BOOK OF ABSTRACTS

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Radiation exposure due to indoor radon and thoron

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In the context of terrestrial radiation, exposure to radon (^{222}Rn) and thoron (^{220}Rn) in indoor environment is often investigated, because on inhalation, these radionuclides can reach the lungs and cause irradiation of the soft epithelium tissues. Overtime, it may cause cancer. So, in the light of this fact, assessment of indoor activity levels of radon and thoron has been carried out in around 20 residential dwellings of Jowai city, Meghalaya, India. A passive integrated device-single entry pin hole dosimeter, based Solid State Nuclear Track Detectors (SSNTDs) has been used for the measurement methodology. Activity concentrations of measured radionuclides were found to vary appreciably amongst the studied dwellings. Overall, the activity levels were within the action level (200-300 Bq·m^{-3}), as prescribed by International Commission on Radiological Protection, ICRP. The estimated inhalation dose due to radon and thoron were also found to be within the permissible limit (3-10 mSv·y^{-1}).

Keywords: radon; thoron; pin hole dosimeter; inhalation dose

Comparison of Protein interaction with different shaped PbS nanoparticles and Corona formation

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Different shaped PbS nanoparticles are synthesized at room temperature by using reagents Lead Chloride, Sulfur powder, and Sodium borohydride in the Ethylene Diamine medium. Sodium borohydride is acted as a reducing agent, whereas Ethylene Diamine is used as a capping agent. The grown PbS nanoparticles are spherical (7 nm size) for the stoichiometric ratio of $PbCl_2$, S, $NaBH_4$ is 1 : 1 : 1, and grown PbS nanoparticles are cubical shape (13 nm size) for the stoichiometric ratio of $PbCl_2$, S, $NaBH_4$ is 1 : 1 : 3. The grown PbS nanoparticles are characterized by structurally and optically. The interaction and formation of the bio-conjugate of bovine serum albumin with PbS nanomaterials are studied for biomedical application. The interaction, complexion process, and conformational changes of bovine serum albumin with PbS nanomaterials are quantified by the photophysical and structural study. PbS nanomaterials enable the aggregation of bovine serum albumin by the way of unfolding. The interaction, as well as the formation of bioconjugate of albumin and PbS nanoparticles, is investigated using optical spectroscopy, HRTEM. UV-VIS-NIR shows the binding process that occurred between albumin and PbS samples.

Keywords: lead sulfide; emission spectra; bovine serum albumin; physiochemical property; bioconjugate

Effect of K_2CrO_4 filler on the Dielectric permittivity and Electrical Modulus of PMMA

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PMMA/K_2CrO_4 films with different concentration (Pure, 1%, 2%, 5% and 10% Wt %) were prepared by the solution casting method at ambient temperature. These composites films were characterized using X-ray diffraction (XRD) and Fourier transform infrared (FTIR) spectroscopy. The XRD pattern of PMMA-K_2CrO_4 shows a unique characteristics of the composite implying co-existence of mixed crystalline and amorphous region with a strong peak.
The FTIR of PMMA-K_2CrO_4 shows that the shift in value of certain vibration modes, disappearance of certain peaks and appearance of new peaks assures that there is a chemical bonding between the filler and the host matrix. The data for understanding the electric behaviour of our prepared composites films has been obtained using WAYNE KERR 6500B Impedance analyzer at room temperature and frequencies in the range 102 Hz to 105 Hz. The electrical parameters like dielectric constant, dielectric loss, loss tangent, a.c. conductivity, and real and imaginary electric modulus were calculated and analyzed. The frequency dependent dielectric behaviour of real and imaginary part of the permittivity (dielectric constant and dielectric loss) of the as-prepared pure and K_2CrO_4 doped PMMA composite at ambient temperature. It is observed that both real and imaginary dielectric constant decreases with increase in frequency. The electrical conductivity measurement showed a plateau-like behaviour in the low-frequency region and dispersion in the high-frequency region. Thus the polymeric composite PMMA-K_2CrO_4 is one of the appropriate candidate for numerous technical applications such as super capacitors, high-speed computers and gate dielectric material for organic FETs.

Keywords: dielectric constants; AC conductivity; electrical modulus; PMMA-K_2CrO_4 composite films

Role of laser pre-pulse and target density modification on the acceleration of protons from a hydrogen plasma sphere

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The production of energetic ions using intense laser-matter interaction is a widely researched area of immense relevance in the fast-ignition of fusion fuel, radio-biology, security purposes, etc. In all the available high-power laser facilities, the intense main-pulse is usually preceded by a pre-pulse of lower intensity which hits the target and ionizes it to form plasma. A 3D PIC simulation study is performed using a circularly polarized femtosecond main-pulse interacting with a spherical hydrogen plasma. A finite time delay between the pre-pulse and the main pulse results in the plasma target to undergo expansion. The target density thus gets modified with a central peak density and gradually decreasing nearly isotropically towards the edges. The results are compared using a homogeneous density sphere in absence of a pre-pulse and found that the interaction of the main-pulse with an expanded target having a density gradient results in higher absorption of the laser energy which eventually translates to a stronger acceleration of protons along the laser propagation direction.

Keywords: density modification; laser pre-pulse; intense femtosecond laser; spherical micron-sized plasma, proton acceleration; PIC simulation

Directed Assembly of Nanomaterials: Methods and Applications

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The chemical, mechanical, and electronic properties of nanomaterials make them useful for application in batteries, photovoltaics, catalysts, and sensors among other applications. Nanomaterials can also be suspended as inks that can be used for printing circuits and interconnects for use in electronics. The methods typically used for printing these inks are often limited in their spatial resolution to tens of microns, or else they sacrifice speed for higher resolution. Using directed-assembly methods, our lab at the NSF Center for High Rate Nanomanufacturing (CHN) has fabricated patterns from commercially available inks with nanoscale precision. This is possible through tuning the functionality of the substrate and the composition of the ink to suit the particular assembly method. In this talk, I will provide motivation for improved printing methods and provide examples from our lab to demonstrate the theory and practice of our methods.

Novel design of multi-band double U Slotted Microstrip Patch Antenna with DGS for X , Ku, and K band Applications

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A compact multi-band double U Slotted microstrip patch antenna is designed and analyzed to accomplish X-band satellite applications like military, weather monitoring, single and dual-polarization, to achieve both transmission and reception of direct broadcast service (DBS) and fixed satellite service (FSS) in Ku band and K band radar applications. The proposed antenna design made up of a reduced double U-shaped slot, four rectangular-shaped slots, and two triangular-shaped slots in the patch with defected ground structure (DGS) for achieving high radiation efficiency, bandwidth enhancement, and multi-bands. It resonates at 8.69 GHz, 12.53 GHz, and 15.70 GHz, 18.41 GHs and 19.02 GHz with impedance bandwidths of 0.6 GHz, 1.055 GHz, 1.733 GHz, and 2.412 GHz, gain of 3 dB, 4.86 dB 5.3 dB, 5.87 dB, and 5.81 dB, and radiation efficiency of 93%, 83%, 82%, 89%, and 84% respectively. This efficiently designed antenna is most suitable for X band (8-12 GHz), Ku band (12-18 GHz), and K band (18-27 GHz) applications.

Optical study of few layer WS_2 nanosheets

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Bulk WS_2 nanosheets were exfoliated using solvo-sonication method with isopropanol (IPA) and isopropanol/water mixture in order to obtain few layer WS_2 nanosheets. Prominent absorbance peaks A and B were observed at wavelengths $\sim$ 633.5 nm and $\sim$ 523 nm, respectively, which could be ascribed to direct excitonic absorption. Following Backes et al., the average number of layers in the assembly was estimated to be $\sim$ 14 nm. It was then followed by preparation of thin film of WS_2 nanosheets. The subsequent fluorescence study of the as-prepared films were investigated to attain more in depth details of few layered WS_2 nanosheets.

Keywords: WS_2 nanosheets; absorbance; thin films; fluorescence

Fabrication and Characterization of Mach-Zehnder Interferometer on a single chip

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Mach-Zehnder and Michelson Interferometers are heart of many optical communication devices and components. These interferometers also find to be the key idea behind optical coherence tomography. On the other hand, miniaturization of these devices requires suitable waveguide design and integration of electro-optic or magneto-optic components for optical modulation. The waveguide fabrication technology has already proven that the low loss waveguide structures are possible with silicon on insulator (SOI) or polymer material-based waveguide. Polymers such as SU-8, Polymethyl methacrylate (PMMA), etc are the most favorable contenders of micrometer and sub-nanometer fabrication of waveguides. In this article, we employed, PMMA as a waveguide material and fabricated micrometer sized Mach-Zehnder interferometer. The electro-optic components, light source and photo-diode are embedded to the device such that a single chip acts as an interferometer. The paper discuss the results of miniaturized lab-on-chip device suitable for clinical applications.

Keywords: optical coherence tomography; integrated optical device; lab-on-chip

Wavelet and scaling analysis of rainfall time series in Northeast region of India: intraseasonal to interdecadal oscillations and the solar activity and cosmic ray influence

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Monthly and annual rainfall time series from 12 gauging stations and 3 subdivisions of the Northeast region, India, during 1950-2013 and 1871-2016 were studied using continuous wavelets tools toward variance and time-frequency localization and detection dominant oscillations. Apart from the high frequency, semiannual and annual oscillation, the rainfall series show enhanced power at interannual and interdecadal low-frequency scales. Applying Rescaled range analysis, the scaling properties of the rainfall time series through the computation of Hurst exponent (H) are determined. Most of the investigated rainfall series shows weak persistence with $H > 0.5$, indicating the trend will be maintained in the future. It is apparent that data with low-frequency components reveals higher Hurst exponent values, i.e., some amount of persistence, than the data without such components. Further correlation analyses were also performed between rainfall of the Northeast region with solar activity and galactic cosmic ray at the time interval 1964-2016 through Cross wavelet (XWT) and wavelet coherence (WTC) tools. Though correlation studies do not hint any linear relation, still XWT and WTC spectra give an idea of common periodicities within 2-8 years and 8-16 years period band, evidence for the influence of solar activity and galactic cosmic ray on rainfall pattern of the Northeast region.

Keywords: northeast region of India; Hurst exponent; continuous wavelet transform; cross wavelet transform; wavelet coherence; solar activity; galactic cosmic ray

Extremely Low Energy Isomers and their applications

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Nuclear isomers are meta-stable states in nuclei, which hold the promise of many unique applications in fundamental research and practical usage as well. Extremely Low Energy (ELE) isomers have emerged as those quantum states of nuclei, whose decay is hindered due to very low excitation energy. Decay by internal conversion also gets affected as the energy available for decay is not enough. These isomers sit at the interface of the atoms and nuclei. As a specific example, we consider the unique lowest energy isomer observed in ^{229}Th. This isomer, with an excitation energy of 8 eV, has led to a flurry of activities, and promises to open new vistas of development in nuclear physics and many other areas. It holds the promise of realizing the dream of first nuclear laser, most precise nuclear clock, new era of nuclear quantum optics, testing of temporal variation of fundamental constants, and observing the effect of chemical environment on nuclear decays. We discuss these in this talk.

Tropical Cyclones: A look through double eye walls

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The primary upward brunch of the secondary circulation is called the eyewall of a Tropical cyclone. Most intense Tropical Cyclones in general experience two concentric eyewalls during their lifetime. Formation of secondary eye wall is associated with significant intensity changes. The eyewall replacement cycle refers to the replacement of primary eyewall by the secondary The weakening of a cyclone occurs with the formation of the secondary eyewall gradually replacing the primary eyewall due to the increase in central pressure. The radius of the eye and eyewall increases after the replacement cycle. During this time, the TC can resume its intensification if the environmental condition is favorable. Therefore, the proper understanding of this replacement mechanism is essential for predicting the intensity of tropical cyclones.
In this presentation, a brief account of structure and intensity changes of tropical cyclones will be given along with an idea of modelling the eyewall replacement cycle for the Tropical cyclone Phaillin.

Review on Magnetism in nanomaterials and Superparamagnetism

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Nanotechnology play prominent role in the fabrication of novel materials by controlling the structure of matter at the nanodimensional scale. The particles at the nano scale change their material properties in a dramatic way showing unique properties. In many ferromagnetic materials when the size of the particle is reduced to nano level, magnetic property enhances leading to superparamagnetic state. The magnetic moment of the material randomly flips the direction of their magnetisation and random orientations of magnetic spins inside the particles result to zero remnant magnetisation and zero coercivity. The hysteresis loop changes unusually and passes through the origin showing the state of zero magnetisation.

Keywords: nanomagnetism; superparamagnetism

Realisation of Left right symmetric model by discrete flavor symmetries

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In this work, we have realised TeV scale Left-Right symmetric model (LRSM), where type I seesaw terms arises naturally using $A_4 \times Z_2$ discrete flavor symmetry. Within the model we have considered type I dominant cases to study neutrino phenomenology.Neutrinoless double beta decay is studied in the model by considering various contributions coming from different particle of LRSM . We basically tried to find the leading order contributions to NDBD coming from type I seesaw along with the decay rate of the process in our work.

Observation and characterization of repetitive particle growth process in capacitively coupled rf discharge of Ar-C_2H_2 gas mixture

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Particle growth in reactive plasma is a very well-known phenomena that occurs in various technological (semiconductor fabrication) and astrophysical (star formation) environments. A new experimental set up (nDuPlEx) has been designed and optimized for the study of particle growth. A repetitive or cyclic growth process of carbonaceous dust particle up to 4 cycles is observed in the capacitively coupled rf discharge of a reactive gas mixture of Argon (Ar) and Acetylene (C_2H_2) when the C_2H_2 is kept ON for a longer period of time. It has been found that the repetition of the growth process tremendously affects the discharge voltage and current signal of the rf discharge. The phase angle between the discharge voltage and current signal is measured. The measurement of scattered light intensity from the particle cloud also proves the repetitive growth process. The cloud evolution is recorded in a specialized camera and it has been observed that the new and old generation of particle clouds are separated by a distinguishable separation.

Keywords: particle growth; reactive plasma; capacitively coupled rf discharge; carbonaceous particle; cyclic growth

Lifetime Cancer Risk Assessment due to Gamma Radioactivity in Building Materials of East Khasi Hills District of Meghalaya, India

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As most people spend about 80% of their time indoors, the estimation of the radiological parameters from the specific activities of radionuclides in commonly used building materials is important in order to establish their effects on the health of the population. The activities of ^{40}K, ^{226}Ra and ^{232}Th in Bq kg^{-1} were found to be ranges from 40.9–777.1, 3.8–92.7 and 14.2–112.2 with their total average values of 312.4, 47.4 and 57.7, respectively. Different radiological parameters were estimated and compared with the recommended safety limits. The Excessive Lifetime Cancer Risk (ELCR out and ELCR in) varies from 0.05×10^{-3}–0.51×10^{-3} (0.30×10^{-3}) and 0.40×10^{-3}–3.90×10^{-3} (2.27×10^{-3}), respectively. The total average value of 2.57×10^{-3} (ELCR out and ELCR in) is found to be lower than the recommended limit of 3.5×10^{-3} for public exposure. The findings showed that different types of commonly used building materials did not pose any radiation hazards to the population. They are therefore safe for the construction purposes.

Keywords: lifetime cancer risk; gamma radioactivity; building materials; East Khasi Hills district

Study on Structural, Spectral and Optical properties of Lithium Sulphate Monohydrate L- Valine Semiorganic Crystal

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L-Valine Lithium sulphate LV+LS crystal of considerably good size, a nonlinear optical material is semiorganic type. It has been grown by slow evaporation solution technique at elevated temperature (40 °C). LV+LS crystal has enhanced crystallinity and is sufficiently good for SHG. To get high optical perfection it is recrystalized by SEST at 40 °C, from supersaturated solution by stirring it for several hours. LV+LS with monoclinic crystal system is fairly suitable for NLO applications because of its wide optical transparency.

Keywords: crystal growth; LV+LS; optical transparency; SEST at 40 °C

Statistical Analysis of Cosmological Data

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In this Article, we used Extreme Value Theory to Investigate Non-Gaussianity in High-z cosmological data. We Apply this statistic to the set of 67 Long Gamma Ray Burst(LGRBs) data and their combination with the Supernovae type Ia (Union2.1) data set. Our statistical analysis shows that both sets of data display poor signature of Non-Gussianity with consistence direction dependence.

Keywords: cosmology:observations, gamma-ray burst:general, supernovae type Ia:general

Structural, morphological and optical properties of titanium dioxide nanomaterials prepared by sol gel technique

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Titanium dioxide (TiO_2) nanoparticles have been successfully prepared by sol-gel technique. Titanium tetrachloride and ethanol have been used as starting reagents where titanium tetrachloride dissolved in an ethanol as a precursor under acidic environment to study insight behaviour of TiO_2 nanoparticles. The prepared TiO_2 nanoparticles have been characterized for structural, morphological and optical properties by using X-ray diffraction (XRD), fourier transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM) and UV spectroscopy (UV-vis). Structural analysis confirms the formation of crystalline nanoparticles and line broadening technique has been employed to determine the crystallite size. FTIR reveals the lattice vibration in characteristic absorption frequency band and FESEM explore the surface morphology of synthesized material.

Keywords: TiO_2; XRD; FTIR; FESEM; UV-Vis spectroscopy

Improved potential approach and Masses of heavy flavour mesons

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In non-perturbative QCD potential models are extensively used to study several static and dynamic properties of heavy flavour mesons throughout the years with resonable phenomenological sucess. In this paper, we consider a new potential as reported recently by Hassanabadi etal., for $Q\bar{Q}$ system and applied quantum mechanical variational scheme to estimate the masses of a few heavy flavour mesons. Detailed comparison is made with the results of different other approaches in this arena and also with experimental data.
PACS Nos.:03.65.Ge,12.39.Pn,14.40.n.

Keywords: quantum chromo dynamics; mesons

Study of electronic and lattice dynamical properties of half-Heusler RuCrP alloy

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In the present study, we have explored the electronic and dynamical properties of half-Heusler compound RuCrP using density functional theory (DFT) implemented in Quantum ESPRESSO package based on the plane-wave basis and pseudopotential method. The exchange-correlation energy of the electrons was treated with the generalized gradient approximation proposed by Perdew-Burke-Ernzerhof (PBE-GGA). The analysis of electronic band structure and the density of states predict the half-metallic nature of the compound. The indirect energy bandgap of 0.45 eV along the *L*-*X* direction was observed in the minority spin channel. We also investigated the phonon dispersion curve and found that all the phonon frequency modes were positive indicating the dynamical stability of the compound. The observed optical phonon modes were a mixture of Raman and infrared phonon modes.

Keywords: half Heusler alloy; DFT; GGA; energy bandgap; phonon dispersion curve

A Theoretical review to analyze the response between the radiographic film and the living tissue in terms of energy absorption

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The concept of this theoretical work has been boosted by the fact that different medium responds to ionizing radiation in different ways. In diagnostic radiology, after being exposed to X-rays, the useful information coming out of the patient in the form of X-ray photons and then converted to light photons is being decoded as Optical density in the X-ray film as a function of exposure. Similarly in radiotherapy, the concept of relative biological effectiveness (RBE) is the ratio of doses required by different types of radiation to produce the same level of effect in the living tissue as a function of linear energy transfer (LET).
The optical density which provides the information of how much light photon has been stopped by the X-ray film. This helps to differentiate between the soft tissue, air and bones based on the level of energy absorption in the patient's body. The linear energy transfer provides the information of the pattern generated by the deposition of radiant energy in biologic medium which differentiates between the various types of radiation involved. All these phenomenons are depicted in their respective curves which are comparable in certain respect.

Keywords: LET; RBE; optical density; x-ray film; dose

Dependence of particle current and diffusion on the system parameters in a model under-damped inhomogeneous periodic potential system

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The study of particle dynamics in a driven under-damped inhomogeneous periodic potential system forms an important field of study as many systems are encountered in nature which are inhomogeneous. In the presence of noise, particles in such a system undergo a directed transport even in absence of any external biased. This effect becomes more pronounced with the inclusion of a small asymmetry in potentials. The particle current is found dependent on the various system parameters. Also, the particles undergo diffusion. The dynamics of the particles can be controlled by tuning the system parameters. This can have important technological applications. In this work we study the dynamics of the particle in a model inhomogeneous system and show the dependence of particle current and diffusion on the system parameters.

Keywords: inhomogeneous systems; particle current; particle diffusion

Soliton in Inhomogeneous Plasma

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In laser plasma interaction, plasma is both inhomogeneous and nonlinear to large amplitude plasma waves. The large amplitude wave packet modifies the plasma density through the action of ponderomotive force. Soliton propagation and the dynamics in inhomogeneous plasma can be described by the inhomogeneous Nonlinear Schrodinger Equation. Accelerating stable pulses in the form of solitons are found to exist in the inhomogeneous plasma. We propose a generalized reversible transformation between the generalized Nonlinear Schrodinger Equation (NLSE) and the generalized inhomogeneous NLSE. We obtain soliton solution of the generalized inhomogeneous NLSE hierarchy accelerated in an nonuniform medium using the reversible transformation. The solution in the from of soliton successfully describe the propagation of wave packet in inhomogeneous plasma. The reversible transformations allow us encompassing inhomogeneous NLSE hierarchy belonging to the class of nonisospectral family of inverse scattering problems into the family of isospectral NLSE class of equations and study them under a general mathematical framework.

Keywords: soliton; reversible transformation; NLSE hierarchy

Study of Damping of Ion Acoustic Waves in Two-Electron Temperature Plasma

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Plasmas having more than one electron group with different temperatures and densities are frequently observed in laboratories as well as in space environment. The characteristics of this type of plasmas are found to be different than that of a normal electron-ion plasma. Such a plasma containing two electron populations with two distinct temperatures is produced by adopting the method of diffusion. A cylindrical stainless steel chamber is used for plasma production where two magnetic cages of varied surface field strength are employed for plasma confinement. Plasmas are individually produced using filamentary discharge mechanism inside the cages and are allowed to diffuse in the middle of the chamber. The production method is reasonably simple and gives a good control over the plasma parameters. An Ion Acoustic Wave (IAW) is launched in the plasma using a stainless steel mesh grid of 40% transparency. The wave is detected by a planar Langmuir probe. It is found that the wave suffers damping while travelling through the plasma. The damped wave amplitude with respect to propagation distance is measured. An analytical treatment of wave damping is also carried out and the outcomes of the theoretical calculations have been compared with the experimental findings. It is observed that presence of energetic electrons has a noteworthy contribution on the damping of IAW.

Keywords: ion acoustic waves; two-electron temperature plasma

Observing Nuclear Burning on the Surface of White Dwarf Stars

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White Dwarf Stars are formed at the end of stellar evolution, when all hydrogen in the centre of the star is consumed. Hydrogen burning supports the stars against gravitational collapse until this energy source ceases for lack of burning material, and the star collapses to a White Dwarf. If there is a nearby companion star, fresh hydrogen can be accreted to the surface where it accumulates until ignition conditions for explosive nuclear burning are reached. Such thermonuclear explosions are known as Classical Novae, the small brothers of supernovae. The white dwarf is not destroyed during a nova outburst, and a small number of novae are recurrent. Under very special conditions, the accretion rate is so fine-tuned that a balance bewteen nuclear burning and supply of new hydrogen-rich material is maintained, leading to a permanent super-soft X-ray source. In this presentation, I will focus on what we can observe in X-rays showing some impressive high-resolution X-ray spectra powered by surface nuclear burning putting on display atmospheric spectra with bright blackbody-like continuum emission and deep, blue-shifted absorption lines arising in the expanding, hot, ejecta.

Keywords: white dwarf; nuclear burning; nova; super soft source; x-ray

Radiation interaction with Matter: Special emphasis on Solid State Nuclear Track Detection technique

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To understand nature has been the ultimate goal of the mankind in all the ages. Various groups of scientist are working throughout the world to explore the hidden mysteries of the nature. One of the branches, in an attempt to understand such mysteries is 'Heavy Ion Physics'. Heavy nuclei consisting of quite number of nucleons, when subjected to energetic collision, nuclear matter assume the conditions which probably prevail at the time of supernova. In this paper we primarily study the interaction of ionizing radiation with matter, in particular the organic and inorganic materials. Initially the source and types of ionizing radiation and its effects on matter are discussed in detail. Various detection technique for interaction of these ionizing radiation is discussed in this paper, with emphasis on the solid state nuclear track detection technique.

Keywords: interaction; radiation; SSNTDs; ionization; radiochemical technique; counter technique; etching; LR-115; CR-39

Bio synthesis, Characterisation and antibacterial performance of Trimanganese tetraoxide nano particles using Azadirachta Indica leaf extract

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Nanoscale materials often present properties different from their bulk counterparts as their high surface to volume ratio results in the exponential increase of reactivity at the molecular level. Transition metal oxides are fascinating class of materials due to its distinct structural features combined with fascinating physico chemical properties. In this respect, manganese oxides have a great potential because of their ability to adopt various oxidation states and particularly nano structured hausmannite (Mn_3O_4) has efficacious application in the fields of Pharmceutical industries, catalysis, biosensors, high density magnetic storage media,varistors etc. The present study reports the preparation of biosynthesised Trimanganese tetra oxide nanoparticles by the reduction of potassium permanganate ($KMnO_4$) using Azadirachta Indica leaf extract at room temperature. The biosynthesised nanoparticles were characterised by x-ray diffraction, Fourier transform Infrared spectroscopy, scanning electron microscope, Photoluminescence, UV spectroscopy and vibrating sample magnetometer. Crystal phase identification of the nanoparticles was characteried by XRD analysis and the formation of crystalline Mn_3O_4 has been confirmed. FTIR study revealed the formation of Mn_3O_4 nano particles. UV-Vis studies was used to investigate the optical properties of the prepared samples. Morphological studies was carried out using SEM at different magnification level. VSM was used to study the magnetic properties of nanoparticles as a function of magnetic field, temperature and time. Antibacterial activity was screened against micro organisms by Gel-Diffusion method.

Keywords: nanocrystalline materials; Mn_3O_4; XRD; UV-Vis; PL; SEM; VSM; antibacterial activity

Variation of high and low energetic electron densities across a magnetic filter in a hot cathode discharge

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In a hot cathode gas discharge, at a pressure equal to and more than 10-4 mbar, two electron temperature groups are found to exist. In this experiment, a hot cathode discharge is produced in a chamber in which a magnetic filter that acts as an electron cooler divides the whole chamber into two regions: Source and Target. Two cylindrical magnetic cages are present on either side of the magnetic filter. Plasma produced in the source region diffuses towards the target region. Using a method employed by Yamazumi and Ikezawa, the density of hot and cold electron groups is calculated. The data has been collected using Langmuir probe and the analysis done using Hiden's EspSoft. By changing the plasma production conditions, the density of high energetic and low energetic electrons are found out at different experimental parameters and a comparative study performed. With increase of working pressure, the density of both high and low energetic electron groups decreased, but as the filament current and discharge voltage are increased, there is a significant increase in the density of the two-electron groups.

Keywords: hot cathode discharge; two-electron temperature; hot and cold electrons; magnetic filter

Moisture Content Study of Soil Found in the Sung Valley, Meghalaya

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The Sung Valley in West Jaintia Hills Meghalaya is abundant with a unique type of soil which has been used for making pottery by the local tribe since ages. It is observed that the manufactured products are heavy, highly sturdy and durable. A characteristic study of the soil would enable us to scientifically justify its properties and establish its other useful applications. In this work, moisture content with respect to depth of the soil found in Sung Valley, West Jaintia Hills, Meghalaya has been studied. Moisture content study has a correlation with the measured Thoron exhalation rate, as reported earlier by HOSODA et.al. From their study it is realized that with the decrease in soil moisture content, the radioactivity increases. Therefore, such soil moisture content analysis will be essential in predicting the radioactivity of the soil present in the valley. The soil samples from the valley are collected up to a depth of 10 feet from the surface and its moisture content is measured using the gravimetric method. From the measured data it is observed that the moisture content follows a random path within a depth of 0-6th feet with the moisture content being over 20-35%. Thereafter, the moisture content follows a parabolic nature below 6th feet up to the depth of 10th feet, from where most of the soil is extracted for manufacturing process. The moisture content in this region is around 25-48% with the minimum value being 26%. From the obtained results, it is realized that the elemental concentration of the soil varies with depth which in turn would influence its radioactivity.

Keywords: moisture content; gravimetric method

Space and Ground-based Observation of Mesoscale Convective System Thunderstorms Lightning

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On March 4, 2019, a lightning bolt lit up the sky over Argentina and lasted a mind-boggling 16.73 seconds. A lightning bolt on October 31, 2018 also set the new record in channel length. It stretched 709 kilometres from the Atlantic Ocean, across the part of Brazil and into Argentina, a length more than twice that of the previous record. These extreme Mesoscale lightning discharges are studied using the Geostationary Lightning Mapper (GLM) data. This study is essential for monitoring climate change and for addressing safety concerns. Most lightning is located in the convective cores of thunderstorms where strong updrafts are located (Peterson et al. 2020). We analysed these extreme lightning flashes using World Wide Lightning Location Network (WWLLN) data. The investigation involving the correlation between the lightning flash density and upper atmospheric Ice Water Content (IWC) is in progress. These Mesoscale lightings are expected to influence Earth's overall atmospheric radiative energy budget and the variability of cloud micro-physical properties.

Keywords: lightning mega flash; MCS; climate feedback

On the possible effects of extra-spatial dimension on the running quark gluon coupling constant and confinement parameter in QCD and masses of Heavy Flavour mesons

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There has been considerable discussion on the possibility extra-spatial of dimension since 1927,when Kaluza and Klein for the first time introduced the notion to unify electromagnetic interaction with gravity in a geometrical manner. Recentyears saw the increase in interest in the models gravity of beyond standard model (BSM), such as, Arkani-Dimopolous-Divali (ADD) and Randall-Sundrum (RS) model. Only gravity was allowed to propagate in the extra-spatial dimension in their Recently, Applequist models et. al., proposed a new model of extra-dimension popularly known UniversalExtra- as Dimension (UED), which allows all the SM particles also to propagate in all possible extra- dimensions without any special status to gravity.The extra-dimensional effects in the potential model formulation of QCD is obtained by calculating the masses of a few heavy flavour mesons.At first,we modify the $\frac{1}{r}$ i.e. inverse distance potential to $\frac{1}{r}e^{-\mu r}$ in a space with one extra-spatial dimension. In the present paper, we introduce such extra- dimensional effect to the linear confinement parameter as well and calculated the masses of heavy flavour mesons. Moreover, the effect extra-spatial of dimension on the masses of heavy flavour mesons is studied with considering linear and inverse distance potential together. Our analysis yields,theoretical bounds on the size ofextra-spatial dimension, which are compared with the values experimental of data and different theoretical models, available in the literature.

Lee-wave clouds in Martian Atmosphere: A study based on the images captured by Mars Color Camera (MCC)

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We may see the evidence of the formation of gravity wave cloud, commonly known as lee-wave cloud over the north-eastern slope of Ascraeus Mons in Mars. Mars Colour Camera (MCC) on-board India's first Mars Orbiter Mission (MOM), has captured over 25 images of Lee -wave clouds during Martian years 33 and 34. In the present study, we objectify our focus on the atmospheric parameter related to all lee-wave events near Ascraeus Mons and to interpret our results physically. We have analyzed all the images and estimated their TOA reflectance, wavelength, wind speed, height, formation temperature, nature of the cloud particle, and other atmospheric parameter related to the events. The wavelength of the Lee-wave cloud varies from 27 to 39 km. The wind speed ranges from 32 to 54 m/sec at the height of 25 to 37 km from the surface of the planet. We used the Global Circulation Model (GCM) model to validate our initial results. The estimated AOD value varies from 0.8 to 2.4 for the blue channel. In contrast, the scale height of AOD varies from 3 to 6.5 km for the observed region indicates the presence of a non-homogeneous mixture of air and airborne dust near the lee side of Ascraeus Mons. We find the major part of the Lee-wave cloud is considered to be composed of water ice particles. We may also observe a Spatio-Temporal distribution of lee wave cloud over the lee side of the mountain during the observed period as a function of solar longitude (L_S). Moreover, the formation temperature for the lee-wave cloud is estimated to be 160 to 185 K during solar longitude 73° to 136°.

Keywords: Lee-wave cloud; wavelength of the cloud; GCM; AOD; TOA

Distribution of X-ray flux: RXTE-PCA observation of Cygnus X-1

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We will report the distribution of X-ray flux of Cygnus X-1 using the RXTE-PCA (Proportional Counter Array) data to understand its long term behaviour. The source shows variability on different time-scales ranging from seconds to months. It is important to understand the high energy behaviour of the accretion disk of compact sources and the processes which originate in the acceretion disk. Previous studies with sky monitor data suggested bimodal distribution for X-ray flux. Analysis of a large number of pointed observations by a more sensitive instrument RXTE/PCA will provide significantly better information than the sky monitor data. We will also discuss the correlation between the results obtained using sky monitor data and pointed observations.

Keywords: x-ray binaries; statistical method; accretion disks; radiation mechanisms

Fluorescent Nanoparticle based Sandwich Immunoassays: A promise for ultrasensitive, highly specific, rapid, robust and early detection of HIV infection

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Exploiting the unique properties like higher quantum yields, greater stability, strong ability to resist photo bleaching, SiO_2 , ZnO, Silver nanoparticles, Gold nanoclusters, Copper nanoclusters, Europium nanoparticles and carbon quantum dots have been synthesized employing the appropriate cost effective synthesis routes and engineered for the purpose of conjugating with streptavidin and functionalized with streptavidin (SA) for detection of p24 antigens using the detection methods based on well-established non-covalent interaction between streptavidin and biotin thus developing nanoparticle based immunoassays for the detection of infectious disease causing agents like HIV (human immunodeficiency virus). The analytical sensitivities have been evaluated through clinical HIV^{+} , HIV^{-} blood serum samples and the specificity of the assays was further evaluated to test the interference of other viruses in the detection of HIV-1 p24 by testing HIV^{-ve}/HBV^{+ve}, HIV^{-ve}/HCV^{+ve} and $HIV^{-ve}/Dengue^{+ve}$ plasma samples. The findings of this study might help in the developing a point of care detection kit which can be affordable, sensitive, specific, user-friendly, rapid, robust and equipment-free, and delivery to those who need it, a point of care detection kit for low-resource settings to enhance the overall quality of life of global population.

Study of a dusty plasma sheath in presence of a non-uniform magnetic field

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In plasma processing devices, negatively charged dust particles appear as contamination in etching, sputtering, and deposition processes. The dynamics of the dust particles at the edge region of the plasma play an important role in such processes. The present study deals with a low-pressure plasma to investigate the effect of dust particles on the properties of plasma sheath in presence of a non-uniform magnetic field. A multi-fluid model is used to simulate the dynamics of electrons, ions, and dust particles. The governing equations for all the plasma species are solved numerically using the fourth-order Runge-Kutta (RK4) method. It has been observed that the presence of the dust particles significantly affects the plasma sheath parameters such as potential, electric field, particle density, particle velocity, etc. The present study is supposed to help in understanding the dynamics of negatively charged dust grains in the sheath. Therefore, the study may be helpful in the plasma processing of materials as well as in plasma wall-interactions for various plasma-aided industrial applications.

A mathematical and radiological correlation between the malignant tumour inside the cancer patient's body and the outer body surface

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This is an assumption based study intends to open up mathematically the routine procedure of simulation in radiotherapy. CT Simulator uses X-rays to provide precise radiological localization of the malignant tumour inside the patient's body. Taking into consideration the Euclidean space and Euclidean geometry as the heart of this study, two assumptions are laid down. These ease the use of Cartesian coordinate system. In radiotherapy, lead markers are used during the simulation, serves as reference points for localization of the tumour on the body surface. The most vital aspect of radiotherapy which is to match up the malignant tumour in the patient's body with the surface of the body is accomplished by an algebraic and analytical geometric correlation.

Keywords: malignant tumour; radiotherapy; Euclidean space; CT simulator; algebra; coordinate geometry

Neutrinoless double beta decay in a flavor symmetric Scotogenic model

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We have studied the scotogenic model proposed by Ernest Ma, wherein the Standard Model is extended by three singlet right handed neutrinos and a scalar doublet. This model proposes that the light neutrinos acquire a non-zero mass at 1-loop level. We have done a $A_4 \times Z_4$ realisation of the scotogenic model in this framework. This model results in the production of non-zero θ_{13} by the assumption of a non-degeneracy in the right handed neutrino masses. We have further studied the $0\nu\beta\beta$ in the model by the consideration of constraints from neutrino oscillation data and KamLAND-Zen limit.

Investigating Leptonic CP Invariance using Weak Basis Invariants in Hybrid Textures of Majorana Neutrino Mass Matrix

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In the present paper, I have derived the CP odd weak basis invariants (WB) at low energies, for Majorana neutrino mass matrix with two zeros and an equality between arbitrary non-zero elements, also known as hybrid textures in the basis, where charged lepton mass matrix is diagonal. This particular conjecture of neutrino mass matrix is found to be compatible with the experimental data, as shown by S. Dev and D. Raj in their recent work. The analysis attempts to find the necessary and sufficient condition for CP invariance corresponding to each viable possibility of hybrid texture, along with some important implications.

Keywords: CP odd weak basis invariants; neutrino mass matrices

Searching limits on heavy Majorana neutrino mass spectrum for different textures of Majorana neutrino mass matrices

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Seesaw mechanisms are used to generate the ultra small mass of three active, observable neutrinos, in which three heavy right handed Majorana neutrinos are needed. These three heavy Majorana neutrinos have so far remained undetected in the present day collider experiments. The limits on this heavy neutrino mass spectrum can provide us interesting information on some other phenomenologi- cal aspects, such as absolute mass scale of neutrinos, Leptogenesis, etc, which still remain unknown. In this work, we shall present a detailed analysis to measure the limits on the heavy Majorana masses for different textures of heavy Majorana masses matrices. Also, we still are not sure about how the fermions obtain the observed flavour structure. To address both these issues, therefore, a type I seesaw is constructed using A_4 flavour symmetry from which the resultant constraints on the heavy Majorana masses are compared with the constraints on the current collider experiments, such as LHC as well as other future experiments.

Keywords: majorana neutrinos; type I seesaw

Effect of Europium (Eu) doping on optical absorption spectra of Yttrium Oxide (Y_2O_3) nanoparticle

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Yttrium Oxide (Y_2O_3) is a wide band gap semiconductor. It is a suitable host for doping of various rare earth elements including Eu, Sm, Ho etc. In this work, we synthesised Eu doped Yttrium oxide (Y_2O_3:Eu) by a combustion method. The doping concentration of Eu was varied from 0 to 5%. An X-ray diffraction analysis confirms the crystalline nature with body centred cubic structure. The average crystallite size was found to be ∼17.60–46.38 nm. The surface morphological analysis showed spherical shaped particles with average particle size ∼30–60 nm. An elemental analysis revealed the presence of Y, O and Eu in the samples. Measurement of absorption spectra of the undoped Y_2O_3 showed a maximum at 228 nm whereas that of the doped samples shifted from 225 to 222 nm with the increase in concentration of Eu from 1 to 5%. The blue-shift observed in the absorbance band is due to incorporation of Eu in the host matrix. In addition to the primary absorption band, a secondary absorption band was also observed between 264 and 360 nm. The optical band gap of the undoped sample was found to be 5.00 eV and that of the doped samples increased from 5.07 to 5.24 eV with the concentration of the dopant. This widening of band gap with doping is attributed to the Burstein-Moss effect. The tuning of band gap can result various emission bands which are useful for numerous optoelectronic applications.

Keywords: yttrium oxide (Y_2O_3); europium (Eu); UV-VIS absorbance spectra; band gap; doping

Characteristic range of ^{238}U ion in polycarbonates

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Interaction of radiation with matter has fascinated the researcher of different field for many decades and intensive studies have been done. It is found that they can with stand high temperature and can easily discriminate the high energy radiation with background radiation. Advantage of SSNTDs technique lies in the fact that it has flexible geometry and when an ionizing radiation falls on it a damage trail of 10-100 Ådiameter is created in the material. In this study stakes of Makrofol-E and CR-39 detector are irradiated with 16 MeV/u ^{238}U ion. From the study we could find if are irradiated with the same ion and with same energy Makrofol-E and CR-39 detector (both of which are organic polymers, a product of Carbon, Hydrogen and Oxygen, with variation in their composition and other parameters like density) shows almost the similar result for range and track length created by the trail.The detector has been irradiated at XO channel of UNILAC, GSI Dermstat Germany. The experimental data is compared with the theoretical data obtained from SRIM and DEDXT programs. Key Words: SSNTDs, Makrofol-E, CR-39, Range, maximum etchable track length.

Keywords: SSNTDs; Makrofol-E; CR-39; range; maximum etchable track length

Microscopic Study of nuclear structure properties of some odd mass Palladium isotopes

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The whole series of Palladium (Pd) isotopes with $99 < A < 117$ shows various interesting Nuclear structure properties like anti-magnetic rotation (AMR) phenomenon, weak deformations, rotational alignments, etc. We have applied a theoretical Model known as Projected Shell Model (PSM) for studying the negative parity yrast band of these Pd isotopes. The results have been obtained for the yrast spectra, band crossings, backbending phenomena, etc. The PSM successfully reproduced the observed nuclear structure properties in these nuclei whereas some properties like the $B(E2)$ transition probabilities values have been reported, for the first time for these nuclei.

Keywords: projected shell model; palladium

Study of heavy metal oxides as gamma ray shielding glasses

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Radioactive materials are used in various sectors such as nuclear power plants, nuclear reactors, nuclear medicine, agriculture etc. but overexposure to these radiations can have harmful effects on humans. Gamma radiations are highly penetrating electromagnetic radiations in the environment. Therefore, it is essential to provide shield against gamma radiations. The present work has been undertaken to analyze comparative study of gamma ray shielding parameters for different glasses containing heavy metal oxides. Shielding parameters such as mass attenuation coefficient, half value layer, effective atomic number etc. has been compared for heavy metal oxides (Bi_2O_3 and PbO). It has been concluded that bismuth based glasses provide better shielding effects in comparison to lead based glasses and can replace concrete walls at nuclear sites.

Keywords: glass structure; gamma rays; mass attenuation coefficient

Fabrication and Characteristics of Methylammonium lead halide perovskite solar cell processed at ambient condition

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For next generation and clean energy conversion high efficiency and low-cost solar cell is very much desired. Instability of perovskite material in ambient condition is a great challenge for commercialization of perovskite solar cell. We report here the use of Cu electrode in perovskite solar cell that potentially allows the stable operation. The anti-solvent promotes the rapid growth of Methylammonium lead halide (MAPI) perovskite crystal and enlarge the grains. Anti-solvent chlorobenzene (CB) treated MAPI perovskite film offers enhanced power conversion efficiency of 5.56% which is a significance achievement in developing environment-friendly high-quality perovskite solar cells in the future.

Keywords: perovskite; MAPI; efficiency; environment-friendly; solar-cell

Analyzing Fusion Excitation Functions Around the Barrier for ^{18}O + ^{116}Sn

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Enhancement of the sub-barrier fusion cross-section for some systems is observed as compared to its corresponding theoretical predictions. Among the various degrees of freedom that influence the sub-barrier fusion enhancement, the role of static deformation and quantal zero point motion is well established but there are still ambiguities in the quantitative effects of positive *Q*-value neutron transfer channels. To investigate this effect, an experiment was carried out at IUAC, New Delhi using a recoil mass spectrometer – Heavy Ion Reaction Analyzer (HIRA) to measure the fusion excitation function of the system ^{18}O + ^{116}Sn having positive *Q*-values for the two neutron stripping channels. Measurements were done at energies from 11% below to 46% above the Coulomb barrier. Large enhancement, compared to one dimensional barrier penetration model, was observed in the sub-barrier region of this system after thorough data analysis. The experimental results were analyzed within the framework of coupled-channels model (ECC). It was found that behind the enhancement, there is a significant role of neutron transfer along with the inelastic couplings. Therefore the role of positive *Q*-value neutron transfer channels could be established for this system using ECC code. The details of measurements and analysis will be presented in the conference.

Keywords: ECC; sub-barrier fusion cross-section; neutron transfer; HIRA; fusion excitation function

Impact of texture zeros of neutrino mass matrix on dark matter phenomenology

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We study an inverse seesaw ISS (2, 3) framework to explain neutrino phenomenology and dark matter simultaneously with one zero textures of neutrino mass matrix. ISS (2, 3) is obtained by the addition of two right handed neutrinos and three gauge singlets sterile fermions to standard model. The model is more predictive because of presence of less number of right handed neutrinos than the conventional inverse seesaw. Moreover, texture zeros in the structures of the mass matrices reduce the free parameters. We extensively study the effect of different textures of neutrino mass matrix on sterile neutrino dark matter phenomenology. The zero textures highly constrain parameter space of the model. Based on the allowed cosmological ranges of the relic abundance, decay rates as well as the dark matter mixing with the active neutrinos, we verify the viability of the different one zero textures of the light neutrino mass matrix.

Dark matter and vacuum instability in singlet scalar, inert doublet and mixed scalar dark matter models

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The presence of dark matter (DM) is an exciting and puzzling feature of our Universe. Although the presence of dark matter is strongly supported by many astrophysical and cosmological observations, there is no candidate of dark matter in the standard model (SM) of particle physics. Another unsolved issue in the SM is the vacuum instability problem. Different extensions of the SM provide candidates of dark matter. In this work we consider scalar extensions of SM - a singlet scalar (SSM), an inert scalar doublet (IDM) and a mixed scalar model (MSM) to explain the existence of dark matter as well as study the one-loop vacuum stability bounds in the models. The SSM faces a large number of experimental and theoretical constraints, most notably from the results of direct detection experiments like XENON1T. The IDM on the other hand can be valid up to the Planck scale (M_{PL}). The MSM model is an admixture of SSM and IDM. In MSM we consider mixing between the singlet and the CP-even component of inert doublet dark matter particles. The lightest neutral Higgs that comprises of the CP-even component of inert doublet and the singlet scalar is considered to be the DM candidate. We find the parameter space, which is consistent with the constraints of relic density and at the same time can solve the instability of the electroweak vacuum. The current limits from XENON1T experiment is used to study the constraints on the parameter space of the models and match our theoretical results with the same.

Keywords: beyond standard model; dark matter; vacuum instability; XENON1T

Programmable Electro-Mechanical Dust Dispenser for Dusty Plasma Experimental Device

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An electro-mechanical dust dispenser has been designed and developed for dropping dust into the plasma in dusty plasma experimental setup. Mechanical setup of the dust dispenser has been developed and fabricated in the laboratory. The frequency of vibration and amplitude of the developed dust dispenser can be controlled electronically to ensure precise and accurate dust density in dusty plasma experiments. Drive circuits have been developed and integrated in the system that enable voltage and frequency control of the dispenser. Control signals are generated by LabVIEW software and applied to the inputs of the drive circuit. A provision to set predefined time interval for dust dropping is also incorporated in the LabVIEW program. The dust dispenser has been calibrated for dust density using laser beam and photo diode arrangement.

Keywords: dusty plasma; dust dispenser; drive circuit; LabVIEW program

Cogent optical properties of Stanene from the perspective of first-principles calculations

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The successful discovery of graphene with enticing properties has led to a motivated considerable exploration of other two-dimensional materials. Stanene, an obverse of graphene, but with tuneable electronic structure, can be considered as a methodical material for the fabrication of electronic and optoelectronic devices and next generation integrated circuits. We present here a computational approach using first-principle calculations for the investigation of topological and optical properties of Stanene. We here systematically study the topological properties in the presence of various types of dispersive interactions within an effective spin-orbit interaction. Many-body perturbation technique has been utilized for the investigation of the optical properties which form a reliable bridge between the complex optical functions and the band structure. Our results are effective and illuminating for future research and applications on stanene and other related buckled systems.

Keywords: topological Insulator; first-principle calculations; optical characteristics; dissipation energy

Plasma – Liquid Interaction: A Novel Single-step Synthesis Method for Metal Oxide Nanoparticles

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In recent times, scientists around the world are devoting much effort to develop low operational cost, environment-friendly, large scale and single-step synthesis method of nanomaterials for various applications. Plasma – Liquid interaction (PLI) could be one of the possible methods in fulfilling the above criterion to fabricate nanomaterials. Generation of wide range of reactive species and energetic electrons offers the desired synthesis of nanomaterials within a few minutes without using any toxic reducing and stabilizing chemical agents. We have developed a plasma – liquid reactor to generate plasma inside a liquid for the fabrication of molybdenum oxide nanoparticles. A DC power supply is used to generate the plasma between two molybdenum electrodes pointing vertically towards each other inside deionized water. Generation of high temperature at the electrode tips due to the localization of electric field, stimulate the evaporation of molybdenum atoms, which then oxidized by the reactive species present in the plasma zone to form molybdenum oxide nanoparticles. X-Ray Diffraction (XRD) and Transmission Electron Microscope (TEM) provides the crystallinity and size of the nanoparticles respectively, synthesized at different discharge durations. Optical properties are investigated using UV-Visible Spectroscopy, which shows variation in absorption band of the nanoparticles.

Keywords: plasma – liquid Interaction; single-step synthesis; reactive species; nanomaterial; molybdenum oxide

Impact of Systematics due to Multi-Nucleon Effects on the measurement of Neutrino Oscillation Parameters at NOνA Experiment

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Nuclear effects in neutrino interactions are one of the major sources of systematic uncertainties in neutrino beam oscillation experiments. Our present understanding of these effects is still insufficient. Another source of uncertainty is the energy dependence of neutrino oscillation probability which is a nontrivial function of the true incoming neutrino energy. This energy is reconstructed using different methods, which in turn is used in the analysis leading to the extraction of various neutrino oscillation parameters. The extraction of still unknown parameters like the leptonic CP violation phase demands the precision level in these measurements to be very high. The NUMI Off-Axis ν_e Appearance (NOνA), a long baseline neutrino oscillation experiment, is designed to measure ν_e ($\bar{\nu}_e$) appearance probability and ν_μ ($\bar{\nu}_\mu$) disappearance probability at Fermilab's NUMI (Neutrinos at the Main Injector) beam. The NOνA target has graphite segments, and consists of two functionally equivalent detectors - the 300 tonne near detector (ND) is located at Fermilab, 1 km from the NUMI beam and the 14 kilo-tonne far detector (FD) at a distance of 810 km is sited 14 mrad off-axis to produce a narrow-band beam around the oscillation maximum region ($\sim$ 2 GeV). The NOνA experiment investigates neutrino mass hierarchy, CP violation phase in neutrino sector, and precise measurement of θ_{23} and Δm^2_{32}. Neutrinos in the beam have energy in range 0.5-3 GeV , where dominant interactions are - Quasi Elastic (QE), Resonance (RES), and Meson Exchange Currents ($2p2h$/MEC) interactions. In this work, we use the kinematic method of reconstruction of the incoming neutrino energy, both at the near and far detectors of NOνA (USA) experiment, and investigate the role of multinucleon (MN) effects on the sensitivity measurement of various neutrino oscillation parameters. We use the values of various light neutrino oscillation parameters from their latest global fit values in our analysis.

Surface Electron Microscope Based Morphological and Chemical Characterization of Atmospheric Aerosols

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Smoldering and Flaming combustion phases are very important combustion phases in biomass burning due to their different burning characteristics in respect to climate and health effects. In the present study, we have used scanning electron microscope (SEM) to characterize the surface morphology of the samples collected during burning of different woods and branches (Bamboo, Teak, Coconut shell, Jackfruit, Arjun, Akashi, Mango, Blackberry, Guava, and dry leaves) under flaming and smoldering combustion phases. Energy dispersive X-ray (EDS) coupled with SEM is used for the chemical characterization of samples collected during different combustion phases. We have noticed a variation in morphology of particles for both the combustion phases. We have identified different shapes of particles varies from regular to irregular including spherical, nearly spherical, triangular, capsule like shapes. We have found different clusters of particles like chain like structure, soot structure, and other irregular structures. We have found different morphological characteristics when same wood sample is identified using SEM but for different combustion phases. Also we have noticed a difference in the elements present in the sample for different combustion phases but same biomass. We have noticed the major contribution by elements like O, Si, C, and B in the scanned samples. Different elements such as C, O, K, Ca, B, Cr, Mn, Fe, Cu, Zn, Na, Mg, P, Nb, S, Pb, Cl, Al, Kr, Y, Ta, Rb are identified with change in their elemental weight percentage. Details will be presented.

Keywords: atmospheric aerosols; smoldering; flaming; morphology; elemental composition

Influence of doping concentrations of Hf on Structural, Electrical and Optical Properties of Hf_x $Zn_{1-x}O$ Thin Films

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$Hf_xZn_{1-x}O$ thin films ($x = 0$, 2.5, 3, 7.5, 10 and 15 mol %) were deposited on glass substrates using Sol-gel process. The influence of the Hf concentration on the structural, electrical and optical properties of the films were studied. It is found that Hf ions can be effectively doped into ZnO and all films crystallize in the hexagonal wurtzite structure with a preferred *c*-axis orientation. The lattice constants of $Hf_xZn_{1-x}O$ films increase with the Hf contents. The $Hf_xZn_{1-x}O$ thin films structures of high-Hf-content films remain after annealing at 600 °C for 20 min. The optical bandgap increases with the Hf content, but it decreases with the annealing temperature. The reduction of bandgap partly results from the grain growth, which is due to the quantum confinement effect of the small grains. Hf doping increases the resistivity of ZnO owing to the disorder of the material structure and the higher bandgap, which result in more carrier traps and less thermally excited carriers in the conduction bands. Two FTIR peaks centered at about 1432 and 1056 cm^{-1} coexist in the fluorescent spectra. With increasing the Hf contents, the intensity of fluorescent peaks enhances remarkably.

Adsorption Properties of Graphene supported Gold: A DFT Study

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Graphene is a tri-coordinated two-dimensional (2D) honeycomb structured lattice of carbon atoms, first synthesized by Andre Geim and Konstantin Novoselov in the year 2004, for which they received the 2010 Nobel Prize in Physics. The bonding is very strong, hence it is highly stable and possesses phenomenal thermal, mechanical, electrical and optical properties. Several experimental groups have successfully produced and isolated stable graphene at room temperature. It has potential applications in the fields of nanophotonics, nanoelectronics, nanocomposites, gas sensors, biosensors, drug delivery, etc. Lately, transition metal atoms deposited on carbon surfaces have attracted considerable interest in various fields. In this study we investigate the adsorption of gold atom on graphene using Density Functional Theory. The graphene sheet was represented by a basis of 24 carbon atoms, distributed in a honeycomb arrangement. All electron scalar relativistic calculations were performed with M06-L functional and LanL2DZ basis set using Gaussian 09W program. The C-Au distance was found to be 2.950 Å, which is very close to previous reported work. Further, NO molecule will be adsorbed on graphene supported Au atom and its gas sensing property will be studied.

Keywords: graphene; density functional theory; graphene supported Au; NO adsorption

KeV sterile neutrino mass model and related phenomenology

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Active neutrinos can not behave as a dark matter candidate but heavy sterile neutrino ($m_S \sim$ keV) with small mixing with the active neutrinos, can be a potential dark matter candidate. We explore the possibility of a single generation of keV scale sterile neutrino (m_S) as a dark matter candidate within the minimal extended seesaw (MES) framework and it's influence in neutrinoless double beta decay ($0\nu\beta\beta$) study. Three hierarchical right-handed neutrinos were considered to explain neutrino mass. We also address baryogenesis via the mechanism of thermal leptogenesis. A model based on $A_4 \times Z_4 \times Z_3$ flavor symmetry is constructed to explain both normal and inverted hierarchy mass pattern of neutrinos. Notable results on effective neutrino masses are found in presence of heavy sterile mass and active-sterile mixing (θ_S) in $0\nu\beta\beta$. We checked decay width and relic abundance of the sterile neutrino, to establish sterile neutrino as dark matter within this model, which restricted sterile mass (m_S) within some definite bounds. Constrained regions on the CP-phases and Yukawa couplings are obtained from $0\nu\beta\beta$ and baryogenesis results.

Smartphone based colorimetric analyzer for detection of phosphate in water

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This paper reports a low-cost, compact, field-portable smartphone based colorimetric analyzer for detection of phosphate concentration in water medium. A 3D printed cradle housing all the optical components is integrated with the built-in camera of the smartphone using which photographs of the reagent treated test samples are captured. Using an android application, the RGB color model is converted to the HSV color model. For the quantification of phosphate, the V-channel value of HSV color space is corelated with the phosphate concentration. The obtained results are compared with the laboratory grade standard spectrophotometer by measuring its absorbance at a specific wavelength. The designed smartphone sensing tool has an ability to measure phosphate concentration as low as 0.01 mg/L with a good accuracy (%bias <1%) and precision (RSD <2%). The sensing technique can be used as an alternative to existing phosphate level detection sensors as it provides a fast and user-friendly analysis for in-field applications.

Keywords: smartphone; colorimetry; HSV color model; phosphate estimation

A study of multiplicity distribution of secondary particles at ultra high cosmic ray nuclear emulsion interactions and machine range of energy

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Nuclear emulsion with its excellent spatial resolution and high efficiency for the detection of charged particles is observed for studies of high energy hadronic interactions. The analysis of the multiplicity distributions of secondary charged particles produced in interactions of cosmic ray nucleons in nuclear emulsion at high range of energy and compared with machine range of energy. It has been observed that the charged particle multiplicity and angular distributions in nucleon-Emulsion nuclei interactions can well be described by the hydrodynamical model. The distributions can be parametrised for the integral angular distributions. The signature for nuclear multiplicity scaling is also evident from the multiplicity distributions. The multiplicity ratio shows the non-dependence of target nucleus which implies the basic mechanism of particle production in both the nucleon-emulsion and nucleon nucleon interactions.

Keywords: charged particle; nuclear emulsion; pseudo-rapidity distributions; integral angular distributions; multiplicity scaling

Stories from the Nano-bio lab at Clemson

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My group's research interests are at the interface of physics, biology, and nanoscience. We aim to seamlessly integrate the principles of condensed matter physics, optical spectroscopy, and physiological chemistry to understand physics at the nanoscale and nano-bio interfaces. Based on this understanding, we manipulate materials (e.g., introduce nitrogen dopants in graphene) and their environment to overcome otherwise insurmountable problems (e.g., alleviate quantum capacitance limitations in graphene). Beyond the fundamental science, we extend our understanding to reach industrial scale prototype demonstration to allow for facile translation of our discoveries and inventions into the market (from discovery to device). In this talk, I will provide an overview of my group's research in the last five years at Clemson University. Specifically, my talk will focus on three broad themes: 1) Energy conversion and storage: I will describe our work triboelectric nanogenerators (TENGs), batteries (Li-ion, Li-sulfur, and Al-ion), and quantum capacitance in supercapacitors (based on nanocarbons and their hybrids with electrochemically active polymers), 2) Nanotoxicity: I will present our work on integrating quantum mechanics and physiological responses through spectroscopic investigation of nano-bio interactions, and 3) Biosensing and imaging: I will briefly present our work on surface-plasmon coupled emission, graphene sensors, and ZnO-based three-photon imaging.

Branching ratios and Oscillation frequencies of heavy-flavour mesons in a non-relativistic QCD potential model with three-loop effects in V-scheme

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Some of the recent developments are reviewed in heavy-flavour physics include the two- and three-loop effects in the calculation of masses and decay constants of heavy-flavour mesons using Dalgarno's method of perturbation theory. In the present work we make a corresponding calculations of branching ratios and oscillation frequencies of heavy-flavour mesons B and B_s. For this analysis we will use the results of masses and decay constants of heavy-flavour pseudo-scalar mesons (PSM) from our previous work where the first order mesonic wavefunctions are obtained using Dalgarno's perturbation theory for $2S$ and $3S$ higher states.

Free rotation of nanoparticle in BEC

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We propose a new exiting possibility to observe free rotation of dopant particle in BEC to have a better understanding of superfluidity exhibited by BEC. We take the idea from the experiment of doped molecule in ^{4}He as it shows significance of superfluidity because of free rotation as explained by the ro-vibrational spectrum. From the ratio of the interparticle distance of ^{4}He and the dopant molecule there, we find that the dopant in BEC should be a nanoparticle and recommend an experiment to observe free rotation in BEC.

Keywords: microscopic superfluidity; He-clusters; BEC; He nano-droplets; nanodopant

Flux distribution study of Mkn 421 with SPOL, RXTE and Fermi-LAT telescopes

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Blazars are the radio loud Active Galactic Nuclei (AGN), which are characterized by their extreme properties like superluminal motion, high polarizations and occasional spectacular flares etc. Further, the lightcurves of blazars show rapid flux variations extending from radio to gamma-ray energies at time-scales ranging from minutes to years. Modelling their flux distribution over a long timescale can hint about the physical mechanism, which causes such variations. We present here the flux distribution study of blazar Mkn 421, using the Anderson-Darling (AD) test and histogram fitting methods. We used the simultaneous flux lightcurves at optical, X-ray and gamma-ray energies, using SPOL, RXTE and Fermi-LAT observatories. Further, we performed the cross correlation study of these lightcurves in different energy bands.

Keywords: BL Lacertae object: Mrk 421; galaxies: active; X-rays: galaxies; radiation mechanisms: non-thermal; acceleration of particles

Charging of dust grains in presence of two electron groups

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In dust charging, temperature of the incident electrons plays a pivotal role. Increase in the temperature, increases the kinetic energy of the electrons thereby increasing the current contribution on the dust grains. Hence, the presence of a high energetic electron group can change the dust charging scenario significantly. The present experiment is aimed at investigating the role of hot electrons on dust charging. Two temperature hydrogen plasma has been produced in a multi-cusp device using a hot cathode discharge method. Two magnetic cages of different field strengths were used for confining the plasma. The produced plasma was allowed to diffuse at the junction of the magnetic cages, and as a result, two distinct electron groups of different temperatures were observed. Micron sized dust particles of tungsten (W) and alumina (Al_2O_3) were introduced in the system using a dust dropper placed in the dust dropping unit above the plasma chamber. The usual phenomena of decrease in the low energetic electron population due to absorption was not seen. On the contrary, an increase in the lower energetic electrons was observed. This unusual behaviour can be attributed to the secondary electron emission from the dust surface. A cylindrical Langmuir probe was employed to determine the different plasma parameters. A right hand shift in the Electron Energy Distribution Function calculated from the I-V curve indicates the increase in the lower electron population in presence of dust prominently. A comparative study of W and Al_2O_3 dusts in presence of two electron groups and a single component is carried out. A detailed discussion on the work done would be made during the presentation.

Thermal Instability of Two-Component Plasma with Frictional Effect of Neutrals Hall Current and Radiative Heat-Loss Functions

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The effect of neutral frictions, Hall current and radiative heat-loss function on the thermal instability of viscous two-component plasma has been investigated incorporating the effects of finite electrical resistivity and thermal conductivity. A general dispersion relation is obtained using the normal mode analysis method with the help of relevant linearized perturbation equations of the problem and a modified thermal condition of instability is obtained. We find that the thermal instability condition is modified due the presence of radiative heat-loss function, thermal conductivity and neutral particle. The Hall current parameter affects only the longitudinal mode of propagation. We find that the condition of thermal instability is independent of the Hall current, magnetic field strength, finite electrical resistivity and viscosity of two-components, but depends on the radiative heat-loss function, thermal conductivity and neutral particle. From the curves we find that the temperature dependent heat-loss function, thermal conductivity and viscosity of two-components shows stabilizing effect, while density dependent heat-loss function and finite electrical resistivity shows destabilizing effect. The effect of neutral collision frequency is destabilizing in longitudinal mode. These results are helpful in understanding the structure formation in HI region.

Keywords: thermal instability; Hall current: radiative heat-loss functions; neutral collision

On the free rotation of a molecule embedded in helium-4 clusters

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The fact, that ^{4}He atoms on different concentric circular paths around the axis of a quantum vortex move with identically equal angular momentum which represents an important manifestation of superfluidity of He-II, has been used to discover a model which can explain the typical nature of experimentally observed N (number of ^{4}He atoms) dependence of the rotational constant B of the rotor part of a cluster M:He$_N$. It reveals how exactly superfluidity of He-II is related to the said dependence of B on N. We believe that this model, when used with simulation techniques, would render results that would agree closely with experiments.

Keywords: microscopic superfluidity; He-clusters; He-nano-droplets

Phenomenological study of neutrino mass matrices with a vanishing minor and vanishing trace

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In this work we have carried out a systematic study of the existence of one vanishing minor with vanishing trace condition i.e zero sum of the eigen values in the neutrino mass matrices. There are six cases of neutrino mass matrices with one vanishing minor. Here we have studied only two cases i.e $C_{11} = 0$ and $C_{22} = 0$ by imposing the zero trace condition and it is found that both the cases are consistent under the current experimental data at 3σ confidence level. Here we have investigated the allowed ranges of Majorana type CP violating phases and Dirac type CP violating phases for the neutrino mass matrices considering the two constrained equations for one vanishing minor and vanishing trace condition for two cases of one vanishing minor $C_{11} = 0$ and $C_{22} = 0$.

Study of Structural, Electrical and Magnetic properties of Nd-Ti co-doped $BiFeO_3$ Nanoparticles

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Single-phase BFO nanoparticles with compositions $Bi_{0.9}Nd_{0.1}FeO_3$ and $Bi_{0.9}Nd_{0.1}Fe_{0.95}Ti_{0.05}O_3$ have been synthesized by low temperature citric acid assisted auto-combustion route. Thereafter, effect of the co-substitutions on structural, electrical and magnetic properties of BFO has been investigated. X-ray diffraction revealed partial phase transformation from rhombohedral to orthorhombic for 10% Nd-substituted BFO whereas Nd-Ti sample showed traces of pseudo-tetragonal symmetry. TEM micrographs confirmed nearly uniformly shaped particles with particle size under 50 nm. Resistivity of the co-doped sample increased remarkably and found to be $\rho_{dc} = 1.85 \times 10^{11}$ Ω-cm. Thus, Ti^{4+} ion reduced leakage current by suppressing oxygen vacancies. Ferroelectric nature has been improved on account of structural distortion induced by Nd-Ti ions as well as decreased leakage current. Also, dielectric behaviour improved significantly on doping. A broad peak nearby T_N in temperature-dependent dielectric confirmed magnetoelectric coupling for all the samples. The wasp-waisted type *M-H* loop was observed with improved weak ferromagnetism due to structural distortion induced by dopant ions and super-exchange like interaction between dopants and host ions. Therefore, co-doping of Nd and Ti ions considerably has enriched the electric and magnetic properties of BFO nanoparticles.

Keywords: multiferroics; bismuth ferrite; Nd-Ti co-doping; ferroelectric properties; magnetism

Growth, Structural, Optical, Thermal and Mechanical Studies of a Novel Nickel Sulphate Doped Sulphamic Acid Single Crystals for Optical Applications

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A novel good quality crystal of nickel sulphate doped sulphamic acid (NSSA) has been grown by slow evaporation solution growth technique at room temperature. The single crystal XRD confirm that the grown single crystal belongs to the monoclinic system with the space group of $P2_1/C$. Powder XRD studies show good crystallinity of the grown sample. UV-VIS studies reveal that the grown crystals have the good optical transmission in the whole visible region. Photoluminescence spectra for the NSSA crystals were recorded using fluorescent spectrophotometer in the range from 200 nm to 900 nm. EDAX analysis declare that (Ni) ion is incorporated in the compound. The Surface analysis is carried out using a scanning electron microscope (SEM) which show that the atomic layers have different sizes and portray. The surface has fine morphology with microcrystal and mild cracks. Thermo-gravimetric analysis measure the dehydration temperature of the nickel sulphate doped sulphamic acid crystal is about 130°C. Vickers hardness analysis validate that these crystals has good mechanical strength. The non linear optical property of the sample was examined by NLO studies.

Keywords: single crystal XRD; powder XRD; UV-VIS; photoluminescence; SEM-EDAX; TG-DTA studies; hardness

Our Universe: the known, unknown and some speculations

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Our Universe is simple at scales larger than a few hundred megaparsecs: it is smooth, homogeneous, isotropic, spatially flat, and expanding at an accelerating rate, following the laws of general relativity. Yet it presents a number of unresolved problems. These include the origin and fate of our Universe, nature of its main constituents - dark matter and dark energy, and the mechanism behind its high degree of homogeneity, isotropy and flatness. I will describe success and failures of some of the theories which try to address these, and will also present some new ideas which attempt to explain the above.

A comparative study of experimental and theoretical Z (compressibility factor) of Argon as a typical representative of simple fluids

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Based on a theoretical analysis of $Z = \frac{Z_c \rho_c P_r}{\rho T_r}$, obtained from the basic definition of the compressibility factor of a fluid and its analysis for understanding the P_r dependence of Z for at constant T_r, we calculate the Z values for Ar fluid (a typical representative of simple fluids) and compare with corresponding experimental values. We note that $Z(Pr)$ of a low-density gas phase decreases/(increases) with P_r, if $T_r \leq 2.73$ (> 2.73), -corresponding to Boyle temperature $T_B = 2.73 T_c$, while the same of the liquid or high-density gas phase (representing the incompressible state of the system) at a fixed T_r increases linearly with P_r. This not only demonstrates that the physical state of a low-density gas with particles moving, to a good approximation, like a free particle differs significantly from the state of a particle in liquid and high-density gas phase but also provides reasons for which a theory based on single particle basis does not explain several experimental properties of the fluid including liquid to gas transition (L2GT) or gas to liquid transition (G2LT) and related properties and the microscopic basis of several empirical rules and principles of corresponding states.

Relation between the variability of the kilo-Hertz Quasi periodic oscillations and the low frequency noise in $4U\ 1608-52$

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The neutron star low mass X-ray binary 4U 1608–52 is known to show kHz QPOs as well as low frequency noise. The energy dependence of the fractional r.m.s amplitude of the kHz QPO reflect the underlying radiative mechanism responsible for the QPOs irrrespective of their dynamical origin. In this work we compute the energy depedence for 26 instances of kHz QPO observed by RXTE. We typically find as reported before, that the r.m.s increases with energy with slope of ~ 0.4. This indicates that the variation is in the hot thermal compotonization component and in particular the QPO is likely to be driven by variation in the thermal heating rate of the hot plasma. For the same data, we compute the energy dependent r.m.s variability of the low frequency noise component by considering the light curves. In contrast to the behaviour seen for the kHz QPO, the energy dependence is nearly flat i.e. the r.m.s. is energy independent. This indicates that the driver here may be the soft photon source. Thus the radiative mechanism driving the low frequency noise and the high frequency QPO are different in nature.

Keywords: x-rays:binaries; accretion, accretion disks; stars:neutron; QPOs; individual (4U 1608-52)

Transport Coefficients of Dense Stellar Plasma in Strong Magnetic Field

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Following an exact relativistic formalism, we study the transport properties of dense stellar electron-proton plasma in strong quantizing magnetic field. The transport coefficients, namely the coefficients of shear and bulk viscosities as well as thermal conductivity is obtained from the relativistic version of Boltzmann kinetic equation by linearizing the distribution function and using relaxation time approximation. The dependence of the kinetic coefficients on the strength of the magnetic field is discussed. The variation of these coefficients with magnetic fields are found to be insensitive for the field strengths $\leq 10^{17}$ G beyond which decreases with magnetic field. As a consequence, in presence of ultra-strong magnetic field, the electron-proton plasma behaves like a superfluid insulator. Since the electrical conductivity of the medium becomes extremely low (almost zero) in presence of ultra strong magnetic field, the magnetic field at the core region must therefore decay very quickly. Hence strong magnetic field can not exist at the core of magnetars.

Keywords: kinetic coefficients; magnetic field; magnetars

Pulse analysis of the DEASA (Dayalbagh Educational Air Shower Array) at Agra: in relation to air shower parameters

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The DEASA is the first detector array in Northern India (Uttar Pradesh) to study the shower of secondary particles. This array is an educational air shower array for undergraduates and postgraduate students to learn high energy cosmic ray shower at sea level. The location is 168 m above the sea level with the latitude 27.22°N and longitude 78°E. DEASA has been set up and preliminary calibrations have begun in 2020 to study the shower. This array consists of 8 plastic scintillation detectors each of area 1 m^2 and 2 cm thick. These detectors are kept at a distance of 8 cm from each other and this array covers an area of 260 m^2. The pulse analysis of the detectors has been studied and interpreted. The shower properties have also been elaborately studied and observations started. The shower data is to be interpreted and details understood. DEASA has been indigenously designed in house by the undergraduates of the Department of Physics and Computer Science, with the help from the GRAPES3 Experiment.

Addressing Some of the Key Challenges in Thermal Plasma Technology

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Thermal plasma technology has immense potential in vast variety of technological areas that include novel material synthesis, nano-structure generation, thermal barrier corrosion resistant coating, waste management, melting, cutting, welding, extractive metallurgy etc. Presence of highly reactive atomic and ionic species together with high temperature, tremendous enthalpy content and sharp thermal gradient enable thermal plasma technology to convert many conventional multistep wet route highly time consuming lengthy processes into a single step remarkably fast dry one. It builds its strength through reduction in cost, time, equipment and manpower. However, to harness full potential of the technology one needs to address several key challenges in the area. The foremost drawback of the technology is highly energy intensive nature and many times not being economic enough to win over competing technologies. It is a thermal plasma torch that serves at the heart of any thermal plasma technology. The study addresses some of the major issues like generating large volume plasma consuming low electrical power, getting good control over inherent instability in arcs, finding appropriate electrode and structural material with desired characteristics for long life, enabling it to sustain extremely high temperature, highly corrosive harsh environment and tremendous high heat flux.

Keywords: thermal plasma; plasma torches; arc plasma; arc instability; nano-synthesis; waste management; waste to energy; plasma spray coating, plasma CVD

A highly sensitive immunosensor based on gold nanoparticle functionalized poly (3,4-ethylenedioxythiophene): polystyrene sulphonic acid doped with graphene oxide for efficient detection of serum immunoglobulin G (IgG)

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In the present work, we have reported a highly sensitive, selective capacitive immunosensor based on PEDOT PSS and graphene oxide (GO) composite decorated with gold nanoparticles (AuNPs) deposited on ITO electrode. Electrochemical deposition of EDOT over indium tin oxide (ITO) in presence of PSS keeping GO as dopant followed by introduction of chemically inert AuNPs has been achieved resulting in nanohybrid AuNPs/ PEDOT PSS-GO electrode. The antibody (mouse IgG) has been covalently immobilized onto the surface of AuNPs/PEDOT PSS-GO through gluteraldehyde coupler. The presence of functional groups and the surface morphology of the modified electrodes were investigated using Fourier Transform Infrared Spectroscopy (FTIR) and scanning electron microscope (SEM) respectively. Cyclic Voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS) studies have been performed to investigate the electro-catalytic behaviour of the fabricated bioelectrodes. Antibody-analyte interaction was monitored by both CV and EIS. The fabricated immunosensor exhibits high sensitivity with a good linear range of 38-363 ng/mL for goat antimouse IgG antigen. The immunosensor shows fast response towards the specific antigen with sensitivity and detection limit 0.4846 nF/ng/mL and 57.4 ng/mL respectively using transient capacitance response at 77 Hz.

Keywords: poly (3, 4-ethylenedioxythiophene): polystyrene sulphonic acid (PEDOT PSS); IgG; gold nanoparticles; transient capacitance; specific antigen antibody detection

Development of Agro-waste Based Nanosized Cellulose

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Buckles of Nahar seeds available in North East India, which becomes agro-waste after the utilization of the seeds, were collected. Dewaxing by Soxhlet extraction and alkali treatment of the buckles at 80±20 degC followed by bleaching removed the non-cellulosic components. The whitened bleached fibers were then subjected to sulfuric acid (60 wt%) hydrolysis at 42±20 degC for 60, 90 and 120 min respectively followed by sonication to obtain the nanosized cellulose. The formation of nanosized celluloses were confirmed by XRD, FTIR, TGA and FE-SEM techniques. The study showed a diameter of maximum 30 nm and length 210 nm with high crystallinity for the isolated nanosized cellulose samples. The study concludes that the nanosized cellulose derived from nahar based agro-waste of North Eastern India, with renewable potential have tremendous scopes to be utilized as very good reinforcing agents for production of eco-friendly nanobiomaterials. This may, in fact, be a great initiative for reducing environmental pollution.

Keywords: environmental pollution; cellulose; nanosized; renewable; nanocomposite

Theoretical Study of Band Structure of Positive Parity ^{153,155}Pm Isotopes

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We have applied the theoretical framework of the Projected Shell Model with the aim to further understand the nuclear structure of ^{153,155}Pm isotopes. Theoretically, we have been able extended the positive-parity yrast spectra upto the spin of $59/2^+$ for the isotopes. The band structures of these nuclei have been analyzed in terms of quasi-particles configurations. The phenomenon of back bending in moment of inertia is also studied in the present work.

Keywords: projected shell model; Pm isotopes; band structures

Seminconductor Nanostructures: Simple Scaling Approach

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The current era is called the "information age" by some and as "the age of silicon" by others. Regardless of the nomenclature it is well known that it is powered by miniaturized semiconductor devices. The drive towards smaller and ever smaller semiconductor devices is currently at the sub - micron stage (10^{-7} m to 10^{-6} m). It is expected to advance to the nano- stage (10^{-9} m to 10^{-8} m) in the next two decades. Quantum effects become significant at these small sizes. I shall outline a simple scaling approach to understand some of the the properties of semiconductor nanostructures. I shall explain how exotic phenomena such as the fabrication of a single electron transistor and the long standing goal of integrating optics and electronics on the same chip are possible with semiconductor nanostructures. Thus I hope to provide a brief overview of semiconductor nanoscience and nanotechnology which has emerged as a broad, exciting, yet ill -defined field of scientific research and technological innovation. I will also describe work done by host of undergraduate students over with me in this field over the last two decades.

Microscopic foundations of some important empirical rules and $Z(P_r)$ at constant T_r of a simple fluid

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Recently, we published the microscopic theory of simple fluids developed by using pair of particle basis. The theory answers several unanswered questions of great significance. In this paper we use this theory to explain how high energy particles present as a solute weakens the liquid structure and facilitates formation of bubbles which play a key role in triggering liquid to gas transformation (L2GT). It helps us understand why the average kinetic energy of the gas present in the bubbles falls $\approx 3k_BT_c/2$ and find the T_r $(= T/T_c)$ dependence of the number of such particles present in the liquid. We use this result to explain the microscopic details of the origin of Guldberg rule $(T_b^1 = 0.667T_c)$ with its modified statement as reported by Guggenheim and the reason for the observation of triple point temperature $T_t \approx 0.52T_c$. We also use our theory to find detailed microscopic reasons for the observation of Trouton rule and ideal gas behaviour of the gas at Boyle temperature $T_B = 2.73T_c$. Finally, we analyze the mathematical relation,

$$Z = Z_c\rho_c P_r/\rho T_r$$

derived from the basic definition of compressibility factor Z (appearing in $PV = ZRT$, - the equation of state (EOS) of a real gas). Here Z_c and ρ_c, respectively, represent the compressibility factor and density of the fluid at the critical point. We conclude that : (i) $Z(Pr)$ of a low-density gas decreases linearly with an increase in P_r $(= P/P_c)$ because the density of such a gas increases as $\rho = \rho_0 + \eta_1 P_r + \eta_2 P_r^2$ (where η_1 and η_2 have constant values), and (ii) $Z(Pr)$ of high-density incompressible gas and liquid states increases linearly with increase in Pr because the change in ρ $(= \rho_0 + \eta_1 P_r + \eta_2 P_r^2)$ with P_r remains negligibly small in comparison to $\rho = \rho_0$ at $P_r = 0$. As a most significant conclusion of this study we find that vaporization of a liquid is a basic property of gas-liquid interface (GLI) and this inference is strongly supported by experimental results as found in our separate study.

Microscopic theory of coexistence of liquid and gas phases of a simple fluids

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In this paper we report the microscopic account of the coexistence of gas and liquid phases of a simple fluid kept in a closed container at $T < T_c$ by using our model. Our model presumes that: (i) each particle in liquid (gas) phase has a collective binding W_l (W_g), -the way a conduction electron in a metal has similar binding W (known as work function) and (ii) the evaporation and condensation, which control the coexistence, are identical to thermionic emission of electrons from metals. Surface properties of liquid-gas interface (LGI) are the main factors which control the basic parameters of the coexistence such as vapour pressure, ratio of densities of gas and liquid phases, etc. Finally, we find possible reasons for which it is virtually impossible to reach the critical point of a real gas through any experiment including computer simulations and some hitherto unknown aspects of the operation of repulsive and attractive forces among particles. We hope that these aspects will help in finding more accurate understanding of fluids of different classes. The fact that our theoretical results agree closely with experiments for Ar fluid (a typical representative of a simple fluid) underlines the accuracy the accuracy of our model of evaporation and condensation. Calculations for other fluids are expected to corroborate this conclusion.

A breakthrough in the field of microscopic understanding of classical and quantum fluids

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Microscopic theories of widely different many-body systems (MBS) like classical and quantum fluids have been developed by using single-particle basis (SPB) which considers each particle as a freely moving single-particle which can, obviously have any momentum/energy ranging from 0 to ∞. However, these theories do not explain several important experimental properties because SPB does not fit with the actual state of a particle in an MBS, -particularly, when the MBS assumes its incompressible state (high-density gas, liquid or solid) in which each particle closely represents a particle trapped in a cell of size $d = \sqrt[3]{V/N}$ which not only has local motion around its location but also has an additional motion representing the collecting motion like a phonon in the solid/liquid state. While the energy of the former motion is controlled by the nature (harmonic or square well) and depth of potential seen by the particle at its position in the cell, the latter can be identified with the plane wave motion of a phonon like non-interacting quasi-particle. Beside, a particle in such a state can never have an energy $< \epsilon_0$ (zero-point energy allowed by the trapping potential well. This motivated us to find apt alternative of SPB and, we used pair of particles basis (PPB) to develop more viable theories of simple and quantum fluids over the last few decades. PPB identifies each particle in the system as a part or representative of a pair of particles having two independent motions, -one representing the relative motion (q-motion) of two particles with respect to their centre of mass (CM) and the other representing their CM motion (K-motion) in the laboratory frame. This clearly agrees with the actual motion of a particle. Accordingly, our theories explain different properties of simple fluids like H_2O and quantum fluids like liquids ^{4}He and ^{3}He and superconducting electron fluid which are not explained by SPB-theories. In this talk we summarise this breakthrough in the field by highlighting how exactly a liquid state differs from the gas and solid phases and how exactly a quantum fluid differs from that conceived by SPB-theories. We highlight the potential of PPB-theories for concluding : (i) the detailed characteristics of the quantum fluid state of liquid ^{4}He, liquid ^{3}He and superconducting state of electron fluid in a superconductor, (ii) co-existence of ferroelectric state with quantum fluidity and different magnetic phases in superfluid ^{3}He, (iii) absence of superconductivity in metals like Au, Ag and Cu, etc., (iv) possibility of observing room temperature superconductivity, (v) cryogenic emission of electrons, etc. We also report how PPB can be used to develop microscopic theories of the homogeneous mixtures of two or more simple fluids and use this finding to understand the properties of some such mixtures.

Counting of alpha tracks in Coloured LR-115 films using image analysis tools

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Solid State Nuclear Tracks Detectors (SSNTDs) are a class of detectors used in the identification, detection and quantification of highly ionizing particles. Of the SSNTDs that are commercially manufactured, LR-115 Type2 (cellulose nitrate) detectors have become the popular choice in radon research. Apart from its usage in geophysics and geochemistry, radon activity assessment is important for its significant radiological risks to public health. Most of these applications involve large-scale and long-term radon surveys which are best served by SSNTDs due to their robustness, integrated measurement capability and economical nature. However, exposure of large volumes of detectors with the requirement to count statistically adequate number of tracks makes manual counting highly cumbersome. In the present paper, we propose a method for automated segmentation and counting of nuclear tracks from images of etched LR-115 Type2 detectors taken under a transmitted light microscope. The segmentation of the image is achieved through a series of morphological operations, primarily morphological reconstruction. The segmentation requires two input parameters: image magnification and etching time. A comparative study is carried out to show the relative sensitiveness and robustness of the method.

Exploring Invisible Neutrino Decay at Long-Baseline Experiments

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Neutrino decay is one of the popular new physics scenario in neutrino sector. There are three active neutrinos and they can decay into lighter active neutrino state and boson(s), or it could decay into a sterile fermion and boson(s). In visible neutrinos decay, neutrinos decay into final active states and boson(s) and it is visible to the detectors. These scenarios are highly constrained. On the otherhand, if the active neutrinos decay to some final sterile state it is invisible to the neutrino detectors. Here in this work, we aim to study the possibility of invisible neutrino decay scenarios in long baseline experiments. Previous studies show that by combining neutrino oscillation experiments it is possible to improve the constraints in invisible neutrino decay. We, here in this work, plan to combine both DUNE and NOνA experiments to measure the constraints.

Keywords: neutrino decay; long baseline experiment; DUNE; NOνA

NOTES

DEPARTMENT OF PHYSICS, ADBU

The Department of Physics, ADBU started as an independent department in Assam Don Bosco University from 1st April, 2018. Initially, it was a constituent of the Department of Basic Sciences, teaching physics courses of B.Tech. programmes.

In August 2014, M.Sc. (Physics) programme with many specialisations was also started. From July 2018, the department introduced B.Sc. (Honours in Physics) programme.

Apart from the undergraduate and postgraduate courses, the department also has a vibrant Ph.D. programme with areas of interest ranging from high energy physics and astrophysics to plasma physics and superfluidity.

ASSAM DON BOSCO UNIVERSITY

Assam Don Bosco University (ADBU) is a non-profit, co-educational university located in the lush greens of the Tapesia Gardens at Kamarkuchi in Sonapur, Assam.

The university was founded on March, 2008 by the Salesians of Don Bosco (SDB). It is Assam's first-ever state university in the private sector and was set up by the Assam Don Bosco University Act 2009 under the State Private Universities Act of the Government of Assam. The university is recognized by the University Grants Commission (UGC) with 2f and 12B status and accredited with B+ by the National Assessment and Accreditation Council (NAAC), becoming the 4th private university in India to be accorded thus.

In the ranking given by National Institutional Ranking Framework (NIRF) by the MHRD for 2020 the university found its place among the top universities in the country and also became the only private university among all the sister states of Northeast India to be in that category.

The university also featured in the Atal Ranking of Institutions on Innovation Achievements (ARIIA) 2020, Ministry of Education, Government of India, and thus, became one of the four institutions of Northeast India to attain this distinction.

TiMP 2021

Trends in Modern Physics 2021 (TiMP 2021) is an international conference focussing on the recent developments and emerging trends in Modern Physics. The conference is designed to provide a platform for researchers to present their work and interact with each other.

The scientific programme of this two day conference consists of invited topical lectures, contributed oral and poster presentations in the following thrust areas:

- Plasma Physics
- Astrophysics & Cosmology
- Material & Nanophysics
- Particle Physics
- Nuclear Physics