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3 Experimental Nuclear and Particle Physics

3.1 Applied Nuclear Physics

3.1.1 Summary of Research Activities

3.1.2 Publications

3.1.3 Seminars/Lectures given in Conference/Symposium/Schools

3.1.4 Honours and Distinctions

3.2 High Energy Nuclear and Particle Physics

3.2.1 Summary of Research Activities

3.2.2 Publications

3.3 Nuclear Physics

3.3.1 Summary of Research Activities

3.3.2 Developmental Work

3.3.3 Publications

3.3.4 Seminars/Lectures given in Conference/Symposium/Schools

3.3.5 Teaching elsewhere

4 Plasma Physics

4.1 Plasma Physics

4.1.1 Summary of Research Activities

4.1.2 Publications

4.1.3 Ph D Awarded

4.1.4 Seminars/Lectures given in Conference/Symposium/Schools

5 Theoretical Physics & Astroparticle Physics

5.1 Astroparticle Physics and Cosmology

5.1.1 Summary of Research Activities

5.1.2 Developmental Work

5.1.3 Publications

5.1.4 Ph D Awarded

5.1.5 Seminars/Lectures given in Conference/Symposium/Schools

5.1.6 Teaching elsewhere

5.2 Theory

5.2.1 Summary of Research Activities

5.2.2 Publications

5.2.3 Ph D Awarded

5.2.4 Seminars/Lectures given in Conference/Symposium/Schools

5.2.5 Honours and Distinctions

6 Research Fellows/Visiting Fellows/Research Associates

6.1 Visiting Fellows/Research Associates and Research Fellows

6.1.1 Research Fellows

6.1.2 SRF(EX), PDF, RA, VS, VF

6.1.3 Post M Sc Students/Fellows

7 Facilities

7.1 Centre for Advanced Research & Education

7.1.1 The Post-M Sc Associateship Course

7.2 Electron Microscope Facility
HEVESY MEDAL AWARD-2015 First time from INDIA

The George Hevesy Medal Award is the premier international award of excellence in radioanalytical and nuclear chemistry. The George Hevesy Medal is awarded to an individual in recognition of excellence through outstanding, sustained career achievements in the fields of pure as well as applied nuclear and radiochemistry. The Hevesy Medal Award -2015 is given to two candidates (names in alphabetical order) (i) Professor K. V. KATTI from University of Missouri-Columbia, U.S.A., and Professor Susanta LAHIRI from Saha Institute of Nuclear Physics, Kolkata, India. For the first time Hevesy Medal Award has been bestowed to someone from India since its inception in 1968.

Professor LAHIRI will receive his award for his outstanding contributions on heavy ion induced radioisotope production, tracer packet technique, converter targets, and green chemistry. It is noteworthy to mention that except converter targets (which have been carried out in CERN-ISOLDE) all other works have been carried out in India using the Indian accelerator facilities like BARC-TIFR Pelletron and Variable Energy Cyclotron Centre. In heavy ion activation, Professor Lahiri for the first time, produced clinically important alternative radioisotopes by heavy ion activation using heavier projectiles like $^7$Li, $^{11}$B, $^{12}$C, $^{16}$O, etc. The introduction of heavy ion beam made easy access to the neutron deficient short-lived radioisotopes and expanded the horizon of clinically important radionuclides. The idea of tracer packet, conceived and coined by Professor Lahiri, is resurrection in the field of radiotracer technique and is complementary to the multitracer technique. Under his leadership for the first time radiotracer technique was punched in Green Chemistry experiments. His group reported the first radioactive gold nanoparticles using green synthesis route. Professor Lahiri and his colleagues for the first time unveiled total radioisotope inventory when a converter target like Lead-Bismuth Eutectic (LBE) are bombarded with high energy 1.4 GeV proton beam. They pointed out that these converter targets may act as huge source of clinical radionuclides including exotic therapeutic radionuclides like $^{149}$Tb.
Honours & Distinctions

Prof Anjan Kundu, selected as Fellow of Indian Academy of Sciences (IASc), Bangalore, (Jan 1, 2015)

Prof Gautam Bhattacharyya, selected Fellow of Indian Academy of Sciences (IASc), Bangalore (2015)

Prof Munshi Golam Mustafa was awarded Bangabhushan by Govt of West Bengal on May 20, 2014
Faculty Members Joined the Institute

Prof Kalpataru Pradhan

Transition metal oxides (TMOs) show a wide range of electrical and magnetic properties and bear promises of technological importance for the design of new functional materials. The physics is even much more richer at the interface of two TMOs. The central theme of our research is to find a correlation between the electronic and the magnetic properties at the interface. We use model Hamiltonian approach combined with material specific first-principles density functional theory calculations for a deep understanding and further improvement of functionalities of TMOs and their interfaces. We also study magnetic properties of atomic clusters using density functional theory to design new ferromagnetic molecular-magnets.

Prof H Raghuraman

Ion channels and transporters are membrane proteins that play a crucial role in many important cellular processes. Unlike K⁺ and Na⁺ channels, very little is known about the gating and transport mechanisms of Mg²⁺ channels. Broadly, our research will focus on three important research areas namely the (i) Gating-related structural dynamics of Mg²⁺ channels to understand the mechanism of Mg²⁺ transport at the molecular level; (ii) Structural Dynamics of voltage sensor movement; and (iii) Understanding structural and mechanistic details of sodium-calcium exchanger proteins. My aim is to establish a laboratory equipped with membrane protein biochemistry, electrophysiology, and continuous-wave (CW) and pulsed electron paramagnetic resonance (EPR) spectroscopy together with steady-state and time-resolved fluorescence spectroscopy to generate functionally-compatible low-resolution models of novel membrane proteins in different functional states that are not amenable to crystallographic approaches.
Prof Soumen Kanti Manna

Systems-level characterization of the effect of gene-environment interaction on biochemical networks is essential for holistic understanding of pathogenesis and inter-individual variations in the outcome. We are currently using mass spectrometry-based metabolomics to investigate the reorganization of biochemical landscape associated with liver diseases, diabetes, and cancer. The ultimate goal is to identify biomarkers for early diagnosis and target pathways for personalized interventions. We are also working on mass spectrometry-based direct biochemical finger-printing of microbes for high-throughput species identification and functional characterization required for applications in functional metagenomics, public health and critical care set-ups.

Prof Sangram Bagh

The molecular connectivity between genes and proteins inside a cell shows a good degree of resemblance with complex electrical circuits. This inspires the possibility of engineering a cell similar to an engineering device. By adapting engineering principle in the molecular biology regime, we design, construct, and implement synthetic gene circuits to ‘re-program’ living cells to perform various human designed tasks. We are particularly interested in 1) developing cellular robotics platform for cancer gene therapy, 2) developing synthetic biology solutions for in-situ resource utilization in human space missions.
On the occasion of celebration of the Diamond Jubilee year of Department of Atomics Energy, members of Biophysical Sciences in organized a National Symposium on Frontiers of Biology: The DAE Spectra, during the December 23rd and 24th, 2014 with eminent scientists and research scholars from the DAE fraternity BARC, ACTREC, TIFR, NISER and RRCAT along with our own. The Symposium covered subjects under the DAE mandate such as Cancer, Radiation Biology, Structural Biology, Genomics & Proteomics, Stem Cell & Gene Therapy, Chemical Biology and Biospectroscopy. We had received patronage from DAE for organizing the meeting giving excellent opportunity for students and young faculty members to get exposure and interact with scientists of the same family having international repute working in the exiting frontiers of biology.
The 14th International Spin Chemistry Meeting 2015 (SCM-2015) on Spin and Magnetic Field Effects in Chemistry and Related Phenomena was organized first time in India at Saha Institute of Nuclear Physics, Kolkata during March 15-20, 2015 under the convenership of Samita Basu, one of the International Spin Chemistry Committee Members, partially funded by BARD project, SINP, Department of Atomic Energy, India. It was a huge and successful gathering of several eminent scientists along with their groups from Germany, UK, Canada, Japan, USA, Austria, Portugal, Croatia, Russia and India working on theoretical and experimental aspects of spin chemistry, physics as well and biology.
Saha Theory Workshop: Cosmology at the Interface, was hosted by the Theory Division Jan 28-30, 2015. The program included both plenary and parallel sessions. Nearly eighty people participated in the programme that included talks by notable speakers in the field. The workshop was funded by Theory Division, CARE and Ramanujan Fellowship.
Chapter 1

Biophysical Sciences including Chemistry

1.1 Biophysics and Structural Genomics

1.1.1 Summary of Research Activities

Experimental approaches to understand the biomolecular recognition process in different intracellular phenomena have been the major activities in Biophysics. The biomolecular recognition studies include mode of actions of flavones and flavonoids, chemical biology of the aureolic acid group of antibiotics, modulation of chromatin structure by small DNA binding molecules and self association of wild type and mutant lamins involved in laminopathy. In addition we have also studied the biophysical properties of lamins to understand their roles as intermediary filaments. Recognition of multiple stranded DNA (Quadruplex) and putative anticancer agents from plant source have shown that one such agent, ellipticine binds to DNA with 3:2 stoichiometry, with respect to ellipticine: DNA, also inhibiting telomerase activity. The widely prevalent disease of Eastern India, HbE-thalassemia, along with sickle cell anemia, hereditary spherocytosis and leukemia are being studied as model for hematological disorders while Alzheimers, Huntingtons, and the Prion diseases are being studied for the neurodegenerative diseases. Differential proteomics studies are being done in these diseases using clinical samples of cerebrospinal fluid, plasma, urine, red cells, cell extracts and platelets. Hundreds of proteins from these different tissue types are annotated and 10-15 proteins are identified to be differentially expressed in diseases. Classes of redox regulators and chaperone proteins have been found to be up-regulated in hemoglobinopathy. Studies in cell proliferation and differentiation have implicated the roles of self renewal pathways and cross talk between signaling pathways in chronic to blast transformation of CD34+ CML stem cells isolated from patients. Moreover, we have established that cytoplasmic sequestration of the cell cycle inhibitor, p27 led to its interaction with polycomb group of genes (Bmi1, EZH2) and activation of the Rho/Rac GTPase pathway resulting in actin depolymerization which, in turn, caused cellular egression/mobilization from the bone marrow. Currently this pathway is also being investigated to understand the process of metastasis in epithelial cancer. Among the various diseases that affect the nervous system, some of the most debilitating neurodegenerative disorders are Alzheimers, Huntingtons and Prion Diseases. These late onset but eventually fatal diseases are all caused by altered metabolism of individual proteins that interfere with normal cellular homeostasis. Several micro RNAs (miRNA), the negative regulator of protein coding gene expression, have been shown to target the Huntingtin (HTT) gene, whose mutation causes Huntingtons disease (HD). The expression of these miRNAs has been shown to decrease in cell and animal models of HD. Besides, it has been shown that
miR-150 target TP53 gene, explaining the over expression of TP53 in HD. HIPPI, a molecular partner of HTT interacting protein HIP1, has been shown to regulate many genes involved in HD pathogenesis. The normal life cycle of a protein, characterized by its biogenesis, trafficking and degradation, are compromised in these disorders resulting in misfolding, misprocessing or mislocalization of the proteins. Most likely, the aberrant protein can then engage in atypical interactions and ultimately lead to a series of unknown events culminating in cell death. The major focus of our research in Alzheimers disease (AD) is to study the downstream pathogenesis of the disease, mediated through AICD and its adaptor network. AICD possesses conserved motifs that are now known to interact with cytosolic adaptor proteins and these interactions in turn affect different signaling pathways. We have shown that Grb2, one such adaptor, interacted with AICD in late endosomal compartments. The excess protein, thus entrapped, could be degraded by autophagy. Currently, we are also trying to provide a comprehensive understanding of the disruption of the intracellular protein trafficking pathways in late-onset neurodegenerative disorders. With Prion disease as a model system, we plan to simultaneously pursue two broad facets: first, understanding the significance of the ESCRT machinery and the endo-lysosomal pathway in PrP-mediated (Prion protein) neurodegenerative diseases. This will aim to provide a molecular explanation for how the loss of function mutation of Mahogunin results in Prion disease like phenotype of spongiform neurodegeneration. Secondly, we also aim to explore how the various essential molecular components that are regulated during endoplasmic reticular stress (ER stress) and aging, both of which manifest in late onset neurodegenerative diseases. Studies on function and dynamics of transcription factors have been initiated to interprete the epigenetic language in Eukaryotic Cells. We aim to understand the critical interactions between histone posttranslational modifications and the 'readers' which regulate important cellular pathways and their dysfunctions leading to disease. A molecular systems level understanding of the combined effects of microgravity and space ionizing radiation (high energy particles) on human cells and metabolomics-guided system level elucidation of effect of radiation exposure on living systems would be envisaged.

1.1.2 Publications

1.1.2.1 Publications in Journal

Tarun K Dua; Saikat Dewanjee; Moumita Gangopadhyay; et al, Ameliorative effect of water spinach, Ipomea aquatica (Convolvulaceae), against experimentally induced arsenic toxicity, JOURNAL OF TRANSLATIONAL MEDICINE 13 (2015) Art No: 81

Saptaparni Ghosh; Dipak Dasgupta, Quadruplex forming promoter region of c-myc oncogene as a potential target for a telomerase inhibitory plant alkaloid, chelerythrine, BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS 459 (2015) 75

Nandini Pal Basak; Subrata Banerjee, Mitochondrial dependency in progression of acute myeloid leukemia, MITOCHONDRION 21 (2015) 41

Anita Roy; Subrata Banerjee, p27 and Leukemia: Cell Cycle and Beyond, JOURNAL OF CELLULAR PHYSIOLOGY 230 (2015) 504

Biswa Pathik Pahari; Sudip Chaudhuri; Sandipan Chakraborty; et al, Ground and Excited State Proton Transfer of the Bioactive Plant Flavonol Robinetin in a Protein Environment: Spectroscopic and Molecular Modeling Studies, JOURNAL OF PHYSICAL CHEMISTRY B119 (2015) 2533
Saptaparni Ghosh; Jagannath Jana; Rajiv K Kar; et al, Plant Alkaloid Chelerythrine Induced Aggregation of Human Telomere Sequence-A Unique Mode of Association between a Small Molecule and a Quadruplex, BIOCHEMISTRY 54 (2015) 974

Nagaraja Theeya; Atri Ta; Sayan Das; et al, An Inducible and Secreted Eukaryote-Like Serine/Threonine Kinase of Salmonella enterica Serovar Typhi Promotes Intracellular Survival and Pathogenesis, INFECTION AND IMMUNITY 83 (2015) 522

Shreyasi Dutta; Shibojyoti Lahiri; Amrita Banerjee; et al, Association of antitumor antibiotic Mithramycin with Mn2+ and the potential cellular targets of Mithramycin after association with Mn2+, JOURNAL OF BIOMOLECULAR STRUCTURE & DYNAMICS 33 (2015) 434


Shibojyoti Lahiri; Amrita Panja; Dipak Dasgupta, Association of a Zn2+ containing metallo beta-lactamase with the anticancer antibiotic mithramycin, JOURNAL OF INORGANIC BIOCHEMISTRY 142 (2015) 75


Saikat Dewanjee; Moumita Gangopadhyay; Urmi Das; et al, Signal transducer and oxidative stress mediated modulation of phenylpropanoid pathway to enhance rosmarinic acid biosynthesis in fungi elicited whole plant culture of Solenostemon scutellarioides, ENZYME AND MICROBIAL TECHNOLOGY 66 (2014) 1

Shounak Baksi; Sreetama Basu; Debashis Mukhopadhyay, Mutant huntingtin replaces Gab1 and interacts with C-terminal SH3 domain of growth factor receptor binding protein 2 (Grb2), NEUROSCIENCE RESEARCH 87 (2014) 77

Srijan Haldar; Anita Roy; Subrata Banerjee, Differential regulation of MCM7 and its intronic miRNA cluster miR-106b-25 during megakaryopoiesis induced polyploidy, RNA BIOLOGY 11 (2014) 1137

Abhijit Poddar; Rinchen T Lepcha; Debasish Mukherjee; et al, Comparative analysis of 16S rRNA signature sequences of the genus Idiomarina and Idiomarina woesei sp. nov., a novel marine bacterium isolated from the Andaman Sea, RESEARCH IN MICROBIOLOGY 165 (2014) 501

Bidisha Sengupta; Donald Davis; Kisa Harris; et al, Flavonoids as duplex and quadruplex DNA ligands: Biophysical studies, ABSTRACTS OF PAPERS OF THE AMERICAN CHEMICAL SOCIETY 248 (2014) Meeting Abstract: 402-PHYS

Arunabha Chakrabarti; Atri Chatterjee; Mohor B Sengupta; et al, Altered Levels of Amyloid Precursor Protein Intracellular Domain-interacting Proteins in Alzheimer Disease, ALZHEIMER DIS-
EASE & ASSOCIATED DISORDERS 28 (2014) 283

Anindita Deb Pal; Nandini Pal Basak; Aditi Sengupta Banerjee; et al, Epstein-Barr virus latent membrane protein-2A alters mitochondrial dynamics promoting cellular migration mediated by Notch signaling pathway, CARCINOGENESIS 35 (2014) 1592


KK Kulkarni; KG Bankar; RN Shukla; C Das...D Dasgupta, et al, Global gene expression profiling data analysis reveals key gene families and biological processes inhibited by Mithramycin in sarcoma cell lines, Genomics Data, 2015, 3:8-14


1.1.3 Ph D Awarded

Anita Roy [Subrata Banerjee] Cross talk of Self renewal pathways and hematopoiesis, University of Calcutta, April 2014

Sapataparni Ghosh [Dipak Dasgupta], Effect of The Plant Alkaloids on Structure and Function of G-Quadruplex DNA, University of Calcutta, Oct 2014


Kasturi Roy [Debashis Mukhopadhyay] AICD Mediated Cell Fate in Alzheimer’s Disease: Juxtacellular Signaling and Downstream Pathways, University of Calcutta, Sept 2014

Sounak Bakshi [Debashis Mukhopadhyay], Alterations in Growth Factor Receptor Protein Binding Protein 2 (Grb2) Related Signaling in Huntington’s Disease Cell Model, University of Calcutta, Feb 2015

1.1.4 Seminars/Lectures given in Conference/Symposium/Schools

Chandrima Das
i. Decoding the epigenomic landscape by histone reader ZMYND8, 5th meeting of the Asian Forum for Chromatin and Chromosome Biology, 2015, JNCASR, Bangalore, Jan 15-18, 2015
ii. Prolyl isomerization as a novel mode to regulate chromatin function, 4th conclave for the Ramalingaswami Fellowship recipients at Institute of Life Sciences, Nalco Square, Bhubaneshwar, Jan 30- Feb 1, 2015

Kaushik Sengupta

1. Role of LMNA mutations in higher order protein assembly: A possible mechanism in the pathogenesis of Dilated Cardiomyopathy (DCM), Indian Biophysical society meeting at Jamia Millia Islamia, New Delhi, Feb 14-17, 2015


Sangram Bag

Engineering Biology: One way or another, Indo-US Conference and Workshop in Synthetic and Systems Biology, Delhi, Nov 9-12, 2014

1.1.5 Teaching elsewhere

Pulak Ray

1. Electron Microscopy and Atomic Force Microscopy: MSc course on Biomedical Instrumentation, 3rd semester, University of Calcutta, September 2014-January 2015 (10 lectures)

2. Electron Microscopy and Atomic Force Microscopy: MTech course on Biomedical Instrumentation, 2nd semester, University of Calcutta, March-June 2015 (12 lectures)

1.2 Crystallography and Molecular Biology

1.2.1 Summary of Research Activities

In Crystallography and Molecular Biology Division multifaceted approaches are used to study the structure and conformation of proteins which are involved in various regulatory processes in biology under normal and diseased conditions. Therefore, one of the major focuses of the Division is to study the structure and dynamics of proteins and determination of the 3D structures to gain functional insights. Post-translational modification of proteins is an important mechanism to regulate their structures and functions. In this context, the mechanism of phosphorylation and the structural elements that direct the phosphorylation to occur with high fidelity in case of fructokinase and ribokinase have been figured out with high resolution structures. The structures of Psu and the cage structure of an Acylphosphatase drew much attention in recent past. Structure of Psu, solved by Hg-SAD method, revealed a novel fold with a unique knotted dimerisation. The 12-meric nano-cage (8 nm) structure of acylphosphatase from Vibrio cholerae O395 (Vc-AcP), coupled with studies in solutions illuminates the basis for the formation of the cage, while a single (Cys20→Arg) mutation (Vc-AcP-C20R) transforms Vc-AcP to a potent enzyme, but disrupts the assembly into a trimer. Since it is interesting and also useful to engineer protein to obtain useful mechanistic information and modify functional specificity, one of the major focuses of divisional research is Structure-based protein engineering to alter activity, stability and specificity of
proteolytic enzymes. The spacio-temporal regulation of proteolytic activity of cysteine proteases by their cognate pro-domain and through specific inhibitors of serpin family are being studied at structural and molecular level. Moreover, the important questions regarding protein folding are also addressed through theoretical and experimental approaches with cyclophilin as a model system. Differential gene expression is regulated at transcriptional level as well as through various posttranscriptional mechanisms regulating RNA turnover and translation. It has been shown that in case of disease causing Leishmania parasites an octamer motif in the untranslated regions (UTRs) of mRNAs is responsible S-phase specific periodic stability of the messages and a large multidomain ribonuclease cleaves the mRNAs differentially in a monoubiquitination dependent manner. Interestingly, octamer motifs have been found in 5UTRs of several cell cycle regulated genes also in human and their importance in differential stability of the messages and regulation of translation is being investigated. Effect of posttranslational modifications like phosphorylation of some replication factor on initiation step of DNA replication is also being investigated. Cell cycle dependent genome-wide interaction of some initiation proteins with replication origins in human cells will be studied using high throughput ChIP-Seq approach in our newly installed Next Generation Sequencing platform. The parasitic diseases leishmaniasis and growing resistance of the causative parasites to the existing regime of drugs are serious health concern in several countries including India. Works are also focused on bioinformatics related to the leishmanial genome and crystallography of the proteins from the same group of parasites that could be potential drug targets. The basis of development of drug resistance in some of the strains of Leishmania parasites are also being studied using high throughput sequencing approach. One of the key components of cell is the plasma membrane which along with many embedded and associated proteins and its dynamic interaction with cytoskeleton such as spectrin is responsible for maintaining the shape of cell, selective transfer of materials and communication with outside. Recombinant fragments of different structural domains of erythroid and non-erythroid spectrin are being designed, cloned and expressed for further studies using spectroscopic, biochemical and biophysical approaches in the context of lipid-protein interactions and chaperone activities. A laboratory for the study of structure and dynamics of membrane proteins equipped with single-channel electrophysiology and electron magnetic resonance (EPR) spectroscopy together with fluorescence techniques are being established to generate functionally compatible models of novel membrane proteins under physiological conditions that are not amenable to crystallographic approaches. It has been found that chaperone-like protein HYPK interacts with the first 17 amino acid region of the protein Huntingtin (HTT) and modulates mutant HTT-mediated toxicity. Altered microRNA expression has already been implicated in HD pathogenesis. We have demonstrated the transcriptional regulation of multiple miRNAs (miR-100, miR-146a, miR-150) in human and mouse cells and also identified miR-432 as the first miRNA known to be regulated by Heat Shock Factor 1. Investigation is underway on the post-transcriptional regulation of Mitofusin 2 (MFN2) via miR-214 and transcriptional regulation by a transcription factor E2F1.

1.2.2 Publications

1.2.2.1 Publications in Journal

Abhijit Chakrabarti; Malay Patra, Differential interactions of two local anesthetics with phospholipid membrane and nonerythroid spectrin: Localization in presence of cholesterol and ganglioside, GM(1), BIOCHIMICA ET BIOPHYSICA ACTA-BIOMEMBRANES 1848 (2015) 821

Sumana Bhattacharjya; Kumar Singha Roy; Abira Ganguly; et al, Inhibition of nucleoporin member
Nup214 expression by miR-133b perturbs mitotic timing and leads to cell death, MOLECULAR CANCER 14 (2015) Art No: 42

Mahan Ray; Neha Rai; Kuladip Jana; et al, Beta catenin is degraded by both caspase-3 and proteasomal activity during resveratrol-induced apoptosis in HeLa cells in a GSK3 beta-independent manner, INDIAN JOURNAL OF BIOCHEMISTRY & BIOPHYSICS 52 (2015) 7


Kamalika Roy Choudhury; Nitai P Bhattacharyya, Chaperone protein HYPK interacts with the first 17 amino acid region of Huntingtin and modulates mutant HTT-mediated aggregation and cytotoxicity, BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS 456 (2015) 66

Anindita Das; Abhijit Chakrabarti; Puspendu K Das, Suppression of protein aggregation by gold nanoparticles: a new way to store and transport proteins, RSC ADVANCES 5 (2015) 38558


Shilpita Karmakar; Sutapa Saha; Debasis Banerjee; et al, Differential proteomics study of platelets in asymptomatic constitutional macrothrombocytopenia: altered levels of cytoskeletal proteins, EUROPEAN JOURNAL OF HAEMATOLOGY 94 (2015) 43

Sudip Majumder; Susmita Khamrui; Ramanuj Banerjee; et al, A conserved tryptophan (W91) at the barrel-lid junction modulates the packing and stability of Kunitz (STI) family of inhibitors, BIOCHIMICA ET BIOPHYSICA ACTA-PROTEINS AND PROTEOMICS 1854 (2015) 55

Kasturi Guha; Sneha Das; Partha Saha, Lys-413 of S-phase mRNA cycling sequence binding protein from Leishmania donovani (LdCSBP) is modified through monoubiquitination that is responsible for inhibition of its ribonuclease activity, INDIAN JOURNAL OF BIOCHEMISTRY & BIOPHYSICS 51 (2014) 559

Sangita Maiti Dutta; Soumyajit Banerjee Mustafi; Sanghamitra Raha; et al, Assessment of thermal stress adaptation by monitoring Hsp70 and MnSOD in the freshwater gastropod, Bellamya bengalensis (Lamark 1882), ENVIRONMENTAL MONITORING AND ASSESSMENT 186 (2014) 8961
Srijit Das; Nitai Pada Bhattacharyya, Heat shock factor 1 regulates hsa-miR-432 expression in human cervical cancer cell line, BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS 453 (2014) 461

Arup Kumar Bag; Sutapa Saha; Shyam Sundar; et al, Comparative proteomics and glycoproteomics of plasma proteins in Indian visceral leishmaniasis, PROTEOME SCIENCE 12 (2014) Art No: 48

Swasti Raychaudhuri; Rachana Banerjee; Subhasish Mukhopadhyay; et al, Conserved C-terminal nascent peptide binding domain of HYPK facilitates its chaperone-like activity, JOURNAL OF BIOSCIENCES 39 (2014) 659

Rakhi Paul; Madhumita Dandopath Patra; Ramanuj Banerjee; et al, Crystallization and preliminary X-ray analysis of a ribokinase from Vibrio cholerae O395, ACTA CRYSTALLOGRAPHICA SECTION F-STRUCTURAL BIOLOGY COMMUNICATIONS 70 (2014) 1098

Kasturi Guha; Dipankar Bhandari; Titash Sen; et al, Ubiquitination-mediated interaction among domains is responsible for inhibition of RNA endonuclease activity of mRNA cycling sequence binding protein from L. donovani (LdCSBP), PARASITOLOGY RESEARCH 113 (2014) 2941

Soma Banerjee; Siddhi Chaudhuri; Anup Kumar Maity; et al, Role of caffeine in DNA recognition of a potential food-carcinogen benzo[a]pyrene and UVA induced DNA damage, JOURNAL OF MOLECULAR RECOGNITION 27 (2014) 510

Seema Nath; Ramanuj Banerjee; Udayaditya Sen, Atomic resolution crystal structure of VcLMWPTP-1 from Vibrio cholerae 0395: Insights into a novel mode of dimerization in the low molecular weight protein tyrosine phosphatase family, BIOCHEMICAL AND BIOPHYSICAL RESEARCH COMMUNICATIONS 450 (2014) 390

Malay Patra; Madhurima Mitra; Abhijit Chakrabarti; et al, Binding of polarity-sensitive hydrophobic ligands to erythrocyte and nonerythrocyte spectrin: fluorescence and molecular modeling studies, JOURNAL OF BIOMOLECULAR STRUCTURE & DYNAMICS 32 (2014) 852

Sankar Basu; Dhananjay Bhattacharyya; Rahul Banerjee, Applications of complementarity plot in error detection and structure validation of proteins, INDIAN JOURNAL OF BIOCHEMISTRY & BIOPHYSICS 51 (2014) 188

Eashita Das; Nitai Pada Bhattacharyya, MicroRNA-432 contributes to dopamine cocktail and retinoic acid induced differentiation of human neuroblastoma cells by targeting NESTIN and RCOR1 genes, FEBS LETTERS 588 (2014) 1706

1.2.3 Ph D Awarded

Kamalika Roychoudhuri [Prof. Nitai Pada Bhattacharyya], Protein Interacting Partners of HYPK, a Huntingtin-Interacting Protein(University?), March 2014(?)
Joyeeta Ghose [Prof. Nitaipada Bhattacharyya], Regulation of microRNAs by p53 and NFkB in Cell Models of Huntington’s Disease (University?), October 2014

Sankar Basu [Prof. Rahul Banerjee], Self Complementarity: its Application in Probing Protein Internal Architecture, Fold Recognition and Structure Validation (University?), June 2014

1.2.4 Seminars/Lectures given in Conference/Symposium/Schools

1.3 Chemical Science

1.3.1 Summary of Research Activities

Research in the Chemical Sciences Division is wide-ranging and interdisciplinary, and addresses fundamental aspects of science. Overarching goals of the research projects include understanding the excited state dynamics of complex phenomena using ultra fast spectroscopy and single molecule imaging, finding new functions for old drugs: Non Steroidal Anti-inflammatory Drugs (NSAIDs), different areas in Nuclear Chemistry, Radiochemistry and Green Chemistry, developing nanotechnology and novel advanced materials for a myriad of applications, unraveling problems associated with devising new, alternative sources of energy, neutron interaction, nano particle dosimetry and radiation safety. The excited state dynamics involving photo induced electron transfer between riboflavin and aliphatic amine was explored which helps to decipher different mechanisms of electron transfer operating from femtosecond to microsecond time domain. Moreover, photoinduced electron transfer and excited-state proton transfer reactions involving 9-aminoacridine hydrochloride hydrate and methyl viologen as well as simple organic amines were studied using laser flash photolysis corroborated with magnetic field effect. A spectroscopic inquest under surfactant and β-CD confinement involves photophysics of solvent sensitive keto-tetrahydrocarbazole based fluorophores and their interactions with amines. The amine moiety of acridine derivatives binds strongly to the gold nanoparticles which are very important as drug delivery vehicles for clinical applications. The antibacterial efficacy of these drugs coated with gold nanoparticles was studied against various strains of Gram positive and Gram negative bacteria. A control on hydrophobic and hydrophilic interactions was highlighted while studying the structural effects of different copper(II) and nickel(II) Schiff base complexes on hen egg white lysozyme using steady state and time resolved absorption and fluorescence, and circular dichroism spectroscopy.

Copper complexes of Oxicam NSAIDs have been synthesized to study their biological applications. They form a new class of membrane anchors that require neither molecular recognition nor strength of interaction between interacting molecular partners, but still can effectively increase membrane fusogenic efficacy over the bare drugs. This new class of membrane anchors is therefore a step ahead of traditional anchors that are based on two interacting molecular partners. DNA-binding with high base sequence specificity and apoptosis inducing properties have also been found for these complexes.

Au-Polyaniline based conducting nano-composite has been utilized for bio-sensing of glucose, DNA and protein, using different electrochemical techniques and also for detecting the positional effect of single base mismatch in oligonucleotides. PEDOT-MnO2 and graphene based materials have been used to fabricate supercapacitors of high specific capacitance.
A single molecule and ensemble spectroscopic study of protein folding, misfolding, aggregation and DNA-protein interaction have been carried on. Quantum chemical calculations have also been carried out to address some of the fundamental problems based on experimental findings. The Nanophotonics group is actively engaged in the field of sustainable nano-architecture addressing both their development and applications. Recently the group has developed different architecture of nanomaterials which include tunable gold nano-flowers, silver nano-wires, selenium nano-spheres, intercalated nano-prism, branched gold nano-crystals, and porous silver nano-materials. Nanophotonics group also successfully used these materials in effective drug delivery, Raman sensing of environmental heavy metals, catalysis, therapeutic prevention of viral infection, and in nanoplasmon biochip for bioanalytical detection. Recently the nuclear chemistry group along with the international collaboration working at GSI, Germany independently confirmed new element 117 and discovered new isotope 266Lr.

Carbonic acid (H$_2$CO$_3$) molecule is an unstable and elusive species as it decomposes rapidly into CO$_2$ and H$_2$O molecules. However, in the vast literature of carbonic acid, it was not known how carbonic acid decomposes into its constituents CO$_2$ and H$_2$O molecules. This article describes that the primary mechanism for the decomposition of carbonic acid is autocatalytic, especially at its source, where the vapor phase concentration of H$_2$CO$_3$ molecules reaches its highest levels. In other words, H$_2$CO$_3$ molecule decomposes in presence of another H$_2$CO$_3$ molecule. The results of this study specifically and strongly suggest that double hydrogen transfer within the eight-membered cyclic doubly hydrogen-bonded (H-bonded) ring interface of the H$_2$CO$_3$ homodimer is ultimately the starting mechanism for the isomerization of the carbonic acid, especially, during the sublimation of the H$_2$CO$_3$ polymorphs at cold temperature (210-260K). Computational studies for a new mechanism for the diol formation catalyzed by formic acid have been completed. More generally, the results of this study have important mechanistic ramifications for how the gas phase hydrolysis of carbonyl compounds, which is the forbidden process in presence of single water molecule in our atmosphere, can be catalyzed by organic acids in the atmosphere. How glyoxal-diol and glyoxal-tetrol might be formed under atmospheric conditions associated with water-restricted environments have also bee studied. In addition, present work also strongly suggest that the formation of these precursors for secondary organic aerosol growth is not likely restricted solely to the bulk aqueous phase as is currently assumed.

Dose distribution profile for photon and charged particle therapy have been studied in the framework of particle interaction and transport code FLUKA. Synthesis and influence of silver nano-particles in dose enhancement for gamma irradiation is being studied. Effect of nuclear mean field in neutron emission from heavy ion reaction has been studied in the energy range of 10 MeV/amu to 30 MeV/amu. For 20Ne+165Ho system it has been observed to remove the over prediction at back angles.

1.3.2 Publications

1.3.2.1 Publications in Journal

Ankan Dutta Chowdhury; Nidhi Agnihotri; Amitabha De, Hydrolysis of sodium borohydride using Ru-Co-PEDOT nanocomposites as catalyst, CHEMICAL ENGINEERING JOURNAL 264 (2015) 531

Moumita Maiti; Kaustab Ghosh; Susanta Lahiri, Green methods for the radiochemical separations of no-carrier-added Cu-61, Zn-62 from Li-7 irradiated cobalt target, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 303 (2015) 2033
Agnihotri, Nidhi; Ankan Dutta Chowdhury; Amitabha De, Non-enzymatic electrochemical detection of cholesterol using beta-cyclodextrin functionalized graphene, BIOSENSORS & BIOELECTRONICS 63 (2015) 212

Nidhi Agnihotri; Kuntal Chakrabarti; Amitabha De, Highly efficient electromagnetic interference shielding using graphite nanoplatelet/poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) composites with enhanced thermal conductivity, RSC ADVANCES 5 (2015) 43765

Sourav Ghoshal; Montu K Harzra, H₂CO₃ → CO₂ + H₂O decomposition in the presence of H₂O, HCOOH, CH₃COOH, H₂SO₄ and HO₂ radical: instability of the gas-phase H₂CO₃ molecule in the troposphere and lower stratosphere, RSC ADVANCES 5 (2015) 17623

Chaitrali Sengupta; Manas Kumar Sarangi; Abhishek Sau; et al, A case study of photo induced electron transfer between riboflavin and aliphatic amine: Deciphering different mechanisms of ET operating from femtosecond to microsecond time domain, JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY A296 (2015) 25

Amrit Krishna Mitra; Sujay Ghosh; Manas Kumar Sarangi; et al, Influence of microheterogeneity on the solution phase photophysics of a newly synthesised, environment sensitive fluorophore 2-((7,8-dimethyl-1-oxo-2,3,4,9-tetrahydro-1H-carbazol-6-yl)oxy) acetic acid and its tagged derivative, JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY A296 (2015) 66

Moumita Maiti; Susanta Lahiri, Measurement of yield of residues produced in C-12+Y-nat reaction and subsequent separation of Ru-97 from Y target using cation exchange resin, RADIOCHIMICA ACTA 103 (2015) 7

Moupriya Nag; Kallol Beru; Soumen Basak, Intermolecular disulfide bond formation promotes immunoglobulin aggregation: Investigation by fluorescence correlation spectroscopy, PROTEINS-STRUCTURE FUNCTION AND BIOINFORMATICS 83 (2015) 169

Satyag N Guin; Velaga Srihari; Kanishka Biswas, Promising thermoelectric performance in n-type AgBiSe₂: effect of aliovalent anion doping, JOURNAL OF MATERIALS CHEMISTRY A3 (2015) 648

Tahsina Shireen; Arnab Basu; Munna Sarkar; et al, Lipid composition is an important determinant of antimicrobial activity of alpha-melanocyte stimulating hormone, BIOPHYSICAL CHEMISTRY 196 (2015) Pages 33

Anupa Majumdar; Sreeja Chakraborty; Munna Sarkar, Modulation of Non Steroidal Anti-Inflammatory Drug Induced Membrane Fusion by Copper Coordination of These Drugs: Anchoring Effect, JOURNAL OF PHYSICAL CHEMISTRY B118 (2014) 13785


Kaustab Ghosh; Moumita Maiti; Susanta Lahiri; et al, Ionic liquid-salt based aqueous biphasic system for separation of Cd-109 from silver target, JOURNAL OF RADIOANALYTICAL AND
NUCLEAR CHEMISTRY 302 (2014) 925

Arpita Datta; Moumita Maiti; Susanta Lahiri, Separation of Ru-97 from niobium target using PEG based aqueous biphasic systems, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 302 (2014) 931

Moumita Maiti; Kaustab Ghosh; Tania M Mendonca; et al, Comparison on the production of radionuclides in 1.4 GeV proton irradiated LBE targets of different thickness, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 302 (2014) 1003

Alok Srivastava; Susanta Lahiri; Moumita Maiti; et al, Study of naturally occurring radioactive material (NORM) in top soil of Punjab State from the North Western part of India, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 302 (2014) 1049

Ankan Dutta Chowdhury; Nidhi Agnihotri; Amitabha De; et al, Detection of positional mismatch in oligonucleotide by electrochemical method, SENSORS AND ACTUATORS B202 (2014) 917

Amrit Krishna Mitra; Sujay Ghosh; Manas Kumar Sarangi; et al, Photophysics of a solvent sensitive keto-tetrahydrocarbazole based fluorophore and its interaction with triethylamine: A spectroscopic inquest under surfactant and beta-CD confinement, JOURNAL OF MOLECULAR STRUCTURE 1074 (2014) 617

Sujay Ghosh; Amrit Krishna Mitra; Samita Basu; et al, 5,6,7,9-Tetrahydro-[1,3]dioxolo[4,5-h]carbazol-8-one: A solvatochromic PET-acceptor fluorescent probe, JOURNAL OF LUMINESCENCE 153 (2014) 296

Mitra, Piyali; Brotati Chakraborty; Samita Basu, Exploring photoinduced electron transfer and excited-state proton transfer reactions involving 9-aminoacridine hydrochloride hydrate and methyl viologen using laser flash photolysis CHEMICAL PHYSICS LETTERS 610 (2014) 108

Upal Das Ghosh; Chinmay Saha; Moumita Maiti; et al, Root associated iron oxidizing bacteria increase phosphate nutrition and influence root to shoot partitioning of iron in tolerant plant Typha angustifolia, PLANT AND SOIL 381 (2014) 279

Sourav Ghoshal; Montu K Hazra, Autocatalytic Isomerizations of the Two Most Stable Conformers of Carbonic Acid in Vapor Phase: Double Hydrogen Transfer in Carbonic Acid Homodimers, JOURNAL OF PHYSICAL CHEMISTRY A118 (2014) 4620

Shyamaprosad Goswami; Avijit Kumar Das; Abhishek Manna; et al, Nanomolar Detection of Hypochlorite by a Rhodamine-Based Chiral Hydrazide in Absolute Aqueous Media: Application in Tap Water Analysis with Live-Cell Imaging, ANALYTICAL CHEMISTRY 86 (2014) 6315

Swadesh Mandal; Ajoy Mandal, A simple and sensitive separation technique of Mo-99 and Tc-99m from their equilibrium mixture, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 301 (2014) 297

Susanta Lahiri, Letter to the Editor: A simple and sensitive separation technique of Mo-99 and Tc-99m from their equilibrium mixture (DOI: 10.1007/s10967-013-2770-x), JOURNAL OF RA-
**DIOANALYTICAL AND NUCLEAR CHEMISTRY** 301 (2014) 301

Swadesh Mandal, Letter to the Editor: A simple and sensitive separation technique of Mo-99 and Tc-99m from their equilibrium mixture (DOI: 10.1007/s10967-013-2770-x) Reply, JOURNAL OF RADIOANALYTICAL AND NUCLEAR CHEMISTRY 301 (2014) 303


J Khuyagbaatar; A Yakushev; Ch E Duellmann; et al, $^{48}\text{Ca}+^{249}\text{Bk}$ Fusion Reaction Leading to Element Z=117: Long-Lived $\alpha$-Decaying $^{270}\text{Db}$ and Discovery of $^{266}\text{Lr}$, PHYSICAL REVIEW LETTERS 112 (2014) Art No: 172501

Piyali Mitra; Brotati Chakraborty; Samita Basu, A spectroscopic investigation of the photophysical behaviour of 9-aminoacridine hydrochloride hydrate in presence of organic amines in homogeneous and heterogeneous media, JOURNAL OF LUMINESCENCE 149 (2014) 221

Hari Shankar Biswas; Jagannath Datta; Pintu Sen; et al, Raman spectra of electrochemically hydrogenated diamond like carbon surface, CHEMICAL PHYSICS LETTERS 600 (2014) 10

Sourav Ghoshal; Montu K Hazra, New Mechanism for Autocatalytic Decomposition of $\text{H}_2\text{CO}_3$ in the Vapor Phase, JOURNAL OF PHYSICAL CHEMISTRY A118 (2014) 2385

Piyali Mitra; Prabal Kumar Chakraborty; Partha Saha; et al, Antibacterial efficacy of acridine derivatives conjugated with gold nanoparticles, INTERNATIONAL JOURNAL OF PHARMACEUTICS 473 (2014) 636

Banabithi Koley Seth; Aurkie Ray; Sampa Biswas; Samita Basu, NiIISchiff base complex as an enzyme inhibitor of hen egg white lysozyme: a crystallographic and spectroscopic study, METALOMICS 6 (2014) 1737

**1.3.3 Ph D Awarded**

Binita Dutta[Prof Sushanta Lahiri], Studies on Detection, Complexation and Dynamics of Technetium, Rhenium and Osmium using Analytical and Nuclear Techniques, University of Calcutta, Kolkata, July 10, 2014

Sreeja Chakraborty[Prof Munna Sarkar], Metal complexes of NSAIDs and their bio application, Jadavpur University, Kolkata, December 2014
1.3.4 Seminars/Lectures given in Conference/Symposium/Schools

Samita Basu

i. Proteinsmall molecule interactions using spectroscopy and crystallography, Biennial Conference on Frontiers in Chemical Sciences (FICS-2014), Indian Institute of Technology, Guwahati, Dec 4-6, 2014

ii. Deciphering charge transfer reaction of red-ox active riboflavine with amines at different time scales and its application in cell imaging assembled with Au nanoparticles, Advances in Spectroscopy and Ultrafast Dynamics (ASUD-2014), Indian Association for the Cultivation of Science, Kolkata, Dec 12-14, 2014


iv. A spectroscopic study on interactions between hen egg white lysozyme protein and copper and nickel schiff base complexes, National Symposium 2015, Department of Chemistry, Burdwan University, Feb 19-21, 2015

v. Importance of structure of reactant and medium in photoinduced reactions probed by steady-state and time-resolved electronic spectroscopic techniques and magnetic field effect, Barasat University, West Bengal, Feb 19, 2015

vi. Spectroscopy: an interaction of light with matter, DST-JBNSTS INSPIRE Science Camp, JBNSTS, Kolkata, Mar 25, 2015

vii. Electronic Configuration and Valency, DST-JBNSTS INSPIRE Science Camp, JBNSTS, Kolkata, July 23, 2014

1.3.5 Teaching elsewhere

Samita Basu

M Sc (Inorganic Chemistry special), Calcutta University on Spectroscopy, January-March, 2015

M Sc (Physical Chemistry special), Midnapore College, Vidyasagar University, West Bengal, on Photochemistry, April, 2014

M Sc (General and Physical Chemistry special), Bidhannagar College, West Bengal State University, West Bengal on Photochemistry, August-September, 2014

1.4 Computational Science

1.4.1 Summary of Research Activities

Computational Science Division installs and maintains the following infrastructure in the SINP campus. All the central facilities are open to all the users of the Institute.

High Speed Local Area Network Wired and Wireless Infrastructure: SINP boasts to have a fully structured network environment in place for more than a decade now. The network is divided into security zones called MZ (Militarized zone) and DMZ (de-Militarized Zone); and connected to Internet via a Firewall/Router. All inward access is either via VPN or dual-hop inward secured shell access. All the internet facing servers are placed in the DMZ. Presently there are 2 core switches and 12 distribution switches. All the distribution switches are
fibre-connected to both of the core switches forming seamless HA (high available) infrastructure. The main backbone (Core-Distribution) is 1Gbps and Distribution to Edge switches, about 32 in number, are either connected through 100Mbps or in some cases through 1 Gbps via copper. There are about 42 Access Points connecting to Wireless LAN Controller via the wired network to provide wireless access cloud throughout the campus. Various SSIDs are broadcast to facilitate different categories of users. Users are authenticated with Radius servers in the backend which are running in virtual and physical infrastructures on High Availability mode. Segregation between guests and local users are ensured based on local user accounts and hardware addresses to ensure wireless security.

Layer 3 IP Virtual LANs are configured and various access control lists (ACL) are employed to sanitize traffic and ensure better utilization of the network resources. The ACLs also help to mitigate any malware propagation.

**High Available (HA) Cluster running Internet Services:** HA Cluster is running all the major Internet facing services namely Web, Proxy, Ftp, Mail, IMAP/POP, DNS, LDAP, secured dual hop inward access etc. All the services are authenticated from central LDAP services and user uses same credential to access all or most of the services. The Division has installed a Disaster Recovery setup. So that in case of declared disaster, such as fire in the main center (Room no. 235 and 237) that hamper the activities, the setup would provide continued service from a secondary site. To accommodate the data centre needs of Disaster Recovery (DR) site a modular data centre is procured and currently operational in Room no. 3401. The enhanced setup will ensure all round better availability, security and performance. Presently the services run in a mix of Virtual and Physical instances, having high availability achieved between both the instances.

**Modular Data Centre and Data Centre:** New initiative was taken up for the project of implementation of a full-fledged Data Centre at the server room to house namely High performance Computing Facilities, CMS Grid Infrastructure, HA Cluster etc. To house the Disaster Recovery (DR) infrastructure, a Modular Data Centre (MDC) was procured and installed. The Modular Data Centre or MDC, i.e. a Data Centre in a box with all the functionality of a formal Data Centre (DC), e.g. Precision Air Conditioning, HA UPS, Proper design of rack for air-flow etc. MDC architecture is also chosen for its movability. In future if the Institute opens up another campus, we would shift the MDC to that campus to achieve better disaster recovery and meet the guidelines of a proper DR setup. Both the projects assume availability of appropriate backup power like DG sets.

**New Website for the Institute:** The division along with members of New-Website committee worked hand in hand to address the need of a structured CMS (Content Management System) based website for our Institute incorporating modern technology, standards, and UAT and security guidelines. Using the system departmental, personal, different application part of the website can be updated by the appropriate authorised persons in a de-centralized manner. Apart from that the scope included implementation of some applications like Conferences, Colloquia/Seminar, Newsletter, Tender Management, Telephone Directory, Video and Image Gallery, Document Store. The implementation includes a unique Class of User concept for authentication for various services/applications. The new website was inaugurated on the foundation day i.e. 11th Jan, 2014 by the Director.

**Perimeter and End Point Security and other Security Measures:** The Project of hardware Firewall/Unified Threat Management (UTM) system for perimeter and end points, the system was placed in the network replacing its software counterpart. Other than basic Firewalling/Intrusion Prevention System, the UTM also works as a gateway agent for malware and spam control. Some of the benefits of the Unified Threat Management (UTM) system are the following: Hardware Gateway for high-speed Access (>1Gbps)
Authenticated Access and hardware proxy
Anti-malware Gateway
Hardware Firewall
High Availability of Firewall and Internet access
Network Access Control and endpoint security

The division also takes care of the various IT security needs of the above installations and that of the Institute at large. The recommendations and guidelines of the CISAG (Computer & Information Security Advisory Group), DAE are followed and periodic exercises and assessments are carried out. As instructed by the CISAG (Chief Information Security Audit Group, DAE), initiatives were taken to form a group of technical members to help CISO in the domain of work.

1.4.2 Publications

1.4.2.1 Publications in Journal

_Gautam Garai; Biswanath Chowdhury_, A cascaded pairwise biomolecular sequence alignment technique using evolutionary algorithm, INFORMATION SCIENCES 297 (2015) 118

_Manas Mondal; Devapriya Choudhury; Jaydeb Chakrabarti; et al_, Role of indirect readout mechanism in TATA box binding protein-DNA interaction, JOURNAL OF COMPUTER-AIDED MOLECULAR DESIGN 29 (2015) 283

_Sanchita Mukherjee; Senthilkumar Kailasam; Manju Bansal; et al_, Stacking Interactions in RNA and DNA: Roll-Slide Energy Hyperspace for Ten Unique Dinucleotide Steps, BIOPOLYMERS 103 (2015) 134


_Antarip Halder; Sukanya Halder; Dhananjay Bhattcharyya; et al_, Feasibility of occurrence of different types of protonated base pairs in RNA: a quantum chemical study, PHYSICAL CHEMISTRY CHEMICAL PHYSICS 16 (2014) 18383

_Sanchita Mukherjee; Sangeeta Kundu; Dhananjay Bhattcharyya_, Temperature effect on poly(dA).poly(dT): molecular dynamics simulation studies of polymeric and oligomeric constructs, JOURNAL OF COMPUTER-AIDED MOLECULAR DESIGN 28 (2014) 735

_Antarip Halder; Ayan Datta; Dhananjay Bhattcharyya; et al_, Why Does Substitution of Thymine by 6-Ethynylpyridone Increase the Thermostability of DNA Double Helices?, JOURNAL OF PHYSICAL CHEMISTRY B118 (2014) 6586

_Pavan Kumar Pingali; Sukanya Halder; Debasish Mukherjee; et al_, Analysis of stacking overlap in nucleic acid structures: algorithm and application, JOURNAL OF COMPUTER-AIDED MOLECULAR DESIGN 28 (2014) 851
1.4.3 Ph D Awarded

Sukanya Halder[Prof Dhananjay Bhattacharya], Structural Study of Ribonucleic Acids Using Theoretical Approaches, University of Calcutta, February 2014

Sanchita Mukherjee[Prof Dhananjay Bhattacharya], Analysis of Nucleic Acids Through Computational Approaches University of Calcutta, January 2015
Chapter 2

Condensed Matter Physics including Surface Physics and NanoScience

2.1 Condensed Matter Physics

2.1.1 Summary of Research Activities

Colossal piezoresistance effect in Sm$_{0.55}$ (Sr$_{0.5}$Ca$_{0.5}$)$_{0.45}$MnO$_3$ single crystal has been observed. A huge piezoresistance $\sim 10^7\%$ at a small pressure (0.09 GPa) and a remarkable increase (at the rate of $\sim 80$ K/GPa) of metal-insulator transition temperature have been observed for uniaxial pressure applied along the c-axis. [APL 102, 092406 (2013)].

A new mechanism has been presented whereby doping a correlated band insulator leads to a half-metallic ferrimagnet. This mechanism is quite distinct from the mechanisms in well-known materials that exhibit this phenomenon like the manganites, double perovskites, or Heusler alloys. This study can motivate a search for materials having the predicted properties and open up new opportunities in the area of spintronics [PRL 112, 106406].

It has been shown that a charge qubit, comprising of an electron tunneling between two dots in an oxide-based double quantum dot (DQD), has very small decoherence at low temperatures and the size of the system can be only a few nanometers. This is in contrast to the usual charge qubit based on a semiconductor DQD. It has also been show that the stronger the electron couples to the environment the lesser is the qubit decoherence. [PRB 89, 064311 (2014)].

Enhanced dielectric response has been observed for the Gd$_2$Ti$_2$O$_7$-SiO$_2$ nano-composite with smaller Gd$_2$Ti$_2$O$_7$ particles. There is a peak broadening of $\varepsilon'$ (real part of dielectric constant) versus temperature curves on increasing frequency which suggests diffuse phase transition. This work is expected to raise interest in similar materials as potential candidates for device application such as in gate dielectrics. [Mat. Res. Bull., 50, 26 (2014)].

Why gamma like distributions arise in different contexts, irrespective of different dynamical rules,
is addressed. A broad class of mass transport models are studied and it is show that the variance of the subsystem mass in these models is proportional to the square of its mean. This form of the variance constrains the subsystem mass distribution to be a gamma distribution. [PRL 112, 030601 (2014)].

A bundle of fibers has been considered as a model for composite materials, where breaking of the fibers occur due to a combined influence of applied load and external noise [see RMP for fiber bundle review]. They show that there exists a robust phase boundary between continuous (no waiting time) and intermittent fracturing regimes. They propose a prediction scheme that can tell when the system is expected to reach the continuous fracturing point from the intermittent phase. [PRE 88, 012123 (2013)].

They consider a hydrodynamic description of the spherically symmetric outward flow of nuclear matter, using a nuclear model that introduces a weakly dispersive effect in the flow. They show that even arbitrarily small values of dispersion make the horizon fully opaque to any acoustic disturbance propagating against the bulk flow. [PRC 88, 055205 (2013)].

They have achieved giant enhancement of magnetoresistance (MR) by the formation of \( \text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_{3} (\text{LSMO}) \text{Pr}_{0.67}\text{Ca}_{0.33}\text{MnO}_{3} (\text{PCMO}) \) core- shell nanostructure. The observed giant enhancement is the result of significantly weakened charge ordered state in the created ferromagnetic-charge ordered core-shell nano structure. Their study could be important for magnetic field sensor technology. [APL 103, 202406 (2013)].

2.1.2 Publications

2.1.2.1 Publications in Journal

\textbf{M Majumder; S Kanungo; A Ghoshray ; et al,} Magnetism of the spin-trimer compound \( \text{CaNi}_{3}(\text{P2O7})(2) \): Microscopic insight from combined P-31 NMR and first-principles studies, PHYSICAL REVIEW B91 (2015) Art No: 104422

\textbf{Analabha Roy; Arnab Das,} Fate of dynamical many-body localization in the presence of disorder, PHYSICAL REVIEW B91 (2015) Art No: 121106

\textbf{Chandan Upadhyay; Pappu Kumar Harijan; Anatoliy Senyshyn; et al,} Extraordinary enhancement of Neel transition temperature in nanoparticles of multiferroic tetragonal compositions of \( (1-x)\text{BiFeO3-xPbTiO3} \) solid solutions, APPLIED PHYSICS LETTERS 106 (2015) Art No: 093103

\textbf{Hossein Ahmadvand; Sayed Reza Safdari; Ahmad Nozad Golikand; et al,} Exchange bias in \( \text{Co/CoO/Co3O4} \) nanostructures, JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS 377 (2015) 19

S Mukherjee; BK Chakrabarti, Multivariable optimization: Quantum annealing and computation, EUROPEAN PHYSICAL JOURNAL-SPECIAL TOPICS 224 (2015) 17

Anirban Chakraborti; Damien Challet; Arnab Chatterjee; et al, Statistical mechanics of competitive resource allocation using agent-based models, PHYSICS REPORTS-REVIEW SECTION OF PHYSICS LETTERS 552 (2015) 1

S Dhara; R Roy Chowdhury; S Lahiri; et al, Synthesis, characterization and magnetic properties of CoxCu1-x (x similar to 0.01-0.3) granular alloys, JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS 374 (2015) 647

Kalipada Das; Tapas Paramanik; I Das, Large magnetocaloric effect in Ln(0.5)Ca(0.5)MnO(3) (Ln=Gd, DY) compounds: Consequence of magnetic precursor effect of rare earth ions, JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS 374 (2015) 707

SK Giri; Papri Dasgupta; A Poddar; et al, Strain modulated large magnetocaloric effect in Sm0.55Sr0.45MnO3 epitaxial films, APPLIED PHYSICS LETTERS 106 (2015) Art No: 023507

Tirthankar Banerjee; Abhik Basu, Thermal fluctuations and stiffening of symmetric heterogeneous fluid membranes, PHYSICAL REVIEW 91 (2015) Art No: 012119

AI Jaman; Shamik Chakraborty; Rangana Chakraborty, Millimeterwave rotational spectrum and theoretical calculations of cis-propionic acid, JOURNAL OF MOLECULAR STRUCTURE 1079 (2015) 402

G Kalai Selvan; D Bhoi; S Arumugam; et al, Effect of pressure on the magnetic and superconducting transitions of GdFe1-xCoxAsO (x=0, 0.1, 1) compounds, SUPERCONDUCTOR SCIENCE & TECHNOLOGY 28 (2015) Art No: 015009


Rakesh Chatterjee; Anjan Kumar Chandra; Abhik Basu, Asymmetric exclusion processes on a closed network with bottlenecks, JOURNAL OF STATISTICAL MECHANICS-THEORY AND EXPERIMENT (2015) Art No: P01012

MQ Lone; A Dey; S Yarlagadda, Study of two-spin entanglement in singlet states, SOLID STATE COMMUNICATIONS 202 (2015) 73

A Midya; P Mandal, Giant magnetocaloric effect in ferromagnetic superconductor RuSr2GdCu2O8, JOURNAL OF APPLIED PHYSICS 116 (2014) Art No: 223905

Bibekananda Maji; Mayukh K Ray; KG Suresh; et al, Large exchange bias and magnetocaloric effect in TbMn2Si2, JOURNAL OF APPLIED PHYSICS 116 (2014) Art No: 213913


Arafa Hassen; Alexander Krimmel; Prabhat Mandal, Comparative Study of the Layered Perovskites Pr(1-x)A(1+x)CoO(4), (A = Sr, Ca), JOURNAL OF THE AMERICAN CERAMIC SOCIETY 97 (2014) 36090

Santanu K Maiti; Moumita Dey; SN Karmakar, Persistent charge and spin currents in a quantum ring using Green’s function technique: Interplay between magnetic flux and spin-orbit interactions, PHYSICA E-LOW-DIMENSIONAL SYSTEMS & NANOSTRUCTURES 64 (2014) 169

Asim Ghosh; Arnab Chatterjee; Anindya S Chakrabarti; et al, Zipf’s law in city size from a resource utilization model, PHYSICAL REVIEW E 90 (2014) Art No: 042815

Debaleen Biswas; Sk Faruque; Abdul Kader Md; Anil Kumar Sinha; et al, Effect of thermal annealing and oxygen partial pressure on the swelling of HfO2/SiO2/Si metal-oxide-semiconductor structure grown by rf sputtering: A synchrotron x-ray reflectivity study, APPLIED PHYSICS LETTERS 105 (2014) Art No: 113511

Asim Ghosh; Nachiketa Chattopadhyay; Bikas K Chakrabarti, Inequality in societies, academic institutions and science journals: Gini and k-indices, PHYSICA A 410 (2014) 30

RN Bhowmik; G Vijayasri; R Ranganathan, Structural characterization and ferromagnetic properties in Ga3+ doped alpha-Fe2O3 system prepared by coprecipitation route and vacuum annealing, JOURNAL OF APPLIED PHYSICS 116 (2014) Art No: 123905

Mayukh K Ray; Bibekananda Maji; K Bagani; et al, Role of partial Cu/Co substitution on magnetic and electronic properties of Mn-rich Ni46Mn43In11 alloy, JOURNAL OF PHYSICS D 47 (2014) Art No: 385001

A Rajak; BK Chakrabarti, Quantum annealing search of Ising spin glass ground state(s) with tunable transverse and longitudinal fields, INDIAN JOURNAL OF PHYSICS 88 (2014) 951

Paramita Dutta; Santanu K Maiti; Karmakar, SN, Electric field induced localization phenomena in a ladder network with superlattice configuration: Effect of backbone environment, AIP ADVANCES 4 (2014) Art No: 097126

L Gastaldo; K Blaum; A Doerr; et al, The Electron Capture Ho-163 Experiment ECHo, JOURNAL OF LOW TEMPERATURE PHYSICS 176 (2014) 876

Mayukh K Ray; K Bagani; RK Singh ; et al, Effect of Al doping on structural and magnetic properties of Ni50Mn37AlxSb13-x alloy, PHYSICA B 448 (2014) 33

A Midya; N Khan; D Bhoi; et al, Giant magnetocaloric effect in antiferromagnetic DyVO4 compound, PHYSICA B 448 (2014) 43

S Dey; SK Dey; S Majumder; et al, Superparamagnetic behavior of nanosized Co0.2Zn0.8Fe2O4
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Nazir Khan [Prof Prabhat Kr Mondal], Magnetic Phase transition and magnetoelectronic phase separation in La$_{1-x}$Sr$_x$CoO$_3$ single crystals, Dec 26, 2014

Arindam Midya [Prof Prabhat Kr Mondal], Magnetic and magnetocaloric properties of some rare-earth based compounds, Dec 26, 2014

Niladri Sarkar [Abhik Basu], Statistical perspectives on soft matter and biologically motivated system, University Calcutta, Mar 2015

2.1.4 Seminars/Lectures given in Conference/Symposium/Schools

Barnana Pal
Acoustic resonator under pulse excitation and attenuation measurement, Conference on New Advances in Acoustics (NAA2015), Shanghai, China, Jan 31-Feb 2, 2015

Abhik Basu
2.1.5 Teaching elsewhere

Abhik Basu
Statistical Mechanics, M Sc Physics, Aug-Dec 2014, Presidency University

2.2 Surface Physics and Material Science

2.2.1 Summary of Research Activities

Research activities of the Surface Physics & Material Science (SPMS) Division mainly encompass the growth of low-dimensional (mainly in nanometer length scale ~1-100 nm) metallic, semiconducting and organic materials via physical and chemical routes followed by their extensive characterizations with state-of-the-art techniques/tools for achieving tunable mechanical/electrical/magnetic/optical properties relevant in the forefront research areas of micro-nano science & technology. Synthesis of the condensed and soft materials in the form of ultra-thin layer and nanometer sized particles with different morphology are implemented by sophisticated growth techniques, like, molecular beam epitaxy (MBE), metal oxide vapour phase epitaxy (MOVPE), cluster ion deposition, sputtering, ion implantation, Langmuir-Blodgett (LB) techniques along with other conventional growth techniques, like, spin coating and wet chemical methods. The state-of-the-art characterization techniques, such as a 300 kV transmission electron microscope (TEM) attached with electron energy loss spectroscopy (EELS) and energy dispersive x-ray spectroscopy (EDX), high resolution scanning electron microscope (SEM) augmented with cathodoluminescence (CL) optical detection system, versatile x-ray diffraction (VXRD) system, X-ray photoelectron spectroscopy (XPS) systems along with angle resolved detection capability, ultra high vacuum based scanning tunneling microscope (STM) and ambient scanning probe microscopes (SPMs) are utilized for structural, compositional, optical, tribological and surface/interface analysis in routine manner. Epitaxially grown quantum dot structures, ion beam and cluster beam modified patterned surfaces, sputtered deposited oxide based ultrathin layer materials with high dielectric constant, ordered decorated organic thin films and chemically synthesized anisotropic metal nanoparticles render novel physical properties that have potential applications in CMOS technology, bio-sensing, plasmon based nanophotonics, optical switching devices. The ongoing activities of our division also involve strong national and international level collaborative and exchange programs. Additionally, our research activities include the materials collected from industrial areas and or used by human being to understand if they have any detrimental effect so far the social and environmental issues are concerned.

Glimpses of some important activities are given in the following.
Cathodoluminescence (CL) in a scanning electron microscope (SEM) is a powerful tool that is
recently utilized for spectro-microscopy study of nanostructured semiconductors and localized surface plasmon (LSP) modes from metallic nanostructures. While photon emission from semiconductor materials on interaction with an electron beam is well-understood, CL from plasmonic metal nanostructures is a relatively new field and certainly deserves more attention. Using our in-house CL-SEM facility (installed in 2010), we have investigated different LSP modes of varieties of gold (Au) nanoparticles with a high degree of spectral and spatial resolution (in the range of about 10-25 nm) which is of fundamental importance for applications such as biosensing, single molecule detection and photovoltaics. The experimental results are analysed with detail 3D finite-difference time-domain (FDTD) simulation. For a penta-twinned gold nanorod deposited on a silicon substrate, we have shown that, in the visible domain of the spectrum, the plasmon mode gets split into two distinct peaks due to substrate induced hybridization of in-plane and out-of-plane modes. We have demonstrated the first experimental realization on the selective excitation of two closely lying tips from the same spherical core of a multitipped gold nanoparticle with flower-like morphology where coupled plasmon modes are identified to be originated from the interaction between two closely spaced tips with a narrow angular separation.

Current efforts to develop novel nanostructured materials and devices are stimulating the need for implementation of suitable experimental probes to determine the structure and chemical composition of solids. Transmission electron microscopy (TEM) is one such important tool to deal with the structure of low-dimensional objects. TEM studies on various classes of materials to address a few intriguing physics issues were addressed last year. Here, following the two step reduction chemical method, we have synthesized crystalline gold coresilver shell bimetallic nanocrystals with different shapes and sizes in a single reaction environment. The HRTEM studies provide the direct experimental evidence of the silver halide model proposed by Sigmund et al. [Lofton, C.; Sigmund, W. Adv. Funct. Mater. 2005, 15, 1197-1208] to explain the kinetic growth mechanism behind their formation. In recent years, much attention has been paid on studies of metal dendritic nanostructures. We have adopted a simple dip-and-rinse galvanic displacement reaction to prepare dendritic silver nanostructure directly on germanium surfaces which reveal a novel growth process resulting in a new type of heteroepitaxy where large lattice mismatches (about 27.7% for the present case of the AgGe interface) can be accommodated by the formation of low-energy asymmetric tilt boundaries.

Deposition of size-selected metal nanoclusters on a substrate with very low kinetic energy helps to keep the clusters intact with respect to their shapes and sizes as compared to clusters in flight condition. Here we report formation of monodisperse films of size-selected copper nanoclusters (diameter ~3 nm) that are produced in a magnetron based gas aggregation type source equipped with a quadrupole mass filter (QMF) to select sizes of clusters before landing. Transmission Electron Microscopy (TEM) study shows that the size-distributions of isolated islands peaks around the predicted size of clusters which demonstrates very low diffusivity of these nano-scale islands on silicon surface.

The performances of organic semiconductor devices are crucially linked with their stability at the ambient atmosphere. The evolution of electronic structures of 20 nm thick rubrene films exposed to ambient environment with time has been studied by UV and X-ray photoemission spectroscopy (UPS and XPS), near edge X-ray absorption fine structure (NEXAFS) spectroscopy, and density functional theory (DFT). XPS, NEXAFS data, and DFT calculated values suggest the formation of rubrene-epoxide and rubrene endoperoxide through reaction of tetracene backbone with oxygen of ambient environment. Angle dependent XPS measurement indicates that the entire probed depth
of the films reacts with oxygen by spending only about 120 min in ambient environment. The HOMO peak of pristine rubrene films almost disappears by exposure of 120 min to ambient environment. The evolution of the valence band (occupied states) and NEXAFS (unoccupied states) spectra indicates that the films become more insulating with exposure as the HOMO-LUMO gap increases on oxidation. Oxygen induced chemical reaction completely destroys the delocalized nature of the electron distribution in the tetracene backbone of rubrene.

High-\(\kappa\)-based dielectric materials have been studied for its use as gate dielectric, an alternative to SiO\(_2\), to cope with the continuous miniaturization of metal-oxide-semiconductor (MOS) transistor structures for about 16 years. The control of leakage current through gate dielectric material has been still a challenge in the field of high-\(\kappa\) dielectric-based MOS technology and depends mainly on the crystallization of the high-\(\kappa\) film and formation of interfacial silicate layer. Our present studies address these issues for betterment of the high-\(\kappa\)-based devices. Specially, we are interested (i) to know the crystallization process of HfO\(_2\) films; (ii) whether crystallization or Hf-Silicate formation or both are responsible for degradation of the electrical properties of the MOS device; and (iii) identification of a range of annealing temperature above which the performance of the device degrades.

A new theoretical approach for photoacoustic (PA) image simulation of an ensemble of cells with endocytosed gold nanoparticles is reported. In this model, each cell was approximated as a fluid sphere and suspended in a nonabsorbing fluid medium. It was assumed that the cellular optical absorption coefficient changed greatly because of endocytosis of nanoparticles; however, thermophysical parameters remained unchanged because nanoparticles occupied negligible intracellular volume. The proposed model was explored to simulate PA images of numerical phantoms. It was observed that features of the phantoms are retained precisely in those simulated images. Also, speckles in PA images are significantly suppressed because of strong boundary buildup when cells are bounded to a region. Nevertheless, speckle visibility increases when cells are not bounded to a region.

The stability of Cl-terminated Si surface at ambient conditions and its evolution with time, which have immense importance for the growth of interesting nanostructures on it, were investigated using complementary methods. Structures of CTAB-silica mesostructured films on as-prepared and time-evolved Cl-Si substrates, obtained from XR and grazing incidence small-angle X-ray scattering (GISAXS) measurements, show transition from strongly attached near circular micelles to weakly attached more elliptical micelles, confirming the transition (from weak-hydrophilic toward weak hydrophobic) in microscopic level and growth of less homogeneous oxide layer.

The influence of poor solvent and thermal annealing, and their specific roles, in the crystalline ordering of poly (3-dodecylthiophene) [P3DDT] films, which are of immense importance in their performance as semiconducting materials, were investigated using complementary techniques. Edge-on oriented crystallites (Form-II like) are enhanced in the as-cast films prepared after addition of a poor solvent. However, the coil-to-rod-like conformational transition is more prevalent compared to the crystallites, suggesting that a poor solvent predominantly helps to overcome the unfavorable conformational transition. The best edge-on oriented crystallites are found for the P3DDT films prepared from a solution containing a large amount of poor solvent and subsequently annealing the film at around 130 °C.

The magnetic ground state of the Mn\(_{50}\)Ni\(_{38.5}\)Sn\(_{11.5}\) alloy is investigated through dc/ac magne-
tization and low temperature ($\geq 0.15$ K) specific-heat ($C_p(T)$) measurements. The dc and ac magnetization measurements indicate that the system can be identified as a cluster spin glass (CSG) phase in a ferromagnetic (FM) background, and as a conjunction of these two phases an exchange bias effect (EBE) is observed in this system. The presence of coexisting phases is further supported by our $C_p(T)$ measurement. We attribute the existence of the CSG phase to the antiferromagnetic (AFM) interaction arising from the Mn-Mn antisite disorder which further enhances through martensite transformation. We also report the successful synthesis of both pristine Fe$_3$O$_4$ and the Fe$_3$O$_4$@SiO$_2$core@shell structure. From SEM images we observe that each Fe$_3$O$_4$ microsphere is composed of a large number of smaller nanoballs. We have extensively studied the photoluminescence and photoconductivity properties of both pristine and SiO$_2$ coated Fe$_3$O$_4$ particles for the first time. An enhancement in photoluminescence emission is observed in the Fe$_3$O$_4$@SiO$_2$core@shell samples, whereas a reduced and negative photoconductivity is observed in the same sample. SiO$_2$ coating reduces the concentrations of non-radiative trap levels at the interfaces of the core and shell, thereby resulting in the enhancement of photoluminescence intensity in the coreshell particles. An exponential rise and decay in photocurrent is observed upon UV irradiation in the ON and OFF state, respectively, for Fe$_3$O$_4$, whereas for Fe$_3$O$_4$@SiO$_2$, we observe a transient rise in the photocurrent and this photocurrent is not stable. We have explained this unusual behavior of photocurrent.

Convex Arrhenius behaviour, rare in transitions between equilibrium phases of pure systems, is observed in the plot of heating rate vs. temperature for Nematic-Isotropic (N-I) transition of liquid crystalline MBBA through Differential Scanning Calorimetry (DSC). The plot is best fit by a monomolecular growth function, using which an entropy-driven activation barrier, increasing non-linearly with temperature, is obtained. Fourier Transform Infrared (FTIR) studies of MBBA around the N-I transition temperature show increase in out-of-plane benzene ring distortions and decrease in order along the C=N-C axis, consistent with DSC results of conformational entropy-driven barrier.

While monolayer area fraction versus time curves obtained from surface pressure-area isotherms for desorption-dominated (DD) processes in Langmuir monolayers of fatty acids represent continuous loss, those from Brewster Angle Microscopy (BAM) also show a 2D coalescence. For nucleation-dominated (ND) processes both techniques suggest competing processes, with BAM showing 2D coalescence alongside multilayer formation. Imaging Ellipsometry (IE) of horizontally transferred films onto Si(100) shows Stranski-Krastanov (SK) like growth for ND process in arachidic acid monolayer resulting in successive stages of monolayer, trilayer, multilayer islands, ridges from lateral island-coalescence and shallow wavelike structures from ridge-coalescence on the film surface. These studies show that lipophilic attraction between hydrocarbon chains is the driving force at all stages of long term monolayer dynamics.

We present a detailed investigation of the low-frequency dielectric and conductivity properties of conducting polymer nanowires. Our results, obtained by connecting nanowires in parallel, show that these polypyrrole nanowires behave like conventional charge-density wave (CDW) materials, in their nonlinear and dynamic response, together with scaling of relaxation time and conductivity. We find good agreement with a theory of weakly pinned CDW, screened by thermally excited carriers across the CDW gap.

The growth, morphology, and magnetic structure of ultrathin Cr films grown on a Ag(001) substrate are studied using low-energy electron diffraction (LEED), angle-resolved photoemission spec-
troscopy (ARPES), and ab initio density functional theory (DFT) calculations. The presence and temperature dependence of c(2) half-order spots in the LEED pattern, for low electron energies, along with the presence of characteristic Cr 3d bands in the ARPES spectra, confirm the existence of antiferromagnetic ordering for the Cr monolayer case. Our DFT calculations confirm that this is the most favored geometric and magnetic structure of the system. The Cr layer is found to retain a "two-dimensional" character with enhanced Cr 3d magnetic moments, despite being buried below a Ag monolayer, due to the absence of significant hybridization between Cr 3d and Ag 4d electronic states. The coverage dependence of the magnetic ordering indicates a maximum ordering above the expected monolayer coverage, possibly due to intermixing between Ag and Cr atoms in the overlayer.

2.2.2 Publications

2.2.2.1 Publications in Journal

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2.2.3 Ph D Awarded

Pabitra Das [Prof Tapas Kumar Chini], Optical properties of low dimensional structures using cathodoluminescence in a high resolution scanning electron microscope, University of Calcutta, September 2, 2014

Haradhan Mandal [Prof Madhusudan Roy and Prof Ashis Bhattacharya], Investigations into the Nature of some Solid Waste Pollutants through Different Physical Techniques, Viswa Bharati University, February 5, 2015

2.2.4 Seminars/Lectures given in Conference/Symposium/Schools

S Hazra
Structural ordering of semiconducting poly(3-dodecylthiophene) molecules, National Conference on Current Trends in Advanced Materials (CTMat-2014), Kolkata, Nov 19-21, 2014

Biswarup Satpati
i. Heteroepitaxy in chemically grown silver nanodendrites on germanium and mapping its surface plasmon associated photon emission, National workshop onCurrent Trends in Advanced
ii. Ion Beam Induced Pattern Formation and Modification of Nanostructured Materials: Issues and Applications, CPP-IPR Workshop on Linear Tokamak Divertor Simulators for PSI Studies, CPP-IPR, Sonapur, Assam (a remote centre of Institute for Plasma Research, Gandhinagar), Nov 24-26, 2014


Alokmay Datta

i. National Workshop on Physics of Low Dimensional Structures (PLDS 2015) Department of Physics & Technophysics, Vidyasagar University, Mar 25-27, 2015


iii. MATISSE Visiting Professor at Institut des Nanosciences de Paris, Université Pierre et Marie Curie, France, 20 April 2014 iv. DST-JSPS Special Lecture Tour in Japan:
(a) Structure and Dynamics at some Biologically Interesting Interfaces. Nagoya University, Dec 10, 2014
(b) Long term dynamics at the air-water interface, J-PARC, Tokai, Dec 12, 2014
(c) Two-dimensional Pattern Evolution, Kyoto University, Dec 14, 2014
(d) Two Aspects of A Liquid Crystal: Phase Transition and Self-Organized Growth Template, Doshisha University, Dec 15, 2014
Chapter 3

Experimental Nuclear and Particle Physics

3.1 Applied Nuclear Physics

3.1.1 Summary of Research Activities

Research work done at the Applied Nuclear Physics Division involves probing the atomic, nuclear, molecular and nanocrystalline systems using nuclear probes, lasers, X-rays, electron and ion beams. Molecules of biological importance, hydrated crystalline compounds and low-dimensional systems, such as nano-crystalline wide band-gap semiconductors are also being studied to explore their properties. Research conducted during 2014-2015 are in the subject areas of coherent control mechanisms for neutral atoms using lasers, investigation on the structure and phase transition of nanomaterials, multiferroics, crystalline hydrated and intermetallic systems, soft matter and biomaterials, development, characterization and optimization of radiation detectors, model based simulation and cognitive science research to understand the details of visual perception.

In the positron annihilation laboratory, several new classes of materials have been studied using positron annihilation spectroscopic tools. The studies of nanocrystalline wide band gap semiconductors were continued whereas multiferroic materials and hexaferrite systems were also studied this year. Recently, the effects of calcium-doping in magnesium ferrite were studied. Useful information on graphene oxide reinforcement and subsequent reduction of polymer systems has also been obtained.

Inulins, the nano-meter size semi-crystalline particles, composed of oligomeric fructose units, have been subjected to fine micro-structural analysis under temperature variations using mainly positron annihilation spectroscopy for the first time. The results show a non-monotonous temperature sensitive behaviour of the positron parameters that help to understand the molecular stacking pattern. Considerable variation of its free volume size has been observed through the ortho-positronium pick-off component annihilation results. The material shows a major thermotropic transition at $\sim 320K$ and further a structure loss due to glass transition. Differential scanning calorimetry confirms the onset of the major molecular transition around the same temperature. A four detector TDPAC spectrometer, with LaBr$_3$(Ce) and BaF$_2$ scintillation detectors, has been installed where
the excellent $\gamma$-ray energy resolution of LaBr$_3$(Ce) detector is employed for detecting the 133 keV $\gamma$-ray energy of 181Ta (emitted from the 181Hf PAC probe). This gives also a relatively better time resolution compared to a BaF$_2$-BaF$_2$ set up. Using the BaF$_2$-BaF$_2$ and LaBr$_3$(Ce)-BaF$_2$ TDPAC set up, perturbed angular correlation studies in different Nickel, Cobalt, Zirconium, Hafnium and Rubidium based chemical compounds and intermetallic compounds of have been performed. It is found that both ZrF$_4$.3H$_2$O and HfF$_4$.3H$_2$O have monoclinic and triclinic crystal structures which contradict with earlier reports that HfF$_4$.3H$_2$O has monoclinic crystal structure and ZrF$_4$.3H$_2$O belongs to the triclinic crystal structure. The electric field gradient (EFG) in ZrNi has been computed by density functional theory (DFT) and the experimental EFG (from PAC measurement) was found to be in good agreement with the calculated value. In Hf$_2$Co$_7$, no magnetic interaction has been observed from present studies although a weak ferromagnetism was reported from previous PAC measurement. Experimental and numerical investigations on Micro-Pattern Gas Detectors (MPGD) have continued in our division. Studies related to electron transmission, ion back-flow fraction are successfully completed. Numerical studies on the effects of spacers are found to be very successful in predicting experimental results. Numerical studies on distortion in Time Projection Chambers using bulk Micromegas have also met with reasonable success.

Significant progress has been made in carrying out experimental and numerical studies on the effects of geometrical artifacts (including asperities) on the performance of Resistive Plate Chambers. In addition, exploration of the possibility of finding out an environmentally friendly gas mixture has been initiated. Finally, effects of detector ageing, especially due to SF$_6$, are under study.

The neBEM field solver has been parallelized, resulting in substantial improvement in computational efficiency. We are regularly contributing to the INO, RD51, CMS and LCTPC collaborations. The Indo-French collaborative project is also progressing well.

In the field of cognitive science, recent physiological studies has shown that a set of V1 neurons, in the area retinotopically related to blind spot (BS area), exhibit elevated response when completion occurs. In our study at SINP, we investigated filling in process in the framework of efficient hierarchical predictive coding (HPC) of natural images. In this framework, each processing level of visual system learns statistical regularities from natural scene and accordingly, it sends prediction signal to next lower level via feedback connections, as well as receives the residual error signal as an input via feed-forward connection. We simulated the bar completion experiment on the model network of HPC and recorded the response of neurons estimating the input signal at the lower level at the BS area of model network. The recorded responses exhibited good agreement with the physiological findings. Moreover, we generated the perceptual representation of those neural responses, and it resembled the bar completion. This study suggests that filling-in process could be an emergent property of the visual system following the general computational principle of HPC of natural images.

In the laser spectroscopy and Atomic Physics laboratory, observation of Electromagnetically Induced Transparency (EIT) in a six-level Lambda-type system in atomic Rb vapor containing both $^{87}$Rb and $^{85}$Rb is undertaken. The experimental observation includes five velocity selective optically pumped (VSOP) absorption dips for both $^{87}$Rb and $^{85}$Rb. The EIT signal appears on the background of one such VSOP absorption dips. The measured EIT linewidth shows sub-natural values for both lower and higher values of pump Rabi frequencies. A density matrix based theoretical model for the system is developed and solved numerically including the Doppler broadening. The simulated spectra are in good agreement with the experimental findings.

Inner shell ionization in heavy elements, such as Thorium and Uranium, by electron impact at energies 15 to 40 keV was investigated using energy dispersive spectrometer at the electron spectroscopy laboratory. These studies have their importance in establishing the predictive power of the quantitative trace element analysis based on electron impact ionization. The energy dependent
inner shell ionization cross-sections, specifically that of the L-shells and sub-shells were evaluated
and attempts were made to explain the results in the light of DWBA theory and related simulation.
The discrepancies observed were found to be sub-shell dependent and attempts to account for it is
being explored.

3.1.2 Publications

3.1.2.1 Publications in Journal

Bichitra Nandi Ganguly; Madhusudan Roy; SP Moulik, Positron annihilation study of biopolymer
inulin for understanding its structural organization, POLYMER 60 (2015) 137

CC Dey, An unusual structural phase transition in Rb2HfF6, JOURNAL OF PHYSICS AND
CHEMISTRY OF SOLIDS 78 (2015) 12

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A Roy; A Banerjee; S Biswas; et al, Performance simulation of a MRPC-based PET imaging
system, JOURNAL OF INSTRUMENTATION 9 (2014) Art No: C10030

CC Dey, Microcrystalline phase transformation from ZrF4 center dot HF center dot 2H(2)O to
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ing at sub-zero temperature, AIP ADVANCES 4 (2014) Art No: 067101

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cross sections of gold induced by 15-40-keV electrons, PHYSICAL REVIEW A89 (2014) Art No:
052708

NG Kling; D Paul; A Gura;...S De;...et al, Thick-lens velocity-map imaging spectrometer with
high resolution for high-energy charged particles, JOURNAL OF INSTRUMENTATION 9 (2014)
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P Bhattacharya; S Bhattacharya; N Majumdar; et al, Performance studies of bulk Micromegas
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CE Rallis; TG Burwitz; PR Andrews;... S De;... et al, Incorporating real time velocity map image
reconstruction into closed-loop coherent control, REVIEW OF SCIENTIFIC INSRTUMENTS 85
(2014) Art No: 113105
3.1.3 Seminars/Lectures given in Conference/Symposium/Schools

Sankar De
i. Intra-molecular scattering within dissociative diiodoacetylene, 20th National Conference on Atomic and Molecular Physics (NCAMP-XX), Thiruvananthapuram, Dec 2014
ii. Dynamic fieldfree orientation of polar molecules by intense twocolor femtosecond laser pulses, 8th Asian Symposium on Intense Laser Science (ASILS8), Institute of Atomic and Molecular Sciences, Academia Sinica, National Taiwan University, Taipei, Taiwan, Nov 2014

3.1.4 Honours and Distinctions

Sankar De
Received the 5th ISUILS (International Symposium of Ultrafast Intense Laser Science) Award for Young Researchers, 2014. The award was sponsored by Japan Intense Light Field Science Society (JILS) and was presented by the International Committee on Intense Laser Sciences (ICILS). The symposium was held in Jodhpur, India in October, 2014. At the symposium, JPY 100,000 was awarded in cash as financial support to attend the symposium.

3.2 High Energy Nuclear and Particle Physics

3.2.1 Summary of Research Activities

The research activities in HENPP division can be categorized in four major directions. The details of these activities are given below.

ALICE Collaboration activities
The current theory of strong interaction, Quantum Chromo Dynamics (QCD), predicts that at very high temperatures and energy densities, quarks and gluons are no longer confined inside the hadrons and they would exist in the form of free quarks and gluons, a state called Quark Gluon Plasma (QGP). Within the first few microseconds of the birth of the Universe, the temperature and energy density was extremely high and the primordial state of matter was a system of QGP. Thus, to understand the evolution of our Universe during its infancy, we need to create and study the formation of QGP in the laboratory. This can be done by colliding two heavy nuclei at very high energies. In the LHC heavy-ion programme, Lead beams collide at energies up to 30 times higher than in previous laboratory experiments. In these heavy-ion collisions, matter is heated to more than 100,000 times the temperature at the centre of the Sun over a tiny volume of the size of a nucleus and for an infinitesimally short instant. We then observe this QGP state as it reverts to hadronic matter through a complex set of particle and gamma detectors. A Large Ion Collider Experiment (ALICE) is the only dedicated heavy-ion experiment of LHC study this extreme, high-temperature phase of matter and provide novel access to the question of how most of the mass of visible matter in the Universe was generated in the first microseconds after the Big Bang. During the first three years of LHC operation, ALICE has collected data for p-p collisions (\(\sqrt{s} = 0.9, 2.76, 7\) and \(8\) TeV), p-Pb collisions (\(\sqrt{s} = 5.02\) TeV) and Pb-Pb collisions (\(\sqrt{s} = 2.76\) TeV/nucleon).

Hardware and Software Deliverables
The Saha-ALICE group joined the ALICE Collaboration in 1997 and has been one of the founder laboratories who developed the Muon Spectrometer. Incidentally this has been the largest spectrometer ever built and Saha Institute has contributed substantially in its development and functionality. These contributions are:

1. **MANAS Chip**: This chip was designed and built in India and is being used by scientists from India, France, Italy, Russia and South Africa. A total of 1.1 Million tracking channels are read out by this chip and for this purpose a total of 1,10,000 MANAS chips were fabricated, tested and validated for quality assurance indigenously. The chips were fabricated at Semiconductor Complex Laboratory at Chandigarh under ISRO. During the first period of operation of LHC (2010-13) the performance of the chip was exceptionally stable and *eighteen (18) research papers* have been published in reputed journals using the data collected solely with MANAS chip.

2. **The Muon Tracking Chambers**: Saha Institute has fabricated ten (10) Cathode Pad chambers of 1.2 meters in diameter for tracking the muons emitted in the forward direction in ALICE.

All the components of these chambers are made in India and the full assembly was carried out at Saha Institute. These are the largest detectors of its kind ever built. The detectors operation was stable and the data could be collected for the entire period of the LHC operation.

3. **The Muon HLT**: On the software front, the Saha-ALICE group developed the High Level Trigger (HLT) for the Muon Spectrometer right from the beginning. The entire program was developed for real-time operation as there is no data buffer. For this reason, specific hit reconstruction and track reconstruction algorithms were developed at Saha Institute.
This framework runs on a computer cluster at the ALICE experimental cite and is capable of constructing online muon tracks from the digitized data.

Participation in Experiment and Data Analysis

Saha Institute is closely associated with the data collection, analysis and physics of heavy quarks (charm and beauty) which are formed at early stages of collision and are the unique probe for the QGP. The major milestones have been:
1. SINP group was responsible for the run-coordination of Muon Spectrometer in in 2010 which was the first year of operation.
2. All the data were analyzed at SINP using the GRID facility.
3. The first measurements of suppression of Upsilon production at extreme forward angles ($2^\circ$ to $9^\circ$) for the first time in nucleus-nucleus and proton-nucleus collisions and led to four publications of the ALICE Collaboration [Phys. Lett. B738, 361 (2014), Phys. Lett. B740, 105 (2014)].
4. SINP group was first to study Psi(2S) resonance in ALICE using the Muon Spectrometer [Eur. Phys. J. C74, 2974 (2014)]. The recent study on the production cross-section of Psi(2S) in proton-nucleus collisions has shown an anomalous behavior which cannot be described by existing models [Journal of High Energy Physics 12, 073 (2014)].
5. All the four publications are in journals with Impact Factor greater than five.
6. The first measurement of the double differential cross-sections of Jpsi at forward angles at LHC energies.
7. We reported the experimental results on suppression of Upsilon production for the first time in an International Conference which was Hard Probes 2013.

QGP Phenomenology

This activity is being pursued for last 15 years with emphasis on the study of anisotropic quark-gluon plasma (AQGP), intensity correlations and heavy quarks in ultra-relativistic heavy ion collisions. The highlights of these studies in recent times are:
1. We have worked on the characterisation of collective modes induced by relativistic jets in a collision-less anisotropic quark-gluon plasma (AQGP) assuming a colorless Tsunami-like momentum distribution of the jet partons. Within the framework of the transport equation, we derive and discuss the dispersion relations for both the stable and unstable modes of the composite system in the Vlasov approximation. We consider the case when the wave vector is parallel to the anisotropy direction as the growth rate of the unstable mode is maximum in this scenario [Phys.Rev. D89 (2014) 7, 074016].
2. We have also studied the intensity correlation for the photons dileptons at most central collision
at RHIC energy having fixed transverse momentum of one of the photons ($k_1T = 2$ GeV) to have an idea about the emission zone in presence of initial momentum space anisotropy [Phys.Rev. C89 (2014) 5, 054915].

3. We have studies quarkonium production in p-p collisions at LHC energies using the formalism of non-relativistic QCD and showed that the existing data from the four Collaborations namely, ALICE, ATLAS, CMS and LHCb, can well be reproduced within our model. [accepted in Jour. Phys. G.]

4. In another study we have shown that due to the consideration of thermalized charm quark, the energy loss of heavy quark increases if the QCD coupling is taken as running [arXiv:1408.6705]

**CMS Collaboration activities**

After a very successful period of data taking during Run I and the much awaited discovery of the Standard Model Higgs boson, the Large Hadron Collider (LHC) went offline from early 2013 for energy and luminosity upgrade. The CMS detector also underwent a number of upgrade to get ready for the Run II data taking which is scheduled to start in mid-2015. The CMS group from SINP has ongoing responsibilities for the Run II data taking, in detector performance and calibration studies of the hadron calorimeter, tracker validation, bad channel calibration, and tracking performance studies. The group is also involved in the LHC Phase II tracker development studies.

**Run I Physics Studies and Computing:**

A major effort was made in analyzing proton-proton data collected by the CMS experiment during the period 2009-2013 (termed as Run 1). We have contributed to the study of a number of key physics questions with long term involvement, namely: (1) SM Higgs boson studies in the 4-lepton decay mode, e.g. $11\tau\tau$, in associated production with $W$ where the higgs decays into $\tau\tau$; (2) search for dark matter and extra-dimension; (3) search for compositeness for leptons; (4) inclusive jet production at different energies and event shape studies. We have also been involved in (1) SM Higgs boson studies in the $\gamma\gamma$ decay mode (differential distributions), and in the 4-lepton decay mode ($4e, 4\mu, 2e2\mu$). The Asian CMS Data Analysis (CMSDAS) school was held in SINP in November 2013. All the data analysis exercises of the school with more than 50 participants was locally supported by our local computing cluster, set up in 2013. The same cluster also served significantly for the PhaseII Tracker related simulation studies.

**Run II Preparation:**

We have made substantial contribution to the calibration of the hadron calorimeter. Different approaches to do relative and absolute calibration of the calorimeter have been studied. In addition, strategies to trigger on isolated particles are pursued. Our group shares a major responsibility for the validation of the present tracker detector, tracker bad channel calibration and tracking performance studies.

**Hadron Calorimeter Upgrade:**

Several operational limitations and long-term concerns warrant the replacement of all existing photo-detectors that instrument the current HCAL detectors. It has been decided to replace HPDs with Silicon PMs (SiPM) and the single anode PMTs with multi-anode PMTs. There will be substantial increase in the number of channels in barrel (HB), endcap (HE) and forward (HF) detectors. This will demand higher speed communication. Also finer trigger primitives are required to handle high pile-up. So the back-end electronics will be rebuilt by replacing VMEs with $\mu$TCA crates and equipping them with $\mu$HTR cards which are built in India as a joint venture of India-USA.
First set of cards is required for HF. A total of 54 $\mu$HTR cards is required in total within LS1. All the required cards have been built in the industries in Bangalore and tested at SINP before being shipped to CERN. These cards required some power mezzanine cards and they have been tested at SINP. The three crates are now ready to be installed at CERN.

**Phase II Upgrade:**
The CMS tracker detector will be replaced entirely with a new design in order to operate at the high luminosity LHC. The proposed tracker will provide trigger at Level 1 in order to reduce and keep event rate at an acceptable limit. We’ve contributed towards the Associative Memory (AM) based L1 track trigger simulation studies. We have also made major contribution to the study of performance of the proposed L1 track trigger by looking at the improvement in electron rate. This study will be a part of the PhaseII tracker Technical Proposal. We are also responsible for the development of the digitizer software for the new tracker. Both ECAL and HCAL endcap calorimeters need replacement and there are two possible designs that have been proposed. The first of these uses a Shashlik type detector while the second option will utilize highly granular silicon pads for both ECAL and the front part of the HCAL. We have made major contribution to the simulation of both these options. The work will be a part of the Technical Proposal and eventually to the Technical Design Report (TDR).

**Angular momentum generation mechanisms in A~ 100 region**
This work is being carried out at the National Accelerator centers at TIFR and IUAC, Delhi using the Indian National Gamma Array (INGA). INGA is a multi-detector, multi-user facility that is transported to the major accelerator centres in India.
Research work in the field of "Nuclear structure studies at high spins" using the techniques of measuring ultrashort lifetimes of discrete nuclear states has been done. These lifetimes are in the picosecond or sub-picosecond range and are measured by using Doppler shift techniques. These techniques have been extensively used for the last 15 years. The highlights of their recent work in this field are the first experimental evidence of interplay between anti-magnetic and collective rotation [Physics Letters B 694, 322 (2011)]

development of a model to explore this interplay [Physical Review. C. 83, 024305 (2011)]

the first systematic study to establish the transition from magnetic to collective rotation as a function of neutron number [Physics Letters B 710, 587 (2012)]

the first experimental evidence of anti-magnetic rotation in a nucleus other than Cadmium [Phys. Rev. C89, 061303 (R) (2014)]

the first measurement of level lifetimes in Doublet Bands of A 100 region [Phys. Rev. Lett 112, 202503 (2014)].

3.2.2 Publications

3.2.2.1 Publications in Journal

J Sethi; R Palit; JJ Carroll; et al, SPECTROSCOPY OF THE LOW-LYING STATES NEAR THE HIGH SPIN ISOMER IN i^{108}Ag*, ACTA PHYSICA POLONICA B46 (2015) 703

Satyaki Bhattacharya; Mariana Frank; Katri Huitu; et al, Probing the light radion through diphotons at the Large Hadron Collider, PHYSICAL REVIEW D91 (2015) Art No: 016008

AG Agocs; F Barile; GG Barnaföldi; et al, R&D on high momentum particle identification with a pressurized Cherenkov radiator, NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A766 (2014) 92

Payal Mohanty; Mahatsab Mandal; Pradip K Roy, Two-photon correlation in anisotropic quark-gluon plasma, PHYSICAL REVIEW C89 (2014) Art No: 054915

Leonard S Kisslinger; Debasish Das, Psi and Upsilon production in pp collisions at 8.0 TeV, MODERN PHYSICS LETTERS A29 (2014) Art No: 1450082
3.2.2.2 ALICE Collaboration

ALICE Collaboration, Two-pion femtoscopy in p-Pb collisions at root(NN)-N-S=5.02 TeV, PHYSICAL REVIEW C91 (2015) Art No: 034906

ALICE Collaboration,Multiplicity dependence K*(892)(0) and phi(1020) production in Pb-Pb collisions at root s(NN)=2.76 TeV, PHYSICAL REVIEW C91 (2015) Art No: 024609

ALICE Collaboration, Multiplicity dependence of jet-like two-particle correlation structures in p-Pb collisions at root s(NN)=5.02 TeV, PHYSICS LETTERS B741 (2015) 38

ALICE Collaboration, Production of Sigma (1385)(+/−) and Xi (1530)(0) in proton-proton collisions at root s=7 TeV, EUROPEAN PHYSICAL JOURNAL C75 (2015) Art No: 1

ALICE Collaboration, Measurement of electrons from semileptonic heavy-flavor hadron decays in pp collisions at root s=2.76 TeV, PHYSICAL REVIEW D91 (2015) Art No: 012001

ALICE Collaboration, Production of inclusive gamma(1S) and gamma(2S) in p-Pb collisions at, root S-NN=5.02 TeV, PHYSICS LETTERS B740 (2015) 105

ALICE Collaboration, Freeze-out radii extracted from three-pion cumulants in pp, p-Pb and Pb-Pb collisions at the LHC, PHYSICAL REVIEW LETTERS B739 (2014) 139

ALICE Collaboration, Exclusive J/psi Photoproduction off Protons in Ultraperipheral p-Pb Collisions at root s(NN)=5.02 TeV, PHYSICAL REVIEW LETTERS 113 (2014) Art No: 232504

ALICE Collaboration, Measurement of Prompt D-Meson Production in p-Pb Collisions at root s(NN)=5.02 TeV, PHYSICAL REVIEW LETTERS 113 (2014) Art No: 232301

ALICE Collaboration, Beauty production in pp collisions at root s=2.76 TeV measured via semi-electronic decays, PHYSICS LETTERS B738 (2014) 97

ALICE Collaboration, Suppression of Upsilon(1S) at forward rapidity in Pb-Pb collisions at root s(NN)=2.76 TeV, PHYSICS LETTERS B738 (2014) 361

ALICE Collaboration, Multiparticle azimuthal correlations in p-Pb and Pb-Pb collisions at the CERN Large Hadron Collider, PHYSICAL REVIEW C90 (2014) Art No: UNSP 054901

ALICE Collaboration, Measurement of visible cross sections in proton-lead collisions at root
s(NN)=5.02 TeV in van der Meer scans with the ALICE detector, JOURNAL OF INSTRUMENTATION 9 (2014) Art No: P11003

ALICE Collaboration, Neutral pion production at midrapidity in pp and Pb-Pb collisions at \( \sqrt{s(NN)}=2.76 \) TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3108

ALICE Collaboration, Event-by-event mean \( p(T) \) fluctuations in pp and Pb-Pb collisions at the LHC, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3077

ALICE Collaboration, Transverse momentum dependence of inclusive primary charged-particle production in p-Pb collisions at root \( S_{NN}=5.02 \) TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3054

ALICE Collaboration, Azimuthal anisotropy of D-meson production in Pb-Pb collisions at root \( s(NN)=2.76 \) TeV PHYSICAL REVIEW C90 (2014)

ALICE Collaboration, Production of charged pions, kaons and protons at large transverse momenta in pp and Pb-Pb collisions at root \( s(NN)=2.76 \) TeV, PHYSICS LETTERS B736 (2014) 196


ALICE Collaboration, Measurement of quarkonium production at forward rapidity in collisions at TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 2974


ALICE Collaboration, Centrality, rapidity and transverse momentum dependence of J/Psi suppression in Pb-Pb collisions at root\( (NN)\)-N-S\( =2.76\)TeV, PHYSICS LETTERS B734 (2014) 314

3.2.2.3 CMS Collaboration

CMS Collaboration, Search for supersymmetry using razor variables in events with b-tagged jets in pp collisions at root \( s=8 \) TeV, PHYSICAL REVIEW D91 (2015) Art No: 052018

CMS Collaboration, Search for resonances and quantum black holes using dijet mass spectra in proton-proton collisions at root \( s=8 \) TeV, PHYSICAL REVIEW D91 (2015) Art No: 052009

CMS Collaboration, Measurements of jet multiplicity and differential production cross sections of Z plus jets events in proton-proton collisions at root \( s=7 \) TeV, PHYSICAL REVIEW D91 (2015) Art No: 052008
CMS Collaboration, Search for Monotop Signatures in Proton-Proton Collisions at root $s=8$ TeV, PHYSICAL REVIEW LETTERS 114 (2015) Art No: UNSP 101801


CMS Collaboration, Study of $Z$ production in PbPb and pp collisions at root $s$(NN)=$2.76$ TeV in the dimuon and dielectron decay channels, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 3 (2015) Art No: 022

CMS Collaboration, Search for Displaced Supersymmetry in Events with an Electron and a Muon with Large Impact Parameters, PHYSICAL REVIEW LETTERS 114 (2015) Art No: 061801


CMS Collaboration, Search for long-lived neutral particles decaying to quark-antiquark pairs in proton-proton collisions at root $s=8$ TeV, PHYSICAL REVIEW D91 (2015) Issue: 1


CMS Collaboration, Search for new resonances decaying via $WZ$ to leptons in proton-proton collisions at root $s=8$ TeV, PHYSICS LETTERS B740 (2015) 83

CMS Collaboration, Measurement of the pp $\rightarrow_{i} ZZ$ production cross section and constraints on anomalous triple gauge couplings in four-lepton final states at root $s=8$ TeV, PHYSICS LETTERS B740 (2015) 250

**CMS Collaboration**, Searches for heavy Higgs bosons in two-Higgs-doublet models and for t -&lambda; ch decay using multilepton and diphoton final states in pp collisions at 8 TeV, PHYSICAL REVIEW D90 (2014) Art No: 112013

**CMS Collaboration**, Measurement of the t(over-bar) production cross section in pp collisions at root s=8 TeV in dilepton final states containing one tau lepton, PHYSICS LETTERS B739 (2014) 23

**CMS Collaboration**, Search for pair production of third-generation scalar leptoquarks and top squarks in proton-proton collisions at v root s=8 TeV, PHYSICS LETTERS B739 (2014) 229

**CMS Collaboration**, Identification techniques for highly boosted W bosons that decay into hadrons, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 12 (2014) Art No: 017


**CMS Collaboration**, Search for heavy neutrinos and W bosons with right-handed couplings in proton-proton collisions at root s=8TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3149


**CMS Collaboration**, Search for excited quarks in the gamma plus jet final state in proton-proton collisions at root s=8 TeV, PHYSICS LETTERS B738 (2014) 274

**CMS Collaboration; TOTEM Collaboration**, Measurement of pseudorapidity distributions of charged particles in proton-proton collisions at root s=8 TeV by the CMS and TOTEM experiments, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3053


**CMS Collaboration**, Search for the associated production of the Higgs boson with a top-quark...

**CMS Collaboration**, Measurement of the ratio of inclusive jet cross sections using the anti-k(T) algorithm with radius parameters R=0.5 and 0.7 in pp collisions at root s=7 TeV, PHYSICAL REVIEW D90 (2014) Art No: 072006

**CMS Collaboration**, Observation of the diphoton decay of the Higgs boson and measurement of its properties, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3076


**CMS Collaboration**, Description and performance of track and primary-vertex reconstruction with the CMS tracker, JOURNAL OF INSTRUMENTATION 9 (2014) Art No: P10009


**CMS Collaboration**, Measurement of the ratio B(t -¿ Wb)/B(t -¿ Wq) in pp collisions at root s=8 TeV, PHYSICS LETTERS B736 (2014) 33

**CMS Collaboration**, Constraints on the Higgs boson width from off-shell production and decay to Z-boson pairs, PHYSICS LETTERS B736 (2014) 64

**CMS Collaboration**, Search for top-squark pairs decaying into Higgs or Z bosons in pp collisions at root s=8 TeV, PHYSICS LETTERS B736 (2014) 371

**CMS Collaboration**, Search for massive resonances in dijet systems containing jets tagged as W or Z boson decays in pp collisions at root s=8 TeV, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 8 (2014) Art No: UNSP 173

CMS Collaboration, Search for WW gamma and WZ gamma production and constraints on anomalous quartic gauge couplings in pp collisions at root s=8 TeV, PHYSICAL REVIEW D90 (2014) Art No: 032008

CMS Collaboration, Measurement of jet multiplicity distributions in t(t)over-bar production in pp collisions at root s=7 TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3014

CMS Collaboration, Search for jet extinction in the inclusive jet-p(T) spectrum from proton-proton collisions at root s=8 TeV, PHYSICAL REVIEW D90 (2014) Art No: 032005

CMS Collaboration, Measurement of jet fragmentation in PbPb and pp collisions at root s(NN)=2.76 TeV, PHYSICAL REVIEW C90 (2014) Art No: 024908


CMS Collaboration, Search for invisible decays of Higgs bosons in the vector boson fusion and associated ZH production modes, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 2980


CMS Collaboration, Measurement of the production cross section for a W boson and two b jets in pp collisions at root s=7 TeV, PHYSICS LETTERS B735 (2014) 204

CMS Collaboration, Studies of dijet transverse momentum balance and pseudorapidity distributions in pPb collisions at root s(NN)=5.02 TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 2951

CMS Collaboration, Observation of a peaking structure in the J/psi phi mass spectrum from B+-/- - J/psi phi K+-/- decays, PHYSICS LETTERS B734 (2014) 261


CMS Collaboration, Measurement of the production cross sections for a Z boson and one or more b jets in pp collisions at root s=7 TeV, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 6 (2014) Art No: 120


CMS Collaboration, Probing color coherence effects in pp collisions at root s=7 TeV, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 2901

CMS Collaboration, Search for new physics in the multijet and missing transverse momentum

**CMS Collaboration**, Observation of the Associated Production of a Single Top Quark - and a W Boson in pp Collisions at root s=8 TeV, PHYSICAL REVIEW LETTERS 112 (2014) Art No: 231802


**CMS Collaboration**, Search for supersymmetry in pp collisions at root s=8 TeV in events with a single lepton, large jet multiplicity, and multiple b jets, PHYSICS LETTERS B733 (2014) 328


**CMS Collaboration**, Measurements of t(t)over-bar Spin Correlations and Top-Quark Polarization Using Dilepton Final States in pp Collisions at root s=7 TeV, PHYSICAL REVIEW LETTERS 112 (2014) Art No: 182001


**CMS Collaboration**, Search for Top-Quark Partners with Charge 5/3 in the Same-Sign Dilepton Final State, PHYSICAL REVIEW LETTERS 112 (2014) Art No: 171801
3.3 Nuclear Physics

3.3.1 Summary of Research Activities

The main thrust of the research activities in Nuclear Physics Division involves the experimental study of low & intermediate energy nuclear physics using different accelerator centres in India and a few abroad. In addition, members of the division are also actively involved in the setting up of the FRENA facility for nuclear astrophysics research. The other major activities are: theoretical research and developmental activities. Several faculty members of the division actively participated in the summer students programme of the Institute and also undertook teaching courses both in SINP and other neighbouring universities.

Nuclear Structure

Research work in nuclear structure can be broadly classified into two mass regions viz., $A \sim 140$ and $A \sim 40$ regions.

**A \sim 140 region**

Nuclear structure studies in the $A = 140$ region have been extended for the following isotopes: $^{142}\text{Sm}$ & $^{143}\text{Eu}$. Excited states of $^{142}\text{Sm}$ (excitation energy $\sim 12.5$ MeV and spin $28^+$) have been investigated using the INGA set up at TIFR. A new dipole band and three new quadrupole bands has been observed in $^{142}\text{Sm}$. The life-times for the negative parity excited levels of these newly observed bands have been determined by means of DSAM analysis. The experimental $B(M1)$ values of the dipole band are well reproduced in the framework of the SPAC (Shears with Principal Axis Cranking) model calculation and were interpreted as magnetic rotational band.

The parity of the two observed dipole bands in $^{143}\text{Eu}$ has been firmly established from linear polarization measurements. Level lifetimes of these bands have been measured using DSAM. The
drop in B(M1) values, with spin, exhibits a clear signature of magnetic rotational character of these two bands. Configurations were assigned to the bands in the framework of shears mechanism with SPAC model calculation. Alignment of an additional proton in the h11/2 orbital give rise to the unique observation of large increase in the B(M1) values for the higher lying band. Further, life times of the states in the quadrupole structure have been measured using DSAM. The deduced B(E2) values shows the characteristic decrease with spin which conclusively proves that these states have originated from anti magnetic rotation. This is the first evidence of anti magnetic rotation in a region other than A ∼ 100.

A ∼ 40 region
High spin states of 34Cl and 33S, populated through 27Al(12C,αn) and 27Al(12C,αpn) reactions respectively, at E(12C)=40MeV, have been studied using the INGA facility. The level schemes of both these nuclei have been extended, utilizing the results of intensity, directional correlation and linear polarization measurements. Lifetimes of a few excited states have also been estimated for the first time using the DSAM. Large-basis shell-model (LBSM) calculations within the sd-pf space have been done to understand the microscopic origin of the excited states. For 34Cl, the involvement of pf orbitals has been found to be essential to reproduce the negative-parity as well as high spin positive-parity states. Onset of collectivity, manifested through short half-lives and large B(E2) values, have been reproduced well in the calculations. For 33S, three levels of the negative parity yrast sequence were found to be connected by strong E2 transitions. The lifetimes of these states were determined by DSAM and have been utilized to study the evolution of collectivity with spin. These results provide the first experimental evidence of cluster structure and super deformation in odd-A nuclei of upper-sd shell. Theoretical interpretation of these states within LBSM is also unique.

Nuclear Reactions:
Quasi-elastic scattering excitation functions for the systems 6,7Li+159Tb have been measured from near-barrier to deep sub-barrier energies. Presently the data are being analyzed. From the quasi-elastic events the fusion barrier distribution will be extracted. The deep sub-barrier cross sections will be used to determine the surface diffuseness parameters for the two systems. The work on the simultaneous R-matrix analysis of 13C(p,γ)14N* capture reaction and the low energy 13C(p,p) elastic scattering data to constrain the gamma as well as particle widths has been completed using the multi-level, multi-channel R-matrix code AZURE II. The model calculation yielded a lower astrophysical S-factor value than the adopted value in the NACRE compilation. The temperature profile of the reaction rate has been estimated using the estimated S-factor value. In order to understand the effect of coupling of direct reaction channels on fusion and also the back angle quasi-elastic barrier distribution functions, the systems 6,7Li + 64Ni was experimentally studied at near barrier energies. The results on the investigation of fusion of 6Li with 64Ni have been published. Subsequently, the detailed probing of the barrier distribution function in terms of the channel coupling effects have been completed and submitted for publication. The analysis of the experimental measurement of fusion excitation function and quasi-elastic barrier distribution function of 7Li+64Ni has recently been completed.

Study of the astrophysically important 12C(α,γ) reaction have been carried out using the indirect method. Two transfer reactions viz. 12C(6Li,d) and 12C(7Li,t) reactions, at 20 MeV, have been measured and studied. The alpha spectroscopic factor of the bound state of 16O and especially of the ground state has been concluded to be strongly influenced by breakup. This has a scaling effect on the astrophysical E2 S-factor of the alpha capture reaction.
Developmental activities:
A low energy photon spectrometer (LEPS), which is a composite planar HPGe, has been characterized experimentally. It has been shown that beyond 200 keV, effect of image charges deteriorates the efficiency of the detector in its addback mode. Data has been corrected on event by event basis resulting in improvement of the performance.

3.3.2 Developmental Work

3.3.2.1 The development of the gas scintillation counter is being continued

The development of the gas scintillation counter is being continued. The detector has been tested with 55Fe (5.5 keV X ray) source using Xenon gas and without any grid to produce secondary scintillation. A ET VUV Photomultiplier with peak spectral sensitivity at 130-180 nm was used to detect scintillation. However, no primary scintillation could be observed. The grids are now being fabricated to operate the detector in the secondary scintillation mode.

Chinmay Basu

3.3.2.2 Detection of alpha, gamma and Internal conversion electrons using Si-PIN diodes

The Si-PIN diode detectors and the preamplifiers, which are specially designed for X-ray and gamma ray detection, are costly and only available from international vendors. We are working to utilize cheap commercially available Si-PIN diodes to detect alpha, gamma and electrons. We are testing the diodes to select the most suitable one. Later, we are comparing their responses using commercial and locally fabricated preamplifiers for detection of radiation. To decrease the dark current at reverse bias condition, we have designed ways to cool the detector by liquid Nitrogen. Efforts are on to utilise thermoelectric coolers for the same.

Sangeeta Das; Arghya Chakraborty†; Arya Datta†; Suhib Chatterjee; Chandranath Marick; Jonaki Panja, M Saha Sarkar

3.3.3 Publications

3.3.3.1 Publications in Journal

S Sambi; R Raabe; MJG Borge; et al, $^{12}$C+p resonant elastic scattering in the Maya active target, EUROPEAN PHYSICAL JOURNAL A51 (2015) Art No: 25

D Banerjee; A Saha; T Bhattacharjee; et al, Role of p-induced population of medium-mass (A $\sim$ 150) neutron-rich nuclei, PHYSICAL REVIEW C91 (2015) Art No: 024617

JT Matta; U Gary; W Li; et al, Transverse Wobbling in $^{135}$Pr, PHYSICAL REVIEW LETTERS 114 (2015) Art No: 082501

Md Moin Shaikh; Subinit Roy; S Rajbanshi; et al, Barrier distribution functions for the system Li-6+Ni-64 and the effect of channel coupling, PHYSICAL REVIEW C91 (2015) Art No: 034615
Abhijit Bisoi; M Saha Sarkar; S Sarkar; et al, Collective excitations in S-33, PHYSICAL REVIEW C90 (2014) Art No: 024328

S Rajbanshi; Abhijit Bisoi; Somnath Nag; et al, Multiple magnetic rotational bands based on proton alignment in Eu-143, PHYSICAL REVIEW C90 (2014) Art No: 024318

Md Moin Shaikh; Subinit Roy; S Rajbanshi; et al, Investigation of Li-6+Ni-64 fusion at near-barrier energies, PHYSICAL REVIEW C90 (2014) Art No: 024615

S Adhikari; C Basu; IJ Thompson; et al Observation of a breakup-induced alpha-transfer process for some bound states of O-16 populated by the C-12(Li-6,d)O-16 reaction, PHYSICAL REVIEW C89 (2014) Art No: 044618

3.3.4 Seminars/Lectures given in Conference/Symposium/Schools

Ushasi Datta Pramanik
i. Coulomb breakup as a novel spectroscopic tool and New results on 'ISLAND of inversion nuclei' i.e. Neutron-rich Na, Al, Mg, Department of Physics and Astronomy, Rutgers University, Rutgers, USA, Feb 6, 2014
ii. Study of exotic nuclei using RIB facility, Stanford University, Physics Dept, USA, May 15, 2014
iii. Coulomb breakup as a novel spectroscopic tool to probe directly the quantum numbers of the valence nucleon, Cyclotron Colloquium, Cyclotron Institute, Texas A & M, USA, Jun 24, 2014

Asimananda Goswami
i. Advance techniques on gamma ray spectroscopy, DST-SERC School on Nuclear Structure at High Angular Momentum and Isospin, Oct 5-25, 2014, Tata Institute of Fundamental Research, India
ii. Lifetime Measurements using Doppler Shift Attenuation Method

Subinit Roy
Fusion Near Barrier(Two Talk), Summer School on Nuclear Fission and Related Phenomena, Variable Energy Cyclotron Centre, Kolkata, May 13-23, 2014
Experimental activities in and around FRENA (Two Talk), Winter School on Nuclear Astrophysics, Variable Energy Cyclotron Centre, Kolkata, Jan 19-31, 2015

M Saha Sarkar
136Sn and three body forces, 75-years of Nuclear Fission: Present status and future perspectives, May 8-10, 2014, BARC, Mumbai
3.3.5 Teaching elsewhere

Chinmay Basu
Nuclear Reactions & Nuclear Astrophysics, Jan-Mar 2015, Department of Physics, University of Kolkata

Subinit Roy
Nuclear Astrophysics (21 Lectures) in Nuclear Reactions (Advance II), Advance Courses, M Sc (Physics), University of Calcutta, Kolkata, Jan-Mar, 2015

Asimananda Goswami
\(\gamma\) decay & Nuclear Instrumentation in Nuclear Reactions, Department of Physics, University of Calcutta, Jan-Mar, 2015

M Saha Sarkar
i. Shell evolution and collectivity in sd-shell nuclei - an experimentalist’s view, school on Nuclear structure, IUAC, New Delhi, Apr 21-26th, 2014 (6 lectures)

II. Spectroscopy of nuclei near 132Sn and shell model results, SERC-school for graduate students on ”Nuclear structure at high angular momentum and isospin, Mumbai, Oct 5-25, 2014 (3 lectures)
Chapter 4

Plasma Physics

4.1 Plasma Physics

4.1.1 Summary of Research Activities

Research activities in the plasma physics division encompass a variety of theoretical and experimental topics in the field of linear and nonlinear wave propagation. Theoretical studies using nonlinear analysis in Lagrange variables for various types of electrostatic modes in unmagnetized and magnetized plasmas have been carried out to demonstrate wave breaking phenomena due to phase-mixing processes. Such studies have relevance to electron energization and plasma particle heating in astrophysical environments and laboratory experiments. Using Lagrange fluid approach, collapse type processes associated with magnetosonic waves have been identified to be a possible mechanism for generation of strongly localized magnetic fields that are important in the astrophysical context of magnetic star formation. Investigations on Bursian diodes in presence of transverse magnetic fields reveal interesting results that can help in the design of fast electron switches with current interruption. Studies are also being pursued to understand the formation of different types of nonlinear structures in classical as well as quantum plasmas. In the field of strongly coupled dusty plasmas, effects of velocity shear have been extensively studied to show new types of instabilities in dust acoustic and shear waves. In non-Newtonian plasmas, shear flow-rate dependent viscosity in the shear thickening and thinning regimes is shown to modify the growth rates of Kelvin-Helmholtz as well as Rayleigh-Taylor instabilities. The stability of large scale vortex in a strongly coupled dusty plasma is being studied with short scale perturbations. It is shown that the free energy related to the velocity shear of the elliptical vortex flow can drive secondary instabilities of transverse shear wave when the resonance condition between vortex rotation frequency and secondary wave frequency are met. Such process can transfer energy from long scale vortex to the short scale secondary wave ultimately contributing to turbulence.

Experimental activities are being carried out in the MaPLE (Magnetized Plasma Linear Experiment), Double Layer Experiment (DLX), glow discharge plasma and the tokamak devices. In MAPLE device, nitrogen plasma produced by ECR discharge is used to study the parametric decay of waves in the ion cyclotron range of frequencies into linear modes. Along with a mode whose frequency lies in the range of density gradient driven drift wave, sidebands of incident wave are
also observed when the amplitude of the exciter signal goes above a threshold value. Sideband of the second harmonic is also observed. Preliminary analysis shows the possibility of ion Bernstein waves in the device. Wave dispersion studies to confirm the identity of the excited waves are in progress.

In DLX, 2D measurements in a plasma diffusing in a diverging magnetic field have been carried out showing U-shaped potential contours and hollow conical density structures defined by the maximum diverging magnetic field lines passing through the radial edge of the exit aperture of the source. We observe a slow increase of the peak density along a hollow conical surface under various conditions indicating that the phenomenon is generic in nature. Study of self-excited drift waves due to strong density gradient that varies from peaked to hollow in presence of axially varying magnetic fields is also being carried out.

Nonlinear dynamic experiments are being carried out in the DC glow discharge plasma device revealing a variety of nonlinear phenomena such as homoclinic and inverse homoclinic bifurcation, intermittent chaos, mixed mode oscillations, spiking-bursting and coherent resonance. Different statistical and spectral methods have been used to explore the complex dynamics of the system. Theoretical and numerical modelling based on plasma fluid models leading to autonomous differential equations known as jerk and spasm equations explain a number of interesting phenomena based on bifurcation diagrams.

4.1.2 Publications

4.1.2.1 Publications in Journal

S Garai; D Banerjee; MS Janaki; et al., Stabilization of Rayleigh-Taylor instability in a non-Newtonian incompressible complex plasma, PHYSICS OF PLASMAS 22 (2015) Art No: 033702

Neeraj Chaubey; S Mukherjee; AN Sekar Iyengar; et al, Synchronization between two coupled direct current glow discharge plasma sources, PHYSICS OF PLASMAS 22 (2015) Art No: 022312

Debajyoti Saha; Pankaj Kumar Shaw; Sabuj Ghosh; et al, Investigation and quantification of non-linearity using surrogate data in a glow discharge plasma, PHYSICS OF PLASMAS 22 (2015) Art No: 022307


Samiran Ghosh; Nikhil Chakrabarti, Nonlinear wave collapse, shock, and breather formation in an electron magnetohydrodynamic plasma, PHYSICAL REVIEW E90 (2014) Art No: 063111

Vramori Mitra; Arun Sarma; MS Janaki ; et al, Order to chaos transition studies in a DC glow discharge plasma by using recurrence quantification analysis, CHAOS SOLITONS & FRACTALS 69 (2014) 285

Anirban Bose; Mylavarapu S Janaki, A simple method to obtain the equilibrium solution of Wigner-Boltzmann equation with all higher order quantum corrections, EUROPEAN PHYSICAL JOURNAL B87 (2014) Art No: 259
Ashish Adak; Samiran Ghosh; Nikhil Chakrabarti, Rayleigh-Taylor instability in an equal mass plasma, PHYSICS OF PLASMAS 21 (2014) Art No: 092120

SS Ghosh; AN Sekar Iyengar, Effect of cooler electrons on a compressive ion acoustic solitary wave in a warm ion plasma-Forbidden regions, double layers, and supersolitons, PHYSICS OF PLASMAS 21 (2014) Art No: 082104


Abhik Mukherjee; Anirban Bose; MS Janaki, Quantum corrections to nonlinear ion acoustic wave with Landau damping , PHYSICS OF PLASMAS 21 (2014) Art No: 072303

Abhik Mukherjee; MS Janaki, Phase-modulated solitary waves controlled by a boundary condition at the bottom, PHYSICAL REVIEW E89 (2014) Art No: 062903

Arun Sarma; Supin Gopi; Debajyoti Saha, Reformation of hydrocarbons using non-thermal plasma at atmospheric pressure: discharge characteristics and associated nonlinear dynamics, PHYSICA SCRIPTA T161 (2014) Art No: 014064

SK Saha; S Chowdhury; MS Janaki; et al, Plasma density accumulation on a conical surface for diffusion along a diverging magnetic field, PHYSICS OF PLASMAS 21 (2014) Art No: 043502

4.1.3 Ph D Awarded

Chandan Maity [Nikhil Chakrabarti], Lagrangian Fluid Technique to study Nonlinear plasma Dynamics, Jadavpur university, Dec, 2014

Manjistha Dutta [Nikhil Chakrabarti & M Khan], Study of Nonlinear electron acoustic waves and their stability in plasmas, Jadavpur University, Dec, 2014

4.1.4 Seminars/Lectures given in Conference/Symposium/Schools

Nikhil Chakrabarti
Linear and weakly nonlinear waves in a strongly coupled plasma in presence of density dependent viscosity, the Second National symposium on Nonlinear and Complex Phenomena, organized by IASST, CPP-IPR (Assam) in association with ACNCP (Kolkata), Mar 26-28, 2015
Chaired a session

M S Janaki
i. Plasma density pile up on a conical surface during expansion along a divergent magnetic field, 29th National Symposium On Plasma Science & Technology, MG university, Kottayam, Kerala, Dec 8, 2014
iii. Nonlinear jerk equation describing chaotic electrostatic ion-cyclotron oscillations, National Sem-
Chapter 5

Theoretical Physics & Astroparticle Physics

5.1 Astroparticle Physics and Cosmology

5.1.1 Summary of Research Activities

APC The Astroparticle Physics & Cosmology (APC) Division carries out advanced research in the interface areas spanning High Energy Astrophysics, Cosmology, and Particle & Nuclear physics. During the year under review, members of the Division have carried out research on a variety of topics in AstroParticle Physics observational, experimental and theoretical. Some highlights are given below:

(i) Dark matter search with PICO-2L and bubble nucleation in superheated droplets: The PICO-2L dark matter search experiment with 2L C3F8 bubble chamber is currently underway at the SNOLab underground facility in Sudbury, Canada since November 2013. In this context, the SINP group has performed research pertaining to (a) new phenomenon in bubble nucleation with tiny superheated droplets at low frequency. This study is useful in rejecting the backgrounds both in neutron detection and dark matter search. (b) the detection of bubble nucleation event in superheated drop detector by pressure sensor and the associated circuits for the measurement of pressure.

(ii) High Energy Gamma Ray Astronomy: (a) Members of APC Division are involved in the analysis of middle-aged mixed-morphology (MM) supernova remnants (SNRs) interacting with molecular clouds using Fermi, X-rays and TeV gamma-ray data. This analysis has revealed radiative recombination structures of silicon and sulfur from supernova remnant 3C 391 using Suzaku data. The possible origin of this type of radiative plasma and hadronic gamma rays has been discussed. (b) The scientists of APC Division are taking a lead role in various software and hardware activities in connection to the calibration of the telescopes as part of the future Cerenkov Telescope Array project.
(iii) Physics of Supernovae and Neutron Stars: (a) Exotic matter and its influence on neutron star structures have been investigated. A new hyperon equation of state (EoS) has been constructed for supernova simulations and neutron star mergers. This EoS is compatible with the recently observed 2 M solar neutron star. (b) The influence of isospin dependent entrainment has been studied in slowly rotating superfluid neutron stars. The Kepler frequency is modified due to the isospin dependent entrainment.

(iv) Theoretical research on Dark Matter: The particle nature of dark matter is investigated within the framework of non-SUSY beyond standard model and then these theoretical models are confronted with different observed phenomenon such as observed gamma ray excess from galactic centre, 3.55 keV X-ray lines from Andromeda and other galaxies and galaxy clusters as well as direct detection observational results. In this context we investigate two component Dark Matter scenario. The non thermal dark matter whereby dark matter is produced non-thermally such as out of equilibrium decay has been investigated. The astrophysical observations of excess gamma rays as a possible signature of annihilating dark matter and thus a possible indirect dark matter detection is elaborately and extensively studied in case of such gamma rays from galactic centre, dwarf galaxies, Fermi bubbles as well as extra galactic sources.

While the particle nature of dark matter is probed from particle physics, the process of generation of dark matter as well as the astrophysical aspect of dark matter have also been studied in great details. The direct and indirect detection of dark matter have also been addressed with equal importance.

Furthermore, the rotation curve (RC) of the Galaxy has been constructed from a galactocentric distance of $\sim 0.2$ kpc out to $\sim 200$ kpc by using kinematical data on a variety of both disk and nondisk objects that trace the gravitational potential of the Galaxy, without assuming any theoretical models of the visible and DM components of the Galaxy. The resulting RC in the disk region is found to depend significantly on the choice of the Galactic constants (GCs), while the dominant uncertainty in the RC at large distances beyond the stellar disk comes from the uncertainty in the value of the velocity anisotropy parameter of the halo tracer objects.

(v) Neutrino mass models and baryogenesis: In continuation, towards understanding of a model of neutrino masses and mixing through the implementation of symmetries/ansatz, following works have been done: (a) Texture zero neutrino mass matrices with scaling ansatz property within the framework of inverse and linear seesaw mechanisms, (b) Maximal zero textures of the neutrino mass matrices in inverse seesaw mechanism with broken $\mu\tau$ reflection symmetry, (c) In addition baryogenesis through leptogenesis (flavored, unflavored and $\tau$ flavored ) mechanism has been also investigated in a Cyclic symmetric model. (vi) Gravitation: (a) The exact frame-dragging rate inside rotating neutron stars has been derived. The exact frame-dragging rate depends on both the distance and angle. The application of this formalism leads to the appearance of local maximum and minimum along the equatorial distance. (b) The radius of the innermost-stable circular orbit (ISCO) has been computed exactly for extremal KTN, Taub-NUT, massless Taub-NUT spacetimes. It is noted that the radius of the ISCO is independent of the NUT charge in the KTN spacetime.
5.1.2 Developmental Work

Single module detector system using superheated liquid

The R & D on the single module detector system using superheated liquid with condensation chamber for the next generation detector for dark matter search has been carried out. After studying several variations of the module, it has been observed that the bulk superheated liquid in a glass vessel, where possible nucleation sites are reduced using a surfactant, is the most stable one. The up-gradation of this chamber to larger volume and the maintaining of differential temperature along the condensation chamber tube are under way.

Mala Das

5.1.3 Publications

5.1.3.1 Publications in Books/Monographs & Volumes Edited

Debasish Majumdar

5.1.3.2 Publications in Journal

Kamakshya Prasad Modak, 3.5 keV X-ray line signal from decay of right-handed neutrino due to transition magnetic moment, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 3 (2015) Art No: 064

BS Acharya; C Aramo; A Babic; et al, The Cherenkov Telescope Array potential for the study of young supernova remnants, ASTROPARTICLE PHYSICS 62 (2015) 152

Apurba Kheto; Debades Bandyopadhyay, Slowly rotating superfluid neutron stars with isospin dependent entrainment in a two-fluid model, PHYSICAL REVIEW D91 (2015) Art No: 043006


Mainak Chakraborty; H Zeen Devi; Ambar Ghosal, Scaling ansatz with texture zeros in linear seesaw, PHYSICS LETTERS B741 (2015) 210

Basudhara Basu; Sibaji Raha; Swapan K Saha; et al, Observation of a rare cosmic ray event at mountain altitude, ASTROPARTICLE PHYSICS 61 (2015) 88

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Amit Dutta Banik; Debasish Majumdar, Inert do ublet dark matter with an additional scalar singlet and 125 GeV Higgs boson, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3142


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Sarmistha Banik; Matthias Hempel; Debades Bandyopadhyay, NEW HYPERON EQUATIONS OF STATE FOR SUPERNOVAE AND NEUTRON STARS IN DENSITY-DEPENDENT HADRON FIELD THEORY, ASTROPHYSICAL JOURNAL SUPPLEMENT SERIES 214 (2014) Art No: 22

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B Adhikary; A Ghosal; P Roy, Maximal zero textures of the inverse seesaw with broken mu tau symmetry, INDIAN JOURNAL OF PHYSICS 88 (2014) 979

Srijit Bhattacharjee; Parthasarathi Majumdar, Gravitational Coleman-Weinberg potential and its finite temperature counterpart, NUCLEAR PHYSICS B885 (2014) 481

Chandrachur Chakraborty; Kamakshya Prasad Modak; Debades Bandyopadhyay, DRAGGING OF INERTIAL FRAMES INSIDE THE ROTATING NEUTRON STARS, ASTROPHYSICAL JOURNAL 790 (2014) Art No: 2

T Ergin; A Sezer; L Saha; et al, RECOMBINING PLASMA IN THE GAMMA-RAY-EMITTING MIXED-MORPHOLOGY SUPERNOVA REMNANT 3C 391, ASTROPHYSICAL JOURNAL 790 (2014) Art No: 65

Mala Das; Debasish Das; Anjali Mukherjee; et al, Exploring radiation in many splendors CURRENT SCIENCE 107 (2014) 15

Prasanta Char; Sarmistha Banik, Massive neutron stars with antikaon condensates in a density-dependent hadron field theory PHYSICAL REVIEW C90 (2014) Art No: 015801

S Archambault; T Arlen; T Aune; P Majumdar; et al, test of models of the cosmic infrared
background with multiwavelength observations of the blazar 1ES 1218+30.4 IN 2009, ASTROPHYSICAL JOURNAL 788 (2014) Art No: 158

R3B Collaboration, B-13,B-14(n, gamma) via Coulomb Dissociation for Nucleosynthesis towards the r-Process, NUCLEAR DATA SHEETS 120 (2014) 197

Pijushpani Bhattacharjee; Soumini Chaudhury; Susmita Kundu, ROTATION CURVE OF THE MILKY WAY OUT TO similar to 200 kpc, ASTROPHYSICAL JOURNAL 785 (2014) Art No: 63

Chandrachur Chakraborty; Majumdar Parthasarathi, Strong gravity Lense-Thirring precession in Kerr and Kerr-Taub-NUT spacetimes, CLASSICAL AND QUANTUM GRAVITY 31 (2014) Art No: 075006

PICASSO collaboration, Searching for dark matter with PICASSO, Physics Procedia 61 (2015) 107

Kamakshya Prasad Modak; Debasish Majumdar; Subhendu Rakshit, A Possible Explanation of Low Energy γ-ray Excess from Galactic Centre and Fermi Bubble by a Dark Matter Model with Two Real Scalars, JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS 1503 (2015) 011

5.1.4 Ph D Awarded

Lab Saha [Pijushpani Bhattacharjee], Some aspects of gamma-ray astronomy, HBNI, Mumbai, September, 2014


Susnata Seth [Pijushpani Bhattacharjee], Aspects of superheated droplet detectors and their application in dark matter search, HBNI, Mumbai, February, 2015

5.1.5 Seminars/Lectures given in Conference/Symposium/Schools

Mala Das
i. Dark matter direct search with PICASSO/PICO, Conference on Light in the dark side, Banaras Hindu University, Varanasi, Mar 17, 2015
ii. Exploring the dark side of the Universe, DAE Symposium on Nuclear Physics (SNP-2014), Banaras Hindu University, Varanasi, Dec, 8-12, 2014
iii. Activities related to PICO and various aspects of SDD, PICO collaboration meeting’, SNOLab, Sudbury, Canada, Aug, 28-29, 2014
Debasish Majumdar
i. “Dark Matter”, Indian Institute of Technology, Indore, April 2014 (series of two lectures) ii. “A Possible Explanation of Low Energy gamma-ray Excess from Galactic Centre and Fermi Bubble by a Dark Matter Model with Two Real Scalars” invited talk at the meeting International Workshop on Unification and Cosmology after Higgs Discovery (UNICOS2014), Department of Physics, Panjab University, Chandigarh, May 15, 2014
iii. A nonthermal dark matter model for explaining Fermi-LAT observed gamma-ray excess, IBS-MultiDark Joint Focus Programme meeting, Center for Theoretical Physics of the Universe in Daejeon, South Korea, Oct 15, 2014
iv. Confronting GeV γ-ray excess from Galactic Centre and Fermi Bubble with Inert Higgs Doublet Model, Conference on Dark Side of the Universe, Center for Astrophysics Cosmology and Gravity, University of Cape Town, South Africa, Oct 21, 2014
v. Generalising Thawing Dark Energy Models, Seminar on Exploring the Cosmos, North Bengal University, Siliguri, Jan 22, 2015
vi. Late Time Acceleration In A Slow Moving Galileon Field, Topical Conference on Gravity and Cosmology (Eastern Region), Indian Institute of Technology, Kharagpur, Feb 28, 2015
viii. Fermi-LAT Observation of gamma rays from galactic and extra-galactic sources and a possible explanation from dark matter annihilation, Workshop on Light from dark side of the Universe, Banaras Hindu University, Varanasi, Mar 17-20, 2015

Debades Bandyopadhyay
i. Supernova Explosions: The role of hyperon matter, 59th DAE-BRNS Nuclear Physics Symposium, Benaras Hindu University (BHU), Varanasi, Dec 11, 2014
ii. Thermodynamic properties of nuclear surface, workshop on Nuclear Equation of State for Supernovae and Compact Stars 2014, Frankfurt Institute for Advanced Studies (FIAS), Germany, Dec 3-5, 2014
iv. Supernova Explosions: The role of exotic matter, Indian Institute of Science, Bangalore, Sept 2, 2014
v. New hyperon equation of state for supernovae and neutron stars, Institute for Nuclear Physics, Orsay, France, June 11, 2014
vi. Thermal properties of nuclear surface, Colloquium at Texas A & M University, College Station, USA, May 20, 2014

5.1.6 Teaching elsewhere
Debades Bandyopadhyay
Physics of Supernovae and Compact Stars [8 lectures], the Winter school on Nuclear Astrophysics, VECC, Kolkata, Jan 19-31, 2015
5.2 Theory

5.2.1 Summary of Research Activities

a) Particle Physics Phenomenology:
Phenomenology of Two-Higgs-Doublet models has been studied focusing on two aspects in particular, namely, appropriate suppression of flavor-changing neutral currents, and the role of global symmetries in the scalar potential together with their soft breaking terms in ensuring smooth decoupling of heavy scalars.

NLO with Parton Shower: (a) All di-final state processes in the RS model (b) Three photon production process in the SM, to Next to leading order (NLO) in QCD and including parton shower effects, implemented in the aMC@NLO framework. Two Loop Amplitudes: Two loop QCD corrections to amplitudes: (a) massive spin-2 resonance → g + g + g and (b) Higgs → b + b + g. These results constitutes one of the ingredients to a full NNLO QCD process. NNLO: Next to Next to Leading Order (NNLO) QCD corrections to the graviton production in models of TeV-scale gravity, working within the soft-virtual approximation, these predictions are closely comparable to exact NNLO results.

b) Non-perturbative Studies of Quantum Field Theories:
Gauge fixing in the usual Fadeev-Popov and BRST scheme cannot be pursued in the case of non-perturbative compact lattice gauge fields. A new investigation has been started in the Theory Division of SINP to test a equivariant BRST scheme (eBRST) evading a no-go theorem. For the last year, a U(1) compact lattice gauge theory has been studied with a standard BRST breaking gauge fixing term and a dimension two counter term. An interesting phase diagram in this extended parameter space has been obtained which indicates a hitherto unfound continuous phase transition in the weak gauge coupling region. In addition, there seems to exist a tricritical line for strong gauge coupling region where quenched chiral condensates may show a non-trivial behaviour. The Abelian part of the work is near completion.

The fermion measure was studied in the presence of axion fields and it was argued that such fields may not play a decisive role in the so-called strong CP problem.

Towards the goal of extracting the continuum properties, the Topological Charge Density Correlator and the Inverse Participation Ratio for the topological charge density were studied in SU(3) Lattice Yang-Mills theory for relatively small lattice spacings including some smaller than those explored before.

c) Gravity and Cosmology:
Black hole entropy was investigated in the framework of Loop Quantum Gravity with special attention paid to the classical area, which has usually not been taken into account in entropy calculations. The dynamics of multiple scalar fields in inflationary cosmology (N-flation) has been explored in the framework of supergravity and string theory. In addition, phenomenological implications of long lived particles like moduli and gravitinos have been explored. In particular, how the existence or production of these particles affects the inflationary models have been analyzed.

Planck scale corrections to the quasi-normal frequencies of black holes have been calculated using a noncommutative model of quantum gravity.

d) Strings:
A de Sitter solution upto a conformal factor has been constructed from certain anisotropic space-like D3 brane solution of type IIB string theory. Similar constructions as well as accelerating cosmolo-
gies have been obtained from space-like Dp-branes in two different limits. How the thermodynamic phase structures of black D6 brane changes with the inclusion of D0 brane has been demonstrated and its origin has been discussed. Finally, both a supersymmetric as well as a non-supersymmetric versions of interpolations between AdS5 space in the UV and hyperscaling violating Lifshitz space in the IR have been obtained.

The perturbative study of entanglement entropy and thermodynamic first laws of some AdS black hole spacetimes under boost were done. An attempt was made to identify the correct ground state for a strongly coupled large $N$ gauge theory at finite density. A family of solutions of 10-dimensional supergravity, which are dual to the infra-red limit of strongly coupled large $N$ gauge theories at finite density was constructed. The effect of a non-vanishing chemical potential on the thermalization time for a prototypical strongly coupled large $N$ gauge theory by studying the gravitational collapse dynamics in an asymptotically anti de-Sitter space-time was analyzed. The possibility of an effective thermodynamic description for a class of steady-state systems within Gauge-gravity duality was explored.

e) QCD at Finite Temperature and Density:
The determination of static and dynamic quantities of QCD matter are extremely important to QGP phenomenology. These are studied with both perturbative and non-perturbative approach in QCD.

f) Nuclear Theory:
The equation of state (EoS) of nuclear matter is obtained by using the empirically determined values of some of the characteristic constants associated with homogeneous nuclear matter at normal and sub-normal densities. Extrapolation of such EoS at supra-normal densities shows a striking agreement with the one extracted from experimental data. The predicted density dependence of symmetry energy and nuclear matter incompressibility are in close consonance with those gleaned from diverse approaches.

g) Mathematical Physics:
A challenging integrable defect problem is solved, with an innovative application of space-time duality, hidden in integrable systems. Oceanic rogue waves are modeled satisfactorily through exact dynamical lump soliton of a novel nonlinear equation, controlled by ocean currents. Arbitrary bending of optical solitonic beam is achieved, regulated by boundary resonant medium, within the framework of integrable models.

A novel class of exactly solvable spin Calogero models, associated with the $D_N$ root system, has been constructed by using the polarized spin reversal operators. An exact formula for the partition functions of the related spin chains has been derived in terms of products of known partition functions of Polychronakos spin chains of type $A_{N-1}$. Several global properties of the $D_N$-type chain's spectrum such as the asymptotic level density, the distribution of consecutive spacings of the unfolded spectrum, and the average degeneracy have been analyzed at the large $N$ limit. The effect of topological defects on screening and transport properties of gapless graphene have been analyzed.

The von Neumann entropy arising from scaling symmetry breaking has been calculated and its relation to the Cardy formula and the associated quantum information theory has been pointed out.
5.2.2 Publications

5.2.2.1 Publications in Books/Monographs & Volumes Edited

Partha Mitra
Partha Mitra, Symmetries and symmetry breaking in field theory, CRC Press, Taylor and Francis group, Florida, 2014

Palash Baran Pal

5.2.2.2 Publications in Journal

Dante Carcamo; Jorge Gamboa; Fernando Mendez; et al, Cosmic four-fermion neutrino secret interactions, enhancement, and total cross section, PHYSICAL REVIEW D91 (2015) Art No: 065028

Ayan Chatterjee; Avirup Ghosh, Quasilocal conformal Killing horizons: Classical phase space and the first law, PHYSICAL REVIEW D91 (2015) Art No: 064054

Ashok K Das; Sudhakar Panda; JRL Santos, A path integral approach to the Langevin equation, INTERNATIONAL JOURNAL OF MODERN PHYSICS A30 (2015) Art No: 1550028

Ashok K Das; Pushpa Kalauni, Supersymmetry, shape invariance and the solubility of the hypergeometric equation, MODERN PHYSICS LETTERS A30 (2015) Issue: 6

Arnab Kundu; Sandipan Kundu, Steady-state physics, effective temperature dynamics in holography, PHYSICAL REVIEW D91 (2015) Art No: 046004


Koushik Dutta; Anshuman Maharana, Inflationary constraints on modulus dominated cosmology, PHYSICAL REVIEW D91 (2015) Art No: 043503


Anton F Faedo; Arnab Kundu; David Mateos; et al, (Super) Yang-Mills at finite heavy-quark density JOURNAL OF HIGH ENERGY PHYSICS, Issue: 2 (2015) Art No: 010

Aminul Islam Chowdhury; Sarbani Majumder; Najmul Haque; et al, Vector meson spectral function and dilepton production rate in a hot and dense medium within an effective QCD approach, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 2 (2015) Art No: 011

Parijat Dey; Shibaji Roy, Interpolating solution from AdS(5) to hyperscaling violating Lifshitz spacetime, PHYSICAL REVIEW D91 (2015) Art No: 026005
Gautam Bhattacharyya; Dipankar Das, Nondecoupling of charged scalars in Higgs decay to two photons and symmetries of the scalar potential, PHYSICAL REVIEW D91 (2015) Art No: 015005

Amit Ghosh; Daniele Pranzetti, CFT/gravity correspondence on the isolated horizon, NUCLEAR PHYSICS B889 (2014) 1

Cristina Manuel; Sreemoyee Sarkar; Laura Tolos, Thermal conductivity due to phonons in the core of superfluid neutron stars, PHYSICAL REVIEW C90 (2014) Art No: 055803

N Alam; BK Agrawal; JN De; et al, Equation of state of nuclear matter from empirical constraints, PHYSICAL REVIEW C90 (2014) Art No: 054317

Kumar Das; Koushik Dutta, N-flation in supergravity, PHYSICS LETTERS B738 (2014) 457

Michael Strickland; Jens O Andersen; Aritra Bandyopadhyay; et al, Three loop HTL perturbation theory at finite temperature and chemical potential, NUCLEAR PHYSICS A931 (2014) 841

A Sulaksono; Naosad Alam; BK Agrawal, Core-crust transition properties of neutron stars within systematically varied extended relativistic mean-field model, INTERNATIONAL JOURNAL OF MODERN PHYSICS E23 (2014) Art No: 1450072

BK Agrawal, Density content of nuclear symmetry energy from nuclear observables, PRAMANA-JOURNAL OF PHYSICS 83 (2014) 695

Goutam Das; Prakash Mathews; V Ravindran; et al, RS resonance in di-final state production at the LHC to NLO plus PS accuracy, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 10 (2014) Art No: 188

Atanu Rajak; Tanay Nag; Amit Dutta, Possibility of adiabatic transport of a Majorana edge state through an extended gapless region, PHYSICAL REVIEWE90 (2014) Art No: 042107

MK Mandal; Prakash Mathews; V Ravindran Ravindran; et al, Three photon production to NLO plus PS accuracy at the LHC, EUROPEAN PHYSICAL JOURNAL C74 (2014) Art No: 3044

Sanjay K Ghosh; Anirban Lahiri; Sarbani Majumder; et al, Quark number susceptibility: Revisited with fluctuation-dissipation theorem in mean field theories, PHYSICAL REVIEW D90 (2014) Art No: 054030

JX Lu; Jun Ouyang; Shibaji Roy, Modification of the phase structure of black D6 branes in a canonical ensemble and its origin, PHYSICAL REVIEW D90 (2014) Art No: 066003

Taushif Ahmed; Maguni Mahakhud; Prakash Mathews; et al, Two-loop QCD corrections to Higgs $\gamma \rightarrow b + (b)\overline{\text{bar}} + g$ amplitude, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 8 (2014) Art No: 075

Michele Cicoli; Koushik Dutta; Anshuman Maharana, N-flation with hierarchically light axions in string compactifications, JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS, Issue: 8 (2014) Art No: 012

R Shyam; H Lenske, Reaction $\overline{p}\rightarrow\overline{\Lambda}c+\Lambda(c)$ within an effective Lagrangian model, PHYSICAL REVIEW D90 (2014) Art No: 014017

A Ghosh; P Mitra, Absence of log correction in entropy of large black holes, PHYSICS LETTERS B734 (2014) 49

Avirup Ghosh, Note on Kerr/CFT correspondence in a first order formalism, PHYSICAL REVIEW D89 (2014) Art No: 124035

S Benamara; N de Sereville; AM Laird; et al, Nucleosynthesis of Al-26 in massive stars: New Al-27 states above alpha and neutron emission thresholds, PHYSICAL REVIEW C89 (2014) Art No: 065805


Gautam Bhattacharyya; Dipankar Das; Anirban Kundu, Feasibility of light scalars in a class of two-Higgs-doublet models and their decay signatures, PHYSICAL REVIEW D89 (2014) Art No: 095029

Dipankar Das; Ujjal Kumar Dey, Analysis of an extended scalar sector with S-3 symmetry, PHYSICAL REVIEW D89 (2014) Art No: 095025

TV Acconcia; AG Agocs; F Barile; et al, A very high momentum particle identification detector, EUROPEAN PHYSICAL JOURNAL PLUS 129 (2014) Art No: 91

Shibaji Roy, Conformally de Sitter space from anisotropic space-like D3-brane of type IIB string theory, PHYSICAL REVIEW D89 (2014) Art No: 104044

Taushif Ahmed; Maguni Mahakhud; Prakash Mathews; et al, Two-Loop QCD correction to massive spin-2 resonance $\gamma\gamma$, 3 gluons, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 5 (2014) 1

Najmul Haque; Aritra Bandyopadhyay; Jens O Andersen; et al, Three-loop HTLpt thermodynamics at finite temperature and chemical potential, JOURNAL OF HIGH ENERGY PHYSICS, Issue: 5 (2014) 1 Art No: 027


Neelam Guleria; Shashi K Dhiman; Radhey Shyam, Double-Lambda hypernuclei within a Skyrme-Hartree-Fock approach, INTERNATIONAL JOURNAL OF MODERN PHYSICS E23 (2014) Art
No: 1450026

**BK Agrawal; JN De; SK Samaddar**, Probing the density content of the nuclear symmetry energy, *PRAMANA-JOURNAL OF PHYSICS* **82** (2014) 823

**Anjan Kundu; Tapan Naskar**, Arbitrary bending of optical solitonic beam regulated by boundary excitations in a doped resonant medium, *PHYSICA* **D276** (2014) 21


**BK Agrawal; D Bandyopadhyay; JN De; et al**, Thermal properties of the nuclear surface, *PHYSICAL REVIEW* **C89** (2014) Art No: 044320


**Anjan Kundu; Abhik Mukherjee; Tapan Naskar**, Modelling rogue waves through exact dynamical lump soliton controlled by ocean currents, *PROCEEDINGS OF THE ROYAL SOCIETY* **A470** (2014) Art No: 20130576

**Daniel de Florian; Maguni Mahakhud; Prakash Mathews; et al**, Next-to-next-to-leading order QCD corrections in models of TeV-scale gravity, *JOURNAL OF HIGH ENERGY PHYSICS*, Issue: **4** (2014) Art No: 028


**JN De; SK Samaddar; BK Agrawal**, S-matrix approach to the equation of state of dilute nuclear matter, *PRAMANA-JOURNAL OF PHYSICS* **82** (2014) 625


5.2.3 Ph D Awarded

Priti Bhajan Byakti [Palash Baran Pal], Some aspects of supersymmetry breaking, University of Calcutta, December 2014

Kalyan Brata Chatterjee [Gautam Bhattacharyya], Some Implications of R-Parity Violation in Supersymmetry, University of Calcutta, May 2014

Pratyay Banerjee [B Basu-Mallick], Aspects of some quantum integrable systems with long-ranged Interactions, University of Calcutta, March, 2015

Abhishek Chowdhury [A Harindranath], Perturbative and non perturbative aspects of Lattice Quantum Chromodynamics, Homi Bhabha National Institute, December 2014

Najmul Haque [Munshi G Mustafa], Some Applications of Hard Thermal Loop Perturbation Theory in Quark Gluon Plasma, HBNI

Satyajit Seth [Prakash Mathews], A Journey towards QCD Radiative Corrections in the SM and Beyond at the LHC, HBNI, September 2014

5.2.4 Seminars/Lectures given in Conference/Symposium/Schools

Anjan Kundu
2. Generation of Integrable Models from from Ancestor Lax operator and Beyond, International Workshop on Discrete Integrable Systems, Indian Institute of Science, Bangalore, Jun 9-14, 2014

Partha Mitra
2. Black hole entropy with and without log correction, Workshop on ”Field Theoretic Aspects of Gravity”, IISER Mohali, December 2014

Palash Baran Pal
2. What’s so special about neutrinos?, Evening talk at the ”CNT winter school on nuclear astrophysics” Variable Energy Cyclotron Centre, Calcutta, Jan 21, 2015
3. Unification of forces:
   i. Talk at the National seminar on ”Frontiers of research in Physical Sciences”, Karimganj College, Sep 20, 2014
   ii. Physics Department Seminar, Visva-Bharati University, Santiniketan, Mar 28, 2015
4. Discovering elementary particles:
   i. Physics Department Seminar, Indian Institute of Science Education and Research (IISER), Calcutta, Mar 25, 2015
ii. Physics Department Seminar, Presidency University, Calcutta, Nov 05, 2014
5. Satyendra Nath Bose and counting particles, National seminar on “Scientists who dared and made the difference”, organized by the Asiatic Society, Kolkata, 03 Mar 03, 2015
6. Kyalendarer rohosyo (The mystery of calendars):
   i. Lecture at the West Bengal State Science Congress, North Bengal University, Shiliguri, 28 Feb 2015
   ii. Public lecture at Karimganj College, Sep 20, 2014
7. Journey to the world of fundamental particles, Outreach program to commemorate the diamond jubilee of the Department of Atomic Energy of the Government of India, Institute of Physics, Bhubaneswar, Feb 1, 2015
8. Understanding the Higgs boson, CMS outreach program held at the Saha Institute of Nuclear Physics, Calcutta, Jan 8, 2015
9. The world of neutrinos, Lecture at the Outreach Program for the Indian Neutrino Observatory held at Bardhaman University, Bardhaman, Apr 1, 2014

Gautam Bhattacharyya
3. “Geometrical CP violation and nonstandard Higgs decays” – Instituto Superior Tecnico, Lisbon, Portugal, Jun 2014

B Basu-Mallick
i) Clusters of bound particles in a quantum many-body system and number theory, Plenary in The XXIInd International Conference on Integrable Systems and Quantum symmetries (ISQS-22), Prague, Czech Republic, June 23-29, 2014
   Chaired a Session
ii) Exactly solvable many particle systems (3 talks), Workshop on Recent developments in quantum theories, Department of Physics, Banaras Hindu University, Varanasi, Feb 20-24, 2015
iii) Bound states of a quantum many-body system, Physics and Applied Mathematics Unit, Indian Statistical Institute, Kolkata, July 22, 2014

Munshi Golam Mustafa
Rapature -II (Theory), 7th International Conference on Physics and Astrophysics of Quark Gluon Plasma (ICPAQGP), Kolkata, Feb 2-6, 2015

Koushik Dutta
a. Light Fields In Cosmology, Centre for Theoretical Science, Indian Institute of Technology, Kharagpur, Mar 2015
b. Constraints on Moduli Mass from Inflation, StatCosmo, ISI, Kolkata, Feb 2015
c. Inflationary Constraints on Late Time Modulus Dominated Cosmology, LHC to DM, IACS, Kolkata, Feb 2015
d. Inflationary Constraints on Late Time Modulus Dominated Cosmology, DESY Theory Workshop: Particle Cosmology after Planck, Sept 2014
e. Inflation Model Building in Particle Physics, HRI, Allahabad, Aug 2014
f. Cosmology with pNGBs, PASCOS, Warsaw Jun 2014

5.2.5 Honours and Distinctions

Koushik Dutta
Junior Associateship: International Centre for Theoretical Physics (ICTP), Trieste, Italy (2014-2019)
Chapter 6

Research Fellows/Visiting Fellows/Research Associates

6.1 Visiting Fellows/Research Associates and Research Fellows

6.1.1 Research Fellows

6.1.2 SRF(EX), PDF, RA, VS, VF

6.1.3 Post M Sc Students/Fellows
Chapter 7

Facilities

7.1 Centre for Advanced Research & Education
7.1.1 The Post-M Sc Associateship Course
7.2 Electron Micorscope Facility
7.3 Electronics Workshop Facility
7.4 Library
7.5 Radiological Safety
7.6 Central Workshop
7.7 Medical Unit
7.8 Building Maintenance (Civil)
7.9 Building Maintenance (Electrical)
7.10 Telephone Section
7.11 Guest House
7.12 Departmental Canteen
Chapter 8

Administration

8.1 Governing Council
8.2 Members of the Institute [As on March 31, 2015]
8.3 Audited Accounts
8.4 Balancesheet
8.5 Income & Expenditure Account
8.6 Receipts & Payments
Chapter 9

External Collaborators
Chapter 10

Index
Index

Acconcia, TV, 91
Acharya, BS, 83
Adak, Ashish, 79
Adak, Debabrata, 90
Adhikari, A, 52
Adhikari, S, 74
Adhikary, B, 84
Adhikary, Biswajit, 84
Aditya, Gautam, 47
Agnihotri, Nidhi, 26-28
Agoes, AG, 63, 91
Agrawal, BK, 90, 92
Ahlskog, Markus, 49
Ahmadvand, Hossein, 36
Ahmed, Tushif, 90, 91
Alam, N, 90
Alam, Naosad, 90
ALICE Collaboration, 64, 65
Amitabha, De, 27
Andrews, PR, 57
Aramo, C, 83
Archambault, S, 84
Arlen, T, 84
Arumugam, S, 37, 39
Assaf, BA, 48
Aune, T, 84
Babic, A, 83
Bag, Arup Kumar, 24
Bag, Pallab, 49
Bag, Sagar, 21
Bagani, K, 38, 39, 45, 46
Bagani, Kousik, 46, 50
Bagchi, Debashree, 36, 38
Baksi, Shournak, 19
Bal, Jayanta K, 51
Bal, JK, 47
Bandyopadhyay, Aritra, 90, 91
Bandyopadhyay, D, 92
Bandyopadhyay, Debased, 83, 84, 86
Bandyopadhyay, S, 49
Banerjee Mustafi, Soumyajit, 23
Banerjee, A, 20, 57
Banerjee, Anamita, 19
Banerjee, D, 73, 78
Banerjee, Debasish, 23
Banerjee, Pratyay, 92
Banerjee, R, 45
Banerjee, Rachana, 24
Banerjee, Rahul, 24, 25
Banerjee, Ramanuj, 23, 24
Banerjee, S, 39, 50, 51
Banerjee, Sangam, 46
Banerjee, Soma, 24
Banerjee, Subrata, 18, 19
Banerjee, Tirthankar, 37
Banik, Sarmistha, 84
Bankar, KG, 20
Bansal, Manju, 32
Bardhan, KK, 39
Barik, P, 52
Barile, F, 63, 91
Barnafoeldi, GG, 63
Bassak, Soumen, 27
Basu, Abhik, 37, 39-41
Basu, Arnab, 27
Basu, Avik, 23
Basu, Basudhara, 83
Basu, C, 74
Basu, Chinmay, 73, 75
Basu, Mahashweta, 48
Basu, Samita, 28-30
Basu, Sankar, 24, 25, 50
Basu, Sreetama, 19
Basu, Urna, 37
Basu-Mallick, B, 92-94
Bayan, Sayan, 45, 47, 50, 51
Belkhou, Rachid, 39
Benamara, S, 91
Bera, MK, 45
Bera, Kallo, 27
Bera, Manindra, 19
Beuvier, T, 47
Bhandari, Dipankar, 24
Bhardwaj, A, 49
Bhattacharjee, Srijit, 84
Bhattacharjee, A, 52
Bhattacharjee, Ashis, 48
Bhattacharjee, Pijushpani, 85
Bhattacharjee, T, 73
Bhattacharjya, Sumana, 22
Bhattacharya, Satyaki, 63
Bhattacharya, A, 51
Bhattacharya, Ashis, 52
Bhattacharya, Dhananjay, 33
Bhattacharya, P, 57
Bhattacharya, S, 57
Bhattacharyya, Gautam, 9, 93
Bhattacharyya, Satya Ranjan, 47
Bhattacharyya, SR, 49
Bhattacharyya, Dhananjay, 24, 32
Bhattacharyya, Gautam, 90, 91, 94
Bhattacharyya, Nitai P, 23
Bhattacharyya, Nitai Pada, 24
Bhattacharyya, SR, 47, 49, 50
Bhattacharyya, Tanaya, 92
Bhattacherjee, Ashis, 46
Bhaumik, Asim, 46
Bhoi, D, 37–39
Bhunia, S, 51, 52
Bisi, Bhaskar, 48
Bisoi, Abhijit, 74
Biswas, Debaleen, 38
Biswas, Hari Shankar, 29
Biswas, HS, 51
Biswas, Kanishka, 27
Biswas, S, 52, 57
Biswas, Sampa, 29
Biswas, Sananda, 45
Biswas, Nupur, 49
Blau, K, 38
Bondyopadhaya, Nilanjan, 92
Borge, MJG, 73
Bose, Anirban, 78, 79
Brahmachari, Biswajoy, 83
Burwitz, TG, 57
Byakti, Priti Bhajan, 93

Carcamo, Dante, 89
Carroll, JJ, 63
Caudrelier, V, 89
Chakraborti, Abhijit, 22–24
Chakraborti, Anindya S, 38
Chakraborti, Arnab, 19
Chakraborti, Bikas K, 38
Chakraborti, BK, 37, 38
Chakraborti, Jaydeb, 32
Chakraborti, Kuntal, 27
Chakraborti, Nikhil, 78, 79
Chakraborti, Oishee, 20
Chakraborti, Anirban, 37
Chakraborty, Suvankar, 48, 50
Chakraborty, Arghys, 73
Chakraborty, Brotati, 28, 29
Chakraborty, Chandrachur, 84, 85
Chakraborty, Mainak, 83, 84
Chakraborty, Prabal Kumar, 29
Chakraborty, Pranab Kumar, 19
Chakraborty, Purushottam, 47, 51
Chakraborty, Rangan, 37
Chakraborty, Sandipan, 18
Chakraborty, Shamik, 37
Chakraborty, Sreeja, 27, 29
Challet, Damien, 37
Chandra, Anjan Kumar, 37
Char, Prasanta, 84
Chatterjee, Atri, 19
Chatterjee, Arnab, 37, 38
Chatterjee, Ayan, 89
Chatterjee, Kalyan Brata, 93
Chatterjee, P, 51
Chatterjee, Rakesh, 37
Chatterjee, Sujib, 73
Chatterjee, Suprita, 49
Chattopadhyay, Nachiketa, 38
Chattopadhyay, S, 64
Chaubey, Neeraj, 78
Chaudhuri, Siddhi, 24
Chaudhuri, Sudip, 18
Chaudhury, Soumik, 85
Chebil, MS, 47
Chini, Tapas Kumar, 48, 49, 52
Chitnis, VR, 84
Choudhary, Vandana, 48, 51
Choudhary, Harish K, 46
Choudhuri, Madhumita, 52
Choudhury, Biswajit, 45
Choudhury, Debapriya, 32
Choudhury, Soumik, 85
Chowdhury, Abhishek, 91, 93
Chowdhury, Anirban, 37
Chowdhury, Anirban, 37
Chowdhury, Aminul Islam, 89
Chowdhury, Ankan Dutta, 26, 28
Chowdhury, Biswanath, 32
Chowdhury, Debasisree, 47, 49
Chowdhury, S, 79
Cicoli, Michele, 91
CMS Collaboration, 65–71

D’Souza, SW, 50
Dalui, Bapi, 46
Dan, K, 48
Dandopath Patra, Madhumita, 23, 24
Das Ghosh, Upal, 28
Das, Dipankar, 91
Das, AN, 39
Das, Anindita, 23
Das, Arnab, 36
Das, Ashok K, 89, 92
Das, Avijit Kumar, 28, 48, 51
Das, C, 20
Das, Chandrima, 20
Das, Debasis, 63, 84
Das, Debolina, 48
Das, Dipankar, 90, 91
Das, Eashita, 24
Das, Goutam, 90
Das, I, 37, 40, 46
Das, Jayanta, 45, 46
Das, Kalipada, 37, 40, 46, 47
Das, Kumar, 90
Das, Mala, 83–85
Das, Pabitra, 48, 49, 52
Das, PK, 57
Index

Harijan, Pappu Kumar, 36
Harindranath, A, 91, 93
Harris, Kisa, 19
Harzra, Montu K, 27
Hassen, Araf, 38
Hazra, Montu K, 28, 29
Hazra, S, 46, 47, 51, 52
Hempel, Matthias, 84
Herranen, Olli, 49
Hossain, Asif, 47
Huitu, Katri, 63

Iswarari, Sourav, 48
Iyengar, AN Sekar, 78, 79

Jaman, Al, 37
Jana, Kuladip, 23
Jana, Jagannath, 19
Jana, SK, 45, 46, 50
Janaki, M S, 79
Janaki, MS, 78, 79

Kailasam, Senthilkumar, 32
Kalami, Pushpa, 89
Kanjilal, A, 49, 50
Kanungo, S, 36
Kar, Rajiv K, 19
Karmakar, Prasanta, 50
Karmakar, Shilpita, 23
Karmakar, SN, 38, 40
Karmakar, Subhajit, 45
Katmis, F, 48
Kaur, Balwinder, 47
Khamrui, Susmita, 23
Khan, M, 79
Khan, Manoranjan, 78
Khan, N, 38, 39
Khan, Nazir, 40
Khanra, Ritu, 19
Kheto, Apurba, 83
Khuyagbaatar, J, 29
Kisslinger, Leonard S, 63
Kling, NG, 57
Koley Seth, Banabithi, 29
Kore, Rajkumar, 45, 49, 51
Kotamarthi, Hema Chandra, 19
Krimmel, Alexander, 38
Kulkarni, KK, 20
Kumar, Atanu, 92
Kumar, Nand Kishor, 57
Kumar, Promod, 39
Kundu, Arpan, 48
Kundu, Anirban, 91
Kundu, Anjan, 9, 89, 92, 93
Kundu, Arnab, 89
Kundu, Prabhat, 38
Kundu, Arpan, 48
Kundu, Asish K, 45, 46
Kundu, Samapti, 46
Kundu, Sandipan, 89
Kundu, Sangeeta, 32
Kundu, Susmita, 85

Kuriakose, Sini, 48, 51
Lahiri, Anirban, 90
Lahiri, S, 37
Lahiri, Shibojyoti, 19
Lahiri, Susanta, 26-28
Lahiri, Sushanta, 29
Laird, AM, 91
Lansu, Andrea, 49
Lenske, H, 91
Lepcha, Rinchen T, 19
Li, W, 73
Lone, MQ, 37
Lu, JX, 90

Maccherozzi, Francesco, 39
MAGIC Collaboration, 84
Mahakhud, Maguni, 90, 91
Mahakhud, Maguni, 92
Maharana, Anshuman, 89, 91
Mahato, JC, 48
Maiti Dutta, Sangita, 23
Maiti, Arpan, 48
Maiti, Jyotirmoy, 91
Maiti, Moumita, 26-28
Maiti, Santanu K, 38, 40
Majit, Achyut, 48
Majit, Anup Kumar, 24
Majit, Chandan, 79
Majhi, Abhishek, 84, 85, 91
Maji, Bibekananda, 37, 38
Majumdar P, 84
Majumdar, Debasis, 83
Majumdar, Parthasarathi, 84
Majumdar, Anupa, 27
Majumdar, Debasis, 83-86
Majumdar, N, 57
Majumdar, Parthasarathi, 84, 85
Majumder, M, 36
Majumder, S, 38, 45, 46
Majumder, Sarbani, 89, 90
Majumder, Sudip, 23
Majumder, T, 50
Mandal, Haradhan, 48
Mandal, Ajoy, 28
Mandal, Haradhan, 52
Mandal, Mahatsab, 63, 64
Mandal, MK, 90
Mandal, P, 37, 39
Mandal, Prabhat, 38
Mandal, Suman, 39
Mandal, Swadesh, 28, 29
Mano, Abhishek, 28, 51
Manuel, Cristina, 90
Marick, Chandranath, 73
Mateos, David, 89
Mathews, Prakash, 90-93
Mathpal, Mohan Chandra, 39
Matta, JT, 73
Index

Raychaudhuri, Swasti, 24
Rooj, A, 52
Roy Choudhury, Kamalika, 23
Roy Chowdhury, R, 37
Roy M, 52
Roy, Kumar Singha, 22
Roy, A, 57
Roy, Analabha, 36
Roy, Anita, 18, 19
Roy, Barna, 57
Roy, D, 52
Roy, I, 46, 47
Roy, Kasturi, 20
Roy, M, 48, 52
Roy, Madhusudan, 45, 46, 48, 50, 52, 57
Roy, P, 84
Roy, Pradip, 64
Roy, Pradip K, 63
Roy, Probir, 83
Roy, S, 20, 50
Roy, Shibaji, 89–91
Roy, Sourav, 50
Roy, Subinit, 73–75
Roychoudhuri, Kamalika, 24

Safdari, Sayed Reza, 36
Saha Sarkar, M, 73–75
Saha, A, 73
Saha, B, 46
Saha, Chinmay, 28
Saha, Debajyoti, 78, 79
Saha, L, 84
Saha, Lab, 85
Saha, Partha, 23, 29
Saha, R, 52
Saha, Ratan K, 45, 48, 50
Saha, SK, 79
Saha, Sutapa, 23, 24
Saha, Swapan K, 83
Sahoo, PK, 51
Sain, Sumanta, 46
Samaddar, SK, 92
Samanta, Tanusree, 49
Samanta, Tapas, 40
Sambi, S, 73
Santos, JRL, 89
Sanyal, Milan K, 47–49, 51
Sanyal, MK, 45
Sanyal, S, 20
Sarangi, Manas Kumar, 27, 28
Sardar, Debasmita, 49
Sarkar, Sreemoyee, 90
Sarkar, Munna, 27, 29
Sarkar, Niladri, 37, 39, 40
Sarkar, P, 39
Sarkar, S, 74
Sarma, Abhishek, 47, 49
Sarma, Arun, 78, 79
Sarmah, Bhaskar, 46
Satpati, Biswarup, 46
Satpati, B, 48, 50
Satpati, Biswarup, 45–51
Satpati, Biswarup, 52
Sau, Abhishek, 27
Selvan, G Kalai, 37
Sen, Pintu, 29
Sen, Diptiman, 92
Sen, Titash, 24
Sen, Udayaditya, 23, 24
Senapati, Kartik, 45, 47
Sengupta Banerjee, Aditi, 20
Sengupta, Bidisha, 19
Sengupta, Chaitrali, 27
Sengupta, Kaushik, 21
Sengupta, Mohor, 48
Sengupta, Mohor B, 19
Senyshyn, Anatoliy, 36
Seth, Satyajit, 93
Seth, Susnata, 85
Sethi, J, 63
Sezer, A, 84
Shaikh, Md Moin, 73, 74
Shankar, Ravi, 51
Sharma, Manjula, 51
Shaw, Pankaj Kumar, 78
Shireen, Talsina, 27
Shukla, A, 84
Shukla, RN, 20
Shukla, Vinay Kumar, 47
Shyam, R, 91
Shyam, Radhey, 91
Sil, S, 39
Singh, Avanendra, 47
Singh, BB, 84
Singh, RK, 38
Singh, Sanjay, 49, 50
Sinha, Amitabha, 29
Sinha, Anil Kumar, 38
Sinha, Sumona, 47, 50
Siva, Vantari, 45
Srihari, Velaga, 27
Srivastava, Alok, 28
Srivastava, Rajendra, 45–47, 49–51
Strickland, Michael, 90
Sulaksono, A, 90
Sundar, Shyam, 24
Suresh, KG, 37
Ta, Atri, 19
Talukdar, D, 39
Talukdar, Deep, 49
Thapa, S, 57
Theeya, Nagaraja, 19
Thompson, IJ, 74
Thupakula, Umamahesh, 46
Tolos, Laura, 90
TOTEM Collaboration, 67
Tripathi, Anand Kumar, 39
Upadhyay, Chandan, 36

VERITAS Collaboration, 84
Vijayasri, G, 38

Wang, C-H, 47
Wang, C-H, 50
Wang, Jin, 48
Wei, P, 48

Yakushev, A, 29
Yarlagadda, S, 37, 39
Yarlagadda, Sudhakar, 41