BOOK OF ABSTRACTS

12th Conference of the Society of Physicists of Macedonia

coorganized by

Institute of Physics
Faculty of Natural Sciences and Mathematics
Ss. Cyril and Methodius University in Skopje

– CSPM 2018 –

27–30 September 2018, Ohrid, Republic of Macedonia

Technical Editor: Irina Petreska

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Acknowledgements

- The Organizing Committee of CSPM 2018 acknowledges the financial support from *"Ss. Cyril and Methodius" University* in Skopje and the *Ministry of Education and Science* of Republic of Macedonia.
- The Organizing Committee expresses sincere gratitude to the *Scientific Committee* for evaluation of the submitted abstracts and selection of the conference topics.

CSPM 2018 was sponsored by **ARS LAMINA** DOO Skopje.

Preface

It is with great pleasure that we welcome you to our beautiful city of Ohrid for the 12^{th} Conference of the Society of Physicists of Macedonia (CSPM 2018). First, we would like to thank all of you for your participation at the conference. CSPM 2018 is one of the most important and traditional meetings of physicists in Republic of Macedonia, held with biennial periodicity since its first edition in 1996. The conference aims are to provide participants the opportunity to exchange information and new results, identify new challenges in the experimental and theoretical physics, and start or strengthen international collaboration projects.

We are very grateful for the help and advice of the International Scientific Committee of 12^{th} Conference of the Society of Physicists of Macedonia 2018, formed by 24 experts in the field from 14 countries, who helped us to ensure interesting and high-quality scientific presentations for the benefit of all participants of the Conference.

12^{th} Conference of the Society of Physicists of Macedonia has received more than 50 contributed abstracts sent from around 20 different countries, mainly from Europe. With the confirmation of 7 plenary talks, 6 invited session talks, 32 oral presentations, 10 posters and 3 workshops, as detailed in this Book of Abstracts, we are looking forward to a great meeting with fruitful discussions.

This Book of Abstracts builds the basis for the proceedings to follow. All authors are invited to submit full papers which will be published after a rigorous peer review process in the Conference Proceedings.

Olga Galbova – President of the Scientific Committee

Welcome Address

Dear Participants,

First of all, on behalf of all members of the Organizing Committee, I would like to express our great pleasure in welcoming all of you on the 12^{th} Conference of the Society of Physicists of Macedonia, in the beautiful city of Ohrid.

The first Conference of the Society of Physicists of Macedonia was held in 1996. It started as a national conference organized and attended mainly by the physicists from Macedonia. In a view of the increasing importance of international cooperation, its character has been changing over time with a gradual increase of the number of foreign participants. This edition of CSPM is the first of the series for which the selection of papers was done by an international scientific committee comprised of scientists from 14 countries. I use this opportunity to thank all of them for their involvement and contributions.

The current edition of CSPM offers a solid scientific program represented in the form of more than 30 regular and invited talks and a selection of 7 hot topics covered by the plenary speakers. We do believe that the program will keep your attention and will serve as a useful platform for exchange of ideas and networking. We hope that scientific program complemented with the exciting social program, which includes excursion to the attractions of Ohrid and a Conference Dinner, will turn your participation at the conference into an enjoyable one.

I would like also to note that on initiative of the EPS – a section of Young Minds from Skopje, the conference will host a networking event for students' career prospect. This would be great opportunity for the students to ask questions and interact directly with you as scientists. We are hoping that many of you can take part in this event and provide opinion and advice on a number of questions of importance for their future career.

Finally, all this has become possible thanks to your participation and to the financial support from the Ss. Cyril and Methodius University in Skopje and from the Ministry of Education and Science of Republic of Macedonia, as well as our sponsors.

Enjoy the CSPM 2018!

Aleksandar Skeparovski – Conference Chair

Contents

Plenary Talks - PT

PT-01

QUANTUM ZENO EFFECT AND COHERENT CONTROL IN ULTRA-COLD ATOMS

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In quantum mechanics the coherent evolution of a system can be influenced by strongly coupling the system with neighboring states or measuring devices. This profound and counterintuitive phenomenon is known as Quantum Zeno Effect (QZE). I will report on different aspects of QZE. First I will study the dynamics of a quantum system being subjected to a sequence of projective measurements applied at random times (stochastic QZE). This will allow an experimental demonstration of an ergodicity relation between the survival probabilities of different stochastic series that respectively correspond to time and ensemble averages [1]. In a second set of experiments I will show how it is possible to exploit the back-action of frequent measurements and strong coupling to dynamically disconnect different groups of quantum states and constrain the dynamics of sub-regions of a Hilbert space [2]. The demonstration of quantum Zeno dynamics can be a critical step forward to protect and control the dynamics of quantum bits (qubits) and, broadly speaking, quantum information processing.

References

1. **"Ergodicity in randomly perturbed quantum systems"**
S. Gherardini, C. Lovecchio, M. M. Mueller, P. Lombardi, F. Caruso and F. S. Cataliotti, *Quantum Sci. Technol.* **2**, 015007 (2017).
2. **"Experimental realization of quantum zeno dynamics"**
F. Schaefer, I. Herrera, S. Cherukattil, C. Lovecchio, F.S. Cataliotti, F. Caruso and A. Smerzi, *Nature Communications* **5**, 3194 (2014)
DOI: 10.1038/ncomms4194.

FAR-FIELD BEAM RESHAPING BY OPTICAL VORTICES AND VORTEX LATTICES

PT-02

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Optical vortices (OVs) are intriguing phenomena in nature that attract much attention in many areas of physics ranging from micro-manipulation of trapped particles to strong-field physics. The OVs have characteristic spiral phase profiles and point phase singularities in their wavefronts that determine also the intensity structures of the beams [1]. The topological charge (TC) l of an OV corresponds to the total phase change $2\pi l$ over the azimuthal coordinate. The basic interactions between two OVs are rather simple. If two OVs with equal charges are placed on a common background beam, they repel and rotate. If the TCs are opposite, the OVs attract and translate in transverse direction. Phase OV can be created by means of e.g. computer-generated holograms (CGHs), spiral phase plates and spatial phase modulators, just to mention a few.

In this talk we will first discuss the experimental confirmation [2] of the analytically predicted transformation of the TCs of an input OV beam after a fork-shaped binary CGH [3]: The final TC of the vortex is equal to the TC of the incident beam plus the diffraction order (with its sign) times the TC encoded in the binary grating. Further, being inspired by this result, we will describe how a CGH-generated beam whose amplitude profile is X-modulated in azimuthal direction, with a central dark non-vortex core [4], can be transformed into an array of five OVs [5].

While interacting with each other by phase and intensity gradients, multiple (or multiple-charged) vortices can decay into single-charged ones and can arrange themselves in regular patterns (vortex lattices, VLs) [6]. Depending on the signs of the TCs the vortex lattices can exhibit rotation or rigid propagation. Previous experiments on the generation and nonlinear propagation of square and hexagonal optical vortex lattices showed that if the TCs of the vortices have identical signs, the lattice exhibits rotation. If their signs are alternative, stable propagation of the OV lattice has to be expected [7]. Recalling the result that when the TC of an OV beam is "erased" a well formed Gaussian bright peak is observed in the (artificial) far-field [2,3], we extended this approach to the far-field diffraction

of a large square-shaped [8] and hexagonal OV lattices [9] with hundreds of OVs generated by a spatial light modulators. The observed dramatic reshaping of the input beam in the far-field is shown to be in excellent agreement with the numerical simulations. We will further report recent unpublished numerical and experimental results regarding the controllable far-field beam reshaping by mixing square-shaped and hexagonal optical vortex lattices. In our view the observed beam reshaping near the focus of a lens (artificial far-field) is paving the way for further analyses for e.g. all-optical guiding, switching and coupling applications.

In the field of perturbative nonlinear optics we will report experimental and numerical investigation of the white light generation by singly- and doubly-charged OVs propagating in a Kerr medium, where spectral broadening and transfer of TC into emerging spectral satellites takes place due to self-phase modulation and degenerate four-wave frequency mixing.

To exploit intriguing new applications of femtosecond laser beams/pulses, it is often necessary to shorten the wavelength by nonlinear frequency conversion. However, during the conversion the OV tend to break up. We will discuss the first experimental generation of OVs in the extreme ultraviolet region by using the highly nonlinear non-perturbative process of high-harmonic generation [11] and its confirmation by other research groups.

References

1. A. S. Desyatnikov, Yu. S. Kivshar, L. Torner, *Prog. Optics* **47**, 291 (2005).
2. L. Stoyanov, S. Topuzoski, I. Stefanov, L. Janicijevic, A. Dreischuh, *Opt. Commun.* **350**, 301 (2015).
3. S. Topuzoski and Lj. Janicijevic, *J. Modern Optics* **58**, 138 (2011).
4. Lj. Janicijevic, S. Topuzoski, L. Stoyanov, A. Dreischuh, *Opt. Commun.* **389**, 203 (2017).
5. S. Topuzoski, Lj. Janicijevic, L. Stoyanov, I. Stefanov, and A. Dreischuh, *Opt. Commun.* **428**, 206 (2018).
6. D. Neshev, A. Dreischuh, M. Assa, and S. Dinev, *Opt. Commun.* **151**, 413 (1998).
7. A. Dreischuh, S. Chervenkov, D. Neshev, G.G. Paulus, and H. Walther, *J. Opt. Soc. Am. B* **19**, 550 (2002).
8. L. Stoyanov, G. Maleshkov, M. Zhekova, I. Stefanov et al., *J. Opt. Soc. Am. B* **35**, 402 (2018).
9. L. Stoyanov, G. Maleshkov, M. Zhekova, I. Stefanov et al., *J. Opt.* **20**, 095601 (2018).
10. P. Hansinger, G. Maleshkov, I. L. Garanovich, D. Skryabin, et. al., *Opt. Express* **22**, 11079 (2014).
11. M. Zürch, C. Kern, P. Hansinger, A. Dreischuh, and Ch. Spielmann, *Nature Physics* **8**, 743 (2012).

COLLABORATION/COOPERATION IN GROUPS OF AGENTS

PT-03

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This talk addresses two related topics: collaborative ensemble learning in statistical learning theory and cooperation in social dilemmas. Marquis of Condorcet (1785) shown that if each voter is more likely (> 0.5) to vote correctly, then adding more voters increases the probability that the majority decision is correct. This has triggered various ensemble methods for improving the predictive performance of (weak) learning algorithms, in another words, for "garnering wisdom from a council of fools". Algorithmic stability will be utilized to design collaborative ensemble methods in order to reduce generalization error for both binary classifiers and Gaussian conditional random field models. Thus, "collaborative fools could generate even more wisdom".

Ever since the publication of Darwin's epochal work "The Descent of Man and Selection in Relation to Sex" (1888), the apparent paradox of cooperation in social dilemmas has been at the focus of the research community. A framework for studying social dilemmas in networked societies will be suggested where individuals follow a simple state-based behavioral mechanism based on generalized reciprocity, which is rooted in the principle "help anyone if helped by someone". This framework applies to a wide range of social dilemmas including, among others, public goods, donation, and snowdrift games. It will be shown that cooperation through generalized reciprocity emerges as the unique attractor in which the overall level of cooperation is maximized, while simultaneously exploitation of the participating individuals is prevented.

WONDERFUL WORLD OF RANDOM WALKS: FROM LUCRETIUS' "DE RERUM NATURA" TO OPTIMAL SEARCH STRATEGIES

PT-04

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I give a brief survey of the generic models of anomalous non-Brownian random walks of high current relevance, running off in complex physical and biological systems that are far from equilibrium. A particular attention is devoted to continuous time random walk, heterogeneous diffusion processes, Lévy flights, Lévy walks, and fractional motions. The models are illustrated by different examples, classical and very recent as well, demonstrating ubiquity of anomalous diffusion phenomena in surrounding world.

Keywords: Brownian motion, Generalized Central Limit Theorem, heavy-tailed probability laws, long memory effects, Lévy foraging hypothesis.

FRACTIONAL TIME DERIVATIVES, ANOMALOUS DIFFUSION AND POISSON-NERNST-PLANCK MODEL

PT-05

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The very irregular state of motion observed for small pollen grains suspended in water by Robert Brown initiated one of the most fascinating field of the science, which is reported in several contexts of nature, the so-called diffusion process. Satisfactory explanations for this motion were proposed by Einstein, Smoluchowski and Langevin in their pioneering works. The main feature regarding this random motion is the linear growth with time manifested by the mean square displacement, which is an important characteristic of a Markovian process. Contrasting with this scenario, several cases, for example, in living cells, crowding systems, and amorphous conductor, have pointed out that diffusion may exhibit a nonlinear time dependence for the mean square displacement typical of non-Markovian processes which, consequently, has implication on the physical properties of these systems, in particular on the electrochemical properties, which represents a relevant research field of material science.

Despite the deviations between experimental data and theoretical predictions, results from impedance spectroscopy are usually investigated in the framework of the Poisson - Nernst-Planck (PNP) diffusional model and/or equivalent circuits. These disagreements are especially remarkable in the low frequency limit, where the PNP and equivalent circuits with simple elements predict asymptotic impedance Z characterized by a power-law dependence in the frequency ω with a unitary exponent (i.e., $Z \sim 1/(i\omega)$ but the experimental data usually exhibit a different power-law regime. These discrepancies consist, therefore, a strong motivation for investigating extensions/generalizations of the PNP model as well as of the equivalent circuits.

Here, we discuss possible extensions of the PNP model by using the well established features of the fractional calculus, more specifically, fractional time derivatives expressed by the Caputo approach. We first consider changes on the bulk equation and, after that, we extend the boundary conditions in order to take into account the complexity inherent to the surface effects, which can be related to charge transfer, accumulation, and/or adsorption – desorption. We show that the extensions of the PNP model can be related to equivalent circuits. We show furthermore that by means of the electrical conductivity the different diffusive regimes present

in these systems may be evidenced. The results obtained from these extensions are also compared with experimental data, showing in general that the proposed fractional calculus based approach is particularly suitable to describe the data behavior.

ADVANCED ACTIVE ANODE MATERIALS AND ADDITIVES FOR LITHIUM ION BATTERIES

PT-06

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The physics professors that founded SafeLi aim to power the wireless world while making it a safer place for users of electric vehicles, consumer electronics, and many other devices that draw energy from lithium ion batteries. Building on discovery and patenting of Graphene Monoxide, a 2-Dimensional crystalline material that is the first known solid form of carbon monoxide, we are testing applicability in batteries. When Graphene Monoxide layers are stacked on one another, the between-layer spacing is larger than with graphite, the dominant anode material in the past 35 years, thus facilitating faster lithium intercalation resulting in faster charging. We are developing active anode materials and additives that have the potential to double the battery lifetime and charge it at least 6 times faster, while also removing the danger of fires. The paper will summarize how fundamental university research can lead to entrepreneurship in energy storage.

Keywords: Graphene, Graphene Monoxide, Nanomaterials, Lithium Ion Batteries, Anodes, Additives.

HOW WE CAN USE PHYSICS EXPERIMENTS TO HELP STUDENTS BUILD THEIR OWN KNOWLEDGE?

PT-07

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Once we realize that teaching by telling is very inefficient and that learning only occurs when students are actively engaged in the learning process, we also realize that the traditional role of experiments in physics classroom and in the textbooks is no longer useful. In my talk, I will describe how changes in my own views about how people learn physics helped me to see new features of the experiments that are important for learning and would otherwise remain hidden to me. I will show examples of experiments that are used to achieve active engagement of students in the learning processes, experiments that served as a resource for designing new type of problems and experiments that were used as a research tools in physics education.

Invited Talks - IT

IT-01

CHIRAL METAMATERIALS BASED ON TWISTED CLOSED RING RESONATORS

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We analyze propagation of electromagnetic waves through chiral metamaterial composed of twisted closed ring resonators (TCRR). The proposed chiral metamaterial is ultrathin structure which makes this design possible to fabricate and, at the same time, maintains effects which can be observed in conventional chiral 3D metamaterial structures. Dimensions of chiral elements are chosen to provide resonances within THz frequency range. Different geometrical parameters are varied in order to determine their influence on resonant frequency position and losses.

For this TCRR chiral metamaterial structure, we made the analysis of absorbance spectra in order to determine the origins of resonant peaks. Different effects can be distinguished: LC behavior, dipolar response as well as the influence of the periodicity of the structure. Additionally, we calculated circular dichroism spectra and investigate the possibilities for application. It is showed that proposed structure is a good candidate for frequency selective absorbers and THz modulators.

Keywords: twisted closed ring resonators, chiral metamaterial

THE QUANTUM PASCAL: MEASURING PRESSURE AND VACUUM WITH LIGHT

IT-02

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The year 2018 will be one of the most important years in the history of metrology. The 26th meeting of General Conference on Weight and Measures (CGPM) which will take place in Versailles-Paris from 13-16 November will present a new definition of 4 base units of SI measurement system based on universal constants. In the context of all activities to related to the quantum system of units, several physical constants, among them the Boltzmann constant k_B, will be fixed to a certain value. The kelvin will be newly defined by the amount of energy k_BT. This makes the ideal gas law not a new, but a more attractive alternative route with new perspectives for National Metrological Institutes to realize the pressure scale by measuring gas density. It is known that photonic manometer relies on the fact that the refractive index (n) of a gas varies directly with its density, which when known along with temperature will define pressure in terms of energy density with the units of joules/m^3. So, if the temperature is known and held constant, n can serve as a sensitive measure of pressure. The refractive index n, in turn, can be determined to high precision by measuring how it affects light passing through the gas. One recently devised instrument operating on that principle is called the Fixed-Length Optical Cavity, or FLOC.*

Keywords: metrology, pressure, quantum, pascal, light.

*Sefer Avdiaj was guest researcher at NIST during this research work

IT-03

ANOMALOUS-TO-NORMAL DIFFUSIVE CROSSOVER IN COMPLEX SYSTEMS: TEMPERED DYNAMICS APPROACH

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We give theoretical description of characteristic crossover dynamics in complex systems manifesting anomalous diffusion. The crossover dynamics may be either from anomalous to normal or from one anomalous diffusive behavior to another. There are many real life examples, where this behavior is observed, such as the tracer motion in crowded artificial environment or in the cytoplasm of biological cells, diffusion in lipid bilayer membranes, etc. Here, the diffusive behavior is usually described by two independent power-law regimes. In order to have full description of the corresponding process with one model we introduce stochastic processes driven by tempered fractional Gaussian noise, a noise with Gaussian amplitude and power-law correlations, with a cut-off at some mesoscopic time scale. The overdamped Langevin equation (fractional Brownian motion) and fractional Langevin equation, which capture not only the short and long time behavior, but also the intermediate times, are investigated. Our results are in excellent agreement with experiments and computer simulations.

Keywords: tempered dynamics, anomalous diffusion, fractional Gaussian noise, fractional Brownian motion, fractional Langevin equation.

RUNAWAY ELECTRONS IN THE COMPASS TOKAMAK

IT-04

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Research of Runaway Electrons (RE) present a priority topic in development of nuclear fusion reactors based on magnetic confinement of high-temperature plasmas in tokamaks. The COMPASS tokamak contributes to European co-ordinated research programme aimed at improvement of understanding of the RE phenomena. In this contribution, experiments with Massive Gas Injection and impurity seeding into low density tokamak plasmas will be overviewed. Generation of the post-disruption RE beam and electric current conversion from plasma to RE will be detailed. Differences between argon and neon injection shall be described and interpreted. Interestingly, after a secondary fueling (deuterium injection) into the RE beam, a distinctive drop of quenched plasma temperature was observed. Development of novel diagnostic methods for the RE studies, our modelling contributions to the RE research as well as our links to other RE research teams through the EUROfusion consortium will be also presented.

Keywords: nuclear fusion, tokamaks, high-temperature plasmas, Runaway Electrons, plasma diagnostics, plasma modelling.

IT-05

Al_2O_3/HfO_2 MULTILAYER STACKS FOR NONVOLATILE FLASH MEMORY APPLICATIONS

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Al_2O_3/HfO_2 multilayer stacks deposited by atomic layer deposition (ALD) have been investigated from the view point of their application in emerging charge-trapping non-volatile flash memories. Dielectric and electrical properties, charge trapping, retention and endurance characteristics have been shown to depend strongly on the thickness of Al_2O_3 and HfO_2 sublayers as well as on the post-deposition annealing (PDA) steps. O_2 and N_2 PDA introduce different kinds of electrically active defects in Al_2O_3/HfO_2 stacks. The results give convincing evidence that PDA in O_2 enhances substantially electron trapping in deep traps, hence charge storage ability of stacks. RTA in N_2 results in negligible memory windows for thinner samples, i.e. it is not efficient in improving the charge storage ability. Multilayered HfO_2/Al_2O_3 stacks have a potential for implementation as charge trapping layer in non-volatile memory devices and their charge storage ability could be tailored and enhanced by optimization of stack parameters as well as annealing processes.

Keywords: high-k dielectrics; Al_2O_3/HfO_2 multilayer stacks; charge-trapping non-volatile flash memories; atomic layer deposition.

TUNING DIRAC STATES IN TOPOLOGICAL INSULATOR THIN FILMS

IT-06

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3D topological insulators (Tis) are a class of materials that host novel spin-momentum locked electronic phases on their surfaces which are topologically protected from disorder [1]. This property makes them very attractive for future spin/electron applications in devices for quantum computing and alike. The correlation between atomic structure and functionality in thin films, surfaces, and heterostructures of TIs is a key for their exploitation. Hence, the understanding of the growth mechanism, grain structure and interfaces role on the topologically protected states is fundamental.

In this work, on the case of Bi_2Se_3, we show how defects, such as antiphase domain boundaries and misfit edge dislocations, modify Dirac surface states. Based on in-situ scanning tunneling microscopy and scanning-transmission electron microscopy we show that MBE grown Bi_2Se_3 initiates with two-dimensional nucleation, and that spiral growth ensues with pinning of the 2D growth fronts at jagged steps on the substrate [2]. Coalescence of the film grains results in grain boundaries with modified atomic surface structure. At antiphase domain boundaries we show that internal electric filed is responsible for the shift of the Dirac point towards lower/higher energy level depending of their atomic structure [3]. In addition, at low-angle tilt grain boundaries, consisting of arrays of alternating edge dislocation pairs, these dislocations introduce periodic in-plane compressive and tensile strains. From tunneling spectroscopy experiments and first-principles calculations, we find that whereas the energy of the Dirac state shifts in regions under tensile strain, a gap opens in regions under compressive strain, indicative of the destruction of the Dirac states at the surface [4]. These results demonstrate that Dirac states can be tuned by strain at the atomic scale.

Keywords: Topological Insulators, Bi_2Se_3, defects, Dirac point, DFT, STM. STEM, HAADF.

References

1. Hasan, M. Z. and Kane, C. L. Rev. Mod. Phys. 82, 3045–3067 (2010).
2. Liu et al. Phys. Rev. Lett. 108, 115501 (2012).
3. Liu, Y et al. Phys. Rev. Lett. 110, 186804 (2013).
4. Liu Y et al., Nat. Phys. Nat. Phys. 10, 294–299 (2014).

Contributed Talks - CT

CT-01

TRANSFORMATION OF HERMITE-GAUSSIAN MODE (1,1) INTO A BEAM WITH MULTIPLE VORTICES

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We show how a beam described as Hermite-Gaussian mode (1,1) rotated by 45 degrees can be transformed into a lattice of optical vortices, in the process of its Fraunhofer diffraction by a fork-shaped grating with topological charge (TC) p. The analytical formulas for the diffracted wave field are derived. The experiments are performed with two different setups: with computer-generated gratings and with spatial light modulators. When the incident, non-vortex beam diffracts by the fork-shaped grating, in the diffraction pattern an array of spots with five-vortex modulation is observed. An exception is made in the case when the product of the diffraction order m and the fork-shaped grating TC p is equal to two; then, the central vortex is absent, but, the four "satellite" vortices are present. The interference patterns of the diffracted wave field and an inclined plane wave, obtained experimentally and numerically, register optical vortices and their TCs.

Keywords: Optical vortices, Fraunhofer diffraction, fork-shaped grating, Hermite-Gaussian mode (1,1).

APPLICATION OF FBILI METHOD FOR MULTI-LEVEL LINE TRANSFER

CT-02

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The Forth-and-Back Implicit Lambda Iteration (FBILI) is efficient Gauss-Seidel-type iterative scheme developed by Atanackovic-Vukmanovic et al. [1] for a solution of non-LTE radiative transfer (RT) problems of spectral line formation in the stellar atmospheres. In [2] it was more explicitly implemented on non-linear line transfer in multi-level atomic models in 1D geometry, providing high convergence rate to the exact solution with no use of additional acceleration techniques. Here, we apply FBILI method on a benchmark problem of CaII line formation in the solar atmosphere using the VALC atmospheric model and compare its accuracy with the well known code MULTI.

References

1. O. Atanacković Vukmanović , L. Crivellari and E. Simonneau, *Astrophys. J.* **487**, 735–746 (1997).
2. O. Kuzmanovska, O. Atanacković and M. Faurobert, *JQSRT* **196**, 230–241 (2017).

THE THEORETICAL STUDY OF THE ELECTRON CORRELATION AND EXCITATION EFFECTS ON THE ENERGY DISTRIBUTION IN PHOTON IMPACT IONIZATION

CT-03

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We performed a detailed theoretical study of the electron correlation and core excitation effects on the energy distribution of the ejected electrons in the process of photon impact tunnel ionization. We used the Landau-Dykhne approach to obtain analytical formulas for the transition rate and the energy distribution with included these effects. We have limited ourselves to a non-relativistic domain, in which the rate and distribution are determined by electrical component of the laser field while the influence of magnetic can be neglected. We observed helium and helium like atoms. We have shown that the tunneling ionization mechanism may be understood as the combination of mentioned processes. We considered the case of a monochromatic wave with elliptically polarized laser field. We compared our results with experimental and show that ellipticity play an important role and that inclusion of additional processes significantly influences the transition rate, as well as the energy distribution of the ejected photoelectrons.

Keywords: tunnel ionization, electron correlation, core excitation, energy distribution.

FRACTIONAL TELEGRAPHER'S EQUATION IN MODELING TRANSMISSION LINES AND HEAT CONDUCTION

CT-04

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Classical telegrapher's equation arises in modeling transmission lines by using the Heaviside elementary circuit and taking the continuum limit. Also, considering the Cattaneo constitutive heat conduction law instead of the Fourier one, one obtains (simplified) telegrapher's equation. In the case of a transmission line model, fractionalization of telegrapher's equation is performed by considering the fractional electrical elements in elementary circuit instead of the classical ones, as well as by the topological modification of elementary circuit, while in the case of heat conduction, fractional telegrapher's equation is obtained by generalizing the Cattaneo heat conduction law by taking into account not only the history of heat flux gradient, but also the history of temperature gradient. Using the Laplace transform method, fractional telegrapher's equation is solved on semi-bounded domain for the zero initial condition and solution is obtained as a convolution of forcing temperature on the boundary and impulse response.

Keywords: fractional telegrapher's equation, fractional order electrical elements, fractional Cattaneo heat conduction law.

CT-05

COMPARATIVE ANALYSIS OF DIFFERENT NUMERICAL METHODS FOR NONLINEAR FRACTIONAL DIFFERENTIAL EQUATIONS

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The methods of fractional calculus are nowadays shown to have wide range of applications in various branches of applied physics, especially in control theory, viscoelasticity, diffusion, turbulence, electrodynamics, signal processing, etc. This paper is devoted to a numerical analysis of different computational methods applied to nonlinear fractional differential equations, in particular, to fractional-order Lorenz system. The system belongs to a class of nonlinear systems exhibiting double-scroll chaotic attractors at some parameter values, and it is often used by engineers, physicists and mathematicians as a toy-model exhibiting similar features with real physical systems. Numerical solutions are provided by using three different computational methods: Adams-Bashforth, Adams-Bashforth-Moulton, and Multistep Differential Transformation method, where the fractional derivatives are defined in the sense of Caputo. We quantify the distinction between the integration methods by depicting the time series of the absolute difference for different system parameters and initial conditions.

Keywords: Fractional Lorenz system, Fractional multistep differential transform method, Fractional Adams-Bashforth method, Fractional Adams-Bashforth-Moulton method.

SOLUTIONS TO THE FREE-SPINLESS-PARTICLE (1+1)D SALPETER EQUATION: A NON-LOCAL DESCRIPTION FOR RELATIVISTIC BODIES

CT-06

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The spinless Salpeter equation is a non-local relativistic version of the Schrödinger equation. Solutions of the (1+1)D free-particle equation for assigned initial conditions are presented and compared with the corresponding well-known solutions of the (1+1)D Schrödinger equation. The asymptotic analysis of the obtained solutions gives reason for their peculiar features. Also, an analogy between the relativistic evolution and the optical free-propagation is established. The characteristics of the analyzed solutions demonstrate that the apparent problematic non-locality of the Salpeter equation does not alter the light-cone structure of Relativity. In order to inspect the onset of the specific behaviour of the solutions of the Salpeter equation, a new equation is introduced as a trait d'union at the 4th order of approximation in the particle momentum between the non-relativistic and relativistic evolution. A study of the solutions and symmetries of this new equation highlights the emergence of the relativistic behaviour.

Keywords: Relativistic wave equations, Salpeter equation, Cuspoid canonical integrals, Light-cone structure.

CT-07

PULMONARY ARTERIAL NETWORK. A FRACTAL ANALYSIS of X-RAYS IMAGES

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The Chaos theory and fractals analysis makes comprehensible the intricate systems behavior or unpredictable reactions occurrence to scale change and studies extensive and complicated systems, named complex systems. Based on knowledge from chaos theory according to which a small error introduced in the incipient phase of an analysis can provide totally different conclusions at the end of the process, MATLAB software was used to reduce the noise that affects the image as much as possible owing to its ability to work with pixel arrays, fact that allows for detailed image analysis and therefore smaller parts of the network can be considered.

A method of analyzing human x-rays will be presented using a few software algorithms to process the images. Today, helped by x-ray technology, we can study organs due to the differences that occur in the propagation of these rays through various environments that make up the tissue of the human body.

A pulmonary radiograph was analyzed to find out the fractal dimension of a pulmonary artery. For this purpose, the radiograph was processed in MATLAB R2017a to remove lung and just keep the artery. Then, the image was transformed into binary format and the box-count method was applied to reach the results.

It can be mentioned that the resolution of the initial image brings significant influence on the entire analysis process due to the noise it can present, and which is sometimes quite difficult to remove. The software developed in this paper can be fully integrated into a medical equipment which can be used in detection and monitoring of lung diseases or other organs.

Keywords: arterial network, fractal dimension, fractal analysis

SEISMIC ACTIVITY IN THE OHRID EPICENTRAL AREA IN THE PERIOD BETWEEN JUNE-SEPTEMBER 2017

CT-08

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Seismic activity occurred in the period from June to September 2017 in the Ohrid epicentral area were manifested through a series of weak to moderate earthquakes. During this period more than a 3000 earthquakes were recorded by the telemetric seismological network of the Republic of Macedonia and neighboring countries.

The strongest earthquake occurred on 3 July 2017, at UTC 11h 18min. As defined by the Seismological Observatory at PMF-UKIM, the local Richter magnitude of this earthquake was $M_L = 4.9$ and an epicentral intensity of about VII according to EMS-1998. The epicenter of this earthquake was 10 km east from Ohrid city, in the area of the Skrebatno village. The distribution of epicenters showed activity of the Pestansko-Petrinski faults in the northern parts of the epicentral region, with activity absence in its southern parts. Fault-plane solution of the strongest earthquake and more than 30 events, as well, with $M_L > 3.0$, showed activity of the Openicki fault located north of the Pestansko-Petrinski faults.

The sequence is still lasting, although with lesser frequency and size of the events. The analysis of the latest events will help prove correlation with the past seismic activity as deducted from the historical records.

CT-09

IMPROVEMENT OF THE MECHANICAL PROPERTIES OF THE Al-ALLOY AA6082

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In this work we present the results of examination of the mechanical properties of aluminum AA6082 Al-alloy and the possibilities of their improvement with a thermal treatment. Due to the respectable mechanical properties, the AA6082 has industrial application for production parts for variety of appliances. The echnological production parameters influence the mechanical properties and microstructure of the materials, since the mechanical properties of the materials are dependant on the crystalline and micro/nano structural states of the chemical composition, which is also dependant on the processing history. Hense, the selection of the right chemical compound which is further subjected to an optimized technological process of treatment and processing, one can achieve the required mechanical property. In the present work we present the results of evolution of the mechanical properties by means of macrohardness of freshly sintered aluminum AA6082 alloy after its thermal processing for six hours. In addition, quantitative chemical analyses were made by using SEM-EDS. The examined macrohardness of the AA6082 samples before and after the thermal treatment showed that the thermalization induces between 20 and 30% improvement in the macrohardness.

Keywords: Aluminum alloy, AA6082, SEM-EDS, Macrostrength, Microhardness, Microstructure, Thermal Processing.

SHUBNIKOV–DE–HAAS OSCILLATIONS OF THE THERMOELECTRIC FIELD IN LAYERED CONDUCTORS NEAR THE LIFSCHITZ TOPOLOGICAL TRANSITION

CT-10

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We present a theoretical study of thermoelectric phenomena in strongly anisotropic layered conductors with a multisheeted Fermi surface (FS), consisting of a weakly corrugated cylinder and two adjoining planar sheets, at low temperatures near the Lifshitz topological transition. The oscillatory dependence of the thermoelectric field on the inverse value of the quantizing magnetic field $\mathbf{B}$ and the angle θ between $\mathbf{B}$ and the normal to the layers is analyzed. When the distance between the sheets of the FS is very small the migration of charge carriers over different cavities (sheets) of the FS due to magnetic breakdown leads to magnetic breakdown quantum oscillations; for some values of the angle θ_k however, the probability of magnetic breakdown onto one of the planar sheets of the FS can be so small that the electron cannot close the magnetic breakdown trajectory. In this case the magnetic breakdown quantum oscillations of the magnetization and all the kinetic characteristics of the conductor disappear, and their disappearance periodically repeats itself as a function of $\tan\theta$. The experimental investigation of giant quantum oscillations of the thermoelectric field is the most convenient method of detection of the Lifshitz topological transition and permits to get detailed information about the energy spectrum of the charge carriers in degenerate conductors.

Keywords: Layered Conductors, Fermi Surface, Lifshitz Topological Transition, Thermoelectric Field.

ULTRAFAST SPIN DENSITY WAVE DYNAMICS IN IRON-BASED PNICTIDES AT INTENSE OPTICAL PULSE EXCITATION

CT-11

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Ultrafast time-resolved spectroscopy has become an important tool for studying rapidly evolving phase transitions [1-4] because it offers an insight into microscopic process happening during the transition which cannot be observed in equilibrium experiments. Here we present the ultrafast all-optical time-resolved spectroscopy measurements of the system trajectory through a spin density wave (SDW) phase transition in $SrFe_2As_2$ and $EuFe_2As_2$. Using the standard pump-probe technique we estimated the threshold fluence for a nonthermal destruction of the SDW order ($F_{th} \approx 0.3$ mJ/cm^2) at two different pump-photon energies (1.55 eV and 3.1 eV). Using the multi-pulse pump-probe technique the SDW order destruction timescale of ~ 150 fs was found to be fluence independent.

By comparing the temperature dependences of the standard and multi-pulse transient reflectivity long after the arrival of the destruction pulse we determined the transient lattice heating in $SrFe_2As_2$. At high excitation densities ($\sim$ mJ/cm^2) the destruction pulse penetration depth significantly exceeds the equilibrium penetration depth suggesting absorption saturation.

Using the multipulse pump-probe technique we also measured the recovery of the SDW order at different destruction fluences. The fluence of the destruction pulse was used as an adjustable parameter to control the quench conditions [5]. In the case of the fast quench ($F < \sim 1$ mJ/cm^2), when the final lattice temperature does not exceed the SDW transition temperature, the ordered state recovers on a sub picosecond timescale.

The SDW state recovery can be sufficiently well described within the framework of a three temperature model (3TM). The 3TM simulation results suggest that: (i) the SDW destruction timescale is set by the thermalization of the initially excited electronic distribution; (ii) the recovery rate depends on the destruction pulse fluence and is governed by cooling of the optical phonons to the lattice bath. The fluence dependent recovery

timescale can be attributed to the opening of an electronic relaxation channels upon suppression of the pseudogap related to nematic fluctuations in addition to the anharmonic-decay channels.

Keywords: iron pnictides, spin density wave state, photoinduced phase transition, ultrafast time-resolved optical spectroscopy.

References

1. S. Iwai, S. Tanaka, K. Fujinuma, H. Kishida, H. Okamoto, and Y. Tokura, *Phys. Rev. Lett.* **88**, 57402 (2002).
2. A. Cavalleri, Th. Dekorsy, H. H. W. Chong, J. C. Kieffer, and R. W. Schoenlein, *Phys. Rev. B* **70**, 161102 (2004).
3. M. Matsubara, Y. Okimoto, T. Ogasawara, Y. Tomioka, H. Okamoto, and Y. Tokura, *Phys. Rev. Lett.* **99**, 207401 (2007).
4. P. Kusar, V.V. Kabanov, S. Suagi, J. Demsar, T. Mertelj and D. Mihailovic, *Phys. Rev. Lett.* **101**, 227001 (2008).
5. I. Madan, P. Kusar, V.V. Baranov, M. Lu-Dac, V.V. Kabanov, T. Mertelj and D. Mihailovic, *Phys. Rev. B* **93**, 224520 (2016).

CT-12

ELECTRON-PHONON COUPLING IN A CLASS OF ORGANIC MOLECULES

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Quantum many body effects, such as electron-phonon coupling, play an important role in the charge transport processes in novel molecular electronic devices. The present work tackles the problem of *ab initio* estimation of the electron-phonon coupling matrix element for a class of π-conjugated molecules. Charge transport processes in organic molecules often occur via intermediate excited electronic state and it is of crucial importance to provide an accurate treatment of the excited states, along with the ground state of the systems of interest. Excited states and vibrational spectra will be obtained in the frames of configuration interaction (CI) picture for several prototype molecules, such as benzene, anthracene and pyrene, as well as for phenylene ethynylene oligomers. Performing a detailed analysis of the phononic modes in the first excited state of the studied systems, the Hamiltonian matrix, involving electronic and vibronic energies obtained from CI calculations will be composed. This will in turn enable estimation of the off-diagonal elements, that give measure of the intramolecular electron-phonon coupling energy to particular phononic modes.

Keywords: electron-phonon coupling, π-conjugated molecules, configuration interaction picture, phononic modes.

NOISE ABSORBING PROPERTIES OF A SANDWICH-LIKE WALL STRUCTURE FILLED WITH DESERT SAND

CT-13

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Reducing energy consumption and lowering the noise in buildings is of great importance in today's construction practice. Selection of the proper materials and determination of the optimum insulation thickness in buildings lead to advanced reduction in energy consumption and better living comfort. It is important to use "green" insulation materials for the purpose of limiting the environmental impact of the use of the materials. A growing interest emerged on incorporation of low cost recycled materials, such as recycled plastic waste and sand. In this project, a sandwiched wall of bricks with honeycomb-like plastic holder for desert sand with optimum thickness has been designed and fabricated. The desert sand previously filled in the compartments of the structure with thickness 2 - 3.5 cm is enclosed by thermo foil from the both sides. Greater sound absorbance and better noise reduction properties of the same structure has been achieved by using dry desert sand. The arithmetic value of the absorption coefficient at the frequencies 100, 500, 1000, 5000 and 10000 Hz has been followed by using a loudspeaker and a microphone positioned on the opposite sides of the constructed wall. A mounted wall with dimensions 45 cm x 45 cm equipped with the measuring devices was constructed and made transportable. Results show that the honeycomb sandwich-like wall structure filled with dry desert sand have great potential in sound insulation than the wall without or filled with mortar only.

ALGINATE GEL MATRIX AS CARRIER OF AN ULTRASOUND INDUCED WATER SOLUBLE FORM OF (E)-3-[2-(thiazol-2-yl)hydrazinylidene]chroman-2,4-dione AS PROMISING ANTICANCER SUBSTANCE

CT-14

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Calcium cross-linked alginate hydrogel is used as a controlled release system for the most promising anti-carcinogenic series of coumarin substances - (E)-3-[2-(thiazol-2-yl)hydrazinylidene]chroman-2,4-dione. It was found that a water solution of the insoluble substance with concentration up to 1 mg/dl can be achieved with prolonged ultrasound treatment. We propose direct encapsulation method for loading the active substance within a gel matrix that produces excellent homogeneity and complete encapsulation rate of the substance in the gel even after drying. The weak interaction between the chroman and alginate allows the subsequent release of the active substance in a water system from dry gel pellet to be in already water soluble molecular form making it much more bio-available. The time-dependent release kinetics shows a diffusion coefficient of 0.4 and a kinetic constant dependent on the cross-link ratio of the gel, alginate concentration and pH of the release medium.

Keywords: Sodium alginate, hydrogel, drug delivery, chroman, encapsulation, release kinetics.

OUTGASSING MEASUREMENTS OF THE KOSOVO VACUUM STANDARD

CT-15

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Science and the technology of vacuum tend to generate lower level of vacuum inside a certain volume. The actual limit of the lowest level of vacuum generated is called the extreme high vacuum($< 10^{-12}$ mbar). As the process of generating vacuum goes toward this limit, the phenomenon of outgassing appears more and more. Outgassing is the process of release of the gases(especially hydrogen) from the vacuum system walls. The outgassing is more significant when the pressure is under 10^{-8} mbar, but it is also present for higher value of pressure. As a phenomenon and problem can not be ignored, so it is very important to know and measure it. In this paper, the outgassing will be defined, measured and results of measurement will be represented graphically and discussed.

Keywords: vacuum, pressure, outgassing.

OPERATIONAL INTERVENTION LEVELS FOR ENABLING TRANSITION TO AN EXISTING EXPOSURE SITUATION AFTER A RADIOLOGICAL EMERGENCY INVOLVING DISPERSAL OF RADIOACTIVE MATERIAL IN THE ENVIRONMENT

CT-16

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Experience has demonstrated lack of preparedness at national levels to manage the consequences of a radiological emergency in its later phase which, on occasions, resulted in unjustified actions. To assist Member States preparing for this phase, the International Atomic Energy Agency published a guidance (Safety Standards Series No. GSG-11) recommending, inter alia, for operational intervention levels (OIL_T) to be developed for enabling the transition to an existing exposure situation. Using the methodology provided therein, OIL_T for postulated radiological emergencies in the Republic of Macedonia have been calculated and default values are proposed for ambient dose equivalent rate at 1 m above ground level as well as for beta surface and alpha surface contamination measurements as following: $OIL_{T,\gamma} = 5$ μSv/h, $OIL_{T,\beta} = 100$ cps, $OIL_{T,\alpha} = 10$ cps. The default OIL_T values can be used to guide implementation of activities and actions that support the return to new normality after the emergency.

Keywords: radiological emergency, operational intervention level, transition.

PHYSICAL PROPERTIES OF HONEYS FROM NORTH-WEST MACEDONIA AND THEIR INTER-CORRELATION

CT-17

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With the increase in demand, pure natural honey is becoming rarer to find. In this work, 14 samples of pure (extracted and supplied from the hive) honeys from north-west part of Macedonia were analyzed for their physical properties (the bee harvesting region for all honeys is well known). The aim of this research was twofold, one part comparison and classification, and the other part looking for inter-correlation between the physical parameters in honeys. The surface tension, density, water content, refractive index, color, dielectric parameters and viscosity for all samples were analyzed. From the data, all honeys can be separated in three easily distinguishable groups: flower, mountain (pine) and mixed honeys. For each measured parameter we established a value range that puts the honey in the set group. Moreover, we established correlations between some of these parameters and explained the physical background behind them.

Keywords: Natural honey, physical properties, inter-correlation.

SEM/EDX ANALYSIS OF THE DENTAL CEMENTUM TO ESTABLISH ONE HUMAN'S LIFESTYLE FOR FORENSIC APPLICATIONS (Pilot Study)

CT-18

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In our previous work we have introduced an improved method for estimation of a chronological age of a human being by analysing the incremental lines in a dental cementum, using Scanning Electron Microscopy (SEM) images of the longitudinal sections of the tooth roots. In the present study we have used the protocol for incremetal line thickness estimation in order to analyze the elemental content evolution with the age of the individual. The protocol that allows accurate age estimation even if the SEM images reveal limited number of distinct incremental lines was used to analyze 29 samples from different female individuals. Herein we present the results of some of the most typical case studies. The SEM micrographs were subjected to image analysis with a calibrated thickness measuring tool in absolute units from the Adobe Photoshop. The calculated incremental line thickness was used to plot the cementum growth timeline in years of biological age, starting with the year at which the corresponding tooth erupts. The EDX tool was used to study the elemental content along the established timeline. Occurrence of some unusual elements other than those constituting the apatite and other regularly occurring elements in the dental root structure, could associate the individual to a certain lifestyle, relating her/him to a tradition, but also indicate an undesired exposure and implementation of uncommon (Ti, Zn) and/or toxic elements (Cd, Cu, Sr and other) in the cementum structure.

NEW FRONTIERS IN SUPERCONDUCTIVITY: NOVEL STATES AND PROPERTIES FROM TOPOLOGY AND INTERFACES

CT-19

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More than 100 years have passed since the discovery of superconductivity. In the meantime this fascinating phenomenon has provided the basis for a wide range of important applications. Our fundamental understanding of superconductivity has been based on the theory of Bardeen, Cooper, and Schrieffer known as BCS which was published in 1957.

Despite being a well-established field in quantum matter physics, superconductivity has been a continuous source of new discoveries during the past decade. The discoveries have been made possible by the progressive technical mastery of producing artificially structured quantum matter with tunable properties. Surfaces and interfaces play a key role in this context. On the theory side, "topology" emerged as a pervasive concept in characterizing and classifying novel states of quantum matter with fascinating and sometimes exotic properties.

In the present talk I will review some recent developments and ideas which may give rise to opportunities for scientific discovery and potential applications.

MODELING CHARGE CARRIER RECOMBINATION MECHANISMS IN METHYLAMMONIUM LEAD TRIBROMIDE THIN FILM

CT-20

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Grain boundaries play a key role in the performance of thin-film optoelectronic devices, however, their effect in halide perovskite materials is not yet understood. Here we focus on understanding the grain boundary effects on photoluminescence (PL) recombination lifetime in methylammonium lead tribromide thin films. To that end, the decay profile of the PL of methylammonium lead tribromide thin films with different grain sizes is measured using the technique of Time Correlated Single Photon Counting and related to the decay of the carrier density. The carrier density decay profile is fitted with the well-known ABC model in order to extract information about the recombination mechanisms in the films. Correlating the calculated PL lifetime with true grain size offers a possible explanation for the mysteriously long lifetime and record efficiency achieved in small grain halide perovskite thin films, while pointing the way forward to even better performance

Keywords: halide perovskite, grain size effect, carrier lifetime, charge-carrier recombination.

SYNTHESIS AND PHYSICAL CHARACTERIZATION OF GRAPHENE PANI POLYSILOXANE NANOCOATING MATERIALS FOR SHIP HULL APPLICATIONS

CT-21

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We investigated the anticorrosive, hydrophobic and anti-barnacle properties of polyaniline and graphene (PANI/G) nanocomposite filler in the coating matrix applied through brushing to ship hulls. Various formulations of graphene were integrated to polyaniline matrix through in situ polymerization. It was observed that the 0.5%, 1.0%, and 2.5% by weight graphene formulation performed better than the counterparts with higher amount of graphene content as barrier protection. It was also observed that the PANI/G nanocomposite exhibited a hydrophilic property. The addition of polysiloxane to the mixture resulted in a hydrophobic surface with a contact angle of 108 degrees. Results show the absence of barnacle growth on metal samples coated with PANI/G/polysiloxane formulation. It is proposed that this anti-barnacle property is due to the hydrophobicity of the surface.

Keywords: graphene; polymer; anticorrosion; hydrophobic; anti-barnacle.

CT-22

REVERSE-ENGINEERING DENSITY AND TEMPERATURE EVOLUTION OF CORONAL MASS EJECTIONS; AIKEF HYBRID STUDIES

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Mercury is located 0.4 AU from the Sun, and therefore experiences a highly variable solar wind. On multiple occasions, the MESSENGER spacecraft obtained in-situ data demonstrating the drastic effects of coronal mass ejections (CMEs) on the planet's magnetosphere. Using hybrid (kinetic ions, fluid electrons) simulations, we show the impact that these CMEs have on the interaction of Mercury's magnetosphere with the solar wind. Specifically, we focus on a CME that occurred on 8^{th} March 2012, during which the solar wind density and temperature could not be obtained from spacecraft data.

Thus, apart from the magnetic field, direction and the upstream plasma velocity, no further constraints on the solar wind are available.

We introduce an approach aimed at reverse-engineering the time-dependent evolution of the upstream density and temperature of that CME.

We find that within 4 hrs of the MESSENGER orbit the solar wind density and temperature violently ranges from $10 - 60$ cm^{-3} and $0.1 - 2.2$ MK respectively.

Keywords: Plasma interaction, Mercury, Magnetosphere, Hybrid, Simulation, CME.

HYBRID SIMULATIONS OF PLUTO'S PLASMA INTERACTION

CT-23

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We apply a hybrid (kinetic ions, fluid electrons) simulation model to study Pluto's plasma environment during the New Horizons encounter on 14 July 2015. We show that Pluto's plasma interaction is dominated by significant north-south asymmetries, driven by large pickup ion gyroradii on the order of 200 Pluto radii. The transition region from the ambient solar wind to the population of plutogenic ions (called the "Plutopause") also shows considerable asymmetries that cannot be explained by a fluid picture. In our model, we include a dilute population of interstellar PickUp-Ions (PUIs) in the upstream solar wind, to investigate its influence on the overall plasma interaction. We use our model to compare the plasma signatures observed along the New Horizons trajectory with those obtained from our simulation output. We aim to understand whether the interstellar PUI population is necessary for the explanation of the New Horizons plasma data.

Keywords: Pluto, Solar Wind, New Horizons, Numerical Modelling.

Parallel Session: Physics Education

Workshops – EDU-W

EDU-W1

MOTIVATIONAL SIMPLE EXPERIMENTS WORKSHOP

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Since motivation is a key factor in any teaching material we will present a workshop with simple motivational experiments for elementary school students. The concept that combines activity including motor, cognitive and emotional approach (hands-on, minds-on learning) like our workshop proved to be successful. Therefore, we suggest that teachers of physics separate learning of basic physical concepts from specialized physics education for science-mathematical and technical programs. Just the same we don't teach language skills to children to create poets and writers. Only some individuals will actually go into this specialized program and for most students the basic physic concepts and math skills are sufficient in a wide range of other professions and occupations. With this approach, we will change our view on physics to make it fit into a broader framework. Workshop consists of sixteen experiments in mechanics, heat, electricity and optics, and takes about one hour.

Keywords: modern didactical aids, new technologies in education, optics, workshop.

NEW TECHNOLOGIES IN PHYSICS EDUCATION
Experiments with optical sets

EDU-W2

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This workshop is intended for teachers of primary and secondary schools. Teachers will be working in groups. They will be solving problems and conducting experiments by using modern optical sets. Each group will present its results by usage of new IT products.

The goal of the workshop is to persuade teachers that they can conduct experiments in fast and efficient way in their laboratories and classrooms with direct involvement of students. In this manner, motivation for exploring and studying physics phenomena would develop as well as key competencies for 21st century: critical thinking, problem solving, cooperation, efficient communication, persistance, learning how to learn, ...

Optical sets for geometrical and wave optics are functional and mobile didactic aids with visible optical path.

Visualiser and interactive whiteboard will be used for presentation of problem solutions and conduction of experiments. It will make these experiments more visible and interactive.

Keywords: modern didactical aids, new technologies in education, optics, workshop.

EDU-W3

WORKSHOP FOR TEACHERS: PHYSICS, INFORMATICS, INNOVATION VIA INQUIRY APPROACH

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Physics teachers could, by this workshop, give students more possibility for practical interdisciplinary work on complex problems which could be resolved in the frame of STEM. They will have a possibility to work with Material Kits from Natural Science, Technology and Informatics (`http://rukautestu.vin.bg.ac.rs/?Page_Id=1197`) (`http://rukautestu.vin.bg.ac.rs/?Page_Id=1208` tested with teachers of Physics and Natural science in Low Secondary and High Schools.

Keywords: Inquiry, Informatics, Interdisciplinary, STEM.

Physics Education Talks – EDU

EDU-01

CONTACT FORCES IN RIGID BODY DYNAMICS

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Many students have a misconception that the normal force always acts in the center of mass of the body. When drawing a free-body diagram, normal force and frictional force are usually presented as two separate forces. Another approach is treating them as the component forces of a single contact force. Using single contact force can be useful for overcoming this misconception.

Keywords: rigid body, friction, normal force, contact force.

THE MOTIVATIONAL EFFECT OF THE EXPERIMENTS IN PHYSICS TEACHING

EDU-02

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Several experiments that "burn" in physics classes can change physics teaching radically. They can help to: increase the students' attention at the physics lessons, decrease students escaping from classes and overcome the "mathematical weight" - the difficulty and dullness of physical equations. In a word, the choice of approach and the choice of teaching materials - examples, numerical assignments, experimental tasks, demonstrations and experiments are the subject of this paper as a small help for beginner physics teachers.

Keywords: motive, experiment, teaching, fire, pupil motive, experiment, teaching, fire, pupil.

EDU-03

HOW GOOD KNOWLEDGE TESTS USED IN EDUCATION ARE: EXAMPLE OF NATIONAL SCIENCE COMPETITION TESTS

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Tests are very popular tools for knowledge probing. Particularly, test with multiple choice questions are attractive because they are easy to asses. In this research tests from national science competitions in Republic of Macedonia are investigated. In order to make the item analysis for each test from 4^{th}, 5^{th} and 6^{th} grade, difficulty index, index of discrimination and point biserial correlation are calculated. As a measure of test reliability Kuder-Richardson 20 coefficient is calculated.

Keywords: science multiple choice test, test reliability, item analysis, Kuder-Richardson 20 reliability coefficient.

BLOCKCHAIN TECHNOLOGY IN PHYSICS

EDU-04

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The Blockchain technology is a revolution in the field of data security, data processing, and storage. This technology has received significant attention in the last few years with the popularity of cryptocurrencies such as Bitcoin. However, the world of cryptocurrencies is just a showcase of what this new technology can do. Thanks to the leaders in the Information Technologies industry we have seen the power of Blockchain being used in complex business networks. We strongly believe that this technology can solve fundamental problems in the field of physics, specifically social physics, data collection, quantum physics, and education. Firstly, we focus on education and its results. We propose the use of the Blockchain technology in keeping the integrity of all certificates and scientific works while maintaining trust between parties in the network.

Additionally, we believe that the use of Blockchain in social physics can enable more people willing to provide data needed for research, assured that privacy is guaranteed. The use of Blockchain as a global network for all researches in the field of physics can enable a researcher in Bitola, Macedonia to have access to the same results as a researcher in Arizona, USA, enabling them to share their results with every researcher in the network in a fast and straightforward way.

Finally, partnered with quantum physics, Blockchain can become a force to be reckoned with, directed at being used as a disruptive force for the challenges of tomorrow.

We believe that a combination of Blockchain and physics will transform the future, tackling the security challenges of the modern world in a journey towards a better decentralized and distributed reality.

Keywords: Blockchain, social physics, data collection, quantum physics, education.

EDU-05

IMPROVEMENT OF THE PHYSICS TEXTBOOKS FOR THE 8th AND 9th GRADE IN MACEDONIAN SCHOOLS

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In 2016 new physics curricula for 8th grade and 9th grade were introduced in primary education in Republic of Macedonia. The curricula were extracted from the Cambridge Secondary 1 Science Curriculum. Appropriate texts from Cambridge Checkpoint Science Coursebooks were selected and translated, which were used to create and textbooks for 8th grade and 9th grade. Unfortunately, the researchers' experience shows that physics teachers' response to the curricula and the textbooks was very negative. The textbooks were revised and many errors and mistakes were discovered, concerning terminology and adaptation. Errors in the original English text were also found. Corrections were offered and were accepted by the authors and English publisher, as well as Macedonian publisher. The reviewers found many didactical inconsistencies and offered improvements, but unfortunately it was not possible to implement them into the textbooks. Otherwise, authorship would be in doubt.

Keywords: physics textbook, translation, adaptation, errors, didactical improvements.

RELATING MECHANICS AND ELECTROMAGNETISM IN ARDUINO BASED ACTIVITY AIMED AT UNDERSTANDING MOTION OF NEODYMIUM MAGNET FALLING THROUGH A COPPER PIPE

EDU-06

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A strong magnet falling through a copper pipe is a well-known demonstration used to raise the interest and challenge students' understanding of underlying phenomena recognized as core concepts in electromagnetism. Rapid development and availability of affordable sensors and microcomputers, such as Arduino boards, open possibility to easily construct a setup to follow and record magnet's motion through a copper pipe, and the effect it has on the pipe's weight. With this, a possibility opens to extend the use of this demonstration outside electromagnetism and use it to tackle a common problem in teaching mechanics, that of the dependence of forces and motion. Furthermore, the ease of representing gathered data from sensors in a form of graph gives an opportunity to revise yet another important concept in physics education – reading graphs and extracting valid conclusions from them, a skill considered to be a part of today's basic literacy skills.

EDU-07

TESLA AND GOETHE

Š. Ujčić

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The development of science is a continuous process that can surprise us with incredible transformations and unexpected strength and deepening the comprehensiveness of the future application in life and technology.

But the most striking in the creation of scientific truth and its applicability is the spiritual proximity to science with artistic creation.

This paper deals with this mutual intertwining between the spiritual wings and the materialization of their appearance.

We analyze in what way and under what conditions this creative game is happening.

Keywords: science, life, technology, spiritual proximity, artistic creation, spiritual wings.

POSSIBLE PROBLEMS IN PERFORMING ELECTROMAGNETISM DEMONSTRATIONS AND EXPERIMENTS

EDU-08

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One of the key problems in physics education that teachers face is the lack of experimental equipment. This is of particular importance if we take into account that research based teaching has been actualized recently. An additional problem is the preparation of the experiments and failure probability. Therefore, possibilities for applying household stuff for experimenting were investigated in this paper, as well as problems that teachers can encounter when performing experiments. Experiments from the field of electromagnetism were selected, which according to the current curricula should be performed in the classroom. We discover technical problems, didactical problems, as well as which experiments can not be performed with household stuff.

Keywords: experiments, electromagnetism, household stuff, problems.

EDU-09

SMARTPHONES FOR EXPERIMENTATION AND KNOWLEDGE TESTING IN PHYSICS CLASSROOM

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Smartphones became important tool in our daily life, as well as for teaching physics. One of the innovations that should contribute to development of creative students is implementation of teaching and learning approach based on the use of new technology. In this paper we give an overview of effects using smartphones as experimental tool for visualization and understanding features of sound waves with Oscilloscope application and results of testing students with Socrative application. Experimental group took activities with smartphones, while the control group performed traditional activities without smartphones. Test results for students' achievements are not significantly different. Students' response on using smartphones was analyzed and pros and cons were revealed.

Keywords: Smartphone, experimental tool, Oscilloscope, Socrative, sound waves.

Poster Presentations - PP

PP-01

LIQUID-CRYSTALLINE SILVER NANOPARTICLES

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Liquid crystals are very interesting materials because they combine the fluidity of ordinary liquids with the long-range order of the crystalline solids. Due to these specific properties they have been interesting research topic with well-known applications like displays etc. During recent years the attractive object of research became to study metal nanoparticles in liquid crystals. In these nanocomposite systems, many new phenomena arise that make them perspective materials for various optical, electronic and sensing technologies.

In this contribution we present the preparation of several types of liquid crystalline ligands based on lactic acid derivatives, chemically attached to the surface of silver nanoparticles. The prepared systems were characterized using a combination of transmission electron microscopy, x-ray diffraction and dynamic light scattering techniques.

Keywords: liquid crystals, nanoparticles, self-assembly.

MAGNETRON SPUTTERED MoO_x HOLE TRANSPORT LAYER FOR ORGANIC SOLAR CELLS

PP-02

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Bulk heterojunction organic solar cells need selective hole transport layers in order to function efficiently. The most widely used organic hole transport layer is PEDOT:PSS. A commonly applied inorganic layer is MoO_x deposited by thermal evaporation or from solution. In this contribution we study another possible way to deposit these layers - by magnetron sputtering in argon only atmosphere from a MoO_3 sputtering target. The layers are characterized by optical transmission spectroscopy, Raman spectroscopy, XPS and conductivity measurements. MoO_x deposited in the described manner is applied to polymer solar cells with different kinds of active bulk heterojunction layers. The solar cells are characterised by measuring their current-voltage characteristics and their quantum efficiency. The results are compared to those for solar cells with the same active layer deposited in the same run but having PEDOT:PSS hole transport layer. The advantages and disadvantages of MoO_x films as hole transport layers are discussed.

Keywords: solar cells, magnetron sputtering, thin films, polymers, molybdenum oxide.

Acknowledgements: The authors are grateful for financial support to Bulgarian National Scientific Fund (Project DFNI E02/5 of 12.12.2014) and the Program for Support of Young Scientists of the Bulgarian Academy of Sciences (Project DFNI-17-128 of 31.07.2017).

INVESTIGATING LUMINESCENCE CHARACTERISTICS OF SILICATE MINERALS FOR DOSIMETRIC PURPOSES

PP-03

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When exposed to ionizing radiation, minerals gain energy and store it in their crystal lattice in the form of trapped charges. Optical or thermal stimulation of minerals is responsible for release of stored energy. By this phenomenon, called optically stimulated luminescence or thermoluminescence, respectively, a luminescence signal is observed, giving information about minerals' irradiation history. Detected luminescence signal depends on the type of minerals, type of stimulating light, temperature, detection filters, absorbed dose, etc. Taking this into account, luminescence characteristics of samples containing silicate minerals treated with different doses of ionizing radiation are investigated. All studied samples show clear dependence of the luminescence intensity on the absorbed dose, making them eligible for dosimetric applications.

Keywords: Luminescence, minerals, dosimetry.

QUANTUM MOTIONS UNDER GEOMETRIC CONSTRAINTS

PP-04

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We investigate a quantum motion of a particle in two dimensions under geometric constraints in the framework of the Green's function approach. The motion along the x-direction is constrained at $y = 0$. The present work aims to demonstrate physical examples of a quantum motion in two-dimensional comb-like structures, which leads to the time-dependent Schrödinger equation with non-integer time derivative. Power-law tails in the probability density function, that are not observed in the case of the standard Schrödinger equation, are obtained. A constrained quantum motion in presence of the Dirac δ-potential energy function is analyzed as well. Such models have been already successfully applied to describe transport properties in low-dimensional heterogeneous media.

Keywords: Schrödinger equation, constrained motion, comb structures.

PP-05

A dE-E TELESCOPE DETECTOR FOR CHARGED PARTICLE IDENTIFICATION

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A dE-E telescope detector has been constructed from two silicon photodiodes and two charge sensitive preamplifiers. The aim of the realization of such detector is luminosity control of the Nuclotron accelerator from JINR-Dubna. This telescope will be placed on an arm of the internal target station, in vacuum. The first detector dE is realized with a 20 μm thickness silicon thin photodiode type UT20PD1000, from CiS Germany, with an active area of 10x10 mm^2. The second detector E is a large area silicon photodiode, 500 μm thickness, type S3204-05 from Hamamatsu Photonics, with an active area of 18x18 mm^2. The response of such telescope detector, at beta source (Sr-Y)90 and alpha source Am-241 is presented.

Keywords: thin photodiode, luminosity.

AVAILABILITY OF MEDICAL TECHNOLOGY IN EUROPE AND SOUTHEAST EUROPE

PP-06

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The availability of equipment for diagnosis increased rapidly in most EU countries over recent decades. Relative to population size and subject to data availability, Greece, Cyprus, Italy and Finland reported the highest number of imaging equipment, while Albania, Romania and Serbia reported the lowest one. The average number of CT scanners per 100 000 population in the Southeast Europe (EEEU) is 1.7, while in the rest of Europe (EU) it is 2.3. The biggest difference between these two regions was found in numbers (per population size) of MRI and PET scanners, more than factor of two. Regarding to the availability of radiation therapy equipment, Belgium is leading country in EU with 1.84 therapy machines per 100 000 population, while Bulgaria with 0.84 is leading in the SEEU region with increasing tendency in the last years.

References:

1. `http://ec.europa.eu/eurostat/statistics-explained/index.php/Healthcare_resource_statistics_-_technical_resources_and_medical_technology#Availability_of_technical_resources_in_hospitals`
2. `http://ec.europa.eu/eurostat/statistics-explained/index.php/Cancer_statistics`
3. J. Ferlay et al., Cancer incidence and mortality patterns in Europe: Estimates for 40 countries in 2012, *European Journal of Cancer* **49**, 1374–1403 (2013).

EXAMPLE OF INTERACTIVE LEARNING IN NATURAL SCIENCES - THE EFFECTS OF VARIOUS SOURCES OF VISIBLE LIGHT ON THE LIFE OF A PLANT

PP-07
EDU

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The concept of comprehensive, interactive learning can combine learning strategies: learning by exploring, learning by suggesting and confirming the hypothesis. By comprehensive, encompassing learning we are making a connection and forming a relationship between "daily life", students' life environment, and the reciprocal relationship between the life events and the aspects of the particular scientific discipline, or the subject.

Behind the seemingly simple photosynthesis equation is in fact a complex string of physicochemical and biochemical reactions induced by light. The free energy which is being consumed in biological systems derives from the solar energy "trapped" by the photosynthesis. Light absorption by chlorophyll depends on the wavelength of the incident light. The development of a plant and the reactions during its growth will largely depend on the characteristics of the light source. Spinach plants were grown in a controlled environment under the effect of various light sources. Spectral characteristics of different sources of visible light differ, and it is assumed that different effect will consequently occur in the plant which is then possible to pin down and to describe.

Keywords: interactive learning, STEM, light sources, plant.

AN INTERESTING AND EFFICIENT METHOD OF LEARNING HIGH SCHOOL PHYSICS CONTENT: THE SUCCESSFUL METHOD OF JUNKYARD PHYSICS (PHYSICS BASED ON GAMES)

PP-08
EDU

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This study's aim is to research the effect of serious games on helping and supporting primary and high school students on learning physics concept and problems, from the easy everyday concepts to engineering theory. As the internet today changes the world, games indeed change the ways in which students learn today.

In this study, we examine how high school students learn by using prototypes of Junkyard Physics. We used both simple games, teaching students basic physical concepts related to electricity, magnetism, light and color and complex games, teaching students hard physics problems.

And after two weeks of using these games, we compared the abilities on two groups, where the first one includes students who learned by themselves from textbooks, and the second group includes students who used our games. The results indicated that games can be more effective in the learning process than written texts.

PP-09
EDU

INQUIRY BASED APPROACH IN TEACHING GEOMETRICAL OPTICS

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Numerous researches which have been carried out in the region show that students consider physics an uninteresting, incomprehensible and unimportant to everyday life. This notion becomes more and more noticeable, especially with older students and culminates with a steady decrease in the number of students enrolling physics. Such a situation is a consequence of the numerous social changes within the last few decades, while, during this period of time, the teaching of physics has not changed significantly. The most natural way of learning physics is through the inquiry-based approach because the research of the environment is something that children spontaneously implement since birth. In the inquiry-based classes, students are maximally engaged in designing and conducting their own research. A number of ideas for this approach to teaching geometric optics will be put forward in this paper.

Keywords: geometrical optics, inquiry-based teaching, simple experiments.

EXAMINATION OF METALLIC PARTICLES (GSR-GUN SHOT RESIDUE) OBTAINED BY DISCHARGED AMMUNITION OF WEAPON IN ORDER TO DETERMINE THE FIRING DISTANCE WITH SEM/EDX ANALYSIS

PP-10

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Crimes involving the use of firearms are usually performed with guns, revolvers and riffles. During the combustion of the initial explosive mixture, metal particles are formed that are further deposited on objects in the nearby environment. When the projectile is fired from the firearm barrel, a cone-shaped cloud of gas, vapor, hare, and solid particles is formed. This research is focused on the metallic solid particles that accumulate in the vicinity of the penetration of projectile in the target. Three different firearms were used for this research, including: Pietro Bereta mod. 70 (caliber 7.65 mm) and ammunition of the producer PPU; "Crvena Zastava 99" (caliber 9 mm Para) and ammunition of the PPU manufacturer; automatic rifle "Crvena Zastava M70 AB2" (caliber 7.62×39 mm) and ammunition from manufacturer SMB. The projectiles were fired in a wooden target covered with a white cotton cloth (30×30 mm). The test firing distances between the weapons and the target were: 0.25 m, 0.5 m, 0.75 m, 1 m and 1.25 m. test firing was performed three times for each distance. The metal particles deposited on the canvas were lifted with 12 mm diameter pin-stabs that were coated with a sticky conductive carbon tape. The traces were analyzed using a Scanning Electron Microscope equipped with an Electronically Dispersible X-ray Detector (SEM/EDX) coupled with an automated counting software that was able to count and measur the particle diameter in the spherical approximation and determining their elemental composition. The detected particles were classified into three main classes: unique (such as PbBaSb, PbBaSbSn, SbSnBa, SbBaPb, SnBaPb and others), indicative (SbPb, BaPb, SbSn, SbBa), and ammunition (Pb, Sn, Cu, CuZn, Sb, Fe). A particle size classification was made in the diameters range of $0.75 - 5$ μm, with a step of 0.25 μm. The smaller particles than 0.75 μm were excluded from the analytical procedures. For particles larger than 5 μm, the classes were formed with a 0.5 μm steps. The results processed by statistical analytical procedures. It has been shown that there is a tendency of an exponential decay of the number of particles with the distance increase. It has also been shown that the distribution of

the total number of particles by size has a tendency of exponential decline. In other words, the population of the small particle is highest. Hence, the number of the particle could be used to determine (estimate) the distance from which the firing was carried out. On the other hand, the composition of the particles can be an indicator of the used ammunition, if during the event neither the projectile nor the cartridge was found. Finally, a good distance estimate can serve as a criterion for excluding the possibility of self inflicting injures and suicide.

Keywords: Metallic particles, GSR, SEM/EDX, firing distance, elemental content.

Author Index