Abstracts of the First Conference organized by the National Institute of Physics (NIP)

10 - 11 February 2022

Academy of Sciences of Albania

Abstraktet e Konferencës së Parë organizuar nga Instituti Kombëtar i Fizikës (IKF)

10 - 11 Shkurt 2022

Akademia e Shkencave e Shqipërisë

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First Session

Sesioni i Parë

On the dichotomy: continuity-discreteness in physics

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A special role, in creating a worldview, is played by the binary evolution of two basic concepts: concept of continuity and concept of discreteness. This peculiar dichotomy: continuity-discreteness is reflected throughout the centuries in finding answers to some basic questions, which are embodying primarily three fundamental paradigms in perceiving and interpreting in a scientific way the world around us, These questions are: 1) Is the building of our world (structure of matter and behavior of fundamental forces) continuous or discrete? 2) Is the spectrum of different quantities as characteristics of motion and their numerical continuous or discrete? Is the space-time continuous or discrete? In fact, in this work we are trying to provide a general view on that problem; even, in some way, a relatively modest adjustment of some concrete results of the paradigms mentioned above on the binomial continuity – discreteness in the normal matter. However, it could be useful in the studies of dark matter or dark energy. The continuity-discreteness itself could aid also in opening a new path in analyzing such a dichotomy in other aspects of our reality.

Binary pulsars and precision tests of General Relativity

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Since their discovery in 1974, binary pulsars, and especially the only known double pulsar, have provided superb "laboratories" where to test General Relativity to an unrivalled accuracy. This talk will review the history and present status of the field, and emphasize the constraints these confirmations of General Relativity put to "alternative" theories of gravity.

Motion of an ensemble of magnetic microbeads in a microfluidic system

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This study describes the motion of magnetizable particles of spherical shape with radius at most of 1 μm, also referred to as microbeads, immersed in a liquid under laminar flow conditions in a microfluidic channel. An external magnetic field is applied in part of the system such that it permeates the channel and is characterized by a spatially varying magnetic field, i.e., the gradient of the magnetic field is nonzero. The beads are superparamagnetic; hence they can reach high level of magnetization in the presence of a magnetic field, and this magnetization disappears when the field is zero. Therein lies the attractiveness of these microbeads and the potential for applications because their motion can be controlled using an external magnetic field.

The motion is governed by several factors, including the magnetic force acting on microbeads (particles), the drag force due to viscosity, the interaction between particles and the fluid, as well as the interaction between particles themselves. For a single particle case, the trajectory of the motion is determined by balancing the drag and magnetic forces acting on the particle, a calculation that in general requires numerical integration. For a system consisting of an ensemble of interacting particles, several regimes of motion dominated by one of the factors are identified. Of particular interest are the systems dominated by the large number of particles in the ensemble, i.e., high particle concentration, in which cases the wake influences the flow downstream. This effect is qualitatively investigated by considering the Navier-Stokes Equation with and without the magnetic force contribution.

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Beam Dynamics and Wakefield Simulations for Free Electron Lasers

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Free Electron Lasers (FEL) are modern radiation sources that are able to produce photon beams of extremely high brilliance. The main challenge in the simulation of FELs is related to the broad spectrum of effects involved in electron beam dynamics during the acceleration phase. The strong space-charge interaction at low energies requires an accurate electromagnetic field solution with a spatial resolution in the range of a few um. At higher energies, the interaction is dominated by scattered radiation fields – the so called wakefields -developing over tens of meters of propagation distance within the accelerator chamber. Numerical simulations are, thus, faced with the challenge of reproducing all these effects occurring at different temporal and spatial scales while using a possibly small amount of computational resources.

In the talk, we will discuss various numerical approaches used in FEL simulations. These include beam dynamics simulations for space-charge dominated beams, a Lienard-Wiechert approach for the modeling of coherent synchrtron radiation as well as time- and frequency-domain methods for the calculation of electromagnetic wakefields and coupling impedances in accelerator cavities. Beam dynamics simulations for realistic scenarios will be shown and, then, further analyzed with particular emphasis on the influence of the respective physical assumptions on simulation accuracy. The simulation studies refer in the first place to the linear accelarator section of the European XFEL facility at DESY in Hamburg.

Aplikimi i integraleve jo të plota cilindrike në problemet e difraksionit

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Shumë burime optike nuk prodhojnë tufa që mund të përafrohen si valë të rrafshta të njëtrajtshme. Prandaj, është me rëndësi që të shqyrtojmë modifikimet e teorisë së difraksionit të valëve të rrafshta, të tilla që të jenë të zbatueshme për tufat jo të njëtrajtshme të rrezeve. Burimet e rrezeve lazer mund të përdoren për testimin e teorisë së difraksionit. Megjithatë, në këto raste kërkohet që të hulumtohen përafrimet e duhura për apertura apo skaje të trajtave të ndryshme. Në veçanti, ndërrimi i fazës dhe i amplitudës hapsinore, që është karakteristikë për lazerat, i bën ata burime ideale për eksperimente me difraksion që kanë të bëjnë me efektet e madhësisë së tufës. Nga ana tjetër, irradianca a lartë dhe divergjenca e ulët e tufës lazer e thjeshtëson ngritjen e eksperimentit për të kryer eksperimente me saktësi të lartë.

Në këtë punim është paraqitur zbatimi i funksioneve jo të plota cilindrike në difraksionin e tufës gausiane nga një sistem i sektorëve rrethorë me suprina të barabarta. Është treguar se funksionet jo të plota cilindrike sjellin deri te zgjidhja e problemit të difraksionit nga një rrjetë që përmban N sektorë transparentë të barabartë. Tabloja e difraksionit vrojtohet në një rrafsh paralel që ndodhet në një distancë z nga rrafshi i pengesës. Problemi është trajtuar në koordinatat polare (r,θ) në rrafshin e pengesës dhe në koordinatat polare (ρ,φ) në rrafshin ku vrojtohet tabloja e difraksionit. Janë fituar shprehjet mjaft të ndërlikuara për amplitudën komplekse $G(\rho,\varphi,z)$ dhe iradiancën. Megjithatë, një analizë matematike dhe një interpretim numerik është kryer për përafrimet e Fresnel-it dhe Fraunhofer-it. Janë hulumtuar gjithashtu rastet e veçanta të një sektori dhe të difraksionit të tufës gausiane në skaj të pengesës në trajtën e gjysëm-rrafshit. Rezultati i analizës matematike tregon faktin se shpërndarja difraksionale e intensitetit paraqet sistem të elipsave me gjysëmboshtin kryesor paralel me skajin e pengesës.

Second Session

Sesioni i Dytë

Searching for Dark Matter with optomechanical force sensors

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Optomechanical sensors are composite devices exploiting precision optical interferometry techniques to detect, with utmost sensitivity, the response of special micro-mechanical assemblies to external influences. We have developed one such device, where the force acting of a 100 nm thick, high-stress silicon-nitride micromembrane is detected, down to the pico Newton level in a few seconds, using a Michelson-type interferometry scheme.

Following recent theoretical ideas, the motion of the Earth through a galactic background of Dark Matter particles would cause an integrated momentum transfer on a properly oriented membrane, resulting in a force akin to the pressure exerted on a sail by an apparent wind. By continuously monitoring the force acting on a membrane, kept stationary in the laboratory frame, one could detect daily and annual modulation features due to the Earth's motion through the Dark Matter background. We are presently operating two identical optomechanical force sensors, one in Rijeka and one in Trieste, which are taking data in network mode to search for possible time-dependent correlated signals.

A stability criterion for feedback loops in frequency domain

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Feedback control and stability are fundamental to system dynamics. Stability criteria from Nyquist and Bode emerged around 1940's and they are instrumental to every introductory course in control engineering. While Nyquist criterion enjoys generality (for linear behaviors), The Bode criterion derived thereof is rather the applied version, while it assumes conditions that are not always met in practical applications. Inspired by an idea of Tsypkin from 1954 regarding practicality of Nyquist criterion, in this presentation, we suggest another criterion for stability of feedback control loops that dispenses with Bode's constraining assumptions. It closes a gap which young control engineers are left with in their early days of training on control design using Bode diagrams. Its utilization will be demonstrated in the use-case of attitude control of a geosynchronous satellite.

SpaceTRiP simulation code developments for Space Radiation Research

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The increased interest in space exploration raises the need for extensive studies of health risks from space radiation. In contrast to the radiation experienced on Earth where the main contributors to equivalent dose are gamma rays and alpha particles, space radiation is dominated by particles of high energy and charge [1]. For this kind of radiation exist critical uncertainties of radiation health risk estimation and difficulties in finding good strategies for shielding. We are developing a transport code for space radiation research. "SpaceTRiP" is an extension of the TRiP98 (TReatment PlannIng for Particles) [2, 3] developed at GSI. Originally the code was developed as a treatment planning system for heavy ion therapy. The TRiP98 transport model has previously given comparable results with experimental data [4].

SpaceTRiP calculates the dose in the complex geometry of the space vessel, from both the primary beam and the produced secondaries. The main application of this setup is to assess the viability of different shielding materials. The geometry handling follows the same logic as in radiotherapy planning, where the space vessel is described by regular cubic voxels. The information of each voxel is imported from a 3D model in GDML format. Moving from radiotherapeutic applications introduces several changes, such as a difference in particle energy range, more target material, and larger dimensions of the geometrical model.

We present a study of the dose reduction for different shielding materials, with a comparison to the available experimental data and Monte Carlo (MC) approaches.

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Lab-on-a-chip photonic biosensors for point-of-care applications

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In recent years, there have been several examples of serious virus outbreaks raising significant fears that such outbreaks can rapidly spread worldwide to become pandemics with devastating effects on populations and their social and economic development. Therefore fast, on-site, and sensitive detection of viruses is essential in detecting the onset of viral epidemics and preventing their spread. Currently available methods such as PCR and ELISA used for detection of viruses and other analytes, are time-consuming, expensive and require labor-intensive sample preparation and trained personnel for their operation. This has been the motivation behind the increased interest for the development of alternative virus/analyte detection methods.

In this presentation, I will talk about the research, development and commercialization of Labon-a-Chip photonic biosensors and their application for sensitive, rapid and multiplex detection of various analytes such as micro-organisms (viruses and bacteria) and biomarkers (proteins and DNA/RNA molecules). These biosensors can be applied in various application areas such as health care, e.g. for early diagnosis of cancer and heart diseases, food industry, e.g. for sensitive and fast detection of antibiotics in dairy products, national security, environmental monitoring, process technology, etc.

The high sensitivity that photonic biosensors can achieve could result to less sample preconcentration handling, which contributes to faster analysis and savings on operational costs. Moreover, these biosensors are easy-to-use and compact, offering the possibility for development of portable/handheld devices. As such, photonic biosensors are excellent candidates for fast, point-of-care analyte detection.

Interactive Molecular Dynamics Simulations of Biological Molecules

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Molecular dynamics (MD) simulations are often used to provide detailed insights into the dynamics of macromolecular systems (proteins, DNA/RNA, membranes, and their complexes). These dynamics involve transitions between various conformational states due to atomic motions. The main problem of standard MD simulation is the technique's time and size scale limitations in studying slow conformational motions of macromolecular systems. Therefore, the considerable time and size scale physical and chemical phenomena, such as protein/peptide folding free energy landscape, will indeed require new statistical and computational approaches to be studied efficiently. In this study, we show an interactive molecular dynamics simulation virtual laboratory setup for biological molecules (see Figure 1). We will focus on using augmented swarm particle intelligence and Tsallis statistics MD simulation methods to improve conformational sampling in simulations of peptide/protein folding/unfolding and transition path sampling using explicit solvent dynamics. We will discuss new approaches to enhance MD simulations' conformational search and sampling efficiency as case studies. Besides, we will examine the role of solvent in the thermal and chemical denaturation of the protein. In this study, we will combine the dipole-dipole correlations between the protein/peptide and solvent and information-theoretic measures to explain the role of solvent in the folding/unfolding mechanism in the solvent.

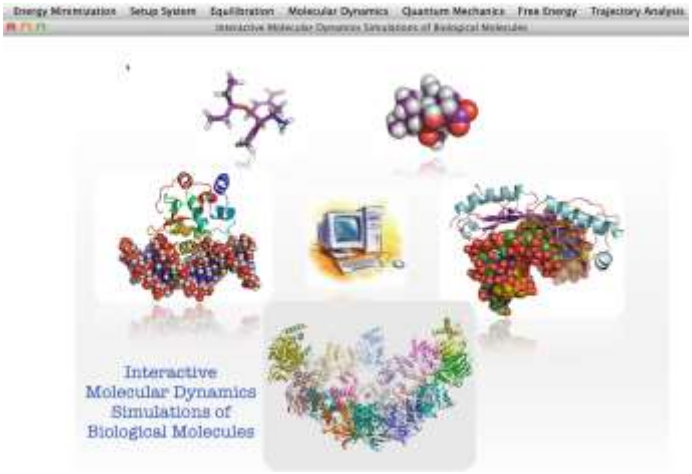

Figure 1: Interactive Molecular Dynamics Simulations of Biological Molecules.

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Third Session

Sesioni i Tretë

The transverse spin structure of nucleons

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The transverse momentum and transverse spin structure of the nucleons bears on the transverse momentum dependent (TMD) parton distribution functions (PDFs), which encode information on the partonic content as well as on the correlations between the quarks and nucleons momenta and spin degrees of freedom. One of the most powerful processes for the investigation of the nucleon structure is the semi inclusive deep inelastic scattering process (SIDIS) where high energy leptons are scattered off a polarized nucleon target and in the final state at least one hadron is observed in coincidence with the scattered lepton. In the SIDIS cross section TMD PDFs are coupled to the fragmentation functions (FFs), which describe the conversion of quarks and gluons in the observed hadrons, giving rise to observable azimuthal asymmetries. After introducing briefly the TMD description of the nucleon structure, this presentation focuses on the Collins asymmetry, a valuable tool currently being used to access the transverse spin structure of nucleons and the quark spin-dependence of the fragmentation process. Experimental measurements of the Collins asymmetry are shown, as well as its fenomenological description particularly within the context of the recently developed quantum mechanical recursive String+$^3P_0$ model of polarized quark fragmentation.

Search for a *HH* production in the *bbZZ* final state at √s = 13TeV with full Run II data

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A search for resonant and non-resonant double Higgs boson production is presented. The extension of the HEFT theory for the non-resonant HH production and Kaluza-Klein Bulk Graviton with spin-2 and Radion with spin-0 are the resonances responsible for the Higgs (H) pair production. For both cases, one of the Higgs boson will be studied into a leptonic final state ($H \rightarrow ZZ$ (4l), where, l = e,μ), meanwhile the other one decays into a pair of b-quarks. The analyzed data corresponds to an integrated luminosity of 137.2 fb^{-1} of *pp*-collision at √s = *13 TeV* collected with the CMS detector during the full RunII period. Advanced statistical techniques are employed to extract the results. Upper limits are set on the signal strength modifier μdefined as the double-Higgs boson rate in the *bb4l* channel to the Standard Model (SM) expectation.

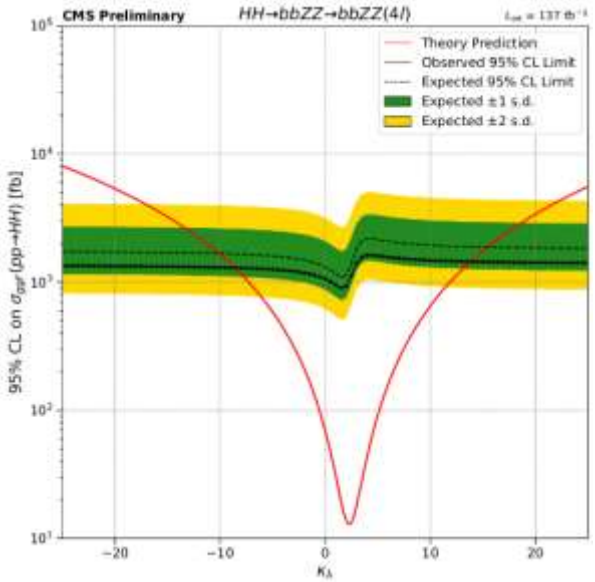

Figure 1: Expected and observed 95% Cls upper limit on the non-resonant $HH \rightarrow bbZZ \rightarrow bb4l$ production cross section derived as a function of k (λ) = λ(HHH) / λ(SM) for the full Run II, with a constraint range at -9(-10.5) < r(k(λ)) < 14(15.5) at 95% Cls where the red line represents the theoretical value of the cross section.

Properties of Boriçi - Creutz fermions as minimally doubled lattice fermions

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Most quark actions in lattice QCD encounter difficulties with chiral symmetry and its spontaneous breaking. Minimally doubled fermions have been proposed as a strictly local discretization of the QCD fermions action, which preserves chiral symmetry at finite cut-off, but whose continuum limit reproduces two degenerate quark flavours. The two zeros of this Dirac operator are connected such that symmetries under charge conjugation or reflection of one particular direction are explicitly broken at finite lattice spacing. Boriçi - Creutz fermions are one type of this kind of fermions, and in this work, we make a review of the studies regarding the symmetries and renormalization of this action. Discrete symmetries, such as parity and time-reversal, are explicitly broken and consequently, when the gauge interactions are included, relevant and marginal operators are generated. Thus, the restoration of these symmetries and the approach to the continuum limit require the fine-tuning of several parameters. In the literature issues of mixing with lower dimensional operators have been proposed, and how to deal with them with appropriate tuning strategies. Counterterms and operator mixing are studied perturbatively, but also independent non-perturbative procedures for the restauration of the broken symmetries are developed by numerical studies of observables for Boriçi - Creutz in quenched approximation. In this work are presented the main important results regarding Boriçi - Creutz fermions properties, taken by our and other groups working with them, and an introduction of how to use them in lattice simulations.

Renormalized Factorization Formula for the h → γγ Decay Process

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Factorization theorems pay a crucial role in understanding the structure of Quantum Chromo Dynamics (QCD) at different energy regimes and they enable calculations that are otherwise difficult or impossible to perform. Derivation of renormalized versions of factorization theorems for different collider processes has become a necessity in the era of precision physics. In this work we derive the first renormalized factorization theorem for a power suppressed process, Higgs boson decay into two photons mediated by a light quark loop. We work in the so-called soft-collinear effective theory framework. We derive this factorization formula using a "plus-type" subtraction scheme to regularize the endpoint divergences and two D-dimensional refactorization conditions for one of the operator matrix elements and a Wilson coefficient. We use the renormalization group evolution equations of the operator matrix elements and their Wilson coefficients to predict the large logarithms at three-loop order. This is the first three-loop result for an observable at sub leading power in soft-collineareffective theory.

Forth Session

Sesioni i Katër

The unique properties of confined systems of electrons in low dimensions

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Low-dimensional materials and, in particular, two-dimensional electron systems are of great interest to many scientific disciplines. The technological interest on such structures stems from the fact that devices built from constituents with low dimensions or with dimensions bordering on the nanoscale may have a wide range of applications in fields such as electronics, optoelectronics, and photonics. On the other hand, the theoretical interest on electron arrangements of this nature is related to the fact that finite two-dimensional and/or small low-dimensional confined systems of electrons in a semiconductor quantum dot represent a unique opportunity to study fundamental quantum theories in a controllable atomic-like setup. In this presentation, I will describe some recent theoretical work and ideas that shed light on the intricate properties of low-dimensional strongly correlated electron systems. The main emphasis of the present exposition is to draw attention to important theoretical physical phenomena that arise in confined systems of electrons under various quantum regimes as well as lay out ideas of future directions of scientific research that can be undertaken in this field.

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A local-probe perspective on correlated quantum matter

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As a local microscopic probe, magnetic resonance is a well established, complementary technique to those used in large-scale facilities, especially suitable for studying materials under demanding experimental conditions, including high magnetic fields, high pressures, and ultra-low temperatures, required to access quantum-critical behaviour. In our work at the ETH condensed-matter laboratory we regularly make use of this potential to investigate strongly-correlated quantum matter with closely competing energy scales. In this overview talk we focus on some recent projects, including low-dimensional spin systems, non-centrosymmetric superconductors, two-dimensional antiferromagnets, as well as on ongoing investigations of quantum-spin liquids and topological materials. After illustrating the new possibilities opened by high-pressure, low-temperature magnetic resonance, we highlight our future projects and present possibilities for new collaborations.

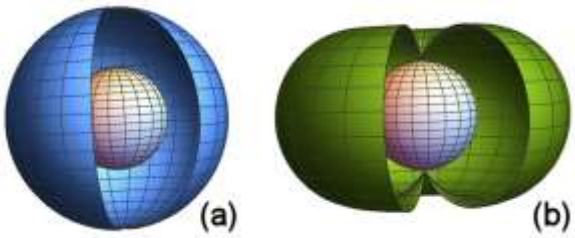

Figure 1: The two superconducting pairing functions of CaPtAs: fully-gapped (a) and nodal (b) [5].

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Effect of Mischmetal (MM) and transition metal elements (TM) doped on properties of the $SmCo_5$ intermetallics

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Sm-Co, a system with excellent magnetic properties, has been investigated towards reduction of both constituent elements, especially Co but also for replacing Sm with other rare-earth (RE) atoms [1]. In the present work we present a preliminary experimental and ab-initio study of a series of compounds with nominal composition $Sm_{1-x}MM_xCo_{5-y-z}Fe_yNi_z$ ($x = 0 – 0.7$; $y = 0.5 – 1.5$; $z = 0.5 - 1$). Compounds with MM content up to 50% were successfully synthesized in $CaCu_5$-type structure, retaining uniaxial magnetocrystalline anisotropy. Magnetization values are within the 85 to 50 Am^2/kg range (Fig. 1). Theoretical calculations predict higher magnetization values, especially in the case of $SmCo_{2.5}Fe_{1.5}Ni$ compound with a value close to that of $SmCo_5$. Ni probably has a positive effect in structure stabilization as also depicted by ab-initio calculations, at the cost of weakening the overall magnetization. In both structural and magnetic properties ab-initio calculations and experimental results are in good agreement, calculated magnetization is larger than experimental results; suggested density functional theory (DFT) parameters are suitable for RE-TM intermetallics. The suggested substitutional approach may provide permanent magnets suitable for some applications with reduced cost and criticality compared to basic $SmCo_5$ system.

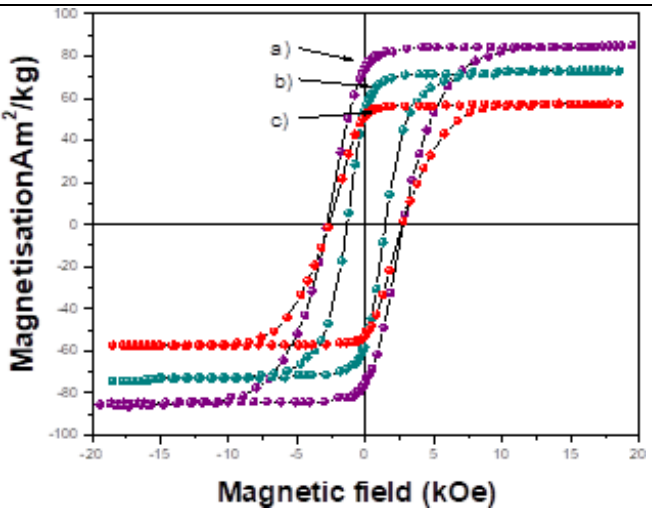

Figure 1: RT hysteresis loops of a) $Sm_{0.5}MM_{0.5}Co_4Fe_{0.5}Ni_{0.5}$ b) $Sm_{0.5}MM_{0.5}Co_3FeNi$ c) $Sm_{0.5}MM_{0.5}Co_4FeNi$ samples.

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Fifth Session

Sesioni i Pestë

The storage ring proton electric dipole moment with the hybrid/symmetric lattice

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Hadronic EDM experiments have been suffering from low statistics, with the neutron EDM sensitivity being at the 10^{-26} e-cm level for more than a decade. Storage ring methods have been presenting a solution to the statistical part of problem since high intensity polarized beams have been available for decades. Recently, we have studied the systematic errors related with a hybrid/symmetric lattice and found it to reduce the major systematic error sources, while it does not compromise essential parameters, e.g., spin coherence time, beam injection, etc. I will present the present status and the prospects of such a method reaching 10^{-29} e-cm, more than three orders of magnitude better than present limits.

Galactic cosmic rays: hurdles toward the Moon and Mars

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After decades of research on low-Earth orbit, national space agencies and private entrepreneurs are investing on exploration of the Solar system. The main health risk for human space exploration is late toxicity caused by exposure to cosmic rays. On Earth, exposure of radiation worker is regulated by dose limits and mitigated by shielding and reducing exposure times. For space travel, different international space agencies adopt different limits, recently modified as reviewed in this paper. Shielding and reduced transit time are currently the only practical solution to maintain acceptable risks in deep space missions. We will present the most recent updates in these research fields to enable safe exploration of the Solar System.

Primordial Black Holes as Dark Matter Candidates

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Primordial Black Holes may form in the early stages of the Universe via the collapse of large density perturbations. Depending on the formation mechanism and based on various constraints, it is found that these objects may exist and populate today the galactic halos with masses in three possible windows 10^{16}-10^{17} g, 10^{20}-10^{24} g and 10-10^{3} solar masses. The last possibility is of particular interest in view of recent detections of gravitational waves by LIGO/Virgo, produced by merging black holes. Gravitational microlensing is a robust and powerful method to detect and constrain Primordial Black Holes, since it does not require that the lensing object be directly visible. We calculate the optical depth and the rate of microlensing events caused by these objects eventually distributed in the Milky Way halo, towards some selected directions of observation. We also discuss the capability of telescopes which might perform microlensing observations, to probe Primordial Black Hole populations in the Galactic halo.

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Signatures from the dark Universe from observations in space

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The existence of the dark Universe started with cosmological observations by Zwicky in the 1930s, because they did not fit gravitational expectation. Last decades there is an enormous work going on worldwide to directly detect dark matter (DM) mainly in underground experiments. Though, a large number of investigations focus also on astrophysical observations like from our Sun, galactic center, pulsars, and recently also in gravitational waves, etc. In my talk I will focus on a number of observations within our solar system which known physics cannot explain since decades. Following our reasoning, the common viable explanation is an as yet overlooked impact by DM in form of streams or clusters. Hence, we conclude the dark Universe is not as dark as anticipated. Then, direct DM searches should mimic some of the aforementioned overlooked observations. Of note, most of such investigations are quasi cost free and can be undertaken parasitically or by re-analyzing data taken for other reasons since more than 100 years.

About some correlations in GRB prompt emission

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Gamma-Ray Bursts (GRBs) are amongst the extreme explosive events in the Universe. By measuring the redshift and observed fluence, it is calculated that GRBs radiate between 10^{48} and 10^{55} ergs, if the energy release is isotropic [1], but there are evidences that GRB outflows are collimated, so energy reduces by a factor $10^2 - 10^3$ relative to the isotropic one [2,3]. The prompt emission (high-energy gamma photons) of the GRB is followed by the afterglow, a long lasting, lower energy emission. Fermi observations have shown that there may be three elemental spectral components that shape the time-resolved GRB spectra: i) a Band-function (non-thermal) component; ii) a quasi-thermal component; iii) non-thermal power law component extending to high energies [4]. Lightcurves of prompt emission of different gamma ray bursts exhibit different structures, on the contrary Fourier power density spectra (PDS) of individual GRB lightcurves show similar shapes: a low frequency component, fitted by a simple power-law or bent power-law, followed by a flat high frequency one [5,6]. In this contribution, by simulating a synthetic GRB pulse sample, calculating and analysing their power density spectra, we discuss on two correlations: peak energy-power-law index of power density spectra and dominant timescale-duration[5,6] to understand their origin.

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Sixth Session

Sesioni i Gjashtë

Modeling Equilibrium Chemistry in Laser Induced Plasmas and Plasma Chemical Reactors

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A brief introduction will be given on modeling chemical reactions in laser induced plasmas using stoichiometric and non-stoichiometric approaches. Several applications will be considered, which can benefit from such modeling. Those include plasma enhanced chemical vapor deposition (PECVD), surface modification and surface coating, and molecular analysis by LIBS. Each application will be illustrated by simulations of relevant chemical systems. For PECVD, chemical systems are $BCl_3/H_2/Ar$, $BF_3/H_2/Ar$, BCl_3/BF_3, $Mo/BF_3/H_2$; for surface modification/coating it is Ti/air; for molecular LIBS they are $CaCO_3/Ar$, $Ca(OH)_2/Ar$, and $CaCl_2/Ar$. Advantages and shortcomings of equilibrium chemical hydrodynamic models of laser induced plasmas will be discussed.

Zhvillimi i Rrjetit Kombëtar të Monitorimit të Rrezatimit Mjedisor

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Në këtë punim paraqitet konfigurimi dhe funksionimi i Rrjetit Kombëtar të Monitorimit të Rrezatimit Mjedisor (RKMRM) në Shqipëri.

Rrjetet e monitorimit të rrezatimit mjedisor u zhvilluan në përmasa botërore pas aksidentit bërthamor të Çernobilit të vitit 1986. Këto rrjete nëpërmjet stacioneve të tyre kryejnë monitorimin e vazhdueshëm të niveleve të rrezatimit mjedisor dhe shërbejnë njëkohësisht për paralajmërimin e situatave emergjente të rrezatimit, që mund të lindin brenda ose jashtë vendit. Situata emergjente të rrezatimit krijohen nga aksidentet radiologjike, aksidentet bërthamore ose nga aktet terroriste bërthamore, me pasoja të dëmshme për publikun dhe mjedisin. Rrjetet e monitorimit të rrezatimit mjedisor kanë një rol kyç në planet kombëtare të reagimit ndaj emergjencave radiologjike dhe bërthamore.

RKMRM është instaluar në Shqipëri për herë të parë në vitin 2004 dhe përbëhej nga pesë stacione, kurse në vitet e fundit ky rrjet është rinovuar me pajisje krejtësisht të reja duke shtuar edhe tre stacione të tjera. Stacioni qendror i këtij rrjeti ndodhet në Institutin e Fizikës Bërthamore të Zbatuar, pranë Universitetit të Tiranës. Stacionet e RKMRM janë të pajisura me instrumenta të posaçme, që masin fuqinë e dozës se rrezatimit gama mjedisor dhe e transmetojnë atë në stacionin qëndror në intervale kohe të përcaktuara. Në rastin e rritjes së niveleve të rrezatimit, rrjeti gjeneron automatikisht një alarm dhe rrit frekuencën e matjeve dhe transmetimin e tyre në stacionin qendror.

Variacionet e përqendrimeve të aerosoleve dhe joneve atmosferike bazuar në proceset e rikombinimit dhe të kapjes*

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Studimet e ngarkesave të aerosoleve atmosferike, të cilat janë një ndër komponentet më të rëndësishme të atmosferës, janë ndër drejtimet kryesore, sidomos në dekadat e fundit, mbasi ato kanë një ndikim të drejtëpërdrejtë dhe të tërthortë në cilësinë e ajrit dhe klimën, dy aspekte me rëndësi jetike për njerëzimin. Me anë të këtij punimi është arritur të sudiohen karateristikat elektrike të aerosoleve dhe joneve atmosferike duke trajtuar hollësisht bashkëprimin elektrik të tyre. Koeficientët e lidhjeve ndërmjet përqendrimeve të joneve atmosferike dhe aerosoleve, të modave të mesme dhe të larta, rezultojnë në vlera jo shumë të larta; (-0.31÷-0.41). Në të tri kategoritë e aerosoleve vihet re një lidhje e zhdrejtë me përqendrimet e joneve atmosferike. Vlerat pozitive të koeficientëve të lidhjeve jon-aerosol, mund të shpjegohen me lidhjet që kanë këto përqendrime me parametra të tjerë, si ato atmosferikë. Parametrat meteorologjikë ndikojnë jo vetëm në shkallën e krijimit të aerosoleve të modave të ndryshme, por edhe në dhe transportin e tyre. Në studimin e karakterisikave elektrike të aerosoleve, është bërë një përcaktim teoriko-eksperimental i ritmit të prodhimit të joneve si dhe i termave të kapjes dhe rikombinimit. Është arritur në përfundimin se gazi i radonit kontribuon në 16.5% të ritmit t përgjithshëm të krijimit të joneve atmosferike, rrezatimi kozmik në 38.4%, ndërsa ai tokësor në 45.1%. Kontributi i kapjes (2.93 $s^{-1}cm^{-3}$ ose 48.2%) është gjithnjë më i lartë se ai i rikombinimit (1.52 $s^{-1}cm^{-3}$ ose 25%). Gjithashtu, vihet re se termi i rikombinimit lidhet negativisht me atë të kapjes nga aerosolet (-0.51). Vlerat e koeficienteve të lidhjeve sugjerojnë që në ambiente të mbingarkuara me aerosole, predominon termi i kapjes, ndërsa në ambiente të pastra predominon termi i rikombinimit. Si hap i fundit është analizuar edhe përcaktimi teorik i një termi shtesë, që përmbledh kontributet e të gjithë faktorve të tjere në reduktimin e joneve dhe vlera e tij del 1.61 $s^{-1}cm^{-3}$ (ose 27%).

** Variability of the atmospheric ion and aerosol concentrations based on their recombination and attachment processes*

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Plasma - material interactions: from nuclear fusion reactors to semiconductor processing

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Solid and liquid metals are promising candidates for plasma-facing components (PFCs) in magnetic fusion devices, such as tokamaks, where large fluences of energetic particles and heat loads are exchanged. Tungsten is an attractive material because it has favorable thermal and mechanical properties. Lithium conditioning of plasma facing surfaces has improved plasma energy confinement and reduced the influx of cold hydrogen (H). However, exposure of tungsten to energetic particles such as H isotopes (D and T), He, and impurities, increases particle retention (on both Li and W) and causes surface modifications (i.e. formation of blisters, bubbles, fuzz, cracking etc.), that may lead to an increase of the erosion yield, dust formation and deterioration of the thermal and mechanical properties of tungsten [1]. Studying these processes in the tokamak environment is challenging, however, surface science investigations can help illuminate the fundamental processes involved. Surface modification by the incident particle flux and fuel retention in tungsten were investigated using linear plasma devices [2]. Unexpectedly, it was found that the variation of the particle flux can have a serious impact on blistering and cracking, leading to higher hydrogenic retention at elevated temperatures [3]. Hydrogen retention was also studied in lithium and lithium oxide ultrathin films formed under UHV conditions. Thermal programmed desorption and Auger electron spectroscopy were used to elucidate the underlying physical and chemical processes. The results suggest that the formation of lithium oxide can have the beneficial effect of reducing the hydrogen influx under fusion reactor conditions [4]. In addition to hot plasmas, cold plasmas are widely used in semiconductor industry for processing, enabling nm-scale feature patterning.

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Electrodeposition of copper and chromium in aluminum alloys AA6063 and AA6060

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Copper electrodeposits have electrical conductivity, thermal conductivity, metallic brightness, good adhesion, and low internal stresses. Chromium electrodeposits improve the hardness, wear resistance, and corrosion resistance of engineering components. These properties made copper and chromium very acceptable for electroplating. Aluminum alloy AA6060 is used for enclosing constructions such as windows, facade construction, winter gardens, internal partitions, stairs, fences, rail, interior equipment of passenger cars, heating and cooling pipes, furniture, and office equipment. On the other hand, aluminum alloy AA6063 is used for architectural extrusions, automotive parts, building products, electrical and electronic parts, etc. These applications make these alloys extremely interesting for electroplating technology. In this work, we have studied the mass and layer thickness of electrodeposited copper in aluminum alloy AA6063 and electrodeposited chromium in aluminum alloy AA6060 by using technical scale and optical microscope with magnification 500x. For the electrolysis process samples were prepared with abrasive papers while for optical microscope observation was used a polishing machine. The solutions used for the electrolysis process were copper sulfate pentahydrate and potassium dichromate. Electrodeposition of copper is performed in five samples of aluminum alloy AA6063 for different time intervals 20 min, 40 min, 50 min, 60 min, and 80 min. Electrodeposition of chromium is performed in five samples of aluminum alloy AA6060 for 20 min, 40 min, 60 min, 80 min, and 100 min. The methods used during the work of this paper have been: electroplating, metallographic specimen preparation, and optical microscopy. The main law of this work is Faraday's first law of electrolysis. We expect copper to be electrodeposited more easily than chromium.

Keywords: Aluminum Alloy 6063, Aluminum Alloy 6060, Electrodeposition, Electrodeposited mass, Thickness of electrodeposited layer, Optical Microscopy.

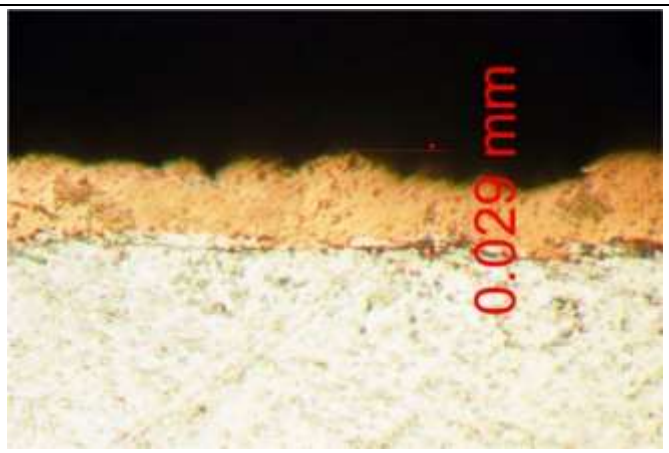

Figure 1: Micrograph of the deposited copper layer in the fourth 6063 aluminium alloy sample for 60 min current flow time.

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Characterization and quantification of crystalline and amorphous phase assemblage in ternary binders during hydration

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Compositions based on Portland cement, Calcium aluminate cements and sulphates are used in the market as technical mortars for concrete fast repair and protection, or flooring installation with self – levelling compound. Despite their extensive use in the industry, little research on characterization and quantification of crystalline and X–ray amorphous hydrates has been carried out.

The dissertation aimed to provide a comprehensive understanding of the evolution of solid phase composition with ongoing hydration in PC–rich and CAC–C$\bar{S}$HX rich ternary pastes. Within the work, two main subjects were thoroughly dealt with: (i) investigation into the formation of crystalline and amorphous hydrates on selected binders with the ultimate goal to strictly quantify the mineralogical changes over time, (ii) investigation into the influence of raw materials variation and water availability on the hydration mechanism and phase assemblage in ternary binders.

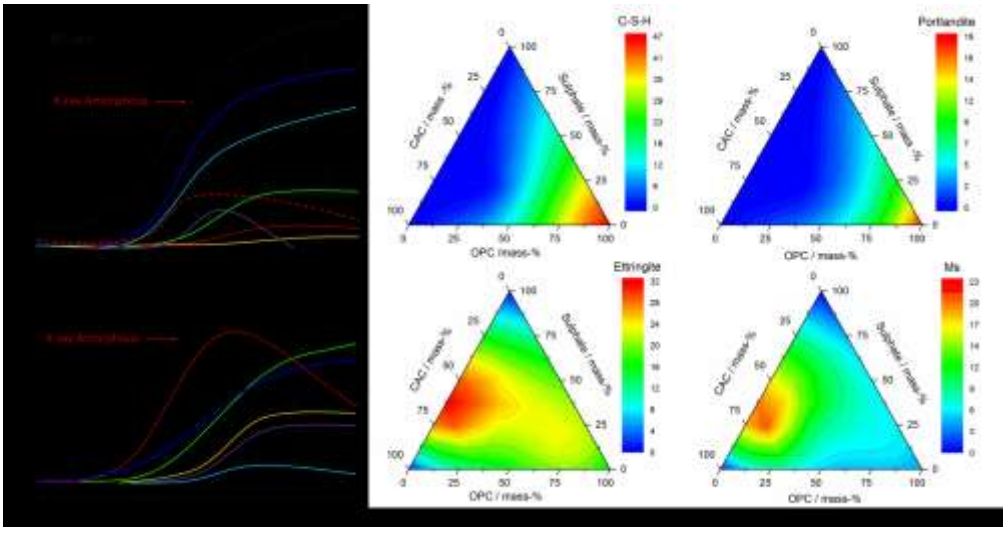

Figure 1: Schematic representation of the formation of hydrate phases during the hydration of PC–rich and CAC-rich formulation *(left)*. Distribution of hydrate quantities in the ternary diagram PC–CAC– C$\bar{S}$HX upon hydration *(right)*.

The work was based on a multi–method approach including XRD, TGA, MAS NMR spectroscopy, calorimetry, microscopy and thermodynamic calculations. From the combinations of results obtained from the different analytical methods, a schematic representation of the phase evolution with ongoing hydration in PC and CAC–C$\bar{S}$HX rich combinations was achieved, along with plots showing the distributing hydrate phases in the ternary diagram PC–CAC–C$\bar{S}$HX (Fig.1). C–S–H, portlandite, ettringite and AFm phases stand as main hydration products in the PC–rich combinations. C–S–H accounts for almost 80% of the X–ray amorphous fraction. In the CAC–C$\bar{S}$HX rich combinations ettringite along with AH_3, monosulphoaluminate, strätlingite and hydrogranet phases precipitate. The high portions of X–ray amorphous fractions in such combinations were mainly attributed to AH_3 gel and AFm phases. Additionally, comparison of QXRD results with stoichiometric calculations, thermal analysis and ^{27}Al NMR revealed that a portion of the formed ettringite and portlandite are in an X–ray amorphous state during hydration.

It was shown that the variation of CAC type and water content strongly influences the hydration mechanism and phase assemblage in the investigated ternary pastes, whereas differences in mixtures with gypsum and anhydrite as sulphate carriers were mainly related to their dissolution kinetics.

Lifetimes measurement in the $f_{7/2}$ shell using the AGATA spectrometer

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Transition probabilities are essential on understanding the collectivity. Such information can be extracted from precise lifetime measurements of the nuclear excited states. In this work the lifetimes of different excited states of the cross conjugate pair of nuclei ^{46}Ti and ^{50}Cr have been measured by using the Doppler Shift Attenuation Method (DSAM). High spin states of these two nuclei have been populated by the fusion-evaporation reaction ^{16}O(^{36}Ar, αn). The experiment was performed in Ganil laboratory on 2018. A beam of ^{36}Ar with energy 115 MeV and intensity 5 pnA was sent in a target which consisted on a thin foil of CaO (550 μg/cm^2 thick) with a gold backing of 10 mg/cm^2 to stop the recoiling nuclei.

The advanced gamma-ray spectrometer AGATA has been placed in the close configuration in backward direction with respect to the beam line, to detect the gamma-rays emitted from the de-excitation of the products of the reaction. Since many reaction channels are open in a fusion-evaporation reaction, AGATA array has been coupled to NEDA and Neutron Wall (neutron detector array) and Diamant (charged particle detector array) to obtain the needed channel selectivity event by event.

The transition probabilities have been obtained from the experimental lifetimes and compared with literature data and with the results obtained from shell model calculations using the KB3G and the GXPF1A interaction. Rotational collectivity decreasing by the yrast termination of the band has been confirmed in both nuclei.

Seventh Session

Sesioni i Shtatë

Fine Grain Cosmological Streams of Dark Matter in Solar Neighborhood

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Cosmological models of dark matter in the galaxy reveal more intricate features than a smooth standard Halo model. One of the features is the existence of numerous fine-grained streams at solar location where these fine-grain streams have very small velocity dispersion owing to the cold non-interacting nature of dark matter. The gravitational focusing of dark matter from the sun and the planets has been explored previously. These studies have shown that a small modulation in dark matter density would result at Earth's location if velocity profile of dark matter is Maxwellian which is the assumption in the standard Halo model. The semi-analytic models indicate large density enhancement are possible for streams. We advance the studies further by considering full numerical N-body simulations which take into account input from cosmological simulations on streams, consider the cumulative gravitational effects of Sun, Moon, Earth on DM, and include dispersion effects. Density enhancements and inferences for dark matter candidate measurements will be presented.

Strong Lensing Time Delay as a Probe of Cosmological Parameters

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The time delay between different images can be measured in any strong lens configuration with a time-variable background source, providing a valuable tool for cosmological investigations. Since the time delay equation contain ratios of angular diameter distances of the source and lens, which depend in their redshifts and the cosmological parameters, its measurement can be used to constrain them and to determine the Hubble Constant (H0). In this work we are focused on strong lensing of quasars by foreground galaxies. We calculate the probability that a quasar observed by Large Synoptic Survey Telescope (LSST), Zwicky Transient Facility (ZTF) and James Webb Space Telescope (JWST) telescopes is lensed by foreground galaxies. Our analysis is based on the mass-luminosity distribution function of galaxies, the galaxy redshift distribution and the quasar redshift distribution. At the same time, by Monte Carlo simulations we find also the time delay distribution between images during the strong lensing events observed by LSST telescope.

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Sunyajev Zel'dovich effect from Cluster of Galaxy

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S-Z effect (Compton inverse Effect) is an important tool for the modern Cosmology. Being completely independent of the red shift, gives us the possibility to enhance the measure of Cosmological parameters as, Angular Diameter of the Clusters of the Galaxies, CMB Temperature etc. Here we estimate the Specter of the Comptonization parameter mapping the effect, with CMB crossing through the hot electronic gas inside the Clusters of Galaxies. Then we simulate the changes in CMB Intensity and Temperature. To do so we first analyze X-ray data from CHANDRA, in order to obtain Temperature and Density profile of the electronic gas, for the density we use both single Beta and double Beta model. The results are fitted with real data for the S-Z observations.

Keywords: S-Z effect, Cluster of Galaxies, Cosmic Microwave Background, Compton Parameter.

Eighth Session

Sesioni i Tetë

The CERN Test Beams and Irradiation Facilities

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The test beam and irradiation facilities at the CERN Proton Synchrotron (PS) and the CERN Super Proton Synchrotron (SPS) are well established. They are highly versatile and provide hadron, electron and muon beams at a configurable momentum and intensity. Depending on the year, ion beams are available as well. Close to one hundred internal and external user groups use utilizing the different facilities every year.
As CERN is ramping up its accelerator chain after the Long Shutdown 2 (LS2), this contribution will give an overview of the test beam facilities and their recent improvements.

Identifikimi dhe vlerësimi i kontributit të burimeve kryesore të ndotjes në fraksionin PM 2,5 të lëndës së grimcuar në ajër në një stacion urban në Tiranë

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Lënda e grimcuar përbën një komponent të rëndësishëm të ndotjes së ajrit dhe konsiderohet se ndikon direkt mbi shëndetin e popullsisë. Burime të ndryshme me natyrë antropogjene por edhe natyrale, që emetojnë grimca primare apo sekondare, janë kontribuesit kryesorë të lëndës së grimcuar në ajër. Evidentimi i këtyre burimeve si dhe vlerësimi sasior i kontributit të tyre përbëjnë të dhëna të rëndësishme në planet për kontrollin e ndotjes dhe menaxhimin e cilësisë së ajrit.

Në këtë punim do të paraqesim të dhëna mbi përbërjen elementare të lëndës së grimcuar në ajër (fraksioni PM2,5) të mbledhura në mënyrë sistematike për një periudhë disa vjeçare në një stacion urban në Tiranë. Analizat janë kryer me metodën e Fluoreshencës së Rrezatimit X me parametra analitike të pranueshëm për këto lloj studimesh. Të gjitha procedurat e mbledhjes së mostrave të lëndës së grimcaur dhe analizave të saj janë kryer në përputhje me procedurat standarte dhe cilësia e zbatimit të tyre është kontrolluar nëpërmjet ushtrimeve të ndërkrahasimeve laboratorike (proficiency tests). Mbështetur mbi të dhënat e mbledhura kemi identifikuar burimet kryesore të ndotjes si dhe vleresuar kontributin e tyre duke përdorur programin "Positive Matrix Factorization" (EPA PMF v 5.0). PMF është një program që përdor metodën e analizës së faktorëve për të dhënat me shumë dimensione dhe që matricën e të dhënave analitike e zbërthen në dy matrica, atë të "kontributit të faktorëve" dhe atë të "profilit te faktorëve". Analisti duhet të bëjë interpretimin e "profileve të faktorëve" duke i lidhur ata me burimet.

Burimet kryesore të identifikuara në stacionin urban të Tiranës janë emetimet nga djegia e biomasës, trafiku, aerosolet sekondare, pluhuri tokësor, si dhe burime me kontribut më të vogël si emetimet nga djegia e naftës, emetime industriale apo djegie mbeturinash. Janë identifikuar edhe burime me veprim të përkohshëm si masat ajrore detare dhe ato me origjinë nga shkretëtira e Saharsë.

Solar energy in Albania: Comparison of solar energy prediction models

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Successive energy crises necessitate the use of renewable energy sources such as solar and wind, they can be properly complementary with other sources. We have presented solar energy and the importance in the current status, and for the future in Albania, from the statistical point of view, including in terms of representative generation parameters. It will be discussed for the assessment of solar potential, feasibility analysis for different regions in Albania. Statistical evaluations are made in terms of technical parameters, capacity for power installation, generation and generalization on economic parameters. Forecasting the power production of grid-connected photovoltaic (PV) power plants is essential for both the profitability and the prospects of the technology. Modelling represents a common approach in calculating the expected power output from numerical weather prediction data. The model selection has a high effect on physical PV power forecasting accuracy, the calculations are made to evaluate the difference between the models in terms of mean absolute error (MAE), root mean square error (RMSE) for a PV plant.

Perspective of Using Artificial Intelligence in Diagnostic Imaging

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Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues. Diagnostics examinations through analogue or digital images, are now the main methods of detection of various diseases. Digital images can be obtained by different methods depending on the used technique. Basically, any technical acquisition of medical imaging, there is a connection of a medical physics interaction process of radiation with matter / environment and with the computers, these processes become visible through digital images. Referring to the nature of physical phenomena that are used and the lack perfection of detection systems, the result is not perfect but is an estimation of “right value" which remains inaccessible. In addition, the human error during a medical examination, the movements of the patient, etc., can lead to the very important artefacts. These artefacts initially must be understood, analyzed and by using numerical methods of medical images processing, be corrected in the final version of these digital images. This paper analyses several numerical methods of digital image correction such are interpolation and convolution, implemented in the MATLAB program. Particularly, interpolation technique is implemented by using feedforward artificial neuronal networks (ANN), The results are significant because with some transformations, technicians and doctors can reach to correct defects that can carry a medical image acquisition during their obtaining process with diagnostic equipment.

Poster Session

Sesioni i Posterave

Correlation and prediction of the viscosities of multicomponent liquid mixtures

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Knowledge of the dependence of viscosities of multicomponent liquid mixtures on composition is essential in different applications for surface facilities, pipeline systems, and mass transfer operations. The invaluable information provided by this physical property has considerably increased the interest in developing models for estimating the viscosity of multicomponent liquid mixtures. In general, these models may be classified as either correlative, where experimental data are used for determining the model parameters, or predictive, where only the properties of pure components are needed. Various correlative and predictive models were tested in this work. The estimated viscosities were compared with experimental data obtained in the Laboratory for Theoretical and Experimental Condensed Matter Physics of the Department of Physics of the University of Prishtina or taken from recent literature. The ability of the models to estimate the viscosities was ascertained by calculating the mean absolute percentage error between experimental and estimated viscosities.

Mbi rregullimin optimal të sistemeve kooperative

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Vitet e fundit, ndihmuar edhe nga arritje tekonologjike në fushën e procesimit dhe komunikimit, vërehet një nevojë në rritje për zhvillimin e teknikave të avancuara për rregullimin optimal të sitemeve dinamike kooperative. Në varësi nga kompleksiteti i sistemit kooperativ, rregullimi mund të relizohet si një arkitekturë qendrore e përbashkët për të gjitha sistemet dinamike ose si arkitekturë e shpërndarë, ku secili sistem konsiderohet si një agjent në vetvete, ne komunikim të vazhdueshem me agjentët tjerë ashtu që këta në mënyrë bashkëpunuese arrijnë qëllimin e përbashkët. Duke konsideruar dy apo më shumë agjentë lind nevoja për zhvillimin e një arkitekture të rregullimit që në vetvete përmban metoda optimale për planifikimin, shperndarjen dhe realizimin e detyrave për secilin agjent vec e vec. Duke u fokusuar kryesisht në arkitekturën qendrore dhe duke konsideruar dinamikën e sistemeve, ne prezentojmë metoda optimale të rregullimit, që kanë për objektiv arritjen e qëllimeve të përbashkëta në kohë minimale. Për të analizuar dhe demonstruar funksionalitetin dhe efikasitetin e metodave të zhvilluara, ne konsiderojmë një sistem kooperativ të përbëre nga dy krahë robotik të cilët ndajnë të njëjtën zonë operative dhe performojnë lëvizje me potencial të lartë kollizioni.

Lattice QCD Simulations with FermiQCD

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The Lattice Quantum Chromodynamics (LQCD) is an algorithmic formulation of QCD theory, the mathematical model that describes quarks interactions. It is based on numerical algorithms derived from a mathematical analogy between the "path integral" in the statistical mechanics and "steps" of the Markov chain in the Monte Carlo algorithm. Numerical simulations of LQCD with Monte Carlo methods can be quite costly and they have to run on larger computer units, such as supercomputers. Parallel calculations using supercomputers with considerable processing power are an option to gain time and computational cost. Also, we have to simulate larger volumes so that the result obtained for a given physical quantity is closest to the continuum one, increasing more the computational cost. In this paper, we performed numerical simulations of pure SU(3) calibration theory to test the FermiQCD. We see that FermiQCD is one of the best paralleled software available today in the field of LQCD. It scales very well up to the number of processors used np = 4. Parallel calculations have been carried out in one of the supercomputers of the HP-SEE project, located in Bulgaria (BG-HPC).

The Critical Slowing of Algorithms in LQCD simulations

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The Chiral symmetry in lattice QCD it is crucial property of the strong interactions. Lattice simulations with chiral fermions have high computational cost because of the complexity of the operator that is related to them. On the other side the main challenge in lattice QCD calculations are simulations with light quarks. The standard algorithms that are used in these simulations suffer from the critical slowing down problem. According to this phenomenon, the number of iterations of the algorithm is scaled with the inverse of the quark mass. In order to develop and test new algorithms that solve this problem we used simulations of U(1) theory in two dimensions, which shares common features and algorithms with QCD. Referring the preconditioned GMRESR algorithm that we proposed in our previous work, in this paper we bring the results of the number of iterations with the quark mass of this algorithm, tested for three coupling constants. The results are compared with another optimal algorithm used in these kinds of simulations. Our algorithm showed that gain more simulation time with light quarks and that this algorithm is scaled by the inverse square root of the quark mass compared to the inverse proportional standard law. Thus, avoid the so-called critical slowdown algorithm for light quark masses. In the future, these results should be extended in SU(3) theory with four dimensions.

Comparison between Cooling flow model an Isothermal model, estimating S-Z effect

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The SZ effect specter depends on Y, v and CMB temperature T_{CMB}, with nondimensional frequency x. We can extract the T_{CMB} when the 3 parameters are known. The Comptonization parameter Y depends on the temperature and the density of the electronic gas and we need to calculate Y by X-ray analysis. So far, we have used only isothermal profile, but some cluster show a Cooling Flow problem influencing the Comptonization parameter Y. We use a different model to fit the temperature of hot electronic gas, the Cooling Flow profile, enhancing the calibrations of the Sunyaev Zel'dovich observations. For a better comparison we used booth models, in order to have a clear picture of the changes induced by the Cooling Flow Model in comparison to the Isothermal model.

Key words: SZ Effect, Clusters of Galaxies, X-Ray Temperature, Cooling Flow.

A treatment planning for head tumours

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In recent years, tumour diseases have become one of the main health problems which always encountered discussions and difficulties. There are more than 200 different types of cancer in humans, each with different causes, symptoms and treatments. Cancer cases are increasing every day and according to the World Health Organization, new cases are projected to increase by 2030 by 25%. About 90-95% of carcinogenic diseases are related to lifestyle factors and 5-10% occur due to genetics. The treatment of these diseases is realized in different ways, combining surgical, chemotherapeutic, radiotherapeutic methods. These methods are accomplished through computer technology involving the diagnosis of patients using sophisticated diagnostic imaging equipment, the radiation treatment plan process using the Treatment Plan System (TPS), and the radiation dose delivery using linear accelerators LINAC or apparatus with cobalt sources (Co- 60). The treatment plan system as in radiotherapy plays an important role for the treatment of the patient. This system aims to ensure the most optimal dose distribution in the tumour volume while preserving as many healthy organs that can surround the structure. The process of treatment in radiotherapy goes through several stages. Once the diagnosis is made and the decision is made that the patient will be treated with radiation, his positioning and immobilization is done. The position must be maintained at each radiation session. Precision images are preferably taken with both Magnetic Resonance Imaging and CT Scanners. The next step is to prepare the treatment plan using the computer system. TPS imports image data so that it can be processed. Doctors outline the anatomical structures, organs, risk and tumour volumes and then the work goes to physicists who will make it possible to distribute the dose in the tumour volume. Dose distribution is estimated by dose-volume histogram analysis. After evaluation and approval by the doctor, the treatment plan is approved and passed for printing for the continuation of the patient's treatment. The treatment planning in Meningioma tumour in the head verify that the tumour zone has been irradiated with more than 95% of the prescribed dose, while the organs in the vicinity of the tumour has taken doses below the dose limits.

Keywords: Treatment Planning System (TPS), dose - volume histogram, radiation field, optimal dose distribution, treatment volumes, risk organs, dose tolerances.

Densities and speeds of sound in binary mixtures of 1-butanol with toluene, aniline, and N, N-dimethylaniline at 298.15 K and ambient pressure

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Densities and speeds of sound of binary liquid mixtures {1-butanol + toluene}, {1-butanol + aniline}, and {1-butanol + N, N-dimethylaniline} were measured over the entire composition range at temperature 298.15 K and ambient pressure. Excess molar volumes, V^E, and isentropic compressibility deviations, $\Delta\kappa_S$, were derived from measured densities and sound speeds and correlated with the Redlich-Kister type polynomial. Variation of V^E and $\Delta\kappa_S$ with composition has been interpreted in terms of molecular interactions between the components of the mixtures and structural effects. Speed of sound is often desirable for designing and optimizing various aspects of multicomponent liquid mixtures. Therefore, Nomoto's, van Dael's, and Rao's relations were used to predict the sound speeds of the studied mixtures. The ability of these relations to predict sound speeds of the tested liquid systems was ascertained by calculating the mean absolute percentage deviation between experimental and estimated values.

Volumetric and refractometric study of the liquid mixtures containing propan-1-ol, pyridine, and benzene

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Densities and refractive indices of binary liquid mixtures {propan-1-ol + pyridine}, {propan-1-ol + benzene}, and {pyridine + benzene} were measured over the entire composition range at temperature 298.15 K and ambient pressure. Excess molar volumes and refractive index deviations were calculated from measured densities and refractive indices and correlated with the Redlich-Kister type polynomial. The binary contribution model of Radojkovic has been used to predict the excess molar volumes and refractive index deviations for the propan-1-ol + pyridine + benzene ternary system. Refractive index deviation can be used as a measure of the strength of interaction between the components of the mixture. Refractive index may also be used for designing many aspects of multicomponent liquid mixtures. Therefore, the mixing rules of Lorentz-Lorenz, Dale-Gladstone, Newton, Oster, and Eykman were used for predicting refractive indices of the studied binary mixtures. All the mixing rules give fairly good agreement between predicted and experimental refractive indices.

Noise monitoring areas in Durrës city

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In the main cities of Albania, noise continues to be a very disturbing phenomenon and with significant impacts on the health of the inhabitants of the most populated areas. Durres, which is the second city after Tirana with a high concentration of inhabitants, turns out to be at levels beyond the allowed norm.

This study was focused in the monitoring of noise measurement in Durres city. Noise level measurement was performed in three zones, zone A (central zone), zone B (industrial zone), zone C (suburban zone), during the period January 2019 - February 2021. Equipment used for noise measurement was the Testo 816-1 model where the measured parameters were categorized according to L_{eq}, L_{min}, L_{max} and L_{mes} levels. The average noise level during the day reached a maximum of about 57.7 dB in the industrial area and at night 46.8 dB in the central area. The least polluted area during the day was the central area with an average value of 51.92 dB, while at night the residential area with an average value of 44.46 dB.

As a conclusion we can say that in the areas where it was identified an increase of the noise level above allowed standards it may have been due to: i) the occasional infrastructure works which generate noise from the movement of heavy tonnage vehicles ii) heavy traffic in some axes, iii) the activities of Durres Port etc.

This study aims to ascertain the areas most polluted by noise which in the future should be continuously monitored by stationary equipment. In this way, interested actors such as the City Municipality or the Ministry of Environment with the generated data will take the necessary steps to improve the health situation of the population.

Modelimi i sforcimeve termike te një shufër metalike

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Në këtë punim do te modelohen sforcimet mekanike në shufra metalike qe vijnë si rezultat i gradientit të temperaturës. Si rezultat i rrjedhjes së nxehtësisë, rrjeta kristalore e metalit deformohet dhe kështu krijohet gjendja e sforcuar. Matematikisht, rrjedhja e nxehtësisë përshkruhet me një ekuacion diferencial në fushën e temperaturës, ndërsa varësia funksionale e sforcimit me deformim me një ekuacion diferencial nga fusha e strukturave - ligji i Hukut. Rezultati final (sforcimet) varet nga qifti i fushave temperaturë - strukturë. Zgjidhjen e këtij problemi e kemi bërë me Metodën e Elementëve të Fundëm (MEF) ndërsa simulimin në ANSYS. Sipas MEF, paraprakisht kemi llogaritur matricën në fushën e temperaturës, zgjidhja e së cilës është temperatura T_j e nyjave të rrjetës së elementeve të zonës integruese (materialit). Duke njohur T_j, mund të njehsohen deformimet termike ε_j të secilës nyje. Varësia e sforcimit nga deformimin sipas MEF shprehet me matricën në fushën e mekanikës së strukturave. Pasi që sforcimi varet nga deformimi, ndërsa ky i fundit nga temperatura, atëherë zgjidhja finale kërkohet nëpërmjet të matricës së përgjithshme e cila në vetë përmban elementet e dy fushave, temperaturës dhe strukturës. Është vërtetuar se, modeli mund të aplikohet për materiale të ndryshme metalike, po ashtu temperatura dhe gjeometri të ndryshme.

Characterization and production technology study of ancient copper alloy objects excavated in Albania

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This consists in the first archaeometallurgical study of antique copper alloy objects excavated in Albania. Around 45 objects from the Historical Museum of Shkodra and the Archaeological Museum Durrës are at the centre of this study. These objects date from the Late Bronze Age till the Middle Age. The purposes of this study are to analyse the copper alloys, to determine the process used for the objects' production and to collect information about the raw mineral utilized. Hence the objects were analysed with μ-XRF, OM with reflected and polarised light, Vickers microhardness test, SEM-EDS, XRD. They resulted Cu-Sn, Cu-Sn-Pb, Cu-Sn-Zn-Pb, Cu-Zn alloys and also pure copper. Minor elements such as Fe, As, Ni were detected almost in all objects suggesting that the raw material utilized might have been copper sulphite minerals. The production processes were performed consistent with the objects' utilization purposes: casted for decorative and exchange goods; hot, cold worked in weapons and tools' cases.

Figure 1: Main types of antique copper alloy objects, weapons and tools are on the left, decorative and exchange goods are on the right.

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Një vlerësim statistikor i aktivitetit sizmik në zonën e thyerjeve Frakull - Kepi i Rodonit

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Përmes këtij punimi synohet të bëhet një analizë statistikore e aktivitetit tërmetor dhe një vlerësim i rrezikut të mundshëm sizmik përgjatë zonës së thyerjes Frakull-Kepi Rodonit (F-KR). Për këtë qëllim, ne u fokusuam në korrelacionin që ekziston mes vlerës së koeficientit sizmotektonik b (Gutenberg-Richter, 1945), vlerës *D*c të dimensionit fractal (Grassberger and Procaccia,1983), vlerës së standardizuar Z (Wiemer and Wyss, 1994) dhe në ndërlidhjet e tyre me njëra-tjetrën. Për analizat u morën në shqyrtim gjithsej 2310 ngjarje sizmike në intervalin kohor ndërmjet 1967 dhe 2020 me $M_L \geq 1.1$. Magnitudës e plotesise konsiderohet si 2.5 dhe vlera b është llogaritur si 0.84±0.04. Vlera b është më e vogël se 1.0 dhe kjo vlerë e vogël mund të konsiderohet si një akumulim më i madh i sforcimit që mund të krijohet me kalimin e kohës dhe të çlirohet nga tërmetet e mundshme në të ardhmen. Dc është vlerësuar 1.93±0.06 dhe kjo vlerë e madhe tregon se aktiviteti sizmik është më i grumbulluar dhe ka shpërndarje homogjene në shkallë më të mëdha ose në rajone më të vogla në zonën e thyerjes F-KR. Shpërndarja e vlerës b më të vogël se 0.8 (Fig.1a) përkon pak a shumë me shpërndarjen rajonale të tërmeteve me $M_L \geq 5.0$ dhe shtrirjet e thyerjeve te njohura te tyre përgjatë zonës së thyerjes F-KR. Vlerat b më të vogla janë të përqendruara në 41.15°N-19.20°L (ndërmjet detit Adriatik, Durrësit, Ndroqit dhe Divjakës) dhe në 41.65°N-19.15°L(ndërmjet detit Adriatik, Kepit të Rodonit, Thumanës, Lezhës, Shëngjinit). Shpërndarja e vlerës standarde të devijimit normal Z (shkalla e renies se aktivitetit sizmik, Fig. 1b) tregon se disa goditje kryesore paraprihen nga renia e shkalles se aktivitetit sizmike. Vlerat më të ulëta të Z tregojnë se ndryshimet në shkallën e aktivitetit sizmik nuk janë të rëndësishme, dhe vlerat më të larta Z tregojnë ulje të shkallës së sizmicitetit. Në hartat me vlerën Z për të gjitha pjesët e F-KR, dy zona shfaqin rënie të konsiderueshme te aktivitetit sizmike: me qendër në 41.00°N-19.78°E (rajoni A, Deti Adriatik, Tale, Rubik, Shëngjin), 40.99°N-20.03 °E (rajoni B, në detin Adriatik, Kavajë, Dushk, Divjakë/Karavasta). Vlerësime bazuar mbi këta parametra mund të japin rezultate paraprake të rëndësishme për të zbuluar potencialin e rrezikut sizmik në zonën e thyerjes F-KR dhe për rrjedhojë, duhet t'u kushtohet rëndësi e veçantë këtyre anomalive rajoneve.

Fjalë kyç: Zona e thyerjeve Frakull - Kepi i Rodonit, rrezik sizmik, vlera b, vlera D_c, vlera Z.

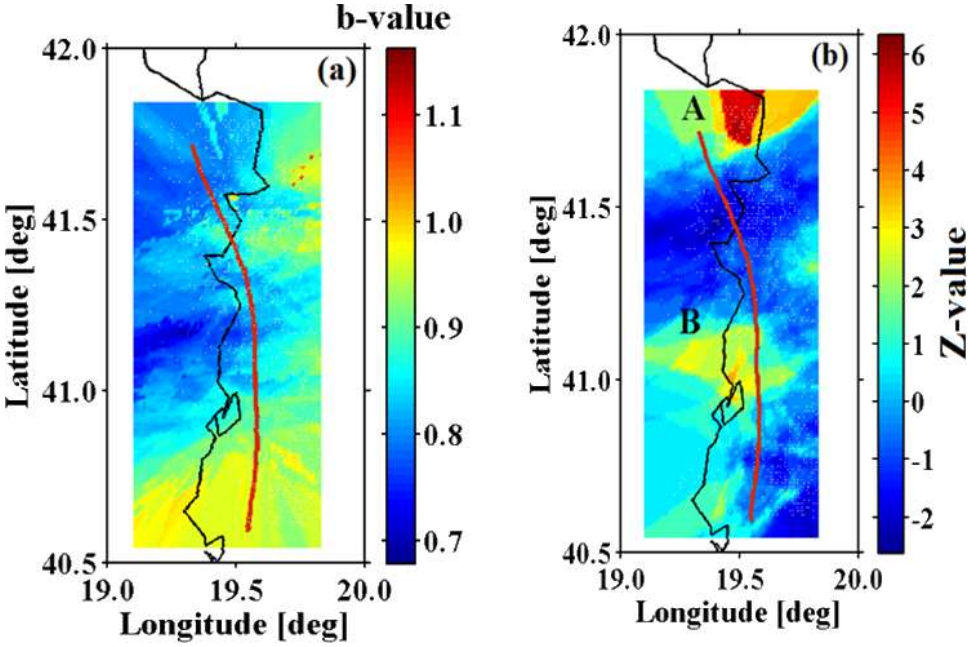

Figure 1: Hartat rajonale aktuale të (a) vlerës *b* dhe (b) vlerës *Z* në zonën e thyerjes F-KR.

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Struktura e bërthamave të breshërit dhe mekanizmi i formimit të tyre

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Veprimtaria mbrojtëse kundër breshërit dhe reve breshformuese është mjaft e gjerë ,ajo përmban në vetvete aplikimin e shumë disiplinave shkencore ,teknike dhe ushtarake. Sistemi mbrojtës kundër breshërit perfshinë metodat më të avancuara të meteorologjisë së zbatuar, meteorologjisë radarike e cila në fizikën e atmosferës ka gjetur zbatim të mirë.

Kosova është një rrafshnaltë ndër më të mëdhatë në Ballkan në një tokë pjellore mbi një million hektare.Duke u mbështetur në të dhënat meteorologjike, statistikore shumë vjeqare pohojnë se dëmet në disa komuna kanë qenë katastofike.Vazhdimisht të rrezikshme kanë qenë retë breshër formuese të ardhura nga Alpet e Shqipërisë , të Malit të Zi dhe Serbisë.Nisur nga të dhënat e fituara gjatë punës sime eksperimentale e duke u konsultuar edhe me literaturën e huaj jemi përpjekur që këto rezultate ti aplikojmë në projektin me teknikën moderne për mbrojtjen nga breshëri në Kosovë me qellim për ti ardhur në ndihmë bujqësisë kosovare nga dëmet e ardhura nga retë breshërformuese të ardhura në vendin tone.Koncepti i sotshëm i mbrojtjes kundë breshërit siq është e njohur kryesisht bazohet në transformimin e proceseve mikrofizike në mbrendësi të masës së resë breshërformuese ,përkatesisht futja e berthamava aktive të kristalizimit në pikat e veprimit te reve ku zmadhohet koncentrimi i tyre meqrast arrihet rindarja e sasis së ujit në një numër më të madhë të bërthamave aktive.Meqrast do të vije te zmadhimi i koncentracionit i cili zvogëlon madhësinë e kokrrave të breshërit kështu që zhvillohen proceset mikrofizike për formimin e berthamave të kristalizimit ,bërthama e breshërit në shtresat e veqanta të kokrrizit(breshërit)në tërësi. Është e mundshme të sqarohet me anë të analizëz së berthamës së breshërit sepse struktura e tijë në një kuptim te përgjithshëm paraqet historikun e zhvillimit të proqesit të breshërit.

Në këtë punim është prezantuar metodologjija e rezultateve të fituara të bërthamës së breshërit e cila është studiuar nga shumë hulumtues shkenctarë.

Properly design of PV power systems

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Photovoltaic solar systems are being widely used around the world to generate electricity. In Albania, since the adoption of the law on promoting the use of energy from renewable energies (law no. 7/2017), the increase of interest for the production of electricity from PV systems has begun. The law stipulates that a consumer of electricity can also be self producer of electricity. PV power systems in on grid mode are economically viable because their payback peridod is relatively short (3-5 years). This fact has led to an increase in the number of installations recently in our country, consequently increasing production capacity, mainly in industrial facilities, and residential facilities. Properly design and installation of such systems will also increase the energy performance of these systems. This study presents the PV system installed on the terrace of an Industrial building in Tirana, and proposes a more efficient way of designing these systems that would lead to increased energy performance. RETScreen software is used as a tool to design the system more efficiently. In the study a comparison was made for the energy produced by the installed PV project, and the energy that the system would produce if it was installed according proposed design.

Keywords: Solar energy, PV power systems, Retscreen sofware, energy performance.

An estimation of wind energy potential in Albania

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Renewable energy has attracted more attention for governments, industries and societies around the world in recent years. This way of generating electricity is highly developed in different countries of the world and one of the main purposes of using renewable energy sources is independence from energy sources of fossil origin. The purpose of the study is to assess the wind energy potential in Albania. The data was obtained from the Global Wind Atlas network. In Albania, the use of wind energy for electricity generation is still in its infancy. It should be noted that the legal framework for the implementation of this technology is done, and the relevant government department has called for the opening of competitions for the construction of projects related to renewable energy in general and wind energy in particular. For the evaluation of the wind energy potential in a certain area, multi-year data of some characteristic wind parameters are needed, such as the average wind speed, its direction, wind speed index, etc. Based on the above data it is determined class of energy of the interested area. Energy class is a very important parameter that gives us a quick information about the energy potential of the area.

Keywords: Renewable energy, wind energy potential, average wind speed, average power density, wind direction, wind speed index, energy class, wind turbines.