam qualities, covering essential clinical requirements. Applicators advanced precision of adjustments by full transparent, shielded applicator body and transparent calotte with centering cross. All applicators are distinctive coded and could be assigned unique to one or more half-value-layers. The applicators are available with focus to skin distance 25, 30, 40 and 50 cm with circular or rectangular shapes. [Ref 1]. The study was carried out for the prescribed dose of 2 Gy.

Two configurations were measured, for two different applicators, at various combinations of Kv, mA and filters, in the beam and at a distance of 3 cm outside the central axis of the beam, with protection screens of lead of different thicknesses. The recording was made by cylindrical and plane parallel ionization chambers and electrometer PTW [Ref 2].

The results showed the sensitivity to the type of applicators and the Kv values to the geometry of the Pb filter thickness and its position.

The experiment is of interest for dose estimates delivered to healthy tissues outside the treatment field, as well as in studies exploring the long-term effects of radiotherapy.

Keywords: X-rays, out-of-field dose.

References: [1] WOLF-Medizintechnik GmbH (WOmed) - Unit T-300 The whole range of x-ray therapy

[2] <https://www.ptwdosimetry.com/en/>

API - Poster presentation

**THE IMPACT OF ACCURATE PARAMETERS ESTIMATION OF A SOLAR CELL ON
PV MODULE PERFORMANCE ASSESSMENT**

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The proper knowledge of the current-voltage (I-V) characteristic of a photovoltaic (PV) module is essential for the assessment of the PV module performance and thus for an accurate estimation of energy production. The theoretical performance is often evaluated using models based on the equivalent circuit whose parameters are determined from the information supplied in manufacturer's datasheet. The mathematical description of the I-V characteristics always presents a challenge when considering the scant information from datasheets (short-circuit current, open-circuit voltage and maximum power point) [1-3]. This study started from a previous paper [4], which highlighted that for the same solar cell, different scientific reports yield significantly different sets of parameters in Standard Test Conditions (STC). Despite the differences, all the parameter sets replicate the I-V characteristics with high accuracy. This paper evaluates the impact of the parameters estimation, on the evaluation of a PV module performance. The study is conducted based on the five-parameter model. Firstly, the accuracy of the I-V characteristics replication using different sets of parameters for the same commercial PV module at STC is discussed. Secondly, using an algorithm for PV module performance estimation under real weather conditions [5], the maximum power is calculated and compared against the measured value. Data measured at the Solar Platform of the West University of Timisoara are used. Finally, the impact of the parameter's accuracy at STC on the evaluation of PV module performance under real weather conditions is talked through.

Keywords: PV module, five-parameter model, real weather conditions

References:

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API - Poster presentation

**STRUCTURE ORGANIZATION OF SILICONE-RUBBER BASED MAGNETIC AND
MAGNETORHEOLOGICAL ELASTOMERS REVEALED BY MEANS SANS AND
NEUTRON DEPOLARIZATION METHODS**

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In the present work, results on small angle neutron scattering and neutron depolarization techniques applied for the microstructural investigation of such composites, are reviewed and discussed.

The analysis of the variation of the structural characteristics of the silicone rubber and the assembly of embedded magnetic particles, resulting from the MR preparation conditions by varying the particle concentration and increasing the intensity of a transverse magnetic field (TF) applied during the polymerization process, have showed that a stronger effect on the value of the interparticle correlation distance is obtained by increasing the particle concentration (for moderate and high particle concentrations), than by imposing higher values of the magnetic field during the polymerization process; contrary to this, for small particle volume concentrations, the magnetic field applied during the polymerization process was found to affect the interparticle correlation distance to a considerable extent.

In another series of elastomeric samples composed from silicone rubber and magnetic particles and polymerized in an applied longitudinal magnetic field (LF) a "magnetostrictive effect" was revealed.

Further, silicone rubber-based magnetorheological elastomer with carbonyl iron microparticles samples were analyzed by means of neutron depolarization (ND) method and differences in their magnetic structure depending on the particle concentration and polymerization in and without applied magnetic field have been analyzed.

Keywords: magnetic elastomers, structure, SANS, neutron depolarization.

API - Poster presentation

**STUDY OF ELECTRICAL PROPERTIES OF SOME ORGANIC TERNARY BLENDS
THIN FILMS FOR PHOTOVOLTAIC APPLICATIONS**

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² *Faculty of Physics*

Taking into account the performances of heterojunctions solar cells and those of tandem solar cells, the trend of these photovoltaic devices has evolved towards ternary solar cells. They are based on an active layer composed either of a donor material and two acceptor materials, or of two donor materials and an acceptor material. This study presents the optical and electrical properties of ternary blends thin films based on a polymer, a non-fullerene and a fullerene (as the second acceptor). The role of a third component in such a blend can be materialized in a solution to the existing intrinsic challenges related to spectral absorption, to the charge carriers mobility, to the inefficient dissociation of excitons, etc.

Equally, there are a multitude of external factors that influence the performance of solar cells: materials used, deposition conditions, storage conditions (environment: temperature, light, humidity, etc.). In this sense, the electrical properties in different situations and working conditions (illumination, temperature variation) will be identified, for thin films based on polymer:non-fullerene:fullerene blends, in several weight ratios, in order to highlight the differences in optical and electrical properties.

Keywords: organic ternary blends, thin films, solar cell

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API - Poster presentation

**A NUMERICAL ANALYSIS OF PARTICLE HANDLING BY
STANDING ACOUSTIC AND DIELECTROPHORETIC FIELDS**

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This paper presents a computational analysis of particle manipulation at microscopic scale. At a first stage, the acoustophoretic motion of particles at various sizes in a microchannel, at large resonant frequencies, in standing acoustic waves is investigated. The motion of these particles is governed mainly by the acoustic radiation force and the viscous drag force. The first force appears due to the scattering of sound field on particles and the second is due to acoustic streaming. The study analyses how increasing the frequency, correlated with a variation of the acoustic-driven microchannel dimensions and the number of particles could lead to a more precise manipulation/sorting of some categories of immersed particles with sub-micron diameters. At a second stage, the role of a dielectrophoretic field, superimposed on the acoustophoretic field, in the manipulation of microparticles is investigated. The time evolution distribution of particles in the neighborhood of the electrodes is calculated. These types of investigations could be important in some studies related to the manipulation of biological systems, especially viral particles from blood cells.

Keywords: standing acoustic waves, dielectrophoretic field, acoustic radiation force

References:

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API - Poster presentation

STATISTICS OF MUSICAL NOTES

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Music is composed so we can listen and enjoy it. We report here numerical results on the distribution of musical notes in classical and non-classical music. By only reading the printed musical notes, the instruments' harmonics and other elements of rhythm which confer authenticity can easily go unnoticed. Our approach is therefore different and we use Fourier transforms to recreate a digital music sheet using publicly available recordings. In order to get as close as possible to what can be heard and acoustically perceived by humans, the musical note is considered together with all its harmonics and subharmonics and not only the written symbol by itself. Looking at musical notes and chords, we observed that the distribution of chords is scale-free-like, much like the well-known Zipf distribution of words in written text [1], and that this distribution is robust across genres and other characteristics. We note that our results complement those on the emergence of power-laws in symbolic music [2].

Figure 1: Chord distributions across the 20%(right) and 99%(left) noise level

Keywords: statistics of music, Zipf law, scale-free distribution

References:

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API - Poster presentation

FORECASTING THE SUNSPOT NUMBER BY USING ARTIFICIAL INTELLIGENCE TECHNIQUES

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The space weather are considerably influenced by the Sun, our star, through his cyclic activity. At the middle 19th century, R. Wolf introduced the Wolf sunspot number [1, 2], number by which the solar activity can be quantified. The sunspot number can be forecasted using the traditional statistic; however, a useful alternative is represented by the artificial intelligence techniques. A component of these techniques, the fuzzy sets theory [3, 4], can be applied with success in this domain. This study describes a new model based on fuzzy systems [5] for forecast the sunspot number. A detailed description of the model and the results obtained are presented in this paper.

Keywords: Fuzzy systems; Sunspot number; Solar activity.

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API - Poster presentation

A HYBRID METHOD FOR MODELING SOLAR IRRADIATION IN TIMISOARA

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The artificial intelligence methods represent an alternative to the statistical approach for modeling the real phenomena from nature. In the fuzzy sets theory [1] the classical logic, True/False, is replaced by a multi-valued logic, allowing intermediate values between these two extremes. These techniques facilitate a realistic approach and have been used for modeling solar radiation [2, 3]. This study proposes a new hybrid method, based on combined statistical-fuzzy methods, as an alternative to the models constructed using only classical statistics methods or only fuzzy sets theory. The aim of this combination is to improve the accuracy of solar irradiation estimation. The model is based on a data base measured in Timisoara, Romania [4, 5] and the results demonstrate that the hybrid model can contribute to efficient estimation of solar irradiation.

Keywords: Solar irradiation; Fuzzy systems; Statistical methods.

References:

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API - Poster presentation

MAGNETICALLY ACTIVE COMPOSITES WITH RELATIVELY GIANT DIELECTRIC PERMITTIVITY

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Magnetically active composites based on silicone rubber, silicone oil, carbonyl microparticles, graphene nanopallots and fabric, as a reinforcing element, are manufactured. For a constant amount of carbonyl iron microparticles and silicone oil, and for different ratios between the amounts of silicone rubber and graphene nanopallots, three composite samples are obtained. Using the plane capacitor method, the relative permittivity of the composites is determined. It is shown that using graphene nanopallots, composites with giant values of relative dielectric permittivity are obtained. It is also shown that the relative dielectric permittivity values are sensitive to the magnetic force induced by the static magnetic field superimposed on the medium-frequency electric field. Using the model of the dipolar magnetic approximation and elements of the theory of dielectrics in medium frequency electric fields, the mechanisms participating in the obtained effects are described.

Keywords: elastomer, carbonyl iron, graphene nanopallots, relative dielectric permittivity, medium-frequency electric field.

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EP - Oral presentation

**INFLUENȚA APLICĂRII MODELULUI UDL
ASUPRA CREȘTERII MOTIVAȚIEI ELEVILOR
PENTRU STUDIUL FIZICII**

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Designul universal de învățare (UDL) este un cadru conceputul care sprijină elevii în învățare, propunând reprezentări flexibile ale conținuturilor învățării, modalități diverse de exprimare a celor învățate -pentru elevii și multiple moduri de participare. (UDL Center). Un astfel de design are scopul de a motiva, de a susține interesul și de a antrena în demersul educativ cât mai mulți elevi, fiind potrivit pentru învățarea mediate de instrumente digitale.

Abordăm în această lucrare diferite modalități de a integra instrumentele digitale în activitățile didactice la disciplina Fizică, având în vedere modelul UDL, cu scopul ca în final elevul să fie unul informat, strategic și motivat [2].

Exemplele prezentate sunt construite pentru elevii ciclului liceal, fiind implicate instrumente digitale utile pentru prezentarea conținuturilor științifice, pentru comunicare și colaborare sau pentru a crea artefacte digitale care dovedesc învățarea.

Anxietatea și atitudinea elevilor față de lecțiile de fizică joacă un rol important în succesul lor școlar și au o influență decisivă asupra rezultatelor învățării lor. Considerăm că activitățile și resursele propuse în această lucrare pot modifica atitudinea elevilor față de învățarea fizicii și suntem interesați să investigăm în continuare această schimbare de atitudine, dar și autoeficiența percepută, utilizând instrumente consacrate din literatură de specialitate.

Cuvinte cheie: design universal de învățare, instrumente și resurse digitale, învățarea fizicii, atitudinea și motivația pentru învățare, autoeficiența percepută.

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EP - Oral presentation

**NEW EXPERIENCES AND FACTS IN MULTIMEDIA TEACHING OF
COSMOLOGY, ASTROPHYSICS AND SPACE TECHNOLOGY TO
STUDENTS FROM ALL FIELDS**

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This article is dedicated to recent developments and facts do to the experience in teaching cosmology and astrophysics (including basics of general relativity) using multimedia facilities . The target students were all undergraduates at our university, even without a basic physics background. A special section will be dedicated to the training of master degree students in didactical physics – future teachers – to provide such type of lectures.

Keywords: general relativity, cosmology, space technology

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EP - Oral presentation

**SOME MODERN METHODS RELATED TO ADVANCED TECHNOLOGIES IN
TEACHING STEM SPECIALISTS**

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In addition to a number of societal and individual impacts, the pandemic of COVID-19 has also greatly affected educational systems everywhere. The education in those universities that prepare STEM specialists like engineers, physicists, chemists, computer scientists, etc. has faced with new requirements and problems. The solutions that were found are closely linked to new technologies, curricula innovation, and rethinking of the organizational structure of higher education. In this framework, different institutions reacted in different ways, working together in an international environment, and exchanging ideas and experiences.

In the ERASMUS+ project "***Applying some advanced technologies in teaching and research, in relation to air pollution***" faculties from four universities from Romania (Craiova), Bulgaria (Plovdiv), Slovakia (Banska Bystrica), and Turkey (Adana) have tried to draw some positive lessons from the pandemic, on how to improve the quality of teaching in an on-line or hybrid environment. Some trends that have been successfully applied in students' education will be presented and outlined as the framework of a conceptual educational model with an enhanced presence of modern educational technologies.

Keywords: Modern teaching methods, E-learning, Augmented Reality, STEM

EP - Oral presentation

THE IMPACT OF BOTH REAL AND VIRTUAL LABORATORY ON PRACTICAL SKILLS DEVELOPMENT FOR EDUCATION IN PHYSICS

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In the last two years of Covid-19 pandemic, teaching has been performed mainly online. Consequently, both students and professors in sciences, engineering or medicine struggled in almost every subject that involved the development of the practical abilities of students. With the help of virtual simulations, different online applications or dedicated software, students nevertheless managed to achieve a minimum level of practical skills.

Nowadays face-to-face teaching is returning after almost two years of the COVID-19 pandemic, and with it the opportunity of combining online and face-to-face teaching.

While focusing on Physics in particular, we raise the questions of what is the impact of combining in-person and online laboratories on the development of practical skills in physics education, and how do these laboratories influence the students' perceived self-efficacy.

This paper reveals learning activities, relevant information and the methodology used in answering the above questions, as well as a comparison with other studies addressing the same questions.

Keywords: laboratory, real, virtual, practical skills, education in physics.

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EP - Oral presentation

INFLUENȚA CLASEI OGLINDITE (FLIPPED CLASSROOM) ASUPRA ELEVILOR DE LICEU LA ORA DE FIZICĂ

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Metodele și tehnicile tradiționale de predare nu mai sunt eficiente pentru generația actuală de elevi [1] promovând o învățare pasivă [2] care nu îi mai motivează pentru studiul acestei discipline [3]. Pentru a îmbunătăți performanța academică a elevilor și pentru a-i implica activ în procesul de învățare au fost dezvoltate noi modele pedagogice bazate pe tehnologia digitală [4]. Cel mai popular model care a atras atenția multor cercetători este modelul mixt de tip Clasa Oglindită (Flipped classroom) în care elevii se familiarizează cu subiectul de studiat acasă, în propriu ritm, prin intermediul videoclipurilor interactive și/sau a altor materiale didactice cel mai adesea în format digital, iar în timpul orelor profesorul utilizează metode active de învățare pentru a clarifica, aprofunda și sistematiza noțiunile învățate [5].

Pentru a explora influența modelului Clasa Oglindită asupra rezultatelor școlare, a motivației în învățarea fizicii (motivația intrinsecă, motivația în carieră, autodeterminarea, autoeficacitatea și motivația notelor), precum și opinia elevilor cu privire la acest model de predare, am realizat un studiu cvasi-experimental pe parcursul unității de învățare Curentul electric, la care au participat 30 de elevi de clasa a X-a, din Timișoara. Rezultatele obținute în contextul acestui studiu au arătat că modelul de predare nu a avut o influență semnificativă asupra rezultatelor școlare ale elevilor, fiind totuși aplicat pe o scurtă perioadă de timp. În ceea ce privește componentele motivației, s-a observat o influență asupra motivației intrinseci, autodeterminării și autoeficacității.

Cuvinte cheie: clasa oglindită, performanța academică, motivația elevilor

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EP - Oral presentation

PARTICULARITĂȚI ALE UTILIZĂRII TIC ÎN ACTIVITATEA DIDACTICĂ LA DISCIPLINA FIZICĂ

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Contextul pandemic ne-a demonstrat, încă o dată, necesitatea practică a acceptării tehnologiei TIC în activitatea didactică. Acest studiu își propune să contribuie la dezvoltarea cunoașterii în domeniu prin investigarea modalităților de utilizare a tehnologiei TIC în România, de către cadrele didactice de la specializarea Fizică în procesul de predare-evaluare.

La acest studiu au participat 86 de profesori de fizică, din regiuni diferite ale țării. Pentru a determina interesul pentru utilizarea TIC în activitățile didactice, am utilizat Modelului de Acceptare a Tehnologiei (TAM) conținând două subscale: utilitatea percepută și ușurința utilizării TIC percepută [1]. Chestionarul a fost tradus în limba română și adaptat pentru studiul de față.

Rezultatele studiului indică diferențe semnificative în funcție de vârstă pentru ușurința utilizării TIC, dar nu și pentru utilitatea percepută a utilizării tehnologiei TIC. De asemenea rezultatele obținute sugerează utilizarea la un nivel ridicat a unor instrumente interactive, cele mai utilizate aplicații/instrumente folosite în procesul de predare de către profesori fiind: "PhetColorado", "Youtube", "PowerPoint", "Padlet", "Jamboard" și "Prezi". De asemenea studiul evidențiază, pentru perioada post pandemică, dorința de a utiliza aceste instrumente în continuare la clasă, inclusiv platformele de management al învățării, în concordanță cu literatura de specialitate [2]. Astfel putem recomanda factorilor de decizie, căutarea unor strategii și soluții pentru a creșterea gradului de informare și familiarizare cu tehnologia TIC pentru ca profesorii să poată valorifica cât mai bine TIC la ora de Fizică.

Cuvinte cheie: nivelul de acceptare al tehnologiei TIC, TAM, aplicațiile/ instrumentele TIC, profesorii de fizică, procesul de predare, procesul de evaluare, platformele de management al învățării

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EP - Oral presentation

ÎNVĂȚAREA FIZICII PRIN INVESTIGAȚIE

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Metoda investigației ține de o categorie puțin mai largă de metode, numite metode inductive. În metodele inductive elevul nu mai are un rol pasiv, ca înainte, ci un rol activ în a-și spori cunoașterea, înțelegerea despre lumea din jur.

Dacă ne referim la științele exacte, sau la științele naturii, elevul trebuie să înțeleagă diferite fenomene din jurul lui, că sunt fenomene fizice, chimice sau din lumea vie. Trecerea de la metode deductive la metode inductive era necesară pentru că e nevoie, într-o măsură mult mai mare, ca viitorii adulți să poată gândi structurat, să poată gândi autonom, să poată procesa situații noi pe care le au în fața lor și să vină cu soluții bune. Pe de altă parte, dinamica economică este tot mai mare, apar ramuri noi, apar domenii noi, altele dispar, apar meserii noi. Cei care sunt acum elevi vor trebui să se adapteze la acest mediu economic, vor trebui să fie capabili să-și formeze alte specializări.

Acest mod de a face școală, în care îi înveți pe elevi să gândească cu mintea lor, să gestioneze situații complexe, să poată lucra autonom și să învețe să învețe, îi va ajuta mai târziu să își poată forma, mult mai rapid, alte specializări.

Un elev învață prin investigație atunci când se află în fața unei probleme, când studiază cu atenție datele și relațiile cauzale, reușind să găsească cea mai bună soluție. Un rol important are aici și învățarea prin cooperare.

În predarea oricărei teme din programa de fizică, profesorul începe lansând elevilor o întrebare/ problemă provocatoare („conflict cognitiv”). Pe parcursul lecțiilor, profesorul nu le oferă de la început răspunsul la întrebare sau explicația pentru fenomenul supus discuției, ci doar îi ajută să-l găsească singuri. Acest mod de predare conduce nu doar la reparația interesului copiilor pentru științele naturii, ci și la retrezirea curiozității pentru lumea înconjurătoare. Mai mult, majoritatea elevilor cu care se lucrează astfel reușesc să înțeleagă relevanța pentru viața de zi cu zi a temelor studiate la orele de științe exacte.

Metoda investigației a ridicat o serie de probleme și înainte de pandemie, în ceea ce privește implementarea. Nu a fost ușor să-i imprimăm acest stil activ, interactiv elevului, să îi trezim curiozitatea, motivația internă, dorința de a căuta. Elevii trebuie obișnuiți să caute, trebuie să își dea seama de ce informații au nevoie, să știe pe unde să le caute, să decidă care sunt informațiile relevante și să știe cum să le folosească după aia.

Cuvinte cheie: investigație, profesor, elev, metodă.

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EP - Poster presentation

**METHODS USED FOR THE PURPOSE OF MOTIVATING THE STUDY OF PHYSICS
AT THE LEVEL OF THE EDUCATIONAL UNIT**

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At the level of an educational unit, the interest in physics must provide the foundations of a scientific culture, in order to form skills necessary for the integrated knowledge of natural phenomena and their approach from various perspectives, as well as the way in which these phenomena influence the quality of life. Physics is probably the most important science of nature if we aim to know and understand its behavior, describe the complexity of the surrounding world, explain the evolution of systems and processes in nature. Physics is also the basis for designing technologies that provide solutions for solving increasingly complex problems of the real world, but especially for understanding everything that happens frequently in everyday life. On the other hand, we always have to make decisions and we certainly want them to benefit us and those around us, the environment and life. It is obvious that not all students will become scientists, teachers or engineers, but science and technologies occupy an increasingly important place in our daily work. Today's students need science education to feel comfortable in an increasingly scientifically and technically complex world. In this context, the Physics discipline provides us, in addition to knowledge, the ways to train essential skills for lifelong learning. In the pre-university education system, these objectives of physical education correspond to high school education. In this sense, the management team of the educational unit must facilitate students' access to all possible resources so that the graduates should be able to decide on their own career, on their own path of intellectual and professional development and to actively integrate into social life.

Keywords: sciences, physics, vocational guidance.

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EP - Poster presentation

UNDERSTANDING THE FORMATION OF SHOCK WAVES THROUGH THE NUMERICAL SOLUTION OF BURGERS' EQUATION

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The formation of shock waves is fundamental to our understanding of many nonlinear processes, particularly rogue waves, sneaker waves and tsunamis. The prototypical equation commonly used to understand the emergence of shock waves is the so-called Burgers' equation, sometimes referred to as the Bateman-Burgers equation, namely:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} = \nu \frac{\partial^2 u}{\partial x^2}$$

which was originally introduced by Harry Bateman in 1915 [1] and revisited by Johannes Martinus Burgers in 1948 [2]. While the equation has become a classic topic in the undergraduate syllabus in science and engineering because of its apparent simplicity, the lack of a freely available, open-source simulation framework has limited its actual use in hands-on student activities.

Here we show two distinct numerical treatments of the Burgers equation, one in Python and one in Julia, which take advantage of the available visualization tools, both 2D and 3D images and short animations/movies. The proposed codes [3] are numerically robust and can be run on computers with limited hardware resources, which makes them ideal for didactic purposes.

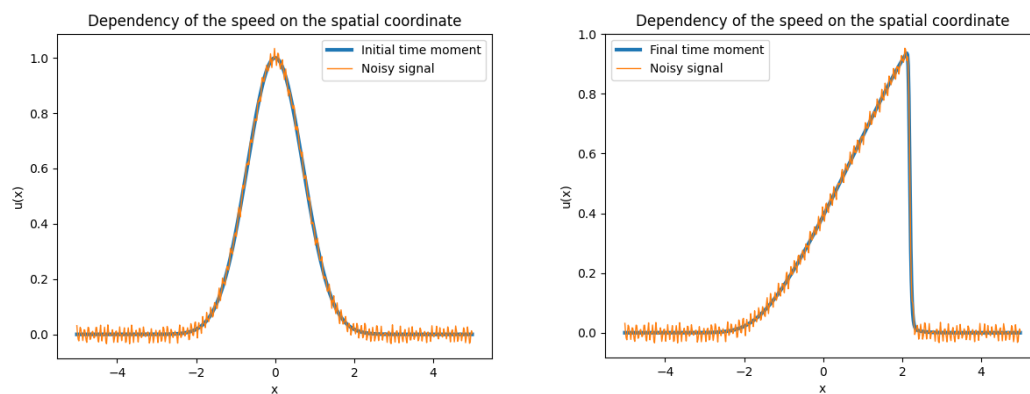


Figure 1: Numerical solution of Burgers' equation. Left panel: initial conditions of the system with added noise. Right panel: final conditions of the system with added noise.

Keywords: Burgers' equation, shock formation



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EP - Poster presentation

THE IMPORTANCE OF PHYSICS EDUCATION IN A MODERN SOCIETY

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The study of physics not only improves the skills to work in the field of science and technology but also provides a way to improve our lifestyle. We know that a modern world is based on advanced technologies and all of them work based on physical principles and laws. An eloquent example is given by the increasing demand for energy, under conditions of minimal impact on the environment, this being dependent on how we understand physics. Another example where physics meets the needs of society is given by medicine. In this field, we cannot talk about modern medicine without thinking about physical principles. Also, as we know, all diagnostic and therapeutic methods used in modern hospitals are based on physics. The use of ionizing radiation, lasers or optical fiber are just a few examples where physics intersects with the territory of medicine. On the other hand, physics is essential in understanding life on our planet, climate change and how we can protect the environment. This article deals with some aspects related to the importance of studying physics in a modern society, focusing on the fact that the teaching of physics at any level must be done so that there are strong connections with the needs of the modern society in which we live.

Keywords: physics education, advanced technologies, medicine, environment.

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EP - Poster presentation

UTILIZAREA APLICAȚIILOR DE TIP “SITE BUILDER” ÎN PREDAREA ȘI ÎNVĂȚAREA FIZICII

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Un prim pas în predarea “altfel” a fizicii ca disciplină, la nivel preuniversitar ar fi utilizarea tehnologiilor digitale, de exemplu construirea unui site web, utilizând aplicații software de tip site builder (generator de site-uri) [1]. Lucrarea își propune să ilustreze un mod alternativ de desfășurare a unei lecții de fizică sau de chimie pe tema *Transformarea izobară* [2], folosind resurse digitale. Astfel am propus elevilor clasei a ... să creeze un site educațional cu aplicația Google Sites, iar simularea experimentală prin care se verifică legea lui Gay-Lussac a fost integrată atât ca soft educațional demonstrativ cât și ca studiu experimental folosind Microsoft Excel. Feedback-ul elevilor este asigurat prin completarea unui formular online creat cu Google Forms. Soft-urile educaționale au o importanță deosebită mai ales în ceea ce privește disciplinele experimentale [3] cum sunt fizica și chimia în care desfășurarea unor lecții precum studiul transformărilor gazelor ideale necesită un efort mai mare din partea elevilor pentru a fi înțelese. Deasemenea am prezentat o modalitate în care elevii pot lucra independent de profesor, simularea interactivă fiind un mijloc de a crește responsabilitatea elevilor față de activitatea propusă.



Figura 1: Interfața site web –pagina Cine a fost fizicianul Gay-Lussac?

Cuvinte cheie: transformarea izobară, site web, instrumente digitale.

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