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INVITED SPEAKERS

Emergent Phenomena at the Oxide Hetero-Interface

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ABSTRACT: Quite remarkably, two insulating oxides $SrTiO_3$ and $LaAlO_3$, joined together to form a heterostructure, produced a highly conductive two-dimensional electron liquid (2DEL) at the hetero-interface. This 2DEL exhibits exciting new phenomena such as finite-momentum triplet superconductivity coexisting with inhomogeneous ferromagnetism, gate-voltage-induced superconductor to insulator and metal to insulator transition, as well as a complex excitation spectrum. We study the role of intrinsic disorder on superconductivity and ferromagnetism at the interface and find that for reasonably strong disorder, the system breaks up into mutually excluded regions of superconductivity and ferromagnetism ruling out an FFLO state [1]. This electronic phase-separation accounts for the unusual coexistence of superconductivity and ferromagnetism observed at the interface. The dynamics of the defects at the interface, such as Oxygen vacancies, are investigated further by a Hybrid Monte-Carlo method and a clustering of vacancies at low temperatures is found [1]. Such a clustering sheds light on ill-understood phenomena like carrier freeze-out at low temperature and pseudo-gap in the superconducting state. A perpendicular magnetic field drives a phase-transition to topological superconductivity and gapless topological excitations [2] at the core of a vortex, such as Majorana fermions, that are vulnerable to disorder. An experimental set-up to realize the Majorana excitation and scenarios for anomalous Hall effect and spin Hall effect with changing Fermi surface topology (a Lifshitz transition) are outlined [3]. We also report the observation of a transient superconducting state above nominal Tc implying a hidden superconducting order [4].

[1] N. Mohanta, AT, J. Phys. Cond. Mat. 26, 025705 (2014); ibid 26, 215703

[2] N. Mohanta and AT, Europhys. Lett. 108, 60001 (2014).

[3] N. Mohanta, S. Bandyopadhyay, S. Lal and AT, arXiv:1407.6539 (2014).

[4] Shelender Kumar, Gopi Nath Daptary, Pramod Kumar, Anjana Dogra,.Mohanta, AT, R. C. Budhani, Aveek Bid, arXiv:1411.3103 (2014).

Surface states and topological order in Bi_2Se_3

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ABSTRACT: Topological insulators possess time reversal symmetry protected metallic surface states over the insulating bulk, where these surface states are expected to be immune to disorder, chemical passivation of the surface or temperature change. However, significant discrepancy from such behavior has been found experimentally in various materials. I will discuss some of our recent results on the electronic structure of a typical topological insulator, Bi_2Se_3. We observed that both, the band structure results and high resolution angle resolved photoemission data reveal significantly different surface electronic structure for different surface terminations. Furthermore, oxygen impurity on Se terminated surface exhibits an electron doping scenario, while oxygen on Bi terminated surface corresponds to a hole doping scenario. The intensity of the Dirac states reduces with aging indicating fragility of the topological order due to surface impurities.

Beyond Einstein's gravity

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ABSTRACT: The need to think beyond General Relativity is felt for a long time. In this talk I shall briefly touch upon some of these efforts from theoretical and observational perspectives.

Creating Matter at Extreme Temperatures in the Laboratory

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ABSTRACT: An overview of the field of Quark-Gluon Plasma will be presented for a general audience. QGP is a new phase of matter discovered about ten years ago in ultra-relativistic nucleus-nucleus collisions at the Relativistic Heavy-Ion Collider at Brookhaven, USA. These experiments led to the claim of formation of the most perfect fluid ever observed in the laboratory. Properties of QGP are being probed intensely in the current experiments at the Large Hadron Collider, CERN, Geneva. Soon after the Big Bang, the universe was in the state of QGP, and the above experiments ("Little Bang") try to recreate that state of matter in the laboratory for a brief period of time. I will highlight the important role the fluid dynamics is playing in this fascinating interdisciplinary area of research at the interface of particle physics and high-energy nuclear physics.

Disentangling the role of geometry and friction in shear jamming

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ABSTRACT: Amorphous packings of spheres have been intensely investigated in order to understand the mechanical and flow behaviour of dense granular matter, and to explore universal aspects of the transition from fluid to structurally arrested or jammed states. Packings of frictionless spheres jam at the random close packing density, of about 64% in volume fraction. However, in the presence of friction, jamming can occur over a broad range of densities, down to the so called random loose packing limit, of 55% in volume fraction. This range also corresponds to interesting phenomena in granular and colloidal suspensions. Recent investigations have focussed on anisotropic packings of frictional grains generated by shear deformation leading to shear jamming, which occurs over a range of densities below the density at which frictionless spheres jam. With the aim of disentangling the role of structures induced by shear deformation and friction in generating shear jamming, we study sheared assemblies of frictionless spheres computationally, over a wide range of densities, extending far below eir jamming point. We demonstrate the emergence of a variety of geometric features characteristic of jammed packings with the increase of shear strain. We thus argue that shear deformation alone is able to generate the necessary structures for shear jamming, while friction is instrumental in stabilising packings over a range of densities below the isotropic jamming point. These results provide a new perspective on random loose packing, and shear thickening behavior that arises above the corresponding density.

Theory and Computer Simulations for Discovery of Materials

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ABSTRACT: The development of novel materials has been essential to technological revolutions occurred in the past, and is rather essential to solving current societal problems of importance, for example using renewable source of energy and water purification. Scientific research for the development of a novel material from a large set of possibilities can be quite long, challenging and expensive. With advances in computing resources and algorithms of simulating materials at various scales, computational modelling and simulations have become an indispensable and cost-effective tool in understanding materials, prediction of novel materials and complementing experiments in materials development. I will first give an essential idea of first-principles theory and simulations of materials, a methodology that captures the dependence of properties of a material on its structure and chemistry. This is achieved through a quantum mechanical description of motion of electrons in a solid. With an example of ferroelectrics, a class of smart materials, I will demonstrate (a) a multi-scale modelling strategy to connect microscopic information of a material at electronic scale to that necessary to model a device based on it [1], and (b) prediction of the world's thinnest known ferroelectric leading to proposal of nano-scale dipolectronic devices. I will finally discuss an integrated computational approach for knowledge-based discovery of materials, in which the existing strengths in materials modelling and their network can be effectively used to generate and share information, train scientists and collaborate with industry in rapid development of new advanced materials.

[1] Umesh V Waghmare, Account of Chemical Research DOI:10.1021/ar500331c (2014).
[2] Sharmila N Shirodkar and Umesh V Waghmare, Phys Rev Lett 112, 157601 (2014).

Cell differentiation: signatures of criticality

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ABSTRACT: Phase transitions are quite common in nature. In a thermodynamic phase transition, there is a transition from one equilibrium phase to another, e.g., from the gaseous to the liquid phase or from the paramagnetic to the ferromagnetic phase. In nonlinear dynamical systems, a different kind of phase transition is possible from one dynamical regime to another, e.g., from a region of monostability to a region of bistability. The transition occurs at special values of the system parameters termed the bifurcation points. Thermodynamic critical point transitions have well-known universal features which do not depend on the molecular details of the systems in which the transitions take place. The transitions at the bifurcation points also exhibit universal features like critical slowing down, rising variance and lag-1 autocorrelation function as well as perfectly correlated/anticorrelated fluctuations. Theoretical modeling combined with experiments provide new insight on dynamical phase transitions in the living cell. The signatures of criticality in such transitions are, however, not well-explored. We discuss the important phenomenon of cell differentiation and some recent experimental observations on the dynamics of cell differentiation. We provide an integrative physical explanation of the experimentally observed features in terms of critical behavior in the proximity of a bifurcation point [1].

[1] M. Pal, S. Ghosh and I. Bose, Physical Biology 12, 016001 (2015)

Quantum Computing with Superconducting Circuits

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ABSTRACT: Quantum mechanics and classical information theory have revolutionized science and technology in the 20th century and have influenced many aspects of our life. Quantum information science brings together these two disciplines and has the potential to further impact science, technology and our life in the 21st century in ways we can only speculate. In this talk, I will introduce the basics ideas behind quantum information and quantum computing. In particular, I will introduce the idea of quantum mechanical electrical circuits and how one can build 'artificial atoms' with quantized energy levels using superconducting circuits. I will provide an overview of the progress in this field and the challenges that lie ahead.

Nanophotonics with Hybrid Plasmons

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ABSTRACT: Surface plasmon-polaritons (SPPs) are surface electromagnetic waves at metal-dielectric interface. In the last decade or so, SPPs have evolved as an important tool in nano-optics, -photonics and –spectroscopy due to the convergence of optical microscopy methods, nano-fabrication tools and numerical modelling. There are generally two varieties of SPPs: localized SPPs and propagating SPPs. The former can lead to localization of optical fields with extremely small mode volumes, and the latter can be harnessed for sub-diffraction limit optical transport. Combining them to form "hybrid plasmons" can lead to sub-wavelength propagation and localization of light on a single platform. In this talk, I shall give two examples of how coupling L-SPPs with P-SPPs can lead to: (a) plasmo-fluidic traps with single-molecule detection sensitivity [1], and (b) nano-optical antennae that can direct light at sub-wavelength scales [2].

[1] P. P. Patra, R. Chikkaraddy, R. P. N. Tripathi, A. Dasgupta, andG. V. P. Kumar, Plasmofluidic single-molecule surface-enhanced Raman scattering from dynamic assembly of plasmonic nanoparticles, Nature Communications *5* (2014).

[2] D. Singh, A. Dasgupta, V. G. Aswathy, R. P. N. Tripathi, and G.V. Pavan Kumar, Directional out-coupling of light from a plasmonic nanowire-nanoparticle junction, Optics Letters *40*, 1006 (2015).

ORAL

Electronic properties of SiC nanorinnons: A density functional theory study

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ABSTRACT: After the synthesis of graphene, research interests on graphenelike materials have been increased. Low dimensionality leads to interesting electronic and magnetic properties that are result of a size and geometry of material. SiC nanoribbons (SiCNR) are derived from their 2D parent material SiC. The interesting properties of these nanoribbons help to tune band gap on the basis of their width and edge geometries. . Using first principle calculations we have performed a systematic study of the electronic structure of SiC nanoribbons, which edges are terminated by hydrogen atom. We studied armchair SiCNR (ASiCNR) and zigzag SiCNR (ZSiCNR) and investigated that ASiCNR are direct band gap semiconductors , exhibit electronic and optical properties, on the other hand ZSiCNR can exhibit half metallicity. Thus, results suggests that ASiCNR are good candidates for can be used in spintronic device applications.

Transport and sensing properties of graphene and its derivatives

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ABSTRACT: Graphene has received tremendous interest in recent years due to its intriguing electronic, mechanical, thermal and optical properties which arise because of its low-dimensionality (2D) and linear band dispersion. Different forms of graphene such as graphene oxide (GO), graphene oxide paper (GOPER) and graphene quantum dots (GQDs) have shown exciting applications in the field of transport, sensing and water purifications. GQDs of average diameter 4.5 ± 0.55 nm, synthesized electrochemically using multiwalled carbon nanotubes (MWCNTs) are found to show hysteresis in current in response to an applied voltage. Hysteresis has been attributed to the presence of charge traps across the channel, which is believed to arise due

to adsorbates present on the quantum dot surface. Our work demonstrates the high sensitivity of GQD and their electrical behavior to the external environment. And the intrinsic humidity sensing properties of graphene quantum dots are explored. The prepared devices were shown to respond to a wide range of relative humidity levels with a fast response time near 8 seconds. The field effect transport studies shows that as prepared graphene quantum dots (GQDs) are p-type in nature ambient condition.
Graphene oxide (GO) has variety of functional groups on the basal planes and the edges which make it a favorable candidate to enhance the surface adsorption of water contaminant molecules. Surface tailored graphene oxide is processed for selective adsorption and to increase the efficiency; it is stacked together through a simple vacuum filtration technique to form a 3-D paper-like material known as graphene oxide paper (GOPER).

Keywords: Graphene, Graphene oxide, Graphene quantum dots, Hysteresis, Humidity Sensors, Water purification

Large Quality Factor of Oscillations in MgO-based spintronics Feedback Based Nano Oscillator

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ABSTRACT: Phenomenon of transferring angular momentum to the local ferromagnetic spins from a spin polarized current has explored novel way of generating microwave oscillations by applying dc current. For practical applications of spintronics oscillators, we need to improve their relatively low output power (~ nW) and relatively larger linewidths (Δf ~ 100 MHz). Here we show, at room temperature, that a narrow linewidth (down to 200 kHz at ~ 2.5 GHz) can be generated from CoFeB-MgO-CoFeB based spintronics oscillator with the proposed scheme. The generated oscillations are observed to be amazingly stable (Q = 12800). Micromagnetic simulations have shown that magnetization precession in different parts of the free layer show phase-locking behavior and hence highly coherent oscillations are obtained. Sustained oscillations of free layer magnetization have been observed in the micromagnetic simulations.These results will be of great significance for

designing MgO-based spintronics oscillators for ultra-sensitive magnetic field sensors and future wireless communication applications.

Structural analysis of $Ge_{1-x}Sn_x$ epilayers grown by MBE

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ABSTRACT: Owing to the development of sophisticated epitaxial growth techniques in the recent past, Ge – on – Si near infrared (NIR) photodetectors (PDs) have emerged to be a very promising candidate for photonic applications. Unfortunately the absorption edge of Ge lies at 1.55 μm and therefore, Ge PDs is not suitable for C – band (1530 to 1565 nm) and beyond in optical fibre communications (OFC). Tin (Sn) in its a-form is also a group-IV semiconductor, and has a zero (direct) band gap. When alloyed with Ge, the bandgap of the resultant alloy can be engineered to values lower than that of pure Ge, which therefore holds the promise of extending the spectral range over which group-IV based photonic devices can be employed. In this paper, we report molecular beam epitaxy (MBE) growth of Ge_{1-x} Sn_x alloys on Ge (001) virtual substrates at TG=1000C, with Sn concentration up to 3.7%. By measuring in-plane and out-of-plane lattice constants in high resolution x-ray diffraction (HRXRD), we could accurately determine the Sn concentration to be 3.7%. Reciprocal space mapping (RSM) of the (004) and (224) reflections revealed that the grown epilayers (113 nm thick) are fully strained. From the width of omega scans in HRXRD we determined the dislocation density to be 8.2×109 cm^{-2}. Cross sectional TEM images showed that the layer grown is highly epitaxial and that the interface is sharply defined. The surface morphology of the alloy epilayers, studied by AFM and HRSEM also revealed the surface roughness increase with increasing Sn concentration. These results bode well for epitaxial growth of Ge_{1-x} Sn_x alloys for highly efficient photonic devices.

Key words: Epitaxy, NIR Photodetectors, MBE, HRXRD.

Heusler alloys for spintronic devices: a material prospective

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ABSTRACT: Due to their high spin polarization, half-metallic ferromagnetic (HMF) materials are found to have potential applications in spintronic devices. Since the prediction of half-metallicity in NiMnSb, Heusler alloys attract a lot of attention due to their high Curie temperature (TC) and tunable electronic structure. Among the large family of Heusler alloys, Co based alloys have special interest due to their experimentally observed high TC and high spin polarization (P). HMF materials have applications as spin polarized current sources for current-perpendicular-to-plane giant magnetoresistive (CPP-GMR) devices, spin injectors to semiconductors, magnetic tunneling junctions, and lateral spin valves. A strong degradation in the transport properties was observed at room temperature for certain materials which show high spin polarization at low temperatures. Thus, further exploration of half-metallic Heusler alloys is strongly desired. In recent studies, a new class of materials known as spin gapless semiconductors (SGS) has been reported to be promising for spintronic applications. SGS have a band structure in which one spin polarized sub-band resembles that of a semiconductor, while the other sub band has a zero band gap at the Fermi level. In my talk, I will discuss some interesting results from the equiatomic quaternary Heusler alloys (EQHAs). We have studied CoFeMnX (X = Si and Ge) and CoFeCrX (X = Al and Ga) alloys in view of their half-metallic and/or spin gapless behavior. CoFeMnSi and CoFeCrGa are found to be SGS, while CoFeMnGe and CoFeCrAl are half-metallic in nature with high P and high TC.

Noble Metal based Anisotropic Nanostructures

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ABSTRACT: Design and study of noble metal based anisotropic nanostructures is a key area of application oriented research due to the tunability of the properties of these nanostructures with respect to parameters such as dimensions, morphology, crystal phase etc. In this work, focus is on subclass of gold based anisotropic nanostructures showing

interesting optical properties. Here, chemical as well as biological synthesis pathways have been developed that lead to formation of anisotropic gold based nanostructures. These nanostructures show substantial absorbance in near infra-red region (NIR) and hence are valuable for a variety of applications including Surface Enhanced Raman Scattering (SERS), sensing and thernostics.

Anisotropic Smartness of Iron oxide Nanoplatform for MRI and Magnetic Hyperthermia

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ABSTRACT: Iron oxide (Fe_3O_4) nanoparticles are most studied magnetic nanoparticles (NPs) for their uses in vast area of technology. Researchers have been doing excellent works to control their magnetic properties which is the key to all applications. Incorporation of different transition metal ions and control their sizes from nanometre to submicron scale serve the purpose effectively. A smarter alternate approach to optimize the magnetic properties is to tailor the shape of the NPs since anisotropy plays a crucial role in deciding magnetic characteristics. For the synthesis of monodisperse NPs we have modified the conventional thermal decomposition to a 'solvent-less' synthesis approach where amine acts as reducing and surface functionalizing agent. Various shapes like rods, octahedrons and nanoparticle assemblies are achieved through simple alteration in reaction conditions. Octahedral shape Fe3O4 NPs exhibits bulk magnetization (~ 92 emu/g) value, due to lesser surface spin disorder. More surprisingly, a characteristic Verwey transition near 120 K is observed in octahedral and cubic NPs of same size with spherical NPs which indicates better stoichiometry in the cubes and octahedral shape. Other than peculiar physical properties, these smarter NPs serve better in application arena also. For example, as a MRI contrast agent, the Fe3O4 nanorods of length 70 nm and diameter 12 nm are efficient with R2 relaxivity value of 608 $mM^{-1}s^{-1}$. NPs assemblies also compared to conventional spherical NPs show much higher SAR value as a potential candidate for hyperthermia treatment and higher R2 value than the commercially available MRI contrast agents.

Effect of substrate and annealing temperatures on magnetic properties of $Co_{(0.1)}Zn_{(0.9)}Fe_2O_4$ thin films deposited by PLD

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ABSTRACT: Cobalt zinc ferrite ($Co_{0.1}Zn_{0.9}Fe_2O_4$) thin films were pulsed laser deposited on fused quartz substrate at various substrate temperatures (Ts) from 150˚C - 750˚C in oxygen pressure of 0.16 mbar. Another set of films deposited at room temperature and ex-situ annealed in air for 2 hours at various temperatures (Ta) from 150˚C - 750˚C. Magnetization measurements of these films were done at 10K and 300K for understanding magnetic properties of this zinc dominant ferrite. Magnetization of the films shows dependence on both substrate and ex-situ annealing temperatures. Magnetization higher than bulk values in these films could be explained based on cationic distribution and grain growth in the films.

Microwave Plasma Simulation and Cavity Designing

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ABSTRACT: There are different types of plasma DC Plasma, Rf Plasma, Microwave plasma etc. I have simulated the Cavity in my MPCVD homemade system will present in this poster. There are so many advantage of use of Microwave plasma over other plasma listed:

1. Stability of the Plasma allows us to grow the film thicker up to months or more.
2. Electrodeless Plasma generation so no formation of plasma sheath take place and also the impurity due to electrode will also not be here as in the case of (HFCVD).
3. Plasma size can be scaled from 6 cm to 16 cm or more.

Disadvantage:
The design of cavity is complicated, but we can simulate it.

Experimental evidence of explosive synchronization in mercury beating heart oscillators.

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ABSTRACT: We have studied, experimentally, the collective behavior of the electrically coupled autonomous Mercury Beating Heart (MBH) systems exhibiting the breathing mode, by varying both the coupling strength and the population size (from N=3 to N=16). For a fixed N, the electrical and the mechanical activities of the MBH systems achieve complete synchronization at different coupling strengths. The electrical activity of each MBH system is measured by the corresponding redox potential (V_i). Additionally, the mechanical activity of each MBH oscillator is visually observed (snapshots and video clips). Subsequently, this activity is quantified by calculating the temporal variation in the area (A_i) of the Hg drop. As a result, the synchronization of the electrical (V_i) and the mechanical (A_i) activities can be measured. The extent of synchronization was quantified by employing the order parameter (r). Our experimental results are found to be in agreement with the Kuramoto theory.

Magnetic and Optical Properties of Trigonal Zigzag Graphene Nanodisks

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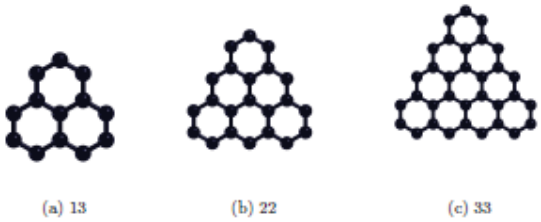
Theoretically, at tight binding, and ab initio density functional theory levels, it has been predicted that triangular shaped nanodisks, with zigzag edges (or trigonal zigzag graphene nanodisks) possess zero energy states, 1,2 which are spin polarized. Because of the triangular shape, the number of A and B sub-lattice sites are unequal, hence at half filling, there exists a finite total spin, due to the unbalanced spins at the two lattices, which in turn, renders these nanodisks magnetic. Figure 1 shows the schematic diagram of three different sizes of trigonal zigzag graphene nanodisks, containing 13, 22 and 33 atoms respectively, containing one, two and three zero energy states at the tight

binding model level. Lieb's theorem3 predicts the total ground spin of graphene based systems, within the Hubbard model with repulsive interactions (U > 0), at half filling to be S =|NA −NB|/2, provided the total number of atoms (NA + NB) is even, where NA and NB are the number of atoms in the two sub lattices A and B respectively.

Multi Reference Singles Doubles Configuration Interaction (MRSDCI) calculations em-ploying Pariser-Parr-Pople (PPP) model have been presented for these nanodisks (cf. Figure1), to find the spin multiplicity of their ground state as a function of size. These ground state calculations have also been undertaken to check whether or not, the results obtained using PPP model, which has long-range Coulomb interactions V , in addition to the on-site Coulomb repulsion U, of the Hubbard model are consistent with those from Lieb's theorem, 3 valid at Hubbard model level. The linear absorption spectra have also been calculated, to get information about the optical signatures of the spin multiplicities of the ground state. From our calculations Lieb's theorem has been verified at PPP model level, for the nanodisk with even number of atoms (22). For the case of nanodisk containing odd number of atoms (33), our computed results predict the low spin (doublet) to be lower in energy than the high spin (quartet), in contrast to Lieb's theorem. Optical measurements can be performed to determine the ground state spin of these nanodisks to test our theoretical results in future experiments.



(a) 13 (b) 22 (c) 33

Figure 1

[1] Motohiko Ezawa. Metallic graphene nanodisks: Electronic and magnetic properties. Phys. Rev. B, 76:245415, 2007.

[2] J. Fernández-Rossier and J. J. Palacios. Magnetism in graphene nanoislands. Phys. Rev. Lett., 99:177204, 2007.

[3] Elliott H. Lieb. Two theorems on the hubbard model. Phys. Rev. Lett., 62:1201–1204,1989

Low temperature growth of highly epitaxial Ge thin films on Si(001) by MBE

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ABSTRACT: High quality Ge epitaxial layers were grown on Si (001) substrates by Molecular Beam Epitaxy (MBE) at TG = 100^0C – 650^0C. Real-time growth monitoring was done by Reflection High-Energy Electron Diffraction (RHEED), which for all samples showed that the germanium films were single-crystalline and two-dimensional. High resolution X-ray diffraction (HRXRD) scans further confirmed that all epitaxial Ge films were fully relaxed and single-crystalline. Full width half maxima (FWHM) measured from scans around (004) peak varied from 0.06^0 to 0.7^0. Raman spectra of all samples exhibit a single sharp peak around 301cm^{-1}, confirming that the Ge layer grown at the lowest temperature (100^0C) also exhibit good crystal quality, comparable to that of high temperature grown films. As TG plays a very important role in achieving layers with sharp contrast in doping concentration (e.g. p-i-n junctions), the present results are promising for realizing various devices such as Ge-based NIR photodetectors and lasers and also for application in CMOS technologies. Further, the epitaxial layers can also be used as virtual substrates for growth of GeSn alloy and GaAs on Si.

Inverted P3HT:PCBM solar cells with high fill-factor

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ABSTRACT: A research project is planned to check the solar cell parameters and understand the device physics of solar cells fabricated with the defect free (DF)- poly(3-hexyalthiophene) P3HT and sigma based commercially available P3HT. Phenyl C61 butric acid methyl ester (PCBM) was used as an acceptor in both the P3HT systems. We achieved a maximum device efficiency of 4.1%

and a fill-factor of 68% after optimizing the device fabrication parameters in DF-P3HT system. The obtained numbers are one of the highest reported values in the inverted P3HT:PCBM solar cells. A comparative study was done for sigma and DF-P3HT based inverted solar cells which were fabricated under same process conditions. Intensity dependent steady state and transient measurement were conducted on the best performing pixels. Ideality factor is calculated from dark I-V and intensity dependent Voc measurements. Decay time constant and charge carrier density of the devices were calculated from the transient photocurrent and photovoltage measurement. DF-P3HT has higher charge carrier concentration when compared to that of sigma based P3HT system which is evident from the EQE and charge carrier density data. We hypothesis that the better performance of the DF-P3HT when compared to sigma-P3HT is due to the higher short circuit current and high charge carrier density. This might be due to the increase in the crystallinity of the DF-P3HT polymer film than that of sigma P3HT films. Examining the cyclic voltammetry and ultraviolet photoelectron spectroscopy data will provide use the complete insight of the reason behind the better performance the defect free P3HT system.

Structural and electronic properties of InN nanowire network grown by VaporLiquidSolid method

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ABSTRACT: Growth of InN nanowires have been carried out on quartz substrates at different temperatures by vaporsolidliquid (VLS) technique using different thicknesses of Au catalyst layer. It has been found that a narrow window of Au layer thickness and growth temperature leads to multi-nucleation, in which each site acts as the origin of several nanowires. In this multi-nucleation regime, several tens of micrometer long wires with diameter as small as 20 nm are found to grow along direction (a plane) to form a dense network. Structural and electronic properties of these wires are studied. As grown nanowires show degenerate n type behaviour. Furthermore, x-ray photoemission study reveals an accumulation of electrons on the surface of these nanowires. Interestingly, the wire network shows persistence of photoconductivity for several hours after switching off the photoexcitation.

Microcontroller Controlled Floating Low Frequency Signal Generation System For Synchronous Detection

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ABSTRACT: Signal recovery from a noisy background is critical to make accurate measurements of parameters like resistances, I-V characteristics of a device or a sample. One of the techniques used to retrieve the signal is synchronous detection. In this technique, an input signal after passing through a sample is multiplied with a reference signal. Mathematically it can be shown that the output signal obtained is a pure DC signal when both the reference and output signal have same frequency and phase.

To implement this technique there are two parts to the instrumentation: the current source and the voltage measurement instrument. In the current source side, when the power supply and the generated output signal are referenced to the ground at different points, the ground potential of the power supply and the output signal are not same, resulting in a ground loop. Due to this, it is necessary to isolate the ground of the power supply, so that the noise does not get picked up at the output. Traditionally, isolation transformers were used for this purpose. However, these transformers are not well suited for applications involving very low frequency (around 1 Hz) due to saturation effects. Therefore, the objective of this project is to design a circuit so as to generate a ground isolated sinusoidal signal using digital opto-isolator.

The project was implemented by interfacing a 32-bit ARM core microcontroller based board with a 16-bit single channel precision digital to analog converter (DAC). Dual power supplies were used with their ground being isolated using a digital isolator. The output when observed with a mixed signal oscilloscope showed that the noise reduction achieved from this module was comparable to the noise level obtained from the commercially available Stanford Research Systems made lock-in amplifier (SR-830). However, it is possible to reduce the noise level to even lower values by using gray coded DAC instead of the present binary coded DAC. This is because in a gray coded DAC, there is only a single bit change between every subsequent change unlike the binary coded DAC. To test the feasibility of this idea, a gray coded DAC will be designed in the near future.

In this project a ground isolated sinusoidal signal was generated with 16-bit resolution in an inexpensive way and the noise level was comparable with the noise level of a commercially available lock-in amplifier. However, there seems to be a scope for further reduction in the noise by using a gray coded

DAC instead of the present binary coded DAC. In future, a design of a gray coded DAC has to be carried out to verify the reduction in the noise level.

Exact background solution for matter coupled higher derivative gravity

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ABSTRACT: AdS/CFT correspondence gives an elegant method to understand transport properties of strongly coupled fluids. The coupling of matter terms with higher curvature gravity theories provides better understanding of the experimentally observed temperature dependent shear viscosity.We present the backreaction of scalar matter coupled higher curvatures on background. We also comment on the effect of backreaction on shear viscosity, entropy density and their ratio.

Infrared Abelian dominance without Abelian projection

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ABSTRACT: Maximal Abelian gauge has been a particular choice to study dynamical generation of off-diagonal gluon masses in QCD. This gauge is a special case of an Abelian projection. Abelian dominance is characterized by off-diagonal gluons acquiring masses in the relevant phase. Here we propose a gauge condition which is quadratic in fields and which does not fall in the class of an Abelian projection. We explore the possible vacua of the gauge-fixed effective action of the theory and find evidence that ghost bilinears may be subject to condensation, which would signal acquisition of masses by off-diagonal gluons. Such a vacuum satisfies the requirement of Abelian dominance, providing an example of the hypothesis through a mechanism other than Abelian projection.

Coherent muon to electron transition experiment at J-PARC facility and relevance of proton beam profile monitor

Amrendra narayan
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ABSTRACT: We will present the physics behind the COMET (coherent muon to electron transition) experiment scheduled to run in 2016 in J-PARC facility in Japan to look for charged lepton flavor violation. It uses a 0.4 μA pulsed beam with 8 GeV energy. We will also introduce the concept and necessity of a beam monitor and extinction monitor for the proton beam on which our team at IIT Bombay is working.

Triplet Harvesting As a Route of Efficient OLED Designing

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ABSTRACT: Emission from organic light emitting diode (OLED) originates due to radiative decay of singlet excitons. The spin statistics limits the formation of singlet exciton in these excitonic materials. Only 25% out of the total exciton produces singlet where the rest form the non-radiative triplet states. The external quantum efficiency (EQE) of an OLED is a measure of emitted photons in the forward direction per injected charge carriers inside the device. EQE of OLED is product of four major factors: charge balance ratio (Υ), singlet formation factor (η_S), photoluminescence quantum yield (η_{PL}) and the light out coupling factor (η_{out}). At ideal conditions by considering perfect charge balance, 25% singlet formation yield, 100% η_{PL} and 20% η_{out} for OLED, the theoretical upper limit for EQE becomes 5%.

The non-radiative triplets in this situation provide an alternative way to improve the OLED efficiency significantly. Having considerably higher lifetimes than singlet, triplet population in the device crosses singlet population by number of orders. This produces triplet-triplet annihilation (TTA) which in turn provides either singlet or higher energy triplet states. The secondary triplet states can further follow the cycle to produce singlet. Thus

the secondary bimolecular TTA process gives birth to radiative singlet and henceforth increasing the device efficiency.

Organic-Inorganic Perovskite ($CH_3NH_3PbX_3$) Materials: structural, Optical properties for device application (X= Cl, Br or I)

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ABSTRACT: We report on the structural, optical properties of AB(I1- xBrx)3 and AB(Br1- xClx)3 (where, A = CH3NH3+, B= Pb2+ and x = 0 to 1) perovskite semiconductor.

POSTER

Experimental evidence of explosive synchronization in mercury beating heart oscillators.

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ABSTRACT: We report experimental evidence of explosive synchronization in coupled chemo-mechanical systems, namely in Mercury Beating Heart (MBH) oscillators. Connecting four MBH oscillators in a star network configuration and setting natural frequencies of each oscillator in proportion to the number of its links, a gradual increase of the coupling strength results in an abrupt and irreversible (first order like) transition from the system's unordered to ordered phase. On its turn, such a transition indicates the emergence of a bistable regime wherein co-existing states can be experimentally revealed. Finally, we prove how such a regime allows an experimental implementation of magnetic-like states of synchronization, by the use of an external signal.

Synthesis of Cu_2ZnSnS_4 (CZTS) thin films and evaluation of their structural, morphology and optical properties for solar cell applications

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ABSTRACT: Interest in the development and commercialization of thin film solar cells has been growing over the past decade because of their low cost and scalability. These two key factors needed to make solar technologies competitive with carbon-based fuels. The recent advances in CdTe and $CuIn_{1-x}Ga_xSe_2$ (CIGS) thin film solar cells have resulted in commercially viable photovoltaic modules. Despite having moderate efficiencies, CdTe and CIGS are not amenable for ultimate TW power production due to the cost and scarcity of Te, In, and Ga. Therefore, one major challenge of thin film technology is to develop PV materials composed of earth abundant and non-toxic elements that can be used to manufacture efficient photovoltaic devices at low cost. The CZTS is an emerging solar absorber that is structurally similar to CIGS, but contains only earth abundant, non-toxic, low cost elements and has a near optimal direct band gap of 1.4-1.6 eV and a large absorption

coefficient of ~ 104 cm^{-1}. A variety of techniques, both vacuum and non-vacuum based have been used to prepared CZTS thin films for absorber layers, such as atom beam sputtering, radio frequency magnetron sputtering, hybrid sputtering, thermal evaporation, photochemical deposition, electrodeposition, spray pyrolysis, pulsed laser deposition. Each method has its own advantages and disadvantages during the growth of CZTS films. For example, in sputtering, the composition of CZTS thin films strongly affected by the RF power employed. Besides the desired CZTS materials, secondary phases $Cu_{2-x}S$ and Cu_3SnS_4 were also observed in the materials and further characterization showed that the carrier concentration of the films was of the order of 1018 cm^{-3}. The sputter and vapor deposition methods for CZTS thin film synthesis are costly, and have low throughput, and can lead to inhomogeneous film composition. Kamoun and Kumar et al. found Cu_xS impurities in spray deposited CZTS films at various substrate temperatures and deposition times while Kumar reported the films were Zn-rich and S-deficient. In sol-gel method, due to the high vapor pressure of sulfur, CZTS films were S-deficient. Scragg, et al. reported the electrochemical deposition of CZTS films but traced amounts of binary impurities such as SnS_2 and ZnS. In all cases the films were Zn-rich but the Zn composition varied across the film. Therefore, investigations of alternative low cost deposition techniques, which allow synthesis of CZTS films of desired properties, are inevitable. Furthermore, preparation of CZTS films with maintaining device material quality is of major technological importance.

The Cu_2ZnSnS_4 (CZTS) is an emerging solar absorber that is structurally similar to CIGS, but contains only earth abundant, non-toxic, low cost elements and has a near optimal direct band gap of 1.4-1.6 eV for solar cell. A variety of techniques, both vacuum and non-vacuum based have been used to prepared CZTS thin films. Each method has its own advantages and disadvantages during the growth of CZTS films. Hence, investigations of alternative low cost deposition techniques, which allow synthesis of CZTS films of desired properties, are inevitable.

Graphene Oxide based Hybrid Nanostructures with ZnO Thin Films and Nanorods

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ABSTRACT: Graphene oxide (GO) monolayer sheets were transferred on to sputtered ZnO films and chemically grown ZnO nanorods by Langmuir-Blodgett technique. SEM images show that the GO sheets are well defined and

uniformly distributed over both surfaces, namely, ZnO film and ZnO nanorods. Raman studies show that the ZnO film has a higher reducing effect on GO monolayers compared to ZnO nanorods, with the most effective reduction at intermediate temperatures in the range of 400 - 600 ^{o}C, and a degradation of GO sheets on both structures, after heat treatment at 800 ^{o}C. Photoluminescence spectra of heat treated GO/ZnO film and GO/ZnO nanorods show characteristic near-band-edge emission of ZnO, which is not significantly affected by the presence of RGO sheets.

Plastic Flow under applied pressure gradient

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ABSTRACT: We are reporting different properties of plastic flow in polycrystal under applied pressure gradient by Modified Phase field crystal method (MPFC) .MPFC is in between atomistic simulation and phase field method. This model includes dislocations, grain boundaries by its natural tendency other than MD where one have to introduce defects by hand. We have seen that the behaviour of polycrystal is in between amorphous material and ideal crystal because it shows plug flow like velocity pattern with finite slip at boundary.It also shows a power law pattern in grain size distribution.

Spin gapless semiconducting behavior in quaternary Heusler alloys

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ABSTRACT: Spin gapless semiconductor (SGS) is a new class of magnetic semiconductors, which has a band gap for one spin sub band and zero band gap for the other, and thus are useful for tunable spin transport based applications. Because of their unique properties along with high Curie temperature (TC), these are being considered as substitutes for diluted magnetic semiconductors and are suitable for room temperature spintronic applications. We have theoretically studied the electronic properties of quaternary Heusler alloys CoFeMnSi (CFMS) and CoFeCrGa (CFCG) and verified these features experimentally by performing magneto-transport and

spin polarization measurements. The most stable atmoic configuration obtained by the theoretical calculation is verified by experiment. The alloys are found to crystallize in the cubic Heusler structure (LiMgPdSn prototype). The electronic band structures of both the alloys exhibit band gap in the minority spin channel and almost zero gap with negligibly small value of density of states (DOS) in the majority spin channel. The saturation magnetizations (MS) satisfy the Slater-Pauling rule and the Curie temperatures (TC) are found to exceed 400 K for both the alloys. Nearly temperature-independent carrier concentration and electrical conductivity are observed which are prerequisite for SGS. Anomalous Hall coefficients of 162 S/cm and 185 S/cm are obtained at 5 K for CFMS and CFCG respectively. Point contact Andreev reflection data has yielded around 60% current spin polarization value, which is found to be robust against the structural disorder. All these properties strongly suggest SGS nature of the alloys, which is quite promising for the spintronic applications.

Cross correlation technique for noise measurements in different configurations.

Aditya Jain
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ABSTRACT: A method of cross correlation technique will be presented, which can measure ultra-low voltages precisely, and measure fluctuations in real time to give average spectrum. And thus we can measure thermal noise and flicker noise.

Linear optical properties of fullerene for singlet and triplet states

Deepak Rai
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ABSTRACT: Linear optical properties of fullerene for singlet and triplet states.

Collective force generation by multiple microtubules against harmonic force

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ABSTRACT: Invitro experiments have been performed on multiple microtubules to study their collective force generation. Here, we investigate the growth of multiple microtubules against a harmonic force, and find that the collective stall force of multi-filament system exceeds the total stall force by the individual filaments. We study the dependence of this result on experimentally variable parameters, namely, concentration of free monomers and the stiffness constant of the harmonic trap.

Single Spin Asymmetry in $e + p^{\uparrow} \rightarrow e + J/\psi + X$

Sangem Rajesh
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ABSTRACT: Single spin asymmetry (SSA) has been observed experimentally, but perturbative QCD has predicted zero SSA. "Sivers functions" can be used as a tool to explain the SSA within the transverse momentum dependent (TMD) factorization formalism. We consider a process $e + p^{\uparrow} \rightarrow e + J/\psi + X$ to extract the gluon sivers function using color evaporation model. We estimate the sizable SSA for JLab, HERMES, COMPASS and eRHIC experiments.

Newly emerging perovskite material for applications in photovoltaics

Parul Maheshwari
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ABSTRACT: Organic–inorganic perovskites are currently one of the hottest topics in photovoltaic research, with power conversion efficiencies of cells on a laboratory scale already competing with those of silicon cells. Most enhancements in cell performance have been achieved by improving the quality and coverage of the perovskite films. My poster talks about two

different fabrication techniques and pros and cons of those. Calculation of excitonic binding energy and effective reduced mass is also discussed.

Impact of nitrogen plasma power variation on the structural and optical properties of InN layers grown on c-sapphire substrates by molecular beam epitaxy technique

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ABSTRACT: High quality epitaxial InN layers were grown by plasma assisted molecular beam epitaxy technique on sapphire substrates with low temperature GaN interlayer. With In flux fixed at beam equivalent pressure of 1.8E-7 Torr, nitrogen plasma power was varied from 240W to 340W in 20W step. It was observed that the initial In-rich growth regime was switched to N-rich condition when the plasma power exceeds 300W. The full width half maximum (FWHM) of the high resolution x-ray diffraction peaks (0002) of InN was estimated to be around 170 arc-sec for all the layers grown with different plasma power. The photoluminescence spectra measured at 78K exhibited a distinct sharp peak at 0.74 eV with FWHM of 10 meV for all the layers. An additional broader peak with FWHM ranging from 40meV to 60 meV was observed to blue shift from 0.75 eV to 0.78 eV with the increasing nitrogen plasma power from 240W to 340W. This peak is apprehended to be the signature of the optical absorption edge and the shift may be attributed to the Moss-Burstein effect of conduction band minimum (CBM) filling due to change in stoichiometric condition which may have led to the band gap renormalization. The Raman data supports the carrier filling effect at the CBM. Further investigations such as infra-red absorption, X-ray and ultraviolet photoelectron spectroscopy to understand the absorption edge, valence band structure and Fermi level are under progress. The present study reveals that the best quality InN films can be obtained at near-stoichiometric condition.

Femtoscopy in ALICE at Large Hadron Collider, CERN

Ashutosh Kumar Pandey
Indian Institute of Technology Bombay

ABSTRACT: In high energy heavy ion collisions, the dimension of fireball produced is of order of uncertainty limit which cannot be measured directly. We use Femtoscopy as a tool to extract the dimension, shape and different particle species emission asymmetry.

Dielectric and Magnetic Properties of Lead-Free Multiferroic (1-x)($Bi_{0.5}Na_{0.5}$)TiO_3/$_xCoFe_2O_4$ Composites

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(1-x)(Bi0.5Na0.5)TiO3/x$CoFe_2O_4$ composites with x=0, 0.1, 0.2, 0.3, 0.4 and 0.5 were synthesized by solid state reaction method. Presence of distinct ferroelectric ($Bi_{0.5}Na_{0.5}$) TiO_3 and ferrite $CoFe_2O_4$ phases in the prepared composites have been confirmed by the X-ray diffraction analysis and field emission scanning electron micrographs. The variation of dielectric constant with temperature for these prepared composites show an anomaly near antiferroelectric to paraelectric phase transition temperature (~345 ^{0}C) of pure ($Bi_{0.5}Na_{0.5}$) TiO_3 ceramics. The dielectric constant of the composites at low frequency range decreases with increase in $CoFe_2O_4$ content up to x= 0.3 but increases for x=0.4 and x=0.5. The value of remnant magnetization for 10 and 50% $CoFe_2O_4$ are 2 and 14 emu/g respectively. The maximum value of magnetocapacitance was found to be ~4.37% for 50% $CoFe_2O_4$ content.

Understanding the role of mobile ion impurities in the organic lateral diode devices made on Glass substrate and Si substrate.

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ABSTRACT: Organic polymers like P3HT, F8BT and F8 have large area of application in opto- electronics. It is necessary to understand charge transport of these material with different substrate. Here we have studied that these polymers have different charge transport properties with respect to substrate and in device configuration. The large instabilities is observed on the glass substrate in different polymer whereas the instabilities is reduced by Si substrate. There are more impurity ions diffused in glass as compare to Si substrate. We also confirmed that the bias stress defects is not depends on semiconductor/dielectric interface whereas it is dependent on material by P3HT lateral device on Si substrate.

Design and Development of Medical Accelerator Head Assembly for Cancer Therapy Application

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ABSTRACT: Important components of a radiation therapy medical accelerator head assembly consisting of a 270 degree magnet, scattering foils, x-ray target and Applicators have been designed, fabricated for 6 to 18 MeV electrons and successfully tested in the laboratory. For radiation therapy, a linear accelerator of variable energy ranging from 6 MeV to 20 MeV is mounted horizontally and the extracted electrons are used for the cancer therapy applications by employing the above mentioned components. The profiles of the electron and photons required for treatment are of square shape and can be varied in the range of 10x10cm2 to 25x25cm2 through specially designed Scattering foils and Applicators. The profiles of 6 to 20 MeV electrons at a distance of 100cm from the scattering foil are found to be uniform within ±5%. The above results reveal that the developed system components can be used for the cancer treatment and other applications.

After successful development and testing of the accelerator head components in hospitals, the present system will be duplicated and produced on commercial basis. Such systems are required at every district place in the country.

Analysis of Raman active modes and charge disproportioned states in $BaFeO_{3-\delta}$: A first principles calculation

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ABSTRACT: Perovskites are materials with chemical composition ABO_3 (B=transition metals). These class of systems often act as promising ferroelectric material. One of the intriguing features of these materials, observed in the recent past, are the evidence of charge disproportionation of 'B' type atom. Although there has been some experimental studies (PRB 71, 245110 (2005)) based on the Raman scattering to explain this feature, but a detailed theoretical understanding is still lacking. Our main aim here is to study the role of lattice dynamics in the formation of charge disproportioned state in $BaFeO_{3-\delta}$. We use first principles Density Functional Perturbation Theory (DFPT) to investigate the electronic structure and various phonon modes (Raman active+inactive) of $BaFeO_{3-\delta}$. We shall also perform Raman spectroscopy measurements to complement our first principles calculations.

The 3 pion decay of the omega meson with WASA-at-COSY experiment

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ABSTRACT: A pilot study on meson decays in proton-proton reactions above the omega meson production threshold has been performed. The challenges of using p-p reactions at the higher energies lies in reconstructing fast protons and in the considerable multi-pion background. We plan to study the feasibility of addressing rare decays in these reactions, especially conversion

decays leading to the determination of transition form factors. First, we focus on the 3 pion final state. In particular, we look for the 3 pion decay of the omega meson to analyze the Dalitz plot distribution.

Heavy-flavour correlations in pp, p-Pb and Pb-Pb collisions with ALICE

Jitendra Kumar
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ABSTRACT: A variety of experimental results and theoretical studies has established that in heavy-ion collisions at RHIC and LHC energies, a state of matter consisting of deconfined quarks and gluons, the Quark Gluon Plasma (QGP), is formed. ALICE (A Large Ion Collider Experiment) is designed and optimized for the study of heavy-ion collisions at the LHC. Because of their large masses, heavy quarks (charm and beauty) are predominantly produced in hard scattering processes in the initial stages of the collision. Therefore, heavy quarks experience the whole collision evolution, and are excellent probes to study the properties of the medium formed in these collisions. While interacting with the medium, they lose energy via both collisional and radiative processes as supported by several measurements. One of them is the observation of the strong suppression of D-meson production for $p_T > 4$ GeV/c in the most central Pb--Pb collisions with respect to pp collisions scaled by the number of binary nucleon-nucleon collisions.
Further insights into the effects of the medium on charm and beauty production can be obtained by measuring the angular correlations between heavy-flavour hadrons (or their decay products) and charged particles. The comparison of the azimuthal correlations in pp and Pb--Pb collisions provides information on the processes by which heavy quarks lose energy in the QGP and the possible modifications of the charm parton shower and hadronization in the presence of the medium. Measurements of angular correlations in p--Pb collisions can be sensitive to cold nuclear matter effects on charm production and hadronization. The azimuthal correlation measurements in pp collisions are also a baseline to interpret p--Pb results, and probe the heavy quark production mechanism and their hadronization.
Results from the analyses of angular correlations of D^+ mesons and charged particles are discussed using the data collected with ALICE in pp collisions at $\sqrt{s}$= 7 TeV and in p--Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV. A comparison to the model expectations will also be discussed.

Tuning the SPR of Biodegradable Liposome-Gold Nanoparticles to NIR Range for Photo-Thermal Therapy of Cancer.

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ABSTRACT: Thermo-sensitive liposomes were prepared by thin film hydration method followed by gold coating to form Liposome-Au nanoparticles (Lipos-Au NPs). These particles were tuned to have an NIR absorbance of 750nm that was put to use in optical/CT imaging and photothermal treatment. Engineered MCF-7-fluc2-TurboFP & HT1080-fluc2-TurboFP cancer cell lines were studied for their response to photothermal effect induced by the Lipos-Au NPs in the presence of 750nm NIR laser. It was observed that the fluorescence of the cells exhibited by the dual reporter firefly luciferase 2 and TurboFP protein significantly reduced ($P = 0.0034$) when Lipos-Au NPs incubated with the cancer cells were irradiated with NIR laser. The luciferase enzyme activity was quantified using D-luciferin substrate addition at the end of 24 hours using the IVIS -Lumina-II imaging system. There was no luminescence observed in the cancer cells that were treated with both Lipos-Au NPs and NIR laser in comparison to the controls. Biodistribution and pharmacokinetics of Lipos-Au NPs were studied in small animals for varying time periods (1, 7 and 14 days). It was observed that these particles were degraded by the enzymatic reaction into smaller particles whose size range was ideal for renal excretion in addition to hepato-biliary route. The long term in-vivo analysis also confirmed the bimodal clearance of these NPs. In the in-vivo tumor model, there was a significant reduction ($P < 0.01$) in tumor volume leading to prolonged survival. These findings hold great promise in translating such novel nanosystems into the clinics to improve patient health care.

Gene expression

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ABSTRACT: Gene expression is the preocess by which proteins are produced from dna. Although it consists of transcription (mrna productionj) and translation (mrna to protein coding), our focus will be mainly on transcription in this poster. We'll consider a single state promoter and then a two state

promoter model to explain the process of transcription and use master equation to find the probability density of having particular no. of mrna at an instant and finally conclude that two state promoter model is more efficient to explain the transcription process in actual eukaryotic cells.

Tube formation in Ftsz coated Vesicles.

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ABSTRACT: Often phospholopid lipid vesicles show formation of tubes on its outer surface. Such tubes can be extruded by applying external suction force through a picropipette or by a motor protein pulling onto the membrane. But bilayer phospholopid vesicles can also undergoes spontaneous tubulation i.e., it can form tubes without application of any external force Bacterial cytoskeletal protein FtsZ when adsorbed onto liposomes can not only create dimples on the membrane but can also give rise to narrow membrane tubes in the presence of excess GTP. Osawa et al reported such tubes whenmembrane targeted FtsZ (FtsZ-mts) adsorbed on large liposomes. Both convex and concave depressions (dimples) have been reported depending on how the membrane targetting has been achieved. Here we theoretically study the resulting membrane deformations and tube formation upon FtsZ adsorption, using energy consideration.

Structural and luminescence properties of GaN nanowires

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ABSTRACT: In recent years, GaN nanowires (NWs) have attracted tremendous attentions because of their potential for developing nanoscale electronic and optoelectronic devices, which are expected to offer new functionalities as compared to their conventional bulk counterparts. Structural and luminescence properties of GaN nanowires grown by vapor-liquid-solid technique using Cobalt phthalocyanine as catalyst are systematically studied using variety of different structural characterization

and photoluminescence (PL) techniques as a function of various growth parameters such as the growth temperature and III/V ratio. The study reveals that most of the nanowires grow along direction in this method. Interestingly, the average wire diameter is found to decrease with the increase of III/V ratio. It has been observed that the growth temperature and III/V ratio can be optimized to completely suppress the defect related luminescence feature. PL does not show any other defect related transition in the sub band gap region. At all temperatures, PL spectrum is found to be dominated only by a band edge feature, which comprises of a free

And a bound excitonic transition. The study further more reveals that the bound excitonic feature is associated with excitons trapped in certain deep level defects, which result from the deficiency of nitrogen during growth.

Effect of Substrate and Annealing Temperatures on Magnetic Properties of Zinc Ferrite Thin Films

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ABSTRACT: Zinc Ferrite ($ZnFe_2O_4$) exhibits paramagnetism in the bulk form but may show ferrimagnetic order at room temperature (RT) in thin film form, under specific preparation conditions [1-2]. We report a novel study of ferrimagnetic ordering along with ferromagnetic resonance (FMR) on the films prepared at varying substrate temperatures (TS) and annealing temperatures (TA). The films are deposited by PLD at different TS in the range, RT to 750 °C. The films were ex-situ annealed in the temperature range 350-650 °C in air for 2 hrs. The XRD of these thin films confirmed them to be single-phase $ZnFe_2O_4$. Magnetic measurements were carried out at 10 K and 300 K using a PPMS. The given figure shows a plot of spontaneous magnetization ($4\pi M_S$) at 10 K, as a function of TS for different TA. For the films annealed at 650 °C, $4\pi M_S$ is very small and the material behaves like bulk. We also find that $4\pi M_S$ goes up with an increase in TS and then decreases. Similar initial increase in $4\pi M_S$ is also seen with TA for TS<450 oC. The films deposited at TS=450 °C, shows a maximum magnetization value of

6620 G. Such a large value of 4.27 Bohr magnetons per formula unit can be explained, only when we assume that ~30% of Fe3+ ions are on A site and the remaining ~70% on B sites. This is unlike the case of bulk ZnFe2O4 where all Fe3+ ions are located on B site. Our study also indicates that the cation distribution correlates well with the observed grain sizes, which in turn correlates with the obtained magnetization. An interesting observation has been the non-monotonic variation of linewidth with the deposition temperature. Details of the magnetization and FMR studies on these thin films as a function of TS and TA would be presented in this paper.

1. Seisuke Nakashima et al., J. Phys.: Condens. Matter 17, 137 (2005)
2. M. Sultan et al., J. Appl. Phys. 105, 07A512 (2009)

Electronic Properties of Excess Cr in FeCr0.02Se Alloy

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ABSTRACT: We have studied the effect of transition-metal chromium (Cr) in excess on the electronic properties of FeCr0.02Se alloy. In our calculations, we have used Korringa-Kohn-Rostoker Atomic Sphere Approximation method within the coherent potential approximation (KKR-ASA-CPA). Our calculations show that FeSe and $FeCr_{0.02}Se$ are non-magnetic. The unpolarized calculations show a subtle change in terms of density of states, band structure and Fermi surface with respect to the pure FeSe.

Cluster spin glass behavior in geometrically frustrated $Zn_3V_3O_8$.

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ABSTRACT: We report the bulk magnetic properties of a yet unexplored vanadium based multivalenced spinel system, $Zn_3V_3O_8$. A Curie-Weiss fit of our dc magnetic susceptibility (T) data in the temperature region of 140−300 K yields a Curie constant C = 0.75 cm^3K/mole V, CW = −370 K. We have observed a splitting between the zero field cooled (ZFC) and field cooled (FC)

susceptibility curves below a temperature Tirr of about 6.3 K. The value of the 'frustration parameter' (| CW|/TN= 100) suggests that the system is strongly frustrated. From the ac susceptibility measurements we find a logarithmic variation of freezing temperature (T_f) with frequency attesting to the formation of a spin glass below T_f . However, the value of the characteristic frequency obtained from the Vogel Fulcher fit suggests that the ground state is closer to a cluster glass rather than a conventional spin glass. We explored further consequences of the spin glass behavior and observed aging phenomena and memory effect (both in ZFC and FC). We found that a positive temperature cycle erases the memory, as predicted by the hierarchical model. From the heat capacity CP data, a humplike anomaly was observed in CP /T at about 3.75 K. Below this temperature the magnetic heat capacity shows a nearly linear dependence with T which is consistent with the formation of a spin glass state below T_f in $Zn_3V_3O_8$.

Synthesis, Characterization and Protein Conjugation of CdTe Quantum Dots

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ABSTRACT: Colloidal semiconductor nanocrystals or quantum dots (QDs) have unique size-dependent properties which have attracted great scientific and technological interest. By modulating the size of the QDs their optical properties can be changed and can be utilized for the various applications. QDs are reported to be used as a fluorescence agent for the biological reporting. There are two methods for organometallic synthesis of QDs, one is aqueous synthesis and other is organic synthesis. As the biological system requires aqueous environment, QDs synthesized with organic solvents need time consuming processes to convert them in water soluble forms. Thus the aqueous QDs synthesis method becomes more attractive as it is much cheaper and also found suitable for biological applications.
We are here reporting the aqueous synthesis of CdTe QDs with bright fluorescence. These QDs were synthesized using the metal salts and mercaptan acid as stabilizing agent. Characterization was done by fluorescence, UV absorbance spectroscopic measurement, XRD, FTIR and TEM. During and thereafter we carried out the fractional separation of the QDs using ethanol and obtained the various color range of QDs. These QDs

have different color range because they have different sizes. These different color and size range of QDs can be utilized in biosensing applications.

SymPhy Souvenir 2015

The Fifth annual
symposium of the
Department of Physics
IIT Bombay

Coordinator: Prof. Aftab Alam

SYMPHY, symposium in Physics organized by the Department of Physics IIT Bombay is entering the 5th year. Over the years, the symposium is gaining momentum as more and more participants are registering to attend. It is good to see that eminent physicists are taking part in the symposium and giving talks, which benefit the students of our department. Giving a national character this year is a plus point to this symposium. Looking at the list of speakers, I am sure the symposium will be a grant success this year and the students are going to immensely benefit.
My best wishes for the symposium and special thanks to the organizing team.

-Prof.C.V. Tomy
Head, Physics Department

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SYMPHY has been organised in the department of physics, IIT Bombay from the last five years. Being a new faculty in the department, i have become a part of it from yesteryear only. The main motivation behind this symposium is to encourage new minds/researchers to come forward and interact with the leading scientists across the country. It has been a unique experience working with the students to organise such a symposium. This year, we tried to attract leading researchers from various fields of physics to come to IIT Bombay and deliver motivational talk. Unlike other conferences/workshops, this symposium is not on a focused research area but rather cover a broad area of physics. The main reason for executing it this way is to entertain the need of ALL the students working in various areas.
This year, the organizing committee has worked really hard to arrange everything in place. I am really happy to see their enthusiasm to work in group and accomplish things in order. Although we received very active participation response from scholars/students, we expect better response from the contributory participants who opted for presentations. On behalf of the organizing committee, i would like to thank ALL the invited speakers to take time out of their busy schedule and enlighten us with their encouraging talk. I hope we will continue the trend of this symposium for years to come.

-Prof. Aftab Alam
Faculty Coordinator, SYMPHY – 2015

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IT was my pleasure to be part of SYMPHY 2014. I was first time got introduced to wide variety of "research in physics" happening in our department. Invited speaker from outside Phys.-IITB and our own faculty colleague delivered very

informative talk which was pitched exactly at right level to get absorbed by wide audience. Poster session and oral presentation made by students were clearly showing the rising bars of research standards in department, my heartiest congratulations to all presentation for their scientific achievements. I wish to part of this event again in future and congratulate the whole SYMPHY team for this successful event.

Best wishes – Prof. Dinesh Kabra

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My heartiest congratulations to the students of Physics department for keeping SYMPHY alive, and well. In my experience of 36 years in the department, the student activities, especially for publicity of the research activities of the department has rarely been sustained, and I sincerely hope, SYMPHY will grow and dispel the general notion of our common Indian public and politicians that IITs gobble up funds with dismal research output. Show it to them boys that the IIT is not behind in research in frontiers of Physics, but behind in showing off, because we are trained to be modest. Good luck to you all for a resounding success of SYMPHY.

-Prof. G. Mukhopadhyay

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It was a great pleasure to have participated in SYMPHY 2014. The students had assembled a very impressive lineup of speakers from both inside and outside IIT Bombay, and I enjoyed and learnt a lot from listening to these speakers talk about their area of expertise and their own fascinating results. I was also impressed with the quality of the student talks that were delivered at SYMPHY. Overall, I felt the symposium was organised very well, and provided a forum for a very stimulating exchange of ideas, with students taking the lead in the organisation and participation. I wish the organisers of SYMPHY continued success, and I look forward to another weekend of engaging seminars and interactions at SYMPHY 2015.

-Prof. Mithun Mitra

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SYMPHY now in 5th year has grown from completely an intra-department event to a multi-disciplinary national symposium. It is a very good platform for the PhD students to showcase their research and to get familiarized with the research carried out by other prominent research groups in the Institute as well as outside. Over the years, Physics department research scholars have been enthusiastically

organizing this event. I am sure that SYMPHY will keep gaining momentum every year and become an important event on the national level.

-Prof. Parinda Vasa

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At the end of March last year, a few research scholars of our department walked into my office and asked me if I would like to be the Faculty Coordinator of SYMPHY 2014. Since I had no clue what SYMPHY stood for, having joined the department only in April of the previous year, I needed to be educated that SYMPHY stood for Symposium on Physics (which later I found out was "of everything"), which the PhD students of the Department organized every year. They told me three things about the event (a) that they wanted to scale it up by inviting speakers from across the country (for the first time), (b) that they had very little time left till the event , and (c) that they didn't have enough funds for the event. Now, who wouldn't want to step in the role of a coordinator of such an event!

In the next thirty days, I would find a team of twenty-odd students work almost round the clock to put up a great show at the end. With five invited talks by distinguished speakers from institutes across the country, hundred-and-fifty-odd student-participants, and the delicious lunch menu, I believe SYMPHY 2014 was quite a successful event. Despite last-minute change of venue and no assurance of funds until almost the last week, the weekend of SYMPHY went surprisingly smooth, thanks to the support of the Deputy Director (DD AIA) and the HOD of the Physics Department. For me it was a great learning experience of organizing an event within the IITB milieu. I'm very happy to see SYMPHY grow up from being an in-house symposium to a "National Conference on Physics".

-Prof. Suddhasatta Mahapatra
Faculty Coordinator, SYMPHY – 2014

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It is good to see the enthusiasm for this conclave among research students. It is a good exposition of work being done in our department and exposure to current trends from invited experts.

-Prof. U A Yajnik

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Being a General Secretary of Research Scholar Association of Physics (2013 – 14) I was supposed to be the co-convener of Symphy – 2014. With so many burdens in

my research activities I can foresee how tough it would be to get my team done with the SYMPHY. The committee selected Prof S. Mahapatra as the convener and I was supposed to inform him. Before informing him I thought the role of convener would be just to give signature to some official letters. But, he really took part in the team and co-ordinate us. He was the one who took the pain and burden for the success of the SYMPHY-2014. And also all my fellow research scholars who were in the committee did all for the success of the event with enthusiasms and hard effort were put into it. Personally though I wasted almost three months for not concentrating my research topic I am happy to be among the members of the team to bring a platform for our fellow researchers to enhance the betterment of mankind through research in physics. I will cherished those great moments whenever I think about IITB Physics Department.

-Krista R Khiange
Co – convener, SYMPHY – 2014