SAHA INSTITUTE OF NUCLEAR PHYSICS

ANNUAL REPORT

2017 – 2018

SINP

Sector – 1, Block - AF, Bidhannagar,

Kolkata – 700 064

CONTENTS

ACTIVITIES OF THE INSTITUTE

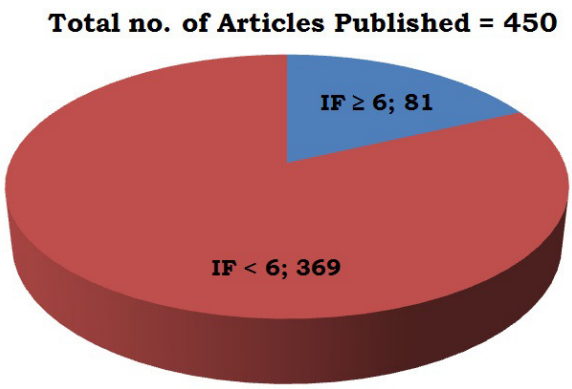
(April 2017 – March 2018)

Saha Institute of Nuclear Physics (SINP) is engaged in basic scientific research on four broad subject areas, namely, (a) Astroparticle Physics & Cosmology and Theory (b) Applied Nuclear Physics, High Energy Nuclear & Particle Physics, Nuclear Physics and Plasma Physics, (c) Condensed Matter Physics, Surface Physics and Material Science (d) Biophysics and structural Genomics, Crystallography & Molecular Biology, Computational Sciences and Chemical Sciences.

The present faculty strength is eighty four (84); thirty five (35) Post M.Sc. students have been inducted into research and teaching program during the year 2017 – 2018. Ten (10) Undergraduate Associates and twenty four (24) summer students coming from different parts of the country have been trained in the Institute. In this period 28 research fellows have been awarded Ph.D. degree.

IMPORTANT ACHIEVEMENTS

Research Publications



In this period about 450 scientific articles (without collaboration 283 & with collaboration 167) have been published in 128 different journals. Among these, 81 scientific articles (without collaboration 20 & with collaboration 61) have appeared in 12 high impact journals (I.F.≥ 6) like ACS Applied Materials & Interfaces, Analytical Chemistry, Astrophysical Journal Supplement Series, Chemical Communications, Chemical Science, Clinical Cancer Research, Journal of Hazardous Materials, Journal of High Energy Physics, Molecular Neurobiology, Nanoscale, Nature Physics and Physical Review Letters.

International Collaborations

Besides, the institute is participating in several International Collaboration programmes like; ALICE, CMS, CMS Tracker, CMS HCAL, ECHo, Fermi-LAT, INO, MAGIC, LCTPC, PICASSO, PICO, R3B.

Awards & Distinctions

Dr. H. Raghuraman

1. Dr. H. Raghuraman has been awarded "Wellcome Trust/DBT India Alliance Intermediate Fellowship" in December 2017.

2. **Mr. Rome Samanta**, a student of Astroparticle and Cosmology Division, has been awarded the prestigious "Newton International Fellowship" in December, 2017 offered by the Royal Society, UK for a two year post doctoral position at university of Southampton. Rome's fellowship is jointly funded by the Royal Society, UK and SERB, India.

National Level Academic Review

Academic review was conducted at SINP during August 7th – 12th, 2017 under the chairmanship of Prof. Srikumar Banerjee with 18 subject experts from various national institutes and university.

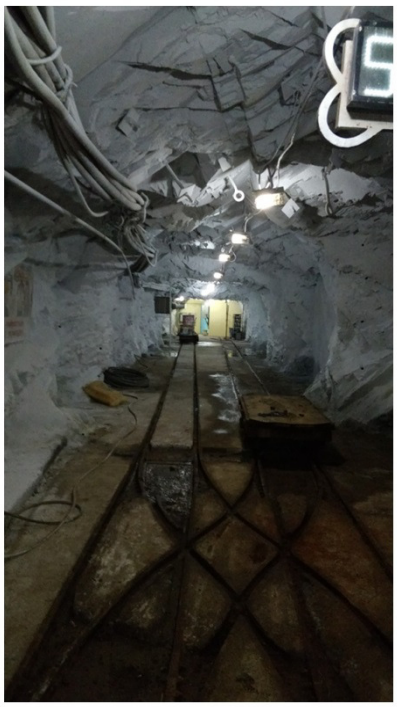
Major Accomplishments (R&D)

1. Establishing Jaduguda Underground Science Laboratory (JUSL) at Jaduguda, Jharkhand for low cosmic background experiments

Inauguration of the laboratory by Chairman Atomic Energy Commission (AEC) and Secretary Department of Atomic Energy (DAE) on 2nd September 2017

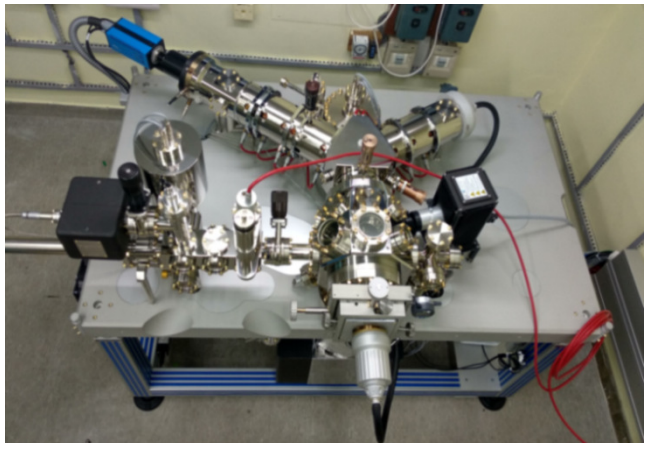
Saha Institute of Nuclear Physics has established an underground laboratory, named Jaduguda Underground Science Laboratory at the existing mine of Uranium Corporation of India Limited in Jharkhand. This laboratory is at present, the only underground science laboratory in India to carry out rare event search experiments, which are otherwise

impossible to do at the Earth surface because of very large cosmic radiation background. With support from the Department of Atomic Energy, Government of India, Saha Institute of Nuclear Physics has set up a small underground science laboratory at 555 m depth of the existing Uranium mine. To begin with, the laboratory is used to study the performance of detectors under development for a future Dark Matter Search and neutrino experiments in which scientists from SINP, Kolkata, Uranium Corporation of India Limited, Jharkhand, National Institute of Science Education & Research (NISER), Bhubaneswar, Bhabha Atomic Research Centre (BARC), Variable Energy Cyclotron Centre (VECC), Kolkata, Institute of Physics, Bhubaneswar, Tata Institute of Fundamental Research (TIFR), Mumbai and other institutions are participating.



Tunnel at 555 m level leading to the JUSL

2. Commissioning of the Low-energy Electron Microscope cum Photo-Emission Electron Microscope (LEEM-PEEM) facility at SINP:



The installation, commissioning and training of the LEEM-PEEM system has been successfully completed at the SPMS division of SINP during 7th March to 22nd March 2018. It is to be highlighted that this is the first such LEEM-PEEM facility available in India. The Low Energy Electron Microscopy (LEEM) and Photo-Emission Electron Microscopy (PEEM) are complementary imaging methods which are not only powerful for imaging the surfaces at very high spatial resolutions (~ 4 nm) but also for the study of different dynamical processes at surfaces in real-time.

3. Launching Pilot Phase of Vigyan Pratibha Project & Teachers Training Camp

Project Launching

The pilot phase project of Vigyan Pratibha (VP) program was launched on 31st July 2017 with a joint session by Homi Bhabha Centre for Science Education (HBCSE), Tata Institute of Fundamental Research (TIFR), Mumbai and Saha Institute of Nuclear Physics (SINP), Kolkata through Video Conferencing. Principals, teachers and students of several KV schools participated in the inaugural programme.

Teachers Training Camp

Vigyan Pratibha Teachers Training Camp was conducted on 13th & 14th November, 2017 in SINP. In this Camp, four instructors namely Prof. K. Subramanium, Director HBCSE, TIFR Mumbai; Prof. Ankush Gupta, Faculty, HBCSE; Prof. G. Nagarjuna, Faculty, HBCSE, TIFR, Prof. Ananda Dasgupta, Faculty, IISER Kolkata from outside SINP were paricipated. 25 teachers from 11 Schools participated in the Camp.

SPECIAL EVENTS

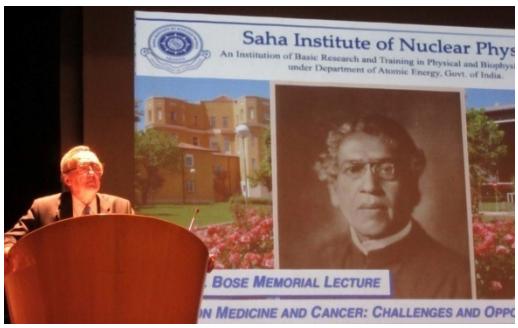
I. Foundation day celebration on 11th January, 2018

Institute celebrated its 68th foundation day on 11th January, 2018 Dr. V.K. Saraswat, member, NITI Aayog graced the occasion as the chief guest. All past and present members joined the celebrations.

Paying Tribute to Prof. M.N. Saha by Chief Guest: Dr. V.K. Saraswat, Member, NITI Aayog on Annual Day Celebration, January 2018

II. On the occasion of 125th Birth Anniversary of Prof. Meghnad Saha, a series of memorial talks were held:

1. Precision medicine and cancer: **J.C. Bose Memorial Lecture** delivered on 12th February, 2018, by Prof. Mariono Barbacid, a Spanish molecular biochemist who discovered the first oncogene. Prof. Barbacid spoke on Precision Medicine and Immunotherapy that represent critical advances in Oncology that eventually will lead to the successful treatment of those advanced human cancers for which we still do not have suitable therapies.



2. "Future of our Universe": **Ramanujan Lecture** delivered on 21st February, 2018 by Prof. Ashoke Sen, distinguished professor at the Harish-chandra research Institute. In his talk, Prof. Sen discussed our current understanding on dark energy that was the discovered 20 years ago.

3. **53rd Saha Memorial Lecture** delivered by Prof. Govind Swarup, FRS on "Radio waves and the universe: Big Bang to Black Holes", 7th March, 2018. Prof. Swarup described some of major astronomical results that have been obtained using the Ooty Radio Telescope (ORT) and the Giant Metrewave Radio Telescope (GMRT) in India. GMRT has been used by astronomers from 32 countries in the world, with ~ 50% usage by astronomers in India.

4. **J.C. Bose Memorial Lecture** on "Electric Field Control of magnetism", by Prof. Ramamoorthy Ramesh, Purnendu chattejee chair professor in material science and physics, University of California, Berkeley delivered on 5th March, 2018. Prof. Ramamoorthy focussed on focussed on ultralow energy electric field manipulation of magnetism that will become the backbone for the next generation of ultralow power electronics.

5. National Science Day Celebration

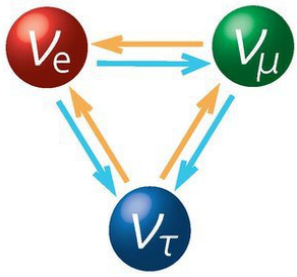
National Science Day was celebrated on 28th February 2018. 428 students and 50 teachers from 10 Kendriya Vidyalaya schools in and around Kolkata visited SINP. Talks, panel discussion and quiz competition were conducted to mark the occasion.

III. Conferences and Schools:

1. **CMNSR 2018:** School cum First Collaboration meeting on Computational Nuclear Structure & Reaction: CMNSR 2018 was jointly organized by SINP and VECC during Jan 2nd – 22nd 2018, where in 40 participants and 22 faculties attended the academic sessions.

2. **Saha Theory Workshop:** Fourth Saha Theory Workshop on Modern Aspects of String Theory was hosted from 19th to 23rd February, 2018. Review and technical talks were presented on Soft Theorems in Gravity, Recent Advances in Conformal Bootstrap, Entanglement & Holography, SYK Models & Holography.

3. **AAPCOS-2018:** On the occasion of the 125th birth anniversary of Prof. Meghnad Saha, a workshop on Advances in Astroparticle Physics and Cosmology was organized during March 6th – 9th, 2018 with special focus on Multimessenger Astrophysics covering Physics and Astrophysics of Neutrinos, Supernovae and Compact Objects, High Energy Cosmic Rays and High Energy Gamma-ray Astrophysics, Dark Matter, Dark Energy, Gravitational waves and Cosmology.



IV. Outreach Programme

SINP participated in the 22nd Sundarban Krishi Mela O Loko Sanskriti Utsab held on December 20th – 29th, 2017 at 24 Parganas (S), West Bengal.

13th 'Jatiya Sanhati Utsav-O Bharat Mela 2017' – a National Level Science, Technology, Space, Atomic Energy & Mass Awareness exibition and seminar was held during December 14th – 18th, 2017 at Simultala Agragrami Play Ground, Ramkrishna Pally, P. S. – Sonarpur, Dist- 24 Pgs (S), Kolkata. SINP participated in this exhibition and seminar.

Photo Collage

Hon'ble Vice President of India, Shri M. Venkaiah Naidu, inaugurated the Facility for Research in Experimental Nuclear Astrophysics (FRENA) at Saha Institute of Nuclear Physics, Kolkata on 28th June 2018

Hon'ble Vice President of India, Shri M. Venkaiah Naidu, exploring the Laser Laboratory

Lamp Lighting by Prof. B.K. Sinha, SINP Ex-Director on Annual Day Celebration, January 2018

Prof. C.N.R. Rao garlanding the bust of Prof. Meghnad Saha on the occasion "Discussion Meeting on Synchrotron Science" organised in SINP during December 13th to 15th, 2017

Flag hoisting and saluting on Independence Day, August 15, 2017

Post M.Sc. Associates 2017

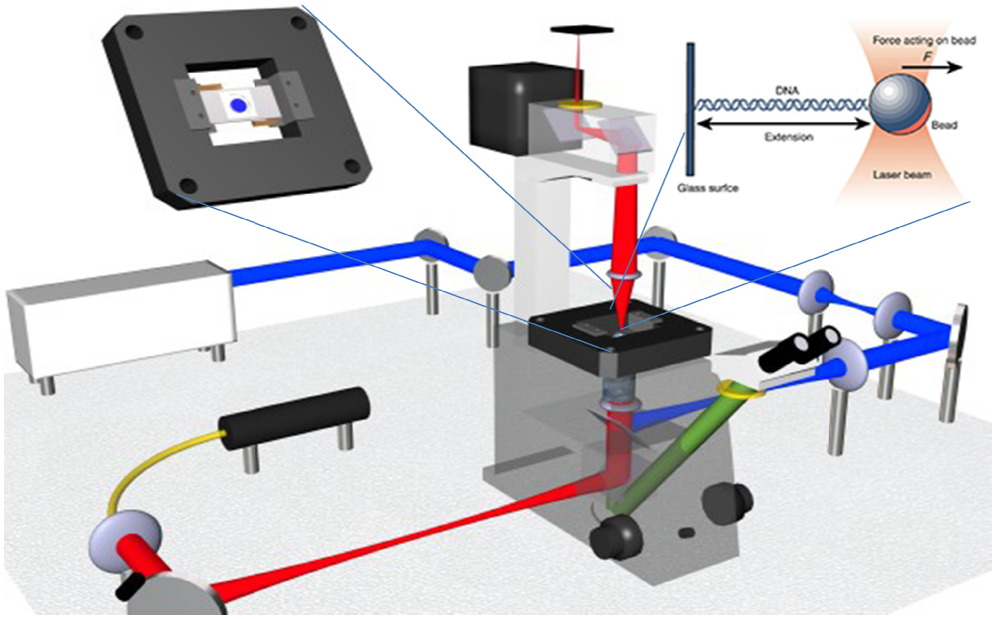
RESEARCH HIGHLIGHTS

1. Chemical Sciences Division

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 of 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 spectrometry and interaction, nano particle dosimetry and radiation safety.

In continuation with our research on improved understanding of the fundamental biophysical processes using different single molecule microscopic/ spectroscopic tools, we have developed single beam optical tweezers for tracking and manipulation of small microscopic particles/ molecules etc.

Optical Tweezer Instrumental Set up



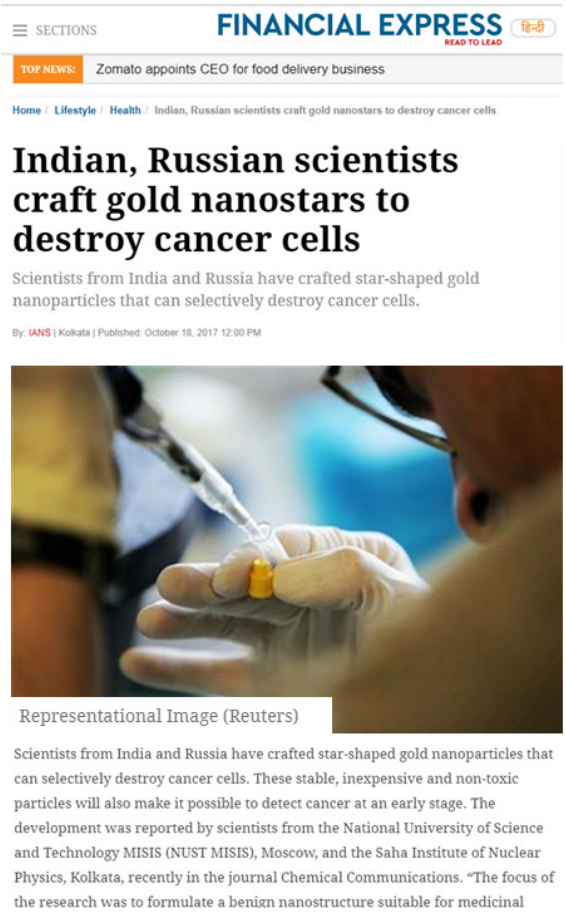
The FRET- Force measuring set up is constructed on an inverted microscope.

We have investigated isomerization dynamics and plausible energy landscape of 4-way Holliday junctions (4WHJs) bound to integration host factor (IHF, a DNA binding protein) considering the effect of applied external force, by single-molecule FRET methods. The identification of chaos in our investigation provides useful information in comprehensively explaining the origin of the complex behavior of the system, that effectively helps to perceive the dynamics of IHF bound 4WHJs under the influence of external force, and also demonstrates the applicability of nonlinear dynamics analysis in the field of biology (*Faraday Discussions, 2018, 207, 251-265*).

An application of femtosecond fluorescence up-conversion kinetics implies that a photoinduced electron transfer reaction takes place from the Tryptophan residue of the serum albumin proteins to acridone, a therapeutically important molecule, which has been authenticated using laser flash photolysis via identification of the radical ions. (*New Journal of Chemistry, 2017, 41, 12520-12534*).

Studies to identify suitable drug delivery vehicles for NSAIDs and their copper complexes have been initiated. Different types of cyclodextrins have been used as delivery vehicles. For any drug delivery vehicle to be suitable for oral administration the host-guest complex needs to withstand large variation in pH from acidic to physiological without breaking apart (*Journal of Physical Chemistry B, 2017, 121, 8455-8466*).

In continuation to the previous year research activities in the field of designing and application of plasmonic, magnetic and magnetoplasmonic anisotropic nanomaterials we have achieved significant results for seedless, surfactant-free salt-induced HHogGNP for *in situ* cancer theranostics exploiting Le Chatelier's principle for a one-pot synthesis of nontoxic HHogGNPs with the sharpest nanoscopic features suitable for tunable plasmon spectroscopy and high throughput SERS sensing. This work has been highlighted in several leading news paper including our institutional website and a compressed image of the news publication is shown below (*Chemical Communications, 2017, 53, 10402-10405*).



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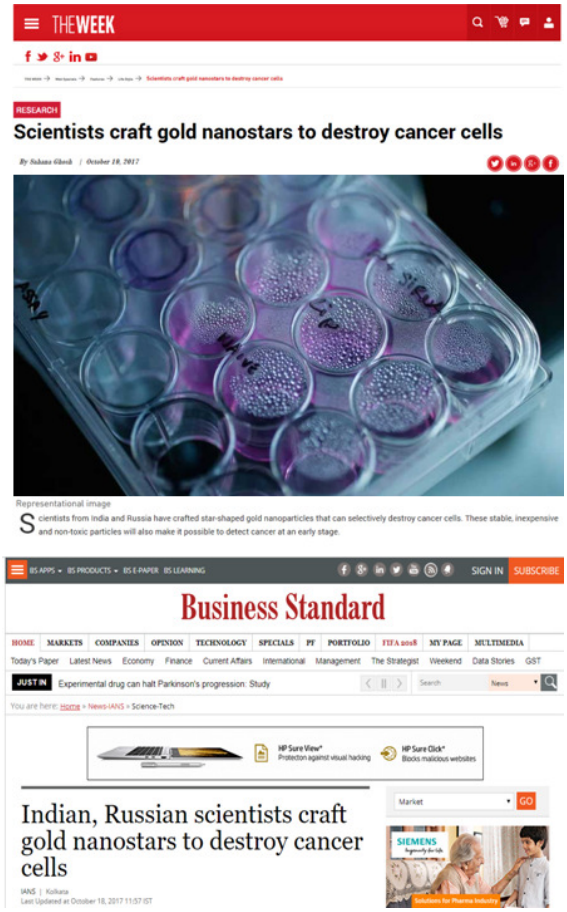
Indian, Russian scientists craft gold nanostars to destroy cancer cells

Scientists from India and Russia have crafted star-shaped gold nanoparticles that can selectively destroy cancer cells.

By: IANS | Kolkata | Published: October 18, 2017 12:00 PM

Representational Image (Reuters)

Scientists from India and Russia have crafted star-shaped gold nanoparticles that can selectively destroy cancer cells. These stable, inexpensive and non-toxic particles will also make it possible to detect cancer at an early stage. The development was reported by scientists from the National University of Science and Technology MISIS (NUST MISIS), Moscow, and the Saha Institute of Nuclear Physics, Kolkata, recently in the journal Chemical Communications. "The focus of the research was to formulate a benign nanostructure suitable for medicinal



THE WEEK

RESEARCH

Scientists craft gold nanostars to destroy cancer cells

By Suhana Ghosh | October 18, 2017

Representational image

Scientists from India and Russia have crafted star-shaped gold nanoparticles that can selectively destroy cancer cells. These stable, inexpensive and non-toxic particles will also make it possible to detect cancer at an early stage.

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HP Sure View* Protection against visual hacking HP Sure Click* Blocks malicious websites

Indian, Russian scientists craft gold nanostars to destroy cancer cells

IANS | Kolkata

Last Updated at October 18, 2017 11:57 IST

Market GO

SIEMENS

Carbon dots, a new class of fluorescent nanomaterial in the carbon family, are expected to have huge potential in field of bioimaging, molecular sensors, optoelectronics and photovoltaics. The most commonly observed phenomena in carbon nanodots are the strong excitation wavelength dependent multicolor fluorescence emission and the particle size distribution between 3–5 nm observed using a transmission electron microscope (TEM). We take the quantum chemical calculations as a tool to understand the observed spectral changes, especially, try to explain the reason behind the strong excitation wavelength dependent multicolor fluorescence emission. *(**Chemical Science,** 2018, **9**, 175-180*).

A smart nuclear targeting thiol-modified riboflavin-gold nano assembly, RfS@AuNPs has been engineered, which accumulates selectively in the nucleus without any nuclear-targeting peptides (NLS/RGD) and shows photophysically *in vitro* DNA intercalation. A theoretical model using molecular dynamics has been developed to probe the mechanism of formation and stability as well as dynamics of the RfS@AuNPs in aqueous solution and within the DNA microenvironment. This study reports a unique nuclear targeting mechanism through targeting the riboflavin receptors, which are upregulated in cancer cells and induce apoptosis in the targeted cells (*ACS Applied Materials & Interfaces, 2018, 10, 4582-4589*).

The nuclear and radiochemistry group is engaged in various activities. Extensive research both on natural radioactivity and artificial radioactivity have been carried out. For the first-time baseline data of natural radioactivity in Indian Sundarban has been reported. Alongside some other collaborative research were carried out by the radiochemistry group in the domain of trace element analysis.

The thick target neutron yield from a 16O6+ beam on a thick 27Al target at 120- and 142-MeV (7.5- and 8.8-MeV/nucleon, respectively) incident energies is presented and compared with theoretical calculations. The measured energy spectrum of neutrons for E>20MeV (the predominant PEQ region) is in good agreement with the PEQ model code HION (*Physical Review C, 2017, 96, 044607(7)*).

1.1. Ph.D. Awarded

1. Dr. Chaitrali Sengupta [Guide: Prof. Samita Basu], “Modulation of intramolecular and intermolecular charge-transfer reactions in heterogeneous assemblies and biological nanocavities”, University of Calcutta, June 2017.
2. Dr. Sathi Goswami [Guide: Prof. Munna Sarkar], “Molecular basis of alternate functions of NSAIDs”, University of Calcutta, February 2018.

2. Crystallography & Molecular Biology Division

Focus of the Crystallography and Molecular Biology Division have been on studies relating the structure and dynamics of biological macromolecules to function, essential part of modern biophysics to unravel the mechanism of action of proteins at the molecular level. EAL domain proteins play essential role in biofilm dispersal through cyclic-di-guanosine monophosphate (c-di-GMP) hydrolysis. Through high resolution structures of apo-Vibrio cholera EAL (VcEAL), its complex with 'substrate' c-di-GMP and 'product' 5'pGpG, coupled with kinetics and growth assay with several mutants, allowed us to decipher the mechanism of c-di-GMP hydrolysis in details. Crystal structure of a unique phospho tyrosine phosphatase (PTP) from Vibrio cholera demonstrates a novel mode of dimerization which in contrast to other PTP retains the catalytic activity. Small heat shock protein 15 (VcHSP15) demonstrates a mushroom shaped trimeric organization and its DNA/RNA binding site was identified. Structure of a Rho dependent transcription termination inhibitor YaeO and detailed studies of its interactions with Rho, both in solution and *in silico*, provided the mechanistic insights of its inhibition. Few mutants of human cathepsin K related to bone disorder have been characterized which revealed that all disease-related mutants are not catalytically inactive. Another study showed that human serpin B3 is a potential inhibitor of falcipain 2, a potential drug target of malaria parasite.

Accurate replication of DNA in eukaryotic cells is controlled by a cell cycle dependent licensing mechanism that allows formation of a competent pre-replication complex only after mitotic segregation of sister chromatids into daughter cells. Intriguingly, Ku – a DNA repair protein is also involved in the process and we have shown that the periodic modulation of replication related function of Ku is dependent on reversible phosphorylation of its Ku70 subunit by cell cycle kinases. The findings establish further insight regarding the regulatory mechanism of replication initiation involving multi-functional Ku protein, which is critical for genomic stability.

A series of antileishmanial compounds some of which were identified previously in the laboratory are screened against leishmanial strains, both promastigotes and amastigotes. Of these suramin and netilmicin were identified with promising antileishmanial activity. Attempts are also being made to crystallize drug targets in Leishmania. *In vitro* screening of known drugs identified by scaffold hopping techniques shows promising leishmanicidal activity for suramin and netilmicin. The hydrophobic core of the peptidyl prolyl isomerase enzyme cyclophilin from *Leishmania donavani* has been redsigned using computational methods formulated in the laboratory. In addition the unfolding characteristics of parvulin from L major, due to heat and chemical denaturants, has been studied. Attempts are also

being made to crystallize this class of leishmanial proteins for structural studies.

Clones of erythroid spectrin domains e.g. the ankyrin binding domain, actin-binding domain, SH3 domain and 'spectrin repeat' domains obtained, proteins expressed and purified to explore protein-protein interactions, chaperone activity and membrane binding potential. Characterization of hemoglobin / globin based amyloid and non-amyloid aggregates are underway. New research area on characterizing the structural dynamics of membrane proteins has been initiated. Although ~30% of human genome codes for membrane proteins and ~60% of available drugs target membrane proteins, structural determination of membrane proteins at atomic level, in spite of recent successes, is quite challenging due to poor expression, low purification yields and the low success rate of forming well-ordered 3D crystals. In this context, site-directed labeling is a powerful approach to provide structural and dynamic information relevant to the function of membrane proteins. Regarding the structural dynamics of membrane proteins, research is focused on understanding the activation gating mechanisms of magnesium ion channels and inward rectifying KirBac potassium channels, and lipid-dependent gating in voltage-gated potassium channels.

2.1. Ph.D. Awarded

1. Dr. Supratim Ghatak [Guide: Prof. Sanghamitra Raha & Nitaipada Bhattacharyya], "Studies on survival and related signaling pathways in cell models of Huntington's disease and cancer", University of Calcutta, January 2018.

2. Dr. Soumita Mukherjee [Guide: Prof. Partha Saha], "Role of Post-translational Modification on Eukaryotic Cell Cycle Progression", University of Calcutta, May 2017.

3. Nuclear Physics Division

The members have been successfully continuing their activities in Accelerator based Nuclear Physics (In-Beam gamma spectroscopy and Reaction studies) using National and International Accelerator Facilities as well working to make FRENA facility operational.

- This group is a constituent member of the Indian National Gamma Array (INGA) collaboration since its inception. During this time-period, collaborating with other National Institutes, our group has actively participated to set-up and maintain INGA array at VECC during the on-going campaign with light ion (proton and alpha) beams.
- FRENA which is the first dedicated Facility for Research in Experimental Low Energy Nuclear Astrophysics is ready for installation very soon. The device is centered around a 3 MV Tandetron capable of delivering high intensity ion beams of proton, helium to heavy ions till gold with variable energy of high precision. Studies of reactions of astrophysical importance will be one of the primary goals for FRENA in the next few years to come. To pursue such studies, dedicated setups with specialized detectors and electronics are being setup.
- Members of this division have published around 24 papers in international peer reviewed journals during 2017-18.

3.1. Ph.D. Awarded

1. Dr. Suprita Chakraborty [Guide: Prof. Subinit Roy (SINP), Dr. Avijit Mukherjee, Dept. of Physics, Jadavpur University], “Systematic analysis of proton and alpha capture reactions on 13C nucleus at astrophysical energies”, Jadavpur University, February 20 2018.

2. Dr. Santosh Chakraborty [Guide: Prof. Ushasi Datta], “Study of the ground state configuration of the neutron-rich Aluminium isotope through electromagnetic excitation”, University of Calcutta, April 2018.

3. Dr. Md. Anisur Rahaman [Guide: Prof. Ushasi Datta], “Study of exotic properties of neutron-rich nuclei around N~20 using radioactive ion beam”, University of Calcutta, January 2018.

4. Applied Nuclear Physics Division

Laboratory of Light – Matter Interactions at SINP is dedicated for research in the field of quantum optics and atomic spectroscopy. Our major thrust till now was experiments on Rubidium atomic system under the influence of electromagnetically induced phenomenon. . We have observed simultaneous occurrence of opaque and transparent behaviour of the atomic medium. We used multiple laser beams to control the interplay between the different transitions of the hyperfine levels of Rb atoms and formed electromagnetically induced transparencies (EIT) within the absorptive profiles. We have used this phenomenon to investigate the slowing down of light inside the atoms. We started our research with atoms in the room temperature but slowly moving towards cooling and trapping them for enhancing their coherence properties. We studied polarization rotation in EIT as a direction towards magnetometry. We also used structured light, namely, Vortex beams to investigate its possible role on the atomic line-shapes.

Laboratory at 555 metre depth at UCIL uranium mine at Jaduguda, named as Jaduguda Underground Science Laboratory (JUSL), was completed as per schedule and operating from September 2017. In collaboration with members from Astroparticle Physics and Cosmology (APC) Division of SINP, BARC, TIFR, VECC, NISER and UCIL, first phase of measurements of the radiation background are completed. Based on these results, the next phase of experiment is planned. This includes light yield (LY) measurements and optimization of the scintillation detectors for operation at cryogenic temperatures, new scintillation light read-out system using silicon photomultipliers, design of radiation shield, etc. Scintillation crystals made of ultrapure materials are indigenously developed at BARC. Prototyping of large cesium iodide scintillation crystal based detectors are also being done in collaboration with BARC, with the goal of setting up reasonably large experiment at JUSL for the search of dark matter candidates. Discrimination between different classes of radiation events using pulse shape analysis is in progress. A few more background radiation related and environmental measurements are planned and instruments for the measurements are being made at SINP. Significant work has been done on simulation of the radiation background at the laboratory site by considering penetrating cosmic rays and residual rock radioactivity. Simulation of the detector response to background neutrons and gamma rays is also in progress. Experiments to validate the simulation results are being done at the underground laboratory and also using radiation sources.

Probing the structural phases, structural defects and their evolution, phase stability, nature of changes taking place over wide temperature excursions, that is, whether the structure phase transitions are reversible or irreversible,

and many other aspects are studied during past year using two different and independent nuclear probe based techniques in our laboratories. These studies find applications in evaluating the phase stability of certain refractory metal fluoride based glassy materials for their suitability in the next generation high temperature tolerant view ports. Some of the intermetallic alloys, by virtue of their composite phases, have the potential applications in fuel cells and other energy storage materials. Synthesis and characterization of certain multiferroic perovskite materials demonstrated an important property that the leakage current through the medium can be controlled by harnessing their crystalline vacancies.

Experimental efforts to study various physics issues in detector dynamics have been initiated with several developments taking place in a brief period of time. A set-up including gas handling system, necessary electronics, data acquisition, several test chambers and couple of simple time projection chambers have been in operation in the Micropattern Gas Detector (MPGD) laboratory. We are also working on the application-oriented field of Cosmic Ray Muon Tomography. Both experimental and numerical simulation tools are being used to explore various possibilities. A stack of position sensitive cosmic muon detectors forming a muon telescope for prototyping cosmic muon tomography is under development. Simulation necessary to understand and optimize a muon telescope is being pursued. The present goal is to achieve Z discrimination of materials. Necessary readout based on ASIC/ NINO front-end and FPGA back-end is being pursued.

Inside Jaduguda Underground Science Laboratory in Jharkand

5. Astroparticle Physics and Cosmology Division

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 observational, experimental and theoretical astroparticle physics. Some highlights are given below:

Dark matter direct search experiment

Feasibility and background study for the low mass target superheated liquid detector for the low mass dark matter search had been explored. The recoil spectra for H, C, F were estimated for different WIMP masses along with the expected exclusion plots for an exposure of 10 kg-days. The sensitivity of the detector to gamma rays was observed experimentally to determine the threshold energy of the detector operation. The R & D on the development of the geyser type of superheated liquid detector has been started.

Simulation was performed to obtain the energy spectrum and angular distribution of muon induced neutrons in SNOLab and estimation of number of neutrons generated by cosmic-ray muons in norite rock for PICO experiment. The simulation results showed that the muon induced neutrons was 0.029±0.004E-07 /cm^2/sec. The visual counting of bubbles in the PICO bubble chamber at SNOLab was performed to match it with the acoustic signal counting data and the group participated in the data formatting for the data of PICO-60 run. The design of the 'Camera Mount system' for the next generation PICO-40/500 experiment has been done at SINP. The fabrication of the device has been started during this period.

High Energy Gamma Ray Astronomy

The scientists of APC Division are taking lead role in various software and hardware activities as regards to the calibration of the telescopes as part of the future Cerenkov Telescope Array (CTA) project. The calibration system has been designed and partially assembled at SINP and all tests regarding the characterisation and validation of the instrument has been completed. The calibration system will now be installed on the prototyep Large Size Telescope at La Palma for carrying out field tests. Our group has been assigned the responsibility of carrying out the absolute light calibration of the MAGIC telescopes using both Monte Carlo simulations and data from the telescopes.

The high energy gamma ray astronomy group at SINP carried out multi-wavelength and multimessenger studies using data from various national and international observatories to look for sources of galactic cosmic rays.

Recently the group investigated the supernova remnant (SNR) 3C 397 and its neighboring pulsar PSR J1906+0722 in high energy gamma rays by using nearly six years of archival data of Large Area Telescope on board Fermi Gamma Ray Space Telescope (Fermi-LAT). The off-pulse analysis of gamma-ray flux from the location of PSR J1906+0722 reveals an excess emission which is found to be very close to the radio location of 3C 397.

In order to explain the broadband multiwavelength spectral energy distribution of Mrk412, members of the group performed extensive simulations using a time dependent leptonic model during a recent outburst from the source.

The High Altitude Water Cerenkov (HAWC) Collaboration has released a catalog of TeV sources, in which 19 show no association with any known high-energy (E < 10 GeV) or very-high-energy (E > 300 GeV) sources. This catalog motivated follow-up studies by both the MAGIC and Fermi-LAT observatories with the aim of investigating gamma-ray emission over a broad energy band. Three HAWC sources were chosen for this study: 2HWC J2006+341, 2HWC J1907+084 and 2HWC J1852+013. Although no significant detection was found in either the Fermi or MAGIC analysis, this investigation allows us to constrain the angular extension of these new gamma-ray sources. The hypothesis that these sources are pulsar wind nebulae is also investigated in details.

Neutron Stars, Gravitational Waves

The tidal deformability in the late inspiral phase was estimated from the gravitational wave signal of binary neutron star (BNS) merger GW170817. This quantity can constrain the equation of state (EoS) of dense matter in neutron stars. Observed tidal deformability, moment of inertia, quadrupole moment of neutron stars are direct probes of neutron star matter. Though these observables depend on EoS individually, it was claimed by different groups that the relations among any two of these observable quantities are EoS independent and universal. We demonstrated for the first time that this universality was violated when the EoS involved a strong first order phase transition from hadronic matter to quark matter. Our work has far reaching consequences in the study of gravitational wave signal in BNS merger when one of neutron stars is massive and the appearance of quarks its interior is a possibility.

The escape of axions adds to the cooling process of the neutron star. The nature of cooling of neutron stars including the axion emission was explored and compared with the scenario when the neutron star is cooled by only the emission of gamma and neutrino.

The energy of a black hole-black hole (BH-BH) binary is radiated in the form of gravitational waves and to compensate for that energy, kinetic energy of the system decreases gradually. Consequently the mutual separation of the objects decreases with time and tends to merge. The whole process can require a very large amount of time, comparable or larger than the age of the universe, especially in the case of low mass mergers. We examined the case in which a massive object compared to the individual masses comprising the binary pair is present nearby such a system. It was found that in this case the merging process took place much rapidly than that of the conventional BH-BH merging process. Scenarios with both an Intermediate Mass Black Hole (IBMH) as well as a Super Massive Black Hole (SMBH) had been studied and the latter was found to provide a much higher overall rate for the BH-BH merger process.

Theoretical research on Dark Matter and Dark Energy

Theoretical research activities on dark matter were focused on various aspects of Astroparticle Physics, namely particle dark matter phenomenology and dark matter self interaction. In addition, an involved participation in the project related to dark matter direct detection experiment at the underground laboratory at Jaduguda uranium mines is being intensely pursued in terms of various theoretical calculations for physics studies and simulation works for different specific detector materials at the said underground facility. Also theoretical studies of dark energy and its models had been carried out.

An alternative candidate for particle dark matter namely Feebly Interacting Massive Particle (FIMP) was explored in the framework of a two component singlet scalar model. Dark Matter self interaction is extensively studied in this model and bounds are given on the masses of FIMP.

Axions were considered to be a dark matter candidate and axion-electron interaction was investigated. The counting rates of atomic ionisation as a function of axion energy by absorption of axions were calculated. Comparing with the experimental results, a bound on axion mass was given.

Neutrino Physics and Astrophysics: Neutrino Physics

The consequences of the generalized reflection symmetry on a scaling ansatz invariant neutrino Majorana mass matrix were investigated. It enables us to determine definite analytical relations between two of the mixing angles, maximal CP violation for the Dirac type and vanishing CP violation for the Majorana type. Beside the other testable predictions on the low energy neutrino parameters such as neutrinoless double beta decay matrix element and the light neutrino masses, the model also has intriguing consequences from the perspective of leptogenesis. With the assumption that the required

CP violation for leptogenesis is created by the decay of lightest of the three heavy right-handed Majorana neutrinos, only a specific flavored leptogenesis scenario was found to be allowed in this model. For a normal (inverted) ordering of light neutrino masses, one of the mixing angle was found to be less (greater) than its maximal value, for the final baryon asymmetry to be in the observed range. Besides, an upper and a lower bound on the mass of the heavy neutrino had also been estimated. Effect of the heavier neutrinos on final baryon asymmetry was worked out subsequently. The predictions of this model will be tested in the future and ongoing experiments such as nEXO, LEGEND, GERDA-II, T2K,DUNE etc.

A fourth sterile neutrino was investigated along with neutrinos in four (3+1) neutrino scheme, the ultra high energy (UHE) neutrino flux from distant gamma ray bursts (GRBs) were explored in terms of possible detection yields at IceCube detector at South Pole. Both the cascade events and track events were considered at IceCube and a comparison of the events at IceCube had been made with the 3-active neutrino case to explore possible existence of sterile neutrino.

5.2. Ph.D. Awarded

1. Dr. Rome Samanta [Guide: Prof. Ambar Ghosal], “A study on impact of residual symmetries in some neutrino mass models”, Homi Bhabha National Institute, March 2018.

6. Biophysics and Structural Genomics Division

Biophysics and Structural Genomics Division is focussed in interdisciplinary area of basic and clinical research involving Proteomics, Biomolecular spectroscopy, Chemical Biology and Synthetic & Structural Biology. The widely prevalent diseases of eastern India, HbE-thalassemia and leukemia are being studied as model for hematological disorders while Alzheimer's, Huntington's, and the Prion diseases are being investigated for gaining insights into neurodegenerative diseases. Differential proteomics studies have been performed using clinical samples of cerebrospinal fluid, blood and plasma. Classes of redox regulators and chaperone proteins have been found to be up-regulated in hemoglobinopathy and an interactome for haemoglobin has been identified in erythrocytes. Investigations in cellular signaling and its role in cell fate determination vis a vis regulation of metabolism were studied using comparative mitochondrial proteome. Our findings clearly underline that cellular signalling and differentiation, lead to the alteration of mitochondrial proteome which in turn affects the functioning of key metabolic pathways. Similar studies have also implicated deregulation in self renewal pathways in the process of metastasis in gastric and breast cancer. Biophysical studies on elasticity of nuclear membrane proteins Lamins have implicated their role not only in cardiovascular diseases but in cell differentiation as well. Currently, investigation on the role of lamins and intermediate filaments in DNA damage response, karyokinesis and carcinogenesis are underway. Epigenomics studies on function and dynamics of transcription factors have been initiated to interpret 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 such as breast cancer.

Neurodegenerative disorders like Alzheimer's, Huntington's and Prion Diseases are being pursued to study the roles of various micro RNAs in the disease process. The major focus of research in Alzheimer's has been the study of the downstream pathogenesis mediated through AICD and its adaptor network. AICD possesses conserved motifs that are known to interact with cytosolic adaptor proteins and these interactions in turn affect different signaling pathways. With Prion disease as a model system, we are trying to understand the significance of the ESCRT machinery and the endo-lysosomal pathway in Prion protein-mediated neurodegeneration. Our aim is to provide a molecular explanation for how the loss of function mutation of Mahogunin results in Prion disease like phenotype of spongiform neurodegeneration. In this regard, Ubiquitin-mediated regulation of the E3 ligase GP78 by MGRN1

in trans have been shown to affect mitochondrial homeostasis and positioning of spindle apparatus in development and disease.

Recently, we have initiated studies on a molecular systems level understanding of the combined effects of microgravity and space ionizing radiation (high energy particles) on human cells along with a metabolomics-guided system level elucidation of the effect of radiation exposure on living systems.

7. Computational Science Division

Computational Science Division maintains various IT infrastructure of the campus as central facilities. In addition members of the department carry out theoretical computational research on Bio-informatics. 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. There are about 1500 end point connections laid for wired machines/devices and about 200+ active wireless end points/nodes connected to our network.

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. The purview of the project included a Disaster Recovery setup so that in case of declared disaster, which hamper the installation, the setup would provide continued service from a secondary site. To accommodate the data centre needs of DR site a modular data centre currently operational in a faraway room. 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.

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.

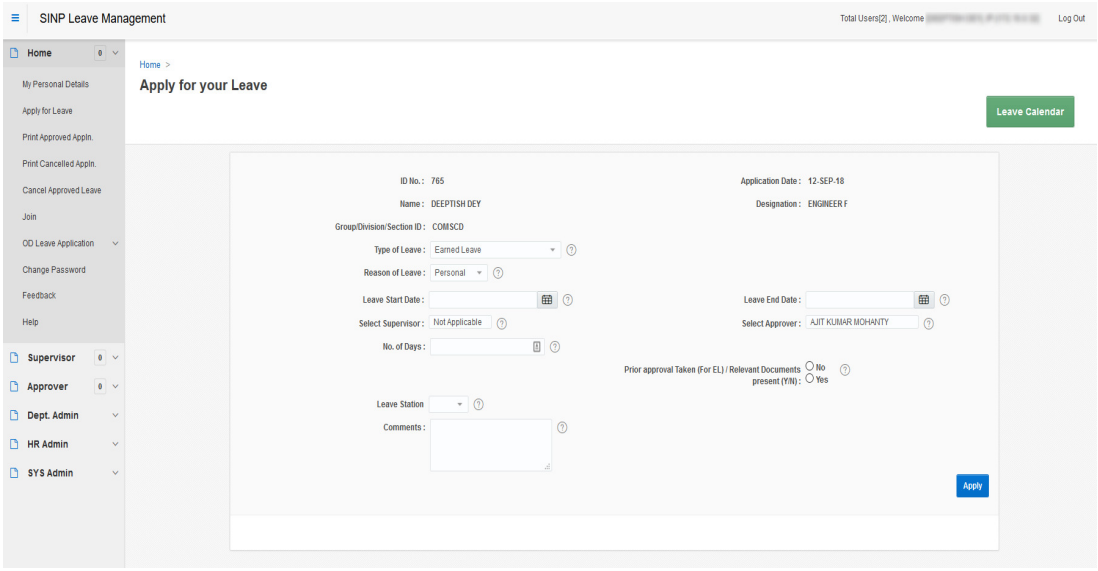
Software Development Initiative

The Director encouraged the members of Comp. Sc. Division to take a lead initiative to evaluate the feasibility of in-house development of different modules for e-Governance project, the previous implementation of which as a complete project was largely unsuccessful. A Proof of Concept (POC) project on Leave Management System (LMS) with APEX on Oracle was undertaken first. Significant developments on two other modules, the Medical Bill Processing System and the Salary Processing System have been done. The system was declared live on 1st Jan 2018. Since then all the members of the Institute have been using this system. The system is in constant development.

The salient features of the developed modules under e-Governance are the following:

- Fully Online system, compatible with most of the modern browsers.
- Employee ID based login
- Component level authorization to specific users.
- Role-based user access to functionalities.
- User role and Password management
- Workflow amongst different user roles like User>Supervisor>Approver>HR (Human Resource)

- Approval/Rejection of Leaves by Supervisor and/or Approver
- Generation of several reports for the requirement of User, Department, Institute in CSV/PDF Format
- Employee Master Management (Service Book Management)
- Addition/Removal of Supervisor and Approver



8. Condensed Matter Physics Division

Topological materials receivedconsiderable attention to scientific community recently due to their potential intechnological application. We have indigenously designed and set-upcrystal growth facility for topological systems and grown high quality single crystal for our study. The electronic transports, magnetic and spectroscopic properties of the single crystals are investigated underextreme conditions. From the quantum oscillation data, different Fermi surface parameters are extracted. Wealso measure the anisotropy in electronic transport and Fermi surfaceproperties along different crystallographic directions usinghigh-resolution sample rotator option. These works have been published inreputed international journals [Phys. Rev. B 96, 245138 (2017); Phys. Rev.B 97, 094112 (2018); Scientific Reports 7, 6321(2017); Scientific Reports7, 4883 (2017)] and received considerable attention to scientific community.

We have synthesized new R_2NiSi_3 (R = Nd, Ho, Tm) intermetallic compounds. Ho_2NiSi_3 is highly frustrated and exhibits large magnetocaloric effect (MCE) [*Scientific Reports*, 7 (2017) 7367]. Large MCE could also be observed in Tm_2NiSi_3 in the paramagnetic region [*J. Phys: Cond. Matter*, 29 (2017) 505801.], while Nd_2NiSi_3 is a reentrant spin-cluster glass material [*Phys. Chem. Chem. Phys* 20 (2018) 7082]. We have also reported a polymorphic-like structural phase transformation of tetragonal inverse-perovskite RPt_3B (R = Sm, and Gd-Tm) compounds to cubic perovskite structure, associated with a large volume reduction (~ 9%) [*Inorg. Chem.*, 56 (2017) 8446]. We have investigated the interrelation of exchange bias behavior and charge ordering phenomenon in $Sm_{1-x}Ca_xMnO_3$ and shown that the stability of the charge-ordered state is one of the key parameters for the exchange bias effect [*Scientific Reports*, 7 (2017) 3220]. Interesting magnetic and electrical properties have also been observed in Ga doped antiferromagnetic semiconductor α-Cr_2O_3 [*J. Magn. Magn. Mater*, 432 (2017) 56].

The magnetoresistance (*MR*) and magnetocaloric properties of layered compound $NdRu_2Si_2$ with a Neel temperature T_N= 24 K have been investigated in the temperature range 60 K $\geq T \geq$1.8 K. It has been shown that a high external magnetic field greatly modifies the *MR* properties of the compound which in its low temperature ferromagnetic state (T<10 K) exhibits an unusual positive *MR* instead of being negative. The results have been explained by considering the appearance of field induced pseudo gaps in the Fermi surface [Physica B 517 (2017) 6].

Ultrasonic wave attenuation constant (α) in pure water exhibits noticeable inconsistency in magnitude. Fourier Transform Ultrasound Spectroscopy is adopted to determine ultrasonic wave propagation parameters. The Fast

Fourier Transform components of the echo signals are taken to compute k, α and r, the reflection constant at the boundary, using Oak Ridge and Oxford method. The results are compared with existing literature values [Ultrasonics73 (2017) 140].The formation, growth, structure and cluster size distribution properties in a two-dimensional system of particles interacting with Lennard-Jones potential under controlled cooling condition have been studied using Monte-Carlo method considering modified Metropolis algorithm to introduce realistic thermal motion of the particles. A compact well-defined ordered structure is obtained for number density $c \gtrsim c_c$ and $\alpha << \alpha_c$ [Int. J. Emerging Tech. Adv. Eng., 7 (2017) 92].

Main focus of the theoretical condensed matter physics division has been on characterization of novel materials that exhibit exotic phenomenon as an effect of correlations, disorder and topology etc. We aim to decode dynamics and correlations in such complex systems in equilibrium and out of equilibrium situations.

Dynamics plays an important role in determining the nature of non-equilibrium steady states (NSS). The unusual correlations associated with NSS leads to surprising phenomena like negative differential response, current reversal, zero current non-equilibrium states. We try to understand these non-equilibrium thermodynamic properties by obtaining exact steady states of different types of dynamics. A class of critical NSS is observed in self organized critical (SOC) systems which are prototype of 'how nature works'. They exhibit hyperuniformity by breaking central limit theorem. The universality of generic SOC is under debate and we are working towards settling this issue. We are also interested in systems with turbulence, transport in non-equilibrium systems and developing formalism for systems out of equilibrium.

Interplay of correlations and dynamics in quantum systems is of great interest and many-body localization is an important example of that. What happens to Anderson localization in the presence of interactions, is a question of immense interest, which remained unanswered for almost five decades. Recently it has been established that for weak interactions system exhibit many-body localization (MBL) with a dynamical transition into delocalised phase at larger interactions. MBL phase is unique in many ways and challenge the basic foundation of quantum statistical physics. MBL phase is non-ergodic and hence an isolated system in MBL phase does not thermalize. We studied MBL in systems which has single particle mobility edges, and quantum spin glasses and demonstrated that MBL can survive even in the presence of single particle mobility edges and infinite range interactions.

Biological systems are common realisations of soft matter systems driven out

of equilibrium. These are usually under system-generated active or non-equilibrium stresses, which make the steady states of these systems very different from their equilibrium counterparts. The steady states, for instance, are often characterised by unusual instabilities or new universal scaling in their ordered phases. As of now, no general theoretical framework (like Gibbs-Boltzmann theory for equilibrium systems) exists to describe them. Our aim is to construct general, symmetry based approaches which are independent of the system details - construction of principles governing non-equilibrium statistical mechanics/thermodynamics.

We also explored magnetism in diluted magnetic semiconductors and manganites.A new framework to increase the ferromagnetic Tc in diluted magnetic semiconductors was proposed using spin-fermion Monte-Carlo calculations on a simple cubic lattice in the intermediate coupling regime. A complete pathway, based on a two-band double exchange model, was provided to understand the phase competitions between the charge-ordered (CO) and the ferromagnetic (FM) nanoclusters above Tc in CMR manganites. The resistivity increases due to the enhancement of the volume fraction of the n=1/2-type (π-π) CO and the FM nanoclusters, with decreasing temperature until Tc. The FM nanoclusters start to grow and merge, and they win the competition below Tc, leading to the sharp drop in the resistivity.

8.1. Ph.D. Awarded

1. Dr. Bijoy Kumar Daga [Guide: Prof. Pradeep Kumar Mohanty], “Interacting extended objects in one dimension, University of Calcutta, 2017.

9. High Energy Nuclear and Particle Physics Division

ALICE Collaboration activities

The Saha groups of ALICE are one of the cofounder laboratories of the Muon Spectrometer and collaborating since 1997. In past years, the Saha members have achieved major milestones such as detector hardware fabrication, designing of MANAS (ASIC readout chip), active participation in ALICE data collection, analysis of large volume data, publication of ALICE results in major national and international conferences and journals. The groups is focused to share the knowledge gained in the frontier of science experiment such as ALICE with the school, college, university students through various seminars and public. A short summary of the major hardware and analysis activities are summarized below.

Saha hardware performance and maintenance

The indigenously built large area cathode pad chamber by Saha group comprises with 2.2 lakh readout channels which have been fully fabricated commissioned and installed by the Saha members of ALICE. Since Muon Spectrometer is a tracking detector, the stable data collection with Indian made detector is critical for the physics prospects of the Spectrometer. Each year LHC exceeds its previous record in terms of luminosity and stable beam delivery. This imposes the detector operation challenging due to the high particle flux. The successful operation of the Indian made Muon detector marked a record due to the stable performance in high luminosity (10^{29} $cm^{-2}s^{-1}$) during the pPb and Pbp data collection.

MANAS

The first stage of detector signal is processed by the ASIC chip named MANAS designed in Saha. Since the readout scheme of Muon Spectrometer and Photon Multiplicity Detector of ALICE are similar, the Saha team has delivered 88 thousands to two detector collaborations. An excellent performance of MANAS chip has been observed in LHC operation during Run I and II in high radiation background environment. The recent successful pPb data collection is an added confirmation of the stable operation of the chip in high luminosity environment.

Detector operation

The detector operation in complex setup like ALICE is a challenging task since ALICE hosts 18 different detection technologies. The Saha group of ALICE is also recognized for its leadership role during critical data collection periods such as pPb and high luminosity pp runs. The group took challenging

responsibility of System Run Coordinator for Muon Spectrometer and ALICE Run Coordinator for ALICE setup in 2016 and 2017, respectively.

Data analysis

The high luminosity pPb runs allow to collect a large statistics for the study of the bound and open heavy flavour mesons of charm and beauty quarks. The suppression (or no suppression) quark-antiquark pair in pPb collisions provides and important information for saturation/shadowing parameter used to understand the quark gluon plasma created during the first epoch of Big-Bang. The number of J/psi, psi(2S), Upsilon(1S) and Upsilon(2S) as measured by the Muon Spectrometer and analyzed by Saha team is shown in the plot below [Fig (1) and (2)]. The anomalous psi(2S) suppression have been reported for the backward rapidity by the Saha group for p-Pb collisions at 8.16 TeV. The analysis note have been submitted for psi(2S) analysis after the completion of the analysis where Saha Institute took leading role.

The Saha team is involved in the analysis of Pb-Pb data of 2015 for the measurement of nuclear modification factor of Upsilon(1S) and (2S) at 5 TeV collsions. The paper draft is prepared in present academic year and ready for collaboration review for publication.

The double differential measurement of J/psi production in Pb-Pb 2015 provide a new insight to the study of recombination effect. The Saha group has initiated this analysis and currently in advanced stage.

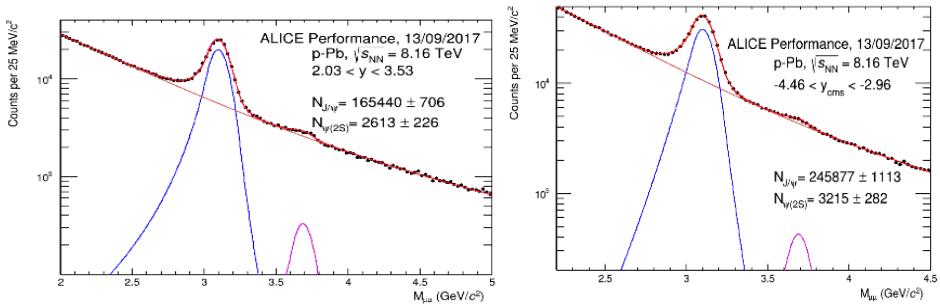


Fig. The J/psi and psi(2S) production in p-Pb collisions at forward (left) and backward (right) rapidities.

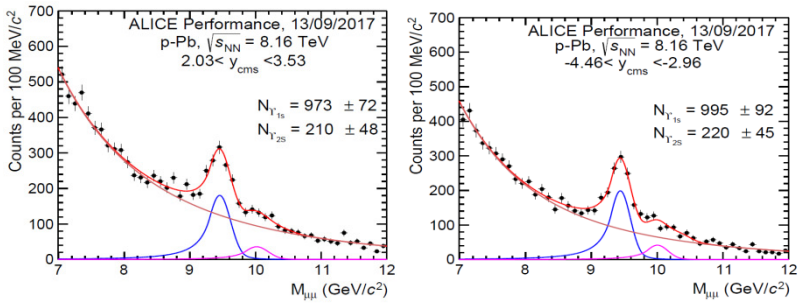


Fig. The Upsilon(1S) and (2S) production in p-Pb collisions at forward (left) and backward (right) rapidities.

The photo production of J/psi in ultra-peripheral Pb-Pb collisions allows to study the electromagnetic production cross-section of charmonium state at relativistic energies. In recent times this has drawn attention of the high energy physics community since it provides access to the electromagnetic production effect without contribution of the hadronic interaction. This measurement is carried out by the Saha group in collaboration with a Ph.D student from Aligarh Muslim University (AMU).

In proton-proton collisions where medium formation is not expected has started to show some peculiar properties which were initially observed only in Pb-Pb collisions such long range correlation. The Saha group is involved in the study of J/psi production in pp collisions at 2.76 TeV and 5. TeV in collaboration with AMU student, which demonstrated that the production of charmonium increases linearly with charge particle multiplicity. This is understood to be originated due to multi-parton interactions in the high energy pp collisions.

The Saha group is also involved to analyze the pp 13 TeV data for the study of heavy flavor decay mouns from various sources.

ALICE Upgrade: Muon Forward Tracker (MFT)

The next ALICE upgrade includes the fabrication of silicon pixel detector in the forward rapidity known as Muon Forward Tracker. This will enhance the signal resolution due to the accurate identification of the collision vertex in the z-direction of the beam. A critical component of the detector in high luminosity environment is the reduction of the heat with proper cooling method. The SINP team is involved with the planning and fabrication of the cooling mechanism for MFT.

ALICE Upgrade: Readout Upgrade for Muon Spectrometer

The LHC luminosity will be increased further after LS2 and current readout of Muon Spectrometer cannot record at such high rate. Therefore, a new design have been proposed for the second station of Muon Spectrometer by the Saha group. The new readout PCB conceptual design has been reviewed and approved by the ALICE collaboration. This will be a multilayer PCB for continuous readout and finalization of detail design is in progress.

QGP Phenomenology

This activity is being pursued for the last 17 years with present emphasis on the properties of hadrons in non-zero magnetic field at finite temperature. The highlights of these studies in recent times are:

a) Spectral properties of rho and pi mesons in magnetic field at non-zero temperature.

b) Study of rho-omega mixing in vacuum in magnetic field.

c) QCD collective oscillations in hot magnetized plasma.

The other studies include the production ratio of Y(3S) to Y(1S) and Y(2S) to Y(1S) via pp collisions at the LHC energies is an important preliminary to the research on QGP. Such effects has been studied for forward rapidities along with J/psi(1S), Psi(2S)(charmonia) and compared with experimental results of ALICE and LHCb to understand both the hot and cold nuclear matter produced at LHC energies.

CMS Collaboration activities

The CMS group of SINP started in 2011 with 5 faculty members and 4 students. Some of the members have been involved in CMS for a much longer period contributing significantly to the design and construction of the CMS expeiment. Since the beginning of data taking, the group has had major responsibilities in tracker operations, Hadron calorimeter (HCAL) calibration and overall Data Quality Monitoring (DQM). In physics analysis, the group's major involvement has been in new particle searches including the Higgs boson. At the time of the Higgs discovery, the group was involved in search for Higgs in the high mass region. The group's work in physics and detector development has resulted in 16 physics papers, about 15 public physics results and 10 detctor related notes. So far, 9 students have graduated from the group. At present, the group with 6 faculty members and 10 students has major involvements in several important channels of Higgs Physics, physics of jets and in searches for dark matter and extra dimensions. The group 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 has commitments for several important upgrades of the CMS detector for the High Luminosity LHC opetations. SINP members have held positions of responsibilities, in detector development, operations and Physics analyses, within the collaboration.

Physics Studies and Computing

Analyses

The SINP-CMS group has been involved in serveral important LHC physics analyses, namely: (1) SM Higgs boson studies in the γγ decay mode, e.g differential cross-section measurement, and in the 4-lepton decay mode (4e,

4μ, 2e2μ). (2) SM Higgs boson searches in the associated production mode with a W, where the Higgs boson decays into a pair of τ leptons and the W decays to an electron or a muon; (3) di-Higgs production at the LHC energies; (4) search for dark matter and extra-dimensions; (5) inclusive jet production at different energies and event shape studies; (6) Feasibility study to trigger on $B_S \rightarrow \varphi\varphi \rightarrow 4$ kaons events at Level 1 using the proposed CMS PhaseII tracker.

The SINP team played a central role in two important publications of CMS in 2016 from dark matter searches and excited lepton searches from 2012 data. Students from SINP were leading analyzers and served as analysis contact persons within the collaboration. The bound on dark matter nucleon scattering cross-section obatined from our monophoton analysis appears in the global plot of dark matter-nucleon scattering cross-section upper bound. The SINP members have also contributed towards rediscovery and first mass measurements of the Higgs boson using the Run II data.

Computing

The SINP-CMS cluster became fully operational in 2013, with the successful hosting of the Asian CMS Data Analysis (CMSDAS) school. The cluster served significantly for the PhaseII Tracker related simulation studies. In 2016 SINP has become a part of the LHCone network supported under the National Knowledge Network (NKN). A new divisional computing center has also been developed during the last year.

Run II Detector Performance related activities

The group has long-term responsibilities on current tracker and HCAL operations and calibration. The group is responsible for the validation of the present tracker detector; tracker bad channel calibration and tracking performance studies. The group have contributing substantially to the calibration of the hadron calorimeter making use of different approaches to do relative and absolute calibration of the calorimeter. In addition, strategies to trigger on isolated particles are pursued.

Hadron Calorimeter Upgrade

The backend electronics of HCAL has been upgraded during the long shutdown period 1 (LS1) of LHC. The group made substantial contribution in two broad areas: 1) microTCA based readout cards for HF and 2) Optical Splitters for barrel and end-cap HB/HE detectors.

A total of 54 μHTR cards were fabricated 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. All the cards were successfully installed and commissioned for RunII data taking in 2015 and have been working successfully ever since.

Optical splitters for LS1 upgrade were crucial for the working of trigger with CMS HCAL back-end electronics. Students and post-doc have played a major role in designing and testing for 3 years, to meet our partial commitment towards LS1 upgrade. Eventually, 206 such units have been shipped to CERN and installed and integrated with the detector.

Phase II Upgrade

A number of sub-detectors of the CMS detector will be upgraded fully before the HL-LHC phase starts. The timeline for upgrade is 2020-23 and R&D activities are in full swing.

The CMS tracker detector will be replaced entirely in order to operate at the High Luminosity LHC. The proposed tracker design allows us to reconstruct tracks with sufficient resolution at Level 1 phase of the trigger system. The tracks reconstructed at Level 1 trigger is crucial to reduce and keep event rate at an acceptable limit. We have 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 is already a part of the PhaseII tracker Technical Proposal (TP). We have also studied whether rare processes like $B_S \rightarrow \varphi\varphi \rightarrow 4$ kaons can be triggered using the PhaseII tracker and the results have been included in the Tracker Technical Design report (TDR). The group members have contributed significantly to the PhaseII tracker module-test software development and Data Quality Monitoring (DQM) tool used in laboratory and Tracker Beam tests. The group is also responsible for the development of the digitizer software for the proposed new tracker. Presently, the group is setting up a module test facility in the institute.

The CMS-GEM activities have been going on since several years with a view to upgrade the tracking and triggering capabilities of the CMS muon system in the high rapidity region. The upgrade is also important to cope up with the HL-LHC scenario.

An infrastructure is being set up which will be used to carry out several quality control steps related to the final production of GE1/1. In addition, the same infrastructure is expected to be used for detector R&D for GE2/1 and ME0 upgrades. It may be noted that a large fraction of the components for this R&D will be based on products made within the country.

We hope to use the same laboratory for studies related to muon tomography, which can be considered as a spin-off having societal applications.

Both ECAL and HCAL endcap calorimeters will be replaced with a new detector, known as HGCal that will utilize highly granular silicon pads for both ECAL and the front part of the HCAL. The group has been involved in simulation studies, beam test data analysis and in setting up a test facility locally in the institute.

10. Plasma Physics Division

Academic activities in plasma physics division are centered around theoretical and experimental investigations on various types of waves & instabilities, nonlinear structures and nonlinear dynamical characteristics in a variety of plasmas. Important highlights of theoretical studies include nonlinear coupling of Langmuir and electron acoustic waves in a viscous plasma, derivation of a completely integrable derivative nonlinear Schrodinger equation for Alfven waves in presence of electron inertia, reduction of transformer ratio in the context of plasma wakefield excitation in cold plasmas, wave breaking of electrostatic modes in electron ion plasmas due to phase mixing, energization of charged particles in uniform electric fields in presence of chaotic magnetic fields. Such studies have relevance to particle acceleration and heating in astrophysical environments and laboratory experiments. Studies on influence of dissipative effects on stationary solutions of non-neutral plasma diodes reveal interesting results that are relevant in the design of thermionic energy converters. Nonlinear dynamical characteristics of magnetic field lines are being investigated to understand their role in transport phenomena.

Experimental activities are being carried out in the MaPLE (Magnetized Plasma Linear Experiment) device, double Layer experimental device (DLX), glow discharge plasma and the currentless toroidal device.

MaPLE device has been designed to study waves and instabilities in a controlled parameter regime. In order to excite magnetic electron drift mode, it is necessary to enhance plasma density. A microwave waveguide converter has been developed to couple high power to plasma via circular mode coupling. Necessary RF diagnostics (magnetic probes) are being developed to study the wave.

Double layer experimental device enables studies in radio-frequency produced plasma in presence of diverging magnetic fields. Self-excited resistive dual upper drift waves with frequency greater than ion cyclotron frequency have been observed in helium plasma coexisting over a wide range of axial and radial locations. Power spectrum of fluctuation also reveals several other modes detected in narrow regions. Bicoherence analysis confirms that these modes arise due to nonlinear interaction between primary modes.

Experiments in DC glow discharge plasmas having cylindrical and toroidal configurations reveal various types of nonlinear oscillations that are analyzed using statistical techniques. A bar magnet placed external to the glow discharge device caused a fireball like structure that is responsible in driving

a period doubling route to chaos in the bulk plasma. The oscillations were characterized using nonlinear dynamical techniques.

10.1. Ph.D Awarded

1. Dr. Pankaj Kumar Shaw [Guide: Prof. M.S. Janaki], “Investigation of nonlinear dynamics of a self excited complex system like plasma”, Homi Bhabha National Institute, September 2017.

2. Dr. Abhijit Ghosh [Guide: Prof. M.S. Janaki], “Study of drift wave instability in RF produced magnetized plasma”, Homi Bhabha National Institute, December 2017.

3. Dr. Sayanee Jana [Guide: Prof. Nikhil Chakrabarti], “Nonlinear Coherent Structures in Plasmas”, Homi Bhabha National Institute, February 2018.

4. Dr. Sabuj Ghosh [Guide: Prof. M.S. Janaki], “On the paths of transitions among different kinds of nonlinear oscillations in glow discharge plasma”, Homi Bhabha National Institute, February 2018.

11. Surface Physics and Material Science Division

In order to achieve superior device performances, it is absolutely necessary to explore the properties of new materials within multifunctional platforms in the nanometer length scale (~1-100 nm), where the surface and the interface essentially dictates the functions. Keeping this view in mind, research activities of the Surface Physics & Material Science (SPMS) Division mainly encompass the growth of low-dimensional 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 cathode luminescence (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 tunnelling microscope (STM) and ambient scanning probe microscopes (SPMs) are utilized for structural, compositional, optical, tribological and surface/interface analysis in routine manner. In short, the faculty members of SPMS division, with their diversified fields of expertise, have been working on systems where surface/interface plays a crucial role in dictating its properties relevant to applications, such as, MOS-based electronic devices, magnetic devices, photonic devices, sensors for detecting hazardous gas and human blood glucose monitoring, bio-imaging, solar cells, to name a few. Many faculty members of the division have also been using advanced synchrotron facilities in India and abroad for a further detailed understanding of these materials, apart from developing an SINP beam line at the INDUS II synchrotron at RRCAT, Indore.

That an atomically sharp interface (revealed by cross-sectional TEM) plays a crucial role in determining the quality of the cutting-edge new materials having possible applications in next generation electronic, spintronic and quantum computation devices, has recently been demonstrated in a high-temperature ferromagnetic topological insulator utilizing our TEM facility through an international collaborative work. Our TEM work has been

instrumental in the discovery of a super dense nonmagnetic fcc phase of cobalt and demonstrating the growth of nanoscale nickel monosilicide, a desired material for the future complementary metal oxide semiconductor (CMOS) technology.

Formation of 2D-networked structures of disk-like islands for ultrathin Langmuir-Schaefer (LS) films of thiol-coated Au-nanoparticles (DT-AuNPs) on H-passivated Si substrates is evidenced for the first time, directly from a broad peak in grazing incidence small angle X-ray scattering (GISAXS) data and also from atomic force microscopy (AFM) images [*RSC Adv*. 2016, 6, 12326]. The structural information of the LS films, obtained at different surface pressure, helps to infer the growth of Langmuir monolayers of DT-AuNPs, which is very important in understanding the self-assembly process of nanoparticles at the air-water interface and in controlling the growth of 2D-networked nanostructures in large areas.

The crystallization process ZrO_2 thin-film is identified and found that 1-D crystal growth took place initially that spreads laterally with temperature and time without increasing their numbers. The growth of Zr-Silicate and silicide is also investigated using differential scanning calorimetry. The substrate dependent performance of the high-k dielectric film is also investigated. Charge storage properties of InP quantum dots in GaAs metal-oxide-semiconductor based nonvolatile flash memory devices is also investigated. A nanoparticle (NP)-based non-volatile memory devices with HfO_2 as tunnel and barrier layers are fabricated and characterized.

We work with nano dimensional organic semiconducting (OSc) thin films prepared on various substrates in ultra high vacuum chamber. Structure and electronic properties of these films are studied. OTFT devices are prepared and the field effect mobility of the devices is measured. We use various spectroscopic and microscopic techniques for our experiments such as XPS/UPS, NEXAFS, PRES (synchrotron based techniques), AFM etc. We also perform density functional theory calculations using StoBe and VASP software. The objective of our study is to understand interfacial's properties that are required for the development high mobility organic semiconductor devices.

We study the structures in different phases and their incorporation into the membrane depending on the temperature-surface pressure phase diagram of the mixed lipids. Self organization mechanism in supramolecular materials in presence of foreign species is also very crucial in developing new functional devices based on these self assembled materials. We have also demonstrated that these supramolecular nanofibers are very promising candidates for various applications such as solar cells, sensors, FETs, etc.

In our recent works on the dynamics in soft matter, i.e., the two-dimensional nanoscale pattern dynamics at air-water interface, we investigated the role of the nanoparticle–monolayer and monolayer–monolayer lipophilic attraction in influencing morphology and dynamics of AuNP cluster patterns in fatty acid monolayers. The corresponding pattern morphology, observed with a Brewster Angle Microscope (BAM) essentially reveals three stages in pattern evolution. On the otherhand, coalescence of myristic acid droplets on water surface is found to exhibit anomalous behaviour such as simultaneous increase of mean droplet size and droplet number with time at low surface pressure.

We have shown that the 3D micro-snowflake structured α-Fe_2O_3 synthesized by simple hydrothermal decomposition of $K_3[Fe(CN)_6]$ without using any surfactant can be used for highly selective, sensitive and stable amperometric sensing of H_2O_2 and N_2H_4 in presence of common coexisting electroactive interferes. As an ideal enzyme less sensing material, the sample has good stability and selectivity against common coexisting interferes. We also report non-equilibrium dynamics and giant spontaneous exchange bias obtained in zero field cooled mode for $Ni_{46}Mn_{43}In_{11}$ alloy. The dc magnetic measurements indicate a super spin glass type magnetic ground state in the system.

We have started work on epitaxial growth of $(Al_{1-y}Ga_y)_xIn_{1-x}P/(Al_{1-y'}Ga_{y'})_xIn_{1-x}P$/GaAs QW structures. Initial low temperature photoluminescence measurements show peaks correspond to the QW emission. While working on the growth of AlxGa1-xAs epitaxial layers in the QW structures, we have observed natural superlattice ordering in the material, which is not reported on (100) GaAs grown by this technique. This growth behaviour is further studied by growth of thick $Al_xGa_{1-x}As$ layer with different composition and their thermal stability using different x-ray techniques, TEM microscopy and photoluminescence. Effect of the superlattice on emission properties of the QW is also being studied in detail.

We have performed extensive studies of the antiferromagnetic NiO single crystals and ultrathin films using XPS, ARPES, LEED, LEEM, XMLD-PEEM methods and have been the subject of many publications. Electronic band structures of low-dimensional layered materials such as single crystal Graphite, MoS_2, $MoSe_2$ etc. have also been extensively investigated. Epitaxial Cr, V and Mn monolayers, and multilayers, as well as their oxides such as V_2O_3, MnO, Mn_3O_4 etc, have been studied in respect of their surface magnetism and electronic structures. Further systems studied includes ultrathin films and overlayers of CoO, MgO, Cu_2O, metallic Sn and SnO etc.

The time evolution of the spontaneous oxidation of the prepared film in air at room temperature (RT) was studied. A compositional analysis of the film was carried out in an ultra-high vacuum (UHV) deposition chamber using an in

situ XPS system. The morphological aspects of the deposited film were studied with a high resolution scanning electron microscope (SEM) and an atomic force microscope (AFM). We report the spontaneous production of highly pure (95%) and technologically appealing nano-crystalline Cu_2O within 300 seconds of air exposure. The crystalline structure was probed using high resolution TEM (HRTEM) and the optical properties were studied using a cathodoluminescence (CL) device attached to a SEM.

Examination of radiative localized surface plasmon resonance (LSPR) modes of individual polyhedral nanoparticles (NPs) with high index facets, such as trisoctahedral (TOH) shaped or concave nanocube (CNC) shaped gold (Au) nanocrystals (NCs) using cathode luminescence (CL) across the visible spectral range show interesting results. Pronounced enhancement is observed in the Raman scattering on Rhodamine 6G (R6G)-covered TOH Au NPs aggregates on a Si substrate whereas for CNC shaped Au NPs, we report the existence of edge quadrupolar mode as well as substrate-mediated hybridized corner quadrupolar and octupolar modes.

11.1. Ph.D. Awarded

1. Dr. Kaustabh Dan [Guide: Prof. Alokmay Datta], “Studies on the phase transition of liquid crystal and mixtures” University of Calcutta, 2017.

2. Dr. Sk. Abdul Kader Md Faruque [Guide: Prof. Supratic Chakraborty], “Study of sputter deposited ZrO2 films under different oxidation and annealing conditions”, Homi Bhabha National Institute, May 2017.

3. Dr. Suvankar Chakraborty [Guide: Prof. Krishnakumar S. R. Menon], “Growth, Structure and Electronic Properties of Ultrathin Metal/Metal-Oxide Films”, University of Calcutta, June 2017.

4. Dr. Asish K. Kundu [Guide: Prof. Krishnakumar S. R. Menon], “Growth, electronic structure and antiferromagnetism of early transition metal and metal oxide ultra-thin films”, University of Calcutta, November 2017.

5. Dr. Achyut Maity [Guide: Prof. Tapas Kumar Chini], “Surface plasmon enhanced optical properties of comlex shaped gold nanoparticles”, Homi Bhabha National Institute, November 2017.

6. Dr. Arpan Maiti [Guide: Prof. Tapas Kumar Chini], “Studying surface plasmons of individual gold nanoparticle on silicon substrate using cathodoluminiscence”, Homi Bhabha National Institute, December 2017.

7. Dr. Tapas Ghosh [Guide: Prof. Biswarup Satpati], “Study of galvanic displacement reaction of metal nanostructures on semiconductor surfaces using transmission electron microscopy”, Homi Bhabha National Institute, March 2018.

12. Theory Division

Particle Physics Phenomenology

Flavor-changing decays of the top quark have been predicted to be small in the Standard Model. The experimental limits on these processes are much higher. We have set up theoretical framework in which experimentally accessible results can be expected in models of new physics. We have discussed two models of supersymmetry, one with conserved R-parity, and the other in which R-parity is mildly violated. We show that in the latter case there is a distinct possibility of detecting the rare decay of top quark decaying to a charm quark and a Z boson at the LHC.

We have also worked on intergenerational symmetries and tried to explain fermion masses and mixings.

The SM at the LHC is being scrutinized at an unprecedented level of precision. It is only natural to have the competing BSM scenarios match the same order of accuracy in QCD as the SM observables.

At the LHC, first step towards a precision phenomenological study of the production of spin-2, coupling non-universally to the SM particles would be to compute form factors to the production of a singlet, on-shell spin-2 state via the quark-antiquark and gluon-gluon production channels, to the same order of accuracy as the SM background. A priori, it is not clear how the UV and IR structure would look like when spin-2 couples to particles of the SM with non-universal couplings, this is investigated up to the three loop level in QCD.

We have performed the very first calculation involving a massive spin-2particle at NNLO level in QCD for the production of a pair of leptons at hadron colliders. We have included all the relevant sub-processes that can contribute to the invariant mass distribution of the di-leptons. The methodology of reverse unitarity and IBP identities are systematically employed to achieve it.

The two-loop QCD correction to massive spin-2 graviton decaying to quark +antiquark + gluon is presented considering a generic universal spin-2coupling to the SM through the conserved energy-momentum tensor. The motivation are to (a) probe the structure of quantum field theory in the presence of a spin-2 field, to check the universality of IR pole structure in QCD and (b) present one of the important ingredients for full two-loop QCD correction for real graviton production in association with a jet.

Using the pseudo-scalar Higgs boson form factors that have recently become available up to three loops and the third order soft function from the real radiations, a complete N3LO threshold correction to the production of a pseudo-scalar Higgs boson at the LHC has been obtained. Using our approach, we have also computed the process dependent coefficient that appears in the threshold resumed cross section, which will be useful for resumed predictions at N3LL in QCD. Using threshold corrected N3LO results; we have presented a detailed phenomenological study of the pseudo-scalar Higgs boson production at the LHC for various center of mass energies as a function of its mass.

Non-perturbative studies of Quantum Field Theories

The standard Wilson lattice gauge theory with compact gauge fields is explicitly gauge-invariant at all stages of the calculation and does not require gauge fixing. This works perfectly well for vector-like gauge theories. However, for proposals of chiral gauge theories on the lattice, gauge invariance is lost because lattice fermions do necessarily break chiral symmetry, and as a result the redundant longitudinal gauge degrees of freedom end up coupling with physical degrees of freedom, and render the theories unsuitable. Gauge-fixing has been suggested as a possible remedy to control the couplings of the redundant degrees of freedom.

However, gauge-fixing at the non-perturbative level of compact gauge fields is a non-trivial business because of a rigorous no-go theorem by Neuberger which says that the partition function of a BRST-invariant theory of compact gauge fields is identically zero, apparently because of cancelling contributions from Gribov copies.

Here at SINP, we are pursuing particular proposals of non-perturbative gauge fixing both for Abelian and non-Abelian compact gauge theories.

For the Abelian case, a higher derivative gauge fixing term, breaking gauge and BRST invariance, is added to the Wilson term along with a counter-term to recover gauge symmetry. A new universality class is found at a continuous phase transition between a broken symmetry phase with regular order and another broken symmetry phase with spatially modulated order that has a vector condensate. Approaching this transition from the regularly ordered phase recovers the gauge symmetry and thereby decoupling the longitudinal gauge degrees of freedom. Contribution of the SINP group has been to determine the phase diagram beyond weak couplings and establish the availability of the new universality class to all gauge couplings through computation of various observables. Investigation of the Abelian gauge-fixing on the lattice has been completed in the past year.

The non-Abelian gauge fixing involves extension of the BRST called equi-variant BRST (eBRST) to evade the Neuberger's theorem. This is basically application of gauge fixing to the coset while a subgroup is kept gauge-invariant, and necessarily involves four-ghost term in the action. We have developed, from scratch, a code for generating gauge configurations with this eBRST action. The work is still in progress.

In pure QCD with free boundary conditions, work was also done to determine the lowest glue ball spectrum.

Gravity and Cosmology

An alternate model of gravity including torsion is being investigated. The main feature of this new model is it reduces to Einstein's theory at long distances and becomes a Yang-Mills' theory at short distances. However, no exact solution beyond the trivial ones (with non-vanishing torsion) has been found in which these features are exhibited. A report on this is yet to come out.

The number of observable e-foldings during inflation is sensitive to the post-inflationary history of the Universe. The generic presence of light scalar fields in theories motivated by supersymmetry or String theory leads to a late-time period of matter domination which lowers the required number of e-foldings, and in turn, the exact predictions of inflationary model. This issue has been explored in a concrete set-up of Kahler moduli inflation in String theory. The initial displacement of volume modulus has been calculated explicitly, and the generic expectation from supergravity theory was confirmed that the initial displacement is of the order of Planck mass. The constraints from reheating has also been analysed for this model in a subsequent work. In separate projects, the issue of attractor models in non-minimal f(R) gravity, and the supergravity contributions to inflation in models with non-minimal coupling to gravity have been analysed.

Strings

It has been shown earlier by us that, like BPS Dp branes, bulk gravity gets decoupled from the brane even for the non-susy Dp branes of type II string theories indicating a possible extension of AdS/CFT correspondence for the non-supersymmetric case. The detailed decoupling limit and the throat geometry of the non-susy D3 brane when the charge associated with the brane is very large have been worked out. This leads to the gravity dual of a non-supersymmetric QCD-like gauge theory with running coupling constant having confinement property. Also starting from an anisotropic non-susy D2 brane solution of type IIA string theory an anisotropic space-like D2 brane solution has been constructed by the standard trick of double Wick rotation. It is shown that upon compactification on six dimensional hyperbolic space of

time dependent volume of this SD2 brane solution leads to accelerating cosmologies on the resultant four dimensional universe. On the other hand, at early times this four dimensional space, under certain situations, leads to four dimensional Kasner-like cosmology. Unlike in the standard four dimensional Kasner cosmology here all three Kasner exponents could be positive definite, leading to expansions in all three directions.

New examples of Lifshitz type vacua in 10D massive typeIIA supergravity are constructed. These Lifshitz geometries arise when `massive' closed strings are excited in D2-D8 brane system. Upon compactification to four dimensions they produce 4-dimensional Lifshitz solutions (with dynamical exponent of time being 2) like in the Einstein-Proca model of Son et. al. We also studied M5 action in six dimensions using Yang-Mills fields and adjoint scalars with the help ofauxiliary vector field and new axion field. The 6D covariant action is well defined for 'instantonic' string solitons.

In addition, the following issues were explored and addressed: a) Building on earlier works that describe a certain steady-state configuration, the causal structure of an emergent geometry, which emerges from the dynamics of open strings, was explored within the context of gauge-string duality. The similarity of causal structures emerging from dynamical gravity and this particular kinematic space-time was elaborated on. b) Motivated by earlier works within holography, a preliminary study of candidate infrared fixed points were carried out in a system of arbitrary number of adjoint and fundamental degrees of freedom, in a strongly coupled large N gauge theory. A large class of exact solutions were obtained, which are non-perturbative in terms of the ratio of the number of fundamentals and the number of adjoints.

QCD at Finite Temperature and Density

A captivating nature of non-central heavy ion collisions indicates that a very strong anisotropic magnetic field is generated in the direction perpendicular to the reaction plane, due to the relative motion of the ions themselves. The initial magnitude of this magnetic field can be very high at RHIC and LHC energies at the time of the collision and then it decreases very fast. The presence of an external anisotropic field in the medium subsequently requires modification of the present theoretical tools that can be applied appropriately to investigate various properties of QGP. We have been involved in developing theoretical tools appropriate for a hot magnetised QCD medium. Also involved in studying non-perturbative aspects of hot QCD medium with effective models.

Nuclear Theory

The strong and model independent correlations of neutron star radii with the linear combination of the slope of the nuclear matter incompressibility coefficient and slope of the nuclear symmetry energy coefficient are reported for the first time. Such correlations are found to be more or less independent of the neutron star mass over a wide range. This correlation is traced back to be linked to the empirical relation existing between the star radius and the pressure at a nucleonic density between one and two times saturation density.

Mathematical Physics

An su(m)-invariant Haldane-Shastry like quantum spin chain with long-range interaction and open boundary condition has been studied. It is shown that this spin chain is integrable for some suitable choice of the lattice sites depending on the roots of the Jacobi polynomial. The ground state wave function of such integrable spin model can be obtained from the chiral correlator of the c=m-1 free boson boundary conformal field theory. The partition function of this spin chain is computed by using the freezing trick. Moreover, a complete description for the spectrum of this spin chain is given in terms of Haldane's motifs and a related classical vertex model.

We analyzed the fermionic quasinormal modes of the BTZ black hole in the presence of space-time noncommutativity. Our analysis exploits a duality between a spinless and spinning BTZ black hole, the spin being proportional to the non commutative deformation parameter. Using theAdS/CFT correspondence we show that the horizon temperatures obtained from the dual CFT pick up non-commutative contributions. We demonstrate the equivalence between the quasinormal and non-quasinormal modes for the non-commutative fermionic probes, which provides further evidence of holography in the noncommutative setting. Finally we present an analysisof the emission of Dirac fermions and the corresponding tunnelling amplitude within this non-commutative framework.

We analyzed the effects of noncommutativity in conformal quantum mechanics (CQM) using the \kappa-deformed space-time as a prototype. Upto the first order in the deformation parameter, the symmetry structure of the CQMalgebra is preserved but the coupling in a canonical model of the CQM gets deformed. We show that the boundary conditions that ensure a unitary time evolution in the non-commutative CQM can break the scale invariance, leading to a quantum mechanical scaling anomaly. We calculate the scaling dimensions of the two and three point functions in the non-commutative CQM which are shown to be deformed. The AdS_2/CFT_1

duality for the CQM suggests that the corresponding correlation functions in the holographic duals are modified. In addition, the Breitenlohner-Freedman bound also picks up a non-commutative correction. The strongly attractive regime of a canonical model of the CQM exhibit quantum instability. We show that the non commutativity softens this singular behaviour and its implications for the corresponding holographic duals are discussed.

We showed that the realizations of noncommutative coordinates that are linear in the Lorentz generators form a closed Lie algebra under certain conditions. The star product and the co-product for the momentum generators are obtained for these Lie algebras and the corresponding twist satisfies the co-cycle and normalization conditions. We also obtain the twisted flip operator and the \mathcal R-matrix that define the statistics of particles or quantum fields propagating in the se-non commutative space times. The Lie algebra obtained in this work contains a special case which has been used in the literature to put bounds on noncommutative parameters from the experimental limits on Pauli forbidden transitions. The general covariant framework presented here is suitable for analyzing the properties of particles or quantum fields at the Planck scale.

We showed that the N-particle Sutherland model with inverse-square and harmonic interactions exhibit orthogonality catastrophe. For a fixed value of the harmonic coupling, the overlap of the N-body ground state wave functions with two different values of the inverse-square inter action term goes to zero in the thermodynamic limit. When the two values of the inverse-square coupling differ by an infinitesimal amount, the wave function overlap shows an exponential suppression. This is qualitatively different from the usual power law suppression observed in the Anderson's orthogonality catastrophe. We also obtain an analytic expression for the wave function overlaps for arbitrary set of couplings, whose properties are analyzed numerically. The quasi-particles constituting the ground state wave functions of the Sutherland model are known to obey fractional exclusion statistics. Our analysis indicates that the orthogonality catastrophe may be valid in systems with more general kinds of statistics than just the fermionic type.

Recently unusual properties of water in single-walled carbon nanotubes (CNT) with diameters ranging from 1.05 nm to 1.52 nm were observed. It was found that water in the CNT remains in an ice-like phase even when the temperature ranges between 105 - 151 C and 87 - 117 C for CNTs with diameters 1.05 nm and 1.06 nm respectively. Apart from the high freezing points, the solid-liquid phase transition temperature was found to be strongly sensitive to the CNT diameter. In this paper we show that water in such CNT's can admit coherent nano-scale structures provided certain conditions are met. The formation of such coherent structures allows for high values of

solid-liquid phase transition temperatures that are in qualitative agreement with the empirical data. The model also predicts that the phase transition temperature scales inversely with the square of the effective radius available for the water flow within the CNT. This is consistent with the observed sensitive dependence of the solid-liquid phase transition temperature on the CNT diameter.

12.1. Ph.D. Awarded

1. Dr. Chiranjib Mondal [Guide: Prof. Bijay Agrawal], "Constraining the density dependence of symmetry energy using mean field models", Homi Bhabha National Institute, 2017.

2. Dr. Naosad Alam [Guide: Prof. Bijay Agrawal], "Correlations of neutron star properties with the parameters of nuclear matter equation of state", Homi Bhabha National Institute, 2017.

3. Dr. Kuntal Nayek [Guide: Prof. Shibaji Roy], "Study on some aspects of non-supersymmetric brane solutions in String theory", Homi Bhabha National Institute, 2017.

4. Dr. Chitralekha Datta [Guide: Prof. Bireswar Basu-Mallick] "Exact solutions of some quantum integrable systems associated with polarized spin reversal operators", Homi Bhabha National Institute, 2017.

5. Dr. Kumar Das [Guide: Prof. Koushik Dutta], "Aspects of Inflationary models in supergravity", Homi Bhabha National Institute, 2017.

6. Dr. Aritra Bandyopadhyay [Guide: Prof. Munshi G. Mustafa], "Non-perturbative study of spectral function and its application in Quark Gluon Plasma", Homi Bhabha National Institute, 2018.

7. Dr. Goutam Das [Guide: Prof. Prakash Mathews], "Precision QCD Study for Spin-2 Production at the Large Hadron Collider", Homi Bhabha National Institute, 2018.

8. Dr. Chowdhury Aminul Islam [Prof. Munshi Golam Mustafa], "Study of hot and dense nuclear matter in effective QCD model", Homi Bhabha National Institute, 2018.

FACILITIES

1. CENTRE FOR ADVANCED RESEARCH & EDUCATION (CARE)

Centre for Advanced Research & Education (CARE) has been making efforts in research-education linkages towards identifying and nurturing young talents in science through its Post M.Sc. training, summer students' and undergraduate associateship programs.

Post-M Sc Associateship Course 2017 – 2018

Theoretical Physics

1. Arunima Bhattacharya
2. Astik Haldar
3. Ayan Kumar Patra
4. Madhurima Sinha
5. Pankaj Sharma
6. Pritam Nanda
7. Ritesh Ghosh
8. Upala Mukhopadhyay

Experimental Physics

1. Anindita Deka
2. Arindam Biswas
3. Arunava Kar
4. Dipali Basak
5. Karimul Islam
6. Md. Saifuddin
7. Pooja Agarwal
8. Pritam Palit
9. Promita Roy

10. Rashika Gupta
11. Rezwana Sultana
12. Sabyachi Karmakar
13. Saikat Bhattacharjee
14. Shubham Dutta
15. Shubhi Parolia
16. Souvik Bhattacharjee
17. Suchanda Mondal
18. Tanmoy Bar

Biophysical Sciences

1. Aditya Singha Roy
2. Chandrayee Mukherjee
3. Debayan Purkait
4. Debolina Bandyopadhyay
5. Duhita Sengupta
6. Indranil Modak
7. Sebabrata Maity
8. Sk. Ramiz islam
9. Subham Paul

Theoretical & Experimental Physics Courses

2016 – 2017 batch: Theoritical Physics

Optional Courses for Third Trimester (April – July' 2017)

1. Topics in String Theory & Field theory (by Prof. Arnab Kundu)
2. Advanced Soft Condensed Matter (by Prof. Avik Basu)
3. Astro-Particle Physics-II (by Prof. Debashis Majumdar)

Physics (Theory) Review Topics (Dec' 2016 – July' 2017)

1. Aranya Bhattacharya, "AdS/CFT primer and some of its applications", (Guide: Prof. Shibaji Roy).
2. Bithika Karmakar, "Finite Temperature Field Theory in imaginary time formalism and its simpler applications", (Guide: Prof. Munshi G Mustafa).
3. Supriyo Ghosh, "Aspects of quench in physical systems", (Guide: Prof. Kumar S Gupta).
4. Avik Paul, "Investigating particle nature of Dark Matter", (Guide: Prof. Debasish Majumdar).
5. Anwesha Chattopadhyay, "Strong correlations and Gutzwiller Projection", (Guide: Prof. Arti Garg).
6. Bishnu Awan, "Interfacial Magnetism in Transition Metal Oxide Heterostructures", (Guide: Prof. Kalpataru Pradhan).

2017 – 2018 batch: Theoritical Physics

Compulsory Basic Courses in First Trimester (August – November' 2017)

1. Advanced Quantum Mechanics, (by Prof. Amit Ghosh)
2. Advanced Statistical Mechanics, (by Prof. Pradeep Mohanty)
3. Quantum Field Theory –I, (by Prof. Asit K De)
4. Numerical Methods and Alogorithms, (by Prof. Kalpataru Pradhan)

Optional Courses in Second Trimester Dec' 2017 – March' 2018

1. Quantum Field Theory – II (by Prof. Koushik Datta)
2. Particle Physics (by Prof. Prakash Mathews)
3. Advanced Mathematical Methods (by Prof. Bireswar Basu-Mallick)
4. String Theory (by Prof. Arnab Kundu)
5. Advanced Condensed Matter – I (by Prof. Abhik Basu)
6. Advanced Plasma Physics – I (by Prof. Nikhil Chakrabarti)

Physics (Theory) Review Topics (Dec' 2017 – July' 2018)

1. Upala Mukhopadhyay, "Anisotropies in Cosmic Microwave Background Radiation and inhomogeneities in Universe", (Guide: Prof. Debasish Majumdar).
2. Pankaj, "Physics of multi-component plasma", (Guide: Prof. Nikhil Chakrabarti).
3. Astik Haldar, "Scaling and critical phenomenon of the XY model in 3D: renormalisation group analysis of the complex scalar field model", (Guide: Prof. Abhik Basu).
4. Pritam Nanda, "Hawking radiation from a black hole at the Hawking temperature", (Guide: Prof. Amit Ghosh).
5. Arunima Bhattacharya, "Precision QCD at the LHC: a primer", (Guide: Prof. Prakash Mathews).
6. Madhurima Sinha, "Yangian quantum group symmetry in exactly solvable spin models with long-range interaction", (by Prof. Bireswar Basu-Mallick).
7. Ayan K Patra, "Black holes, chaos and holography", (Guide: Prof. Arnab Kundu).
8. Ritesh Ghosh, "Quantum Field Theory in nontrivial background", (Guide: Prof. Munshi G Mustafa).

Physics (Experiments) Review Topics (2017-18)

1. Rezwana Sultana, "Effect of Zr content on the Resistive Switching properties of ZrxHf1-xO2- based MOS devices", (Guide: Prof. Supratic Chakraborty).
2. Karimul Islam, "Pt Nanoparticle Embedded HfO2-Based Nonvolatile Memory devices", (Guide: Prof. Supratic Chakraborty).
3. Pooja Agarwal, "Characterisation of graphene on SiC", (Guide: Prof. Biswajit Karmakar).
4. Md. Saifuddin, "Tuning structural ordering of ….. conjugated polythiophenes thin films", (Guide; Prof. Satyajit Hazra).
5. Shubham Dutta, "Study of Electron Background for Dark Matter Direct Detection in Scintillation Detector", (Guide: Prof. Chandicharan Dey).

6. Arunava Kar, “Electronic Structure of Strongly Correlated Systems”, (Guide: Prof. Krishnakumar S.R. Menon).

7. Sabyasachi Karmakar, “Growth and Structural characterization of organic semiconductor thin films”, (Guide: Prof. Mrinmay Mukhopadhyay).

8. Tanmoy Bar, “Simulation of Heat Transfer and Dissipation in targets used in real nuclear astrophysics experiments with basic setup plan”, (Guide: Prof. Chinmay Basu).

9. Arindam Biswas, “Effect of structural ordering on transport properties of poly(3-hexylthiophene) thin films”, (Guide: Prof. Satyajit Hazra).

10. Dipali Basak, “Testing and Optimization of the Gas detector”, (Guide: Prof. Chinmay Basu).

11. Promita Roy, “Numerical simulation of response of gaseous detectors to cosmic ray muons”, (Guide: Prof. Supratik Mukhapadhyay).

12. Saikat Bhattacharya, “Elastic scattering of 6Li+159Tb”, (Guide: Prof. Anjali Mukherjee).

13. Suchanda Mondal, “Magnetic Properties of Layered van der Waals Bonded Ferromagnet: CrI3”, (Guide: Prof. Biswarup Satpati).

14. Shubhi Parolia, “Experimental and numerical studies on the response of triple GEM detectors”, (Guide: Prof. Supratik Mukhopadhyay).

15. Rashika Gupta, “Anomaly of Berylium (Guides: Prof. Bijay Agrawal and Prof. Manoj Sharan).

16. Pooja Agarwal, “Optimization of Lithographically defined metal contact on Planer surface”, (Guide: Prof. Biswajit Karmakar).

17. Karimul Islam, “Role of Pt thin-film on the non-volatile memory properties of HfO2- based MOS devices”, (Guide: Prof. Supratic Chakraborty).

18. Anindita Deka, “Study of nano-pattern formation using low energy ion beam sputtering”, (Guide: Prof. Satyaranjan Bhattacharyya).

19. Pritam Palit, “Study of Level-1 Trigger Objects for the CMS Phase-II Upgrade”.

Anwesha Chattopadhyay *in PMSC (Physics) was the recipient of:* ***Best Performance Award in PMSc (Physics) and Prof. A. P. Patra Memorial Prize in PMSc*** *(Physics) for the session* ***2016-2017****.*

Biophysical Sciences Courses

Compulsory Basic Courses (August – November' 2017)

1. **Biochemistry and Cell Biology (BCB)** (40 lectures by Prof. Abhijit Chakrabarti/ Prof. Kaushik Sengupta, Prof. Oishee Chakrabarti/ Prof. Partha Saha, Prof. Subrata Banerjee, Prof. Chandrima Das)

2. **Chemical Biology and Biophysics (CBB)** (40 lectures by Prof. Montu Hazra, Prof. Padmaja Mishra, Prof. Debashis Mukhopadhyay and Prof. Sangram Bagh).

3. **Spectroscopy and Nanoscience (SPN)** (20 lectures by Prof. Samita Basu and Prof. Dulal Senapati)

4. **Computer Programming & Bioinformatics (CPB)** (40 lectures by Prof. Gautam Garai and Prof. Dhananjay Bhattacharyya)

5. **Macromolecular Structure (MMS)** (40 lectures by Prof. Rahul Banerjee, Prof. Udayaditya Sen/ Prof. Sampa Biswas, Prof. H Raghuraman, Prof. Kaushik Sengupta)

6. **Radiochemistry & Radiation Physics (RRP)** (12 lectures by Prof. Susanta Lahiri & 8 lectures by Prof. Maitreyee Nandi)

Compulsory Research Methodology (August 2017 – March 2018)

1. **Biochemical and Molecular Biology Techniques (BMBT)** (by Prof. Debashis Mukhopadhyay, Prof. Partha Saha)

2. **Spectroscopy and Imaging Techniques (SIT)** (by Prof. Padmaja Mishra/ Prof. Kaushik Sengupta, Prof. Montu Hazra and Prof. H Raghuraman)

3. Good Laboratory Practices, Radiological safety (Radiation Protection Standards, Principles of Monitoring and Protection), Ethics of scientific research, writing of scientific articles and project proposals.

4. **Research colloquium:** During the first week of the course work, presentation on scientific research work carried out in the laboratories where students have opportunity to join for their doctoral work will be made by the respective faculty. Purpose of the colloquiums is to provide an overview of on-going scientific research related to the subject area in the Institute to the new students.

Advance Courses offered in Semester II

1. **Topics in Cell Biology - I** (by Prof. Oishee Chakrabarti & Prof. Partha Saha)
2. **Topics in Cell Biology – II** (by Prof. Kaushik Sengupta & Prof. Chandrima Das)
3. **Membrane Biophysics and Structural Dynamics of Membrane Proteins** (by Prof. H Raghuraman)
4. **Chromatography and Mass Spectrometry** (by Prof. Soumen K Manna)
5. **Synthetic Biology: 21st Century Biological Engineering** (by Prof. Sangram Bagh)
6. **Macromolecular Crystallography** (by Prof. Udayaditya Sen & Prof. Sampa Biswas)
7. **Advanced biophysical Spectroscopy and imaging** (by Prof. Samita Basu & Prof. Padmaja Mishra)
8. **Drug Discovery: Modern Day Approach** (by Prof. Munna Sarkar)

Review-Project Topics

1. Chandrayee Mukherjee, "Lamin A and the pathway to myogenesis", (by Prof. Kaushik Sengupta).
2. Duhita Sengupta, "Modulation of chromosome architecture by lamins in disease models", (by Prof. Kaushik Sengupta).
3. Debolina Bandyopadhyay, "Development of Fluorescence resonance energy transfer (FRET) based DNA biosensors", (by Prof. Padmaja Mishra).
4. Debayan Purkait, "Stabilization of G-quadruplex structures by ligands having antitumor activity - Monitoring the molecular mechanism taking one molecule at a time", (by Prof. Padmaja Mishra).
5. Aditya Singha Roy, "Regulation of gene expression at post-transcriptional level in eukaryotes", (by Prof. Partha Saha).
6. Indranil Modak, "Crosstalk between replication and repair", (by Prof. Partha Saha).
7. Sk. Ramiz Islam, "Role of RNA methylation in oxidative stress response", (by Prof. Soumen Manna).

2. LIBRARY

SINP Library is also one of the major information resource centres within Eastern India in the field of Physical and Biophysical Sciences. It is our privilege to support the institutes march towards its vision- to be the pioneer research institute in India. The Library not only acquires, organizes and disseminates knowledge; it has also put its foot ahead towards policies and procedures, systems and services.

Collections

Library has a huge collection of books, e-books and non-book materials. The details are given below:

- **Technical books accessioned:** 32121 (141 added in this year)
- **Non-technical books accessioned:** E4369 (54 added in this year)
- **E-books available:** 2929
- **Bound volumes of journals accessioned:** P51974
- **Current subscribed online journals:** 225 (Foreign)
- **Total no. of online journals including current subscription:** 3002
- **Number of CD/DVD Rom accessioned:** C1217 (27 CD added in this year)
- **Theses accessioned: T348** (30 added in this year)

Meghnad Saha Archive

Library maintained and preserved the Prof. M.N. Saha Archive from 2017. The archive was a unique collection of numerous letters, documents, writings, personal items, correspondences and memoirs of Prof. Saha and his colleagues. From time to time visitors from India and abroad, who are working on the history of Indian Science and scientists, visit the archive. With the permissions of our Director, library handover copies of these documents to scholars who are working on the subject.

Publication

Preparing and publishing the Annual Report of SINP with Centre for Advanced Research & Education (CARE) under the supervision of the Annual Report Editorial Board.

Membership

In addition to our active 546 (49 members added in this financial year) institute library members among faculties, research fellows and non academic, library has the privilege to serve more than six hundred (633) external users coming from different scientific and educational institutes of Eastern India. The external users includes; Calcutta University, Jadavpur University, Viswa Bharati, IACS, IICB, ISI, Bengal Engineering and Science University, WBUT, CMERI, Guwahati University, North-Eastern Hill University, Patna University etc. apart from numerous Under-Graduate/Post-Graduate colleges and project students.

LIST OF PUBLICATIONS – WITHOUT COLLABORATION

April 2017 – March 2018

1. Aggleton, R.; Ardila-Perez, L. E.; Ball, F. A.; et al. (Dutta, S.). An FPGA based track finder for the L1 trigger of the CMS experiment at the High Luminosity LHC, JOURNAL OF INSTRUMENTATION 12 (2017) Art No.P12019

2. Agnihotri, Nidhi; Sen, Pintu; De, Amitabha; et al. Hierarchically designed PEDOT encapsulated graphene-MnO_2 nanocomposite as supercapacitors, MATERIALS RESEARCH BULLETIN 88 (2017) 218-225

3. Agrawal, B. K.; Samaddar, S. K.; De, J. N.; et al. Mondal, C). Limiting symmetry energy elements from empirical evidence, INTERNATIONAL JOURNAL OF MODERN PHYSICS E-NUCLEAR PHYSICS 26 (2017) Art No. 1750022

4. Ahmed, Ikbal; Dildar, Lucky; Haque, Anamul; et al. (Mukhopadhyay, M.; Hazra, S.). Chitosan-fatty acid interaction mediated growth of Langmuir monolayer and Langmuir-Blodgett films, JOURNAL OF COLLOID AND INTERFACE SCIENCE 514 (2018) 433-442

5. Alam, N.; Pais, H.; Providencia, C.; et al. (Agrawal, B. K.). Warm unstable asymmetric nuclear matter: Critical properties and the density dependence of the symmetry energy, PHYSICAL REVIEW C 95 (2017) Art No.055808

6. Ali, Sajad; Rajbanshi, S.; Das, B.; et al. (Chattopadhyay, S.; Saha Sarkar, M.; Goswami, A.). Evidence of antimagnetic rotation in an odd-odd nucleus: The case of ^{142}**Eu**, PHYSICAL REVIEW C 96 (2017) Art No.021304

7. Ares, Filiberto; Gupta, Kumar S.; de Queiroz, Amilcar R. Orthogonality catastrophe and fractional exclusion statistics, PHYSICAL REVIEW E 97 (2018) Art No.022133

8. Arumugam, S.; Ganguli, C.; Thiyagarajan, R.; et al. (Bhoi, D; Pariari, A.; Mandal, P.). Effect of pressure on normal and superconducting state properties of iron based superconductor $PrFeAsO_{0.6}Fy$ (y=0.12, 0.14), SCIENTIFIC REPORTS 7 (2017) Art No.11731

9. Bal, Jayanta Kumar; Mukherjee, Manabendra; Dildar, Lucky; et al. Conformation mediated preferential swelling of amphiphilic block copolymer ultrathin films, JOURNAL OF POLYMER RESEARCH 24 (2017) Art No.222

10. Bandyopadhyay, Aritra; Mallik, S. Effect of magnetic field on dilepton production in a hot plasma, PHYSICAL REVIEW D 95 (2017) Art No.074019

11. Bandyopadhyay, Aritra; Mallik, S. Rho meson decay in the presence of a magnetic field, EUROPEAN PHYSICAL JOURNAL C 77 (2017) Art No.771

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13. Bandyopadhyay, Debades; Bhat, Sajad A.; Char, Prasanta; et al. Moment of inertia, quadrupole moment, Love number of neutron star and their relations with strange-matter equations of state, EUROPEAN PHYSICAL JOURNAL A 54 (2018) Art No.26

14. Banerjee, Avik; Kundu, Arnab; Roy, Pratik; et al. Oscillating shells and oscillating balls in AdS, JOURNAL OF HIGH ENERGY PHYSICS 7 (2017) Art No.026

15. Banerjee, Avik; Bhattacharyya, Gautam; Ray, Tirtha Sankar. Improving fine-tuning in composite Higgs models, PHYSICAL REVIEW D 96 (2017) Art No.035040

16. Banerjee, Avik; Bhattacharyya, Gautam; Kumar, Nilanjana; et al. Constraining composite Higgs models using LHC data, JOURNAL OF HIGH ENERGY PHYSICS 3 (2018) Art No.062

17. Banerjee, Kakoli; Naskar, Nabanita; Choudhury, Dibyasree; et al. (Lahiri, Sussanta). Trace analysis at the backdrop of women welfare : Assessment of heavy metals in vermillion, JOURNAL OF THE INDIAN CHEMICAL SOCIETY 94 (2017) 1017-1022

18. Banerjee, Tirthankar; Basu, Abhik. Active hydrodynamics of synchronization and ordering in moving oscillators, PHYSICAL REVIEW E 96 (2017) Art No.022201

19. Banerjee, Tirthankar; Basu, Abhik. Symmetries and scaling in generalised coupled conserved Kardar-Parisi-Zhang equations, JOURNAL OF STATISTICAL MECHANICS-THEORY AND EXPERIMENT Art No.013202

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21. Banik, Amit Dutta; Pandey, Madhurima; Majumdar, Debasish; et al. Two component WIMP-FImP dark matter model with singlet fermion, scalar and pseudo scalar, EUROPEAN PHYSICAL JOURNAL C 77 (2017) Art No.657

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23. Bardhan, Munmun; Majumdar, Anupa; Jana, Sayantan; et al. (Ghosh, Tapas; Pal, Uttam; Senapati, Dulal). Mesoporous silica for drug delivery: Interactions

with model fluorescent lipid vesicles and live cells, JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY B-BIOLOGY 178 (2018) 19-26

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26. Basak, Uttam Kumar; Datta, Alokmay. Anomalous behaviour of droplet coalescence in a two-dimensional complex system, PHYSICA A-STATISTICAL MECHANICS AND ITS APPLICATIONS 486 (2017) 284-295

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29. Basu, Moitri; Sengupta, Isha; Khan, Md Wasim; et al. (Das, C.). Dual histone reader ZMYND8 inhibits cancer cell invasion by positively regulating epithelial genes BIOCHEMICAL JOURNAL 474 (2017) 1919-1934

30. Basu, Rudranil; Detournay, Stephane; Riegler, Max. Spectral flow in 3D flat spacetimes, JOURNAL OF HIGH ENERGY PHYSICS 12 (2017) Art No.134

31. Basu, Sankar; Mukharjee, Debasish. Salt-bridge networks within globular and disordered proteins: characterizing trends for designable interactions, JOURNAL OF MOLECULAR MODELING 23 (2017) Art No.206

32. Basu, Tanmoy; Kumar, Mohit; Saini, Mahesh; et al. (Satpati, Biswarup). Surfing Silicon Nanofacets for Cold Cathode Electron Emission Sites, ACS APPLIED MATERIALS & INTERFACES 9 (2017) 38931-38942

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34. Basu-Mallick, B.; Mandal, Bhabani Prasad; Roy, Pinaki. Quasi exactly solvable extension of Calogero model associated with exceptional orthogonal polynomials, ANNALS OF PHYSICS 380 (2017) 206-212

35. Behera, S. P.; Ghosh, Anushree; Choubey, Sandhya; et al. (Mahanty, A. K.). Search for the sterile neutrino mixing with the ICAL detector at INO, EUROPEAN PHYSICAL JOURNAL C 77 (2017) Art No.307

36. Bhat, Sajad A.; Bandyopadhyay, Debades. Dense matter in strong gravitational field of neutron star, JOURNAL OF ASTROPHYSICS AND ASTRONOMY 39 (2018) Art No.18

37. Bhattacharjee, Pritha; Dasgupta, Dipak; Sengupta, Kaushik. DCM associated LMNA mutations cause distortions in lamina structure and assembly, BIOCHIMICA ET BIOPHYSICA ACTA-GENERAL SUBJECTS 1861 (2017) Pt.A 2598-2608

38. Bhattacharjee, S.; Lavanyakumar, D.; Naik, V.; et al. (Mondal, S.; Bhattacharyya, SR). Nanomechanical properties of ion induced Si ripple patterns, THIN SOLID FILMS 645 (2018) 265-268

39. Bhattacharya, Deb Sankar; Bhattacharya, Purba; Rout, Prasant Kumar; et al. (Mukhopadhyay, Supratik; Bhattacharya, Sudeb; Majumdar, Nayana; Sarkar, Sandip). Experimental and numerical simulation of a TPC like set up for the measurement of ion backflow, NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT 861 (2017) 64-70

40. Bhattacharya, G.; Giri, R. P.; Saxena, H.; et al. (Mukhopadhyay, M. K.). Interaction of imidazolium-based ionic liquids with soft supported lipid membrane, EUROPEAN BIOPHYSICS JOURNAL WITH BIOPHYSICS LETTERS 46 (2017) Suppl.1 S361-S361 Meeting Abst. P-941 (O-1)

41. Bhattacharya, G.; Giri, R. P.; Saxena, H.; et al. (Mukhopadhyay, M. K.). Interaction of imidazolium-based ionic liquids with soft supported lipid membrane, EUROPEAN BIOPHYSICS JOURNAL WITH BIOPHYSICS LETTERS 46 (2017) Suppl.1 S105-S105 Meeting Abs O-181 (P-9)

42. Bhattacharya, M.; Mazov, V.; Satpati, B.; et al. Exploiting Le Chatelier's principle for a one-pot synthesis of nontoxic HHogGNPs with the sharpest nanoscopic features suitable for tunable plasmon spectroscopy and high throughput SERS sensing, CHEMICAL COMMUNICATIONS 53 (2017) 10402-10405

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44. Bhattacharya, Sukannya; Dutta, Koushik; Maharana, Anshuman. Constrains on Kahler moduli inflation from reheating, PHYSICAL REVIEW D 96 (2017) Art No.083522

45. Bhattacharyya, Gautam. Hierarchy problem and BSM physics, PRAMANA-JOURNAL OF PHYSICS 89 (2017) Art No.53

46. Bhattacharyya, Sudip; Bombaci, Ignazio; Bandyopadhyay, Debades; et al. Millisecond radio pulsars with known masses: Parameter values and equation of state models, NEW ASTRONOMY 54 (2017) 61-71

47. Bhowmik, D.; Bhattacharjee, S.; Lavanyakumar, D.; et al. (satpati, B.). Synthesis of nano-patterned and Nickel Silicide embedded amorphous Si thin layer by ion implantation for higher efficiency solar devices, APPLIED SURFACE SCIENCE 422 (2017) 11-16

48. Bhowmik, R. N.; Siva, K. Venkata; Ranganathan, R.; et al. (mazumdar, Chandan). Doping of Ga in antiferromagnetic semiconductor α-Cr_2O_3 and its effects on magnetic and electronic properties, JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS 432 (2017) 56-67

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51. Biswas, Debaleen; Mondal, Shyamal; Rakshit, Abhishek; et al. (Bhattacharyya, Satyaranjan, Chakraborty, Supratic). Size and density controlled Ag nanocluster embedded MOS structure for memory applications, MATERIALS SCIENCE IN SEMICONDUCTOR PROCESSING 63 (2017) 1-5

52. Biswas, S.; Palit, R.; Sethi, J.; et al. (Goswami, A.). High-spin states in **^{133}Cs** and the shell model description, PHYSICAL REVIEW C 95 (2017) Art No. 064320

53. Biswas, Sayan; De, J. N.; Joarder, Partha S.; et. al. Multifragmentation model for the production of astrophysical strangelets, PHYSICAL REVIEW C 95 (2017) Art No.045201

54. Biswas, Sayan; Bhattacharjee, Pooja; Majumdar, Pratik; et al. Constraints on dark matter models from the observation of Triangulum-II with the Fermi Large Area Telescope, JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS 11 (2017) Art No.003

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58. Bradt, J.; Ayyad, Y.; Bazin, D.; et al. (Datta, Ushasi). Study of spectroscopic factors at $N = 29$ using isobaric analogue resonances in inverse kinematics, PHYSICS LETTERS B 778 (2018) 155-160

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60. Chakrabarti, Shrabana. Manipulating cold atoms with optical fibres, CURRENT SCIENCE 112 (2017) 1369-1374

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62. Chakraborty, Madhurima; Paul, Somnath; Mitra, Ishani; et al. (Bardhan, Munmun). To reveal the nature of interactions of human hemoglobin with gold nanoparticles having two different morphologies (sphere and star-shaped) by using various spectroscopic techniques, JOURNAL OF PHOTOCHEMISTRY AND PHOTOBIOLOGY B-BIOLOGY 178 (2018) 355-366

63. Chakraborty, S.; Sharma, H. P.; Tiwary, S. S.; et al. (Banerjee, P). Two-Neutron Alignment in ^{127}Xe, BRAZILIAN JOURNAL OF PHYSICS 47 (2017) 406-410

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70. Chowdhury, Ankan Dutta; Agnihotri, Nidhi; Doong, Ruey-an; et al. (De, Amitabha). Label-Free and Nondestructive Separation Technique for Isolation of Targeted DNA from DNA-Protein Mixture Using Magnetic Au-Fe_3O_4 Nanoprobes, ANALYTICAL CHEMISTRY 89 (2017) 12244-12251

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Audited Statements of Accounts

2017 – 2018

K. SHARMA & CO.

CHARTERED ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT TO THE MANAGEMENT OF SAHA INSTITUTE OF NUCLEAR PHYSICS

1. Report of the Financial Statements

We have audited the accompanying financial statements of SAHA INSTITUTE OF NUCLEAR PHYSICS, which comprise the Balance Sheet as at March 31, 2018 and the Income & Expenditure Account and Receipts & Payments Account for the year ended, and a Summary of significant accounting policies and other explanatory information.

2. Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.

3. Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our audit opinion.

4. Opinion

a) Management has started maintaining Fixed Assets Register from 2002-03 to 2017-18. All columns of the Fixed Assets Register has not been filled e.g. date of installation, identification, location etc. Furthermore there is no column for depreciation. The proper record is not maintained. There has been addition of Fixed Assets valued at Rs.17,62,22,384/- during the year. Proper record for Disposal of Assets should be maintained. Memorandum Book should be maintained for movement of Assets used for outside projects. Physical verification of Fixed Assets has not been done, In view of the forgoing comments, it is not possible to opine on correctness or otherwise of the Fixed Assets.

b) Miscellaneous Advance: The balance in Miscellaneous Advance of 13.43 lacs in 2016-17 has come down to Rs.4.22 lacs in 2017-18, includes some of the advances which are more than 10 years old. Efforts should be made to adjust very old balances.

c) Advance to suppliers includes advance of Rs.44,269/- to foreign suppliers which are more than five years old should be adjusted.

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d) Medical Advance are outstanding beyond 6 month are stated to be due to death / dispute of successor.

e) Books and periodicals were last verified in 2014. Usually physical verification is done once in every three years. In 2018 no verification was done. However, it is now being done and stated to be completed soon.

f) Substantial amount is recoverable from sponsors of project. Such recoverable includes 28 projects sponsored by CSIR, DST, UGC, DAE. The value of which is 1.26 crores approx. Efforts should be made to realise the same.

g) Unspent grants under current liabilities for ongoing projects remained static / unadjusted for 3 years or more. Necessary steps to be taken to adjust the same.

h) We refer to the Accounting Policy No.11 wherein the deficit in Income & Expenditure Account has been separately shown as debit balance in Asset side. This is a deviation from the prevailing practice. Had this been adjusted against Corpus Fund. It should have shown a negative balance of Rs.1,67,49,15,403.00.

i) Balance confirmation should be taken from the parties for Security Deposit, Electricity Deposit, Cylinder Deposit, Service station etc. every year.

Subject to the above observations in our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India.

i) In case of the Balance Sheet of the State of affairs of the SAHA INSTITUTE OF NUCLEAR PHYSICS as at 31st March, 2018.

ii) In the case of Income & Expenditure Account, of the deficit for the year ended on that date.

iii) In the case of the Receipt & Payments Account, of the transactions during the year ended on that date.

For K. Sharma & Co.
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No.005313

Place : Kolkata
Date : 12th September, 2018

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REPORT ON OTHER LEGAL AND REGULATORY REQUIREMENTS

As required on the above matters, we report that:

a) We have sought and obtained all the information and explanation which to the best of our knowledge and belief were necessary for the purpose of our audit.
b) In our opinion proper books of accounts as required by law have been kept by Institute so far as appears from our examination of those books.
c) The Balance Sheet and the statements of Income and Expenditure dealt with by this report are in agreement with the books of account.

For K. Sharma & Co.
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No.005313

Place : Kolkata
Date : 12th September, 2018

SAHA INSTITUTE OF NUCLEAR PHYSICS

Balance Sheet as at 31st March, 2018

	Schedule	2017-18	2016-17
CAPITAL FUND & LIABILITIES			
CORPUS / CAPITAL FUND	1	494507842.23	387790058.56
RESERVE & SURPLUS	2		
EARMARKED FUNDS / ENDOWMENT FUNDS	3	5313867.00	5917372.00
SECURED LOANS & BORROWINGS	4		
UNSECURED LOANS & BORROWINGS	5		
DEFFERED CREDIT LIABILITIES	6		
CURRENT LIABILITIES AND PROVISIONS	7	4462091168.16	2963681313.12
TOTAL		4961912877.39	3357388743.68
ASSETS			
FIXED ASSETS			
Gross Block	8	4353315463.51	4178299888.84
Less : Accumulated Depreciation	8	2681580108.13	2502123858.55
		1671735355.38	1676176030.29
INVESTMENTS- FROM EARMARKED/ ENDOWMENT FUNDS	9		
INVESTMENTS- OTHERS	10	173064196.00	593000.00
CURRENT ASSETS, LOANS & ADVANCES	11	817262232.11	1055684023.07
EXCESS OF EXPENDITURE OVER INCOME		2299851093.90	624935690.32
TOTAL		4961912877.39	3357388743.68
SIGNIFICANT ACCOUNTING POLICES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

The Schedules referred to above form part of these Accounts

(V. P. Mishra)
Accounts Officer

(N. Sanyal)
Dy. Controller of Accounts

(Anirban Banerjee)
Registrar

In terms of our attached Report of even date
For K. Sharma & Co
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No. 005313
1/B, Old Post Office Street, Room No.8, (First Floor),
Kolkata - 700 001
Dated :- 12/09/2018

K. SHARMA & CO. ★ KOLKATA-1 ★ CHARTERED ACCOUNTANTS

(Ajit Kumar Mohanty)
Director

SAHA INSTITUTE OF NUCLEAR PHYSICS

Income & Expenditure Account for the year ended 31st March, 2018

	Schedule	2017-18	2016-17
INCOME : -			
Income from Sales/Services	12	314745.00	377600.00
Grants	13	1240738981.10	1005597579.37
Fees / Subscriptions	14		
Income from Investments	15		
Income from Royalty, Publication	16		
Interest Earned	17	0.00	5811907.00
Other Income	18	14542727.00	5460529.32
Increase / Decrease in stock of finished goods and works-in-progress	19		
Excess of Expenditure over Income transferred to Balance Sheet		1674915403.58	624935690.31
		2930511856.68	1642183306.00
EXPENDITURE : -			
Establishment Expenses	20	2494595744.16	1193448756.00
Other Administrative Expenses	21	256235332.82	265676308.59
Expenditure on Grants, Subsidies	22		
Interest	23	7963.12	19774.10
Depreciation	8	179672816.58	183038467.31
Excess of Income over Expenditure transferred to Balance Sheet			
		2930511856.68	1642183306.00

The Schedules referred to above form part of these Accounts

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Accounts Officer

(N. Sanyal)
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For K. Sharma & Co
Chartered Accountants
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Dated :-12/09/2018

K. SHARMA & CO. ★ KOLKATA-1 ★ CHARTERED ACCOUNTANTS

(Ajit Kumar Mohanty)
Director

SAHA INSTITUTE OF NUCLEAR PHYSICS

Receipts & Payments Account for the year ended 31st March, 2018

Receipts	2016-17	2017-18	Payments	2016-17	2017-18
Opening Balance b/f :-					
Cash in hand	16,82,322.00	90.00	Establishment Expenses	68,19,74,527.00	1,00,10,22,773.16
Current Account Balances	49,31,23,982.18	47,48,85,271.52	Administrative Expenses	26,30,15,206.59	25,49,71,738.82
			Bank Charges	19,774.10	7,963.12
Grant-in-aid received from DAE :-			Assets	7,11,76,777.93	17,50,15,574.67
			Investment		17,16,07,316.00
Recurring	88,51,08,000.00	1,16,56,00,000.00	Expenses paid for ongoing projects of other agencies	4,21,04,617.17	3,99,94,747.19
Non-Recurring	30,00,00,000.00	16,57,00,000.00	HBA & Other Advances paid	9,35,807.00	5,15,000.00
Grant received from other agencies			Margin Money deposit	23,62,54,172.00	9,87,60,352.00
for on going projects	2,78,62,450.81	3,08,06,379.00	Other Deposit	6,65,08,000.00	7,000.00
HBA & Other Advance recovery	35,29,679.00	26,24,766.00	Advances paid	2,25,95,171.73	2,11,94,210.00
Realisation of Margin Money Deposit	10,33,84,216.00	16,76,66,844.00	Last Year's provision paid	39,70,346.00	38,56,875.00
Realisation from other Deposit	29,17,000.00	2,55,500.00	Last Year's current liabilities paid		58,11,907.00
Realisation of other advances	2,06,18,629.73	2,54,90,433.66	Pension Fund Payments		
Interest Received	58,11,907.00		Closing Balance c/f :-		
Income Receipts	58,38,129.32	1,48,57,472.00	Cash in hand	90.00	30.00
Liabilities (Deposits)	1,35,63,445.00	3,40,90,495.00	Current Account Balances	47,48,85,271.52	31,05,12,088.22
Pension Fund Receipts		13,00,324.00			
	1,86,34,39,761.04	2,08,32,77,575.18		1,86,34,39,761.04	2,08,32,77,575.18

(V. P. Mishra)
Accounts Officer

(N. Sanyal)
Dy. Controller of Accounts

(Anirban Banerjee)
Registrar

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In terms of our attached Report of even date
For K. Sharma & Co
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FRN 302045E

(K. Sharma)
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Dated :- 12/09/2018

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

SAHA INSTITUTE OF NUCLEAR PHYSICS

		2017-18		2016-17
Schedule : 1 Corpus / Capital Fund				
Opening Balance (DAE) as on 1st April, 2017		38,77,90,058.56		18,43,52,025.63
Add: Non-Recurring (Plan) Grant utilised for Capital expenditure	5,32,33,505.96		18,62,20,859.08	
Recurring (Non-Plan) Grant utilised for Capital expenditure	5,34,84,277.71		1,72,17,173.85	
		10,67,17,783.67		20,34,38,032.93
		49,45,07,842.23		38,77,90,058.56
Balance of Capital Fund (DAE) as at year end		**49,45,07,842.23**		**38,77,90,058.56**
Schedule : 2 Reserve & Surplus				
Schedule : 3 Earmarked Funds				
A A.P.Patra Memorial Prize Fund		63,287.00		62,255.00
New Pension Fund :-				
Employees' Subscription		1,61,991.00		1,61,991.00
Employer's Contribution		1,61,991.00		1,61,991.00
Interest received		2,37,946.00		2,37,946.00
		6,25,215.00		6,24,183.00
B Revolving Fund for HBA & Other Adv	-1,15,74,872.96		-89,81,000.96	
Transfer from/ (to) Recurring Grant for HBA Fund	-21,09,766.00	-1,36,84,638.96	-25,93,872.00	-1,15,74,872.96
Interest received on HBA & Other Advances		1,83,73,290.96		1,68,68,061.96
		46,88,652.00		52,93,189.00
Total		**53,13,867.00**		**59,17,372.00**
Schedule : 4 Secured Loans & Borrowings				
Schedule : 5 Unsecured Loans & Borrowings				
Schedule : 6 Deffered Credit Liabilities				
Schedule : 7 Current Liabilities & Provisions		**2017-18**		**2016-17**
A. Current Liabilities				
1 Unspent Grant from on going Projects				
BARC- M. Nandy				1,47,043.00
CSIR- Consolidated Grant		8,80,005.18		8,80,005.18
CSIR- Avik Basu		2,34,822.00		2,34,822.00
CSIR- Bijoy Kr. Daga		54,221.00		54,221.00

Contd.

Schedule : 7 Current Liabilities & Provisions (Contd.)	2017-18	2016-17
CSIR- Debabrata Ghose	72,910.00	72,910.00
CSIR- K. Chhabita Saha	1,01,729.00	1,01,729.00
CSIR- Kalipada Das	74,522.00	74,522.00
CSIR- Kallor Bera	54,738.00	54,738.00
CSIR- Madhumita Choudhury	38,679.00	38,679.00
CSIR- M. C. Kumar	1,41,222.00	1,41,222.00
CSIR- Moin Shaikh	25,210.00	25,210.00
CSIR- Mausumi Mondal	2,36,250.00	2,36,250.00
CSIR- Nabanita Deb	48,243.00	48,243.00
CSIR- Neha Rai	35,245.00	35,245.00
CSIR- Nupur Biswas	32,105.00	32,105.00
CSIR- Partha Sarthi Guin	53,489.00	53,489.00
CSIR- Piyashi Biswas	1,497.00	1,497.00
CSIR- Polash Banerjee	1,98,227.00	2,38,227.00
CSIR- Prithewish Dutta	77,645.00	77,645.00
CSIR- Rabindra Nath Bhowmick	1,01,570.00	1,01,570.00
CSIR- Rahul Banerjee	1,15,299.00	1,15,299.00
CSIR- Ramanuj Banerjee	1,53,558.00	1,53,558.00
CSIR- Rashika Gupta	13,315.00	
CSIR- Samanawaya Mukherjee	72.00	87,572.00
CSIR- Samsul Islam	7,463.00	2,65,833.00
CSIR- Samik Dutta Gupta	62,998.00	62,998.00
CSIR- Samir Nath Mallick	22,701.00	22,701.00
CSIR- Sanchayita Mondal	31,293.00	31,293.00
CSIR- Sanghamitra Raha	4,52,044.22	4,52,044.22
CSIR- Satyaki Chatterjee	995.00	995.00
CSIR- Sayantani Ghosh	49,175.00	49,175.00
CSIR- Sibnath Roy	46,570.00	46,570.00
CSIR- Sohan Kr. Jha	1,03,132.00	1,03,132.00
CSIR- Sourav Karar	2,01,795.00	2,01,795.00
CSIR- Souvik Mondal	66.00	66.00
CSIR- Sreeja Chakrabarti	69,608.00	69,608.00
CSIR- Sudha Bucha	50,981.00	50,981.00
CSIR- Sukanya Bhattacharya	1,35,305.00	3,19,771.00
CSIR- Ujjal Kr. Gayen	61,485.00	61,485.00
CSIR- Upala Mukhopadhyay	9,151.00	
DAE- BRANS- S. Chattopadhyay		20,00,000.00
DAE- RRF- Naba Kumar Mondal		5,10,000.00
DAE- Pijushpani Bhattacharjee	13,35,660.00	
DBT- Anindita Das	6,957.00	
DBT- Chandrima Das		3,09,349.00
DBT- Debashis Mukhopadhyay	4,54,626.00	5,00,000.00
DBT- Dulal Senapati	2,64,317.00	2,64,317.00
DBT- Nitaipada Bhattacharya - 3	70,576.00	70,576.00
DBT- Supriya Khanra	1,49,715.00	1,41,911.00
DRDO- Dulal Senapati	19,43,200.00	
DST-A.N.S. Iyengar		1,30,000.00
DST- Dalia Nayak		1,86,732.00
DST- Helium (Andaman)	7,96,836.36	7,96,836.36
DST- Helium (Brainstorming)	7,444.50	7,444.50
DST- Helium (Isotope)	6,83,526.79	6,83,526.79

Contd.

Schedule : 7 Current Liabilities & Provisions (Contd.)	2017-18	2016-17
DST- HENPP (ALICE)	1,80,21,356.00	2,00,87,543.00
DST- HENPP- CMS	17,25,595.54	31,09,363.40
DST- ICONSAT-2003(MKS)		6,917.00
DST- ICTP (Avijit Samanta)		10,746.00
DST- Indo-Italy(S R Krishna Menon)		82,138.00
DST- Indo-Russia (SL)		2,56,094.00
DST- Indranil Das	1,82,812.00	4,37,917.00
DST- INSPIRE- Madhurima Pandey	83.00	83.00
DST- INSPIRE- Sridhar Tripathy		91,853.00
DST- ISACST (Bikash Sinha)		46,750.00
DST- J.C.Bose Fellowship-BKC	4,43,451.31	8,904.60
DST- J.C.Bose Fellowship-MKS	1,05,844.00	4,47,146.00
DST- J.C.Bose Fellow (G. Bhattacharyya)	12,06,507.00	3,75,000.00
DST- J.C.Bose (Naba Kumar Mondal)	9,53,398.00	9,95,058.00
DST-MAP(PB)	79,99,119.65	79,99,119.65
DST- Papri Dasgupta 2		2,16,524.00
DST- P. Chakraborty	2,50,690.00	2,50,690.00
DST- P.M.G. Nambissan		30,000.00
DST- Rudranil Basu	2,51,067.00	13,70,947.00
DST- S. N. Mallick 2		1,31,742.00
DST- SERB-A.N.S. Iyenger-2	3,025.00	1,00,000.00
DST- SERB-Chandrima Das	7,19,378.30	8,68,583.00
DST- SERB-Chandrima Jash	1,41,697.00	4,23,548.00
DST- SERB- Dhrubojyoti Roy	1,10,319.00	2,68,379.00
DST- SERB- Haridas Pai	43,173.36	11,90,237.00
DST- SERB- H.Raghuraman	4,30,074.00	10,23,274.00
DST- SERB- Jadunath De	69,844.00	1,98,193.00
DST- SERB- Kaushik Dutta	1,25,297.63	68,554.63
DST- SERB- Kaushik Sengupta	9,91,440.00	5,02,653.00
DST- SERB- Lakshmi Maganti	45,598.00	
DST- SERB-Munmun Bardhan	3,02,461.09	6,95,067.79
DST- SERB- Nikhil Chakraborty	7,74,581.00	13,74,348.00
DST- SERB- Oishee Chakrabarti	5,41,261.00	11,00,000.00
DST- SERB- Radhey Shyam	2,446.00	1,99,984.00
DST- SERB- Rakesh Kr. Mishra	2,11,197.00	
DST- SERB- Sangram Bagh	3,88,523.00	1,77,397.00
DST- SERB- Sansa Dutta	5,67,500.00	1,50,000.00
DST- SERB- Shravanti Mukherjee	1,39,261.00	4,18,595.00
DST- SERB- S. K. Manna	3,68,502.00	5,49,123.00
DST- SERB- Siddhi Chaudhuri	3,01,358.00	
DST- SERB- Subrata Mondal	3,32,974.00	
DST- SERB- Udayaditya Sen	4,93,397.00	11,23,242.00
DST-Shrabana Chakraborty	1,26,751.00	1,87,046.00
DST- Sumana Roy	1,00,210.00	2,301.00
DST- UNANST (MKS)	1,63,80,794.47	1,68,86,215.47
EURO- INDIA - GRID	6,66,969.00	6,66,969.00
IFCPAR- Gautam Bhattacharya	6,75,884.00	4,79,729.00
IFCPAR- SB	2,11,328.00	2,11,328.00
IFCPAR- S. Mukhopadhyay	57,586.00	57,586.00
IUSSTF- MKS	43,652.00	3,09,909.00
INSA- Bilwagopal Ghosh	19,856.00	19,856.00
SINP-BARC	51,773.00	51,773.00
UGC- Abhishek Sau	1,444.00	2,515.00

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Schedule : 7 Current Liabilities & Provisions (Contd.)	2017-18	2016-17
UGC- Anupa Majumdar		7,768.00
UGC- Avinanda Banerjee		90.00
UGC- Benazir Alam	13,673.00	1,006.00
UGC- Ch. Aminul Islam		9,375.00
UGC- Debdatta Mookherjee	14,769.00	2,103.00
UGC - Joy Chandran	15,386.00	15,386.00
UGC- Subhas Chandra Bera		7,496.00
UGC- Swadesh Mondal	96,158.00	1,10,372.00
UGC- Uttam Kr. Basak		9,375.00
W.B.S.T. Congress	54,047.00	54,047.00
Publication Grant for Works of Meghnad Saha	3,00,000.00	3,00,000.00
Stitchtung Fund Research Grant	14,49,599.00	5,85,719.00
	6,82,85,304.40	**7,67,08,619.59**
2 Other Current Liabilities		
Deposit Against House Allotment	5,000.00	
Earnest Money Deposit	80,80,527.00	46,03,430.00
Security Money Deposit	64,59,511.00	42,43,493.00
Retention Money Deposit	71,457.00	71,457.00
Income Tax deducted at source	54,51,203.00	37,30,847.00
Sales Tax deducted at source		2,56,832.00
Professional Tax	78,355.00	76,495.00
GPF Subscription	18,11,250.00	8,56,707.00
VPF Subscription	28,53,520.00	25,55,246.00
P.F. Loan Recovery	6,22,861.00	6,70,831.00
SINP Co-Operative	24,64,331.00	23,65,807.00
Life Insurance Premium	3,27,200.30	3,38,532.50
House Building Loan(Banks)	91,925.00	1,15,925.00
Recurring Grant (Salary) carried over	2,30,25,728.14	2,39,49,786.30
Recurring Grant (General) carried over	3,01,143.85	5,33,74,644.92
Non - Recurring Grant carried over	30,17,03,160.77	26,75,64,507.31
Unclaimed Medical Expenses	8,143.00	8,143.00
GSLIS Premium Recovery	38,640.00	40,540.00
GSLIS Maturity Claim	8,325.00	63,654.00
Salary Payable	5,62,12,009.70	2,37,95,425.50
Pension Payable	1,41,44,854.00	2,40,71,980.00
SINPEU- Members' Subscription	27,450.00	28,680.00
PM National Relife Fund	1,000.00	1,000.00
BARC- A/c Director, SINP	35,456.00	31,542.00
BARC- Co-Operative Dues Recovery	500.00	500.00
Misc. Recovery (Registrar)	3,65,189.00	13,349.00
Employee's Subs. to New Pension Fund Trust	6,50,162.00	
Employer's Subs. to New Pension Fund Trust	6,50,162.00	
Interest on Margin Money	15,22,348.00	
Interest on STD	13,54,856.00	
	42,83,66,267.76	**41,28,29,354.53**
B. Provisions		
Provision for Electricity Charges	52,79,637.00	50,64,184.00
Provision for Audit Fees	15,000.00	15,000.00
Provision for Accrued Gratuity	25,57,01,701.00	19,18,49,899.00
Provision for Accrued Leave Encashment	20,72,09,503.00	19,23,84,706.00
Provision for Accrued Pension	3,49,72,33,755.00	2,08,48,29,550.00
	3,96,54,39,596.00	**2,47,41,43,339.00**
TOTAL	**4,46,20,91,168.16**	**2,96,36,81,313.12**

SAHA INSTITUTE OF NUCLEAR PHYSICS

Schedule : 8 **Fixed Assets**

			GROSS BLOCK				DEPRECIATION				NET BLOCK
		Rate of Depre-ciation	Cost at the beginning of the year	Net Addition during the year	Sale / Disposal during the year	Total Cost at the year end	Accumulated Depreciation at the begining of the year	Depreciation during the year	Adjustment for Sale / Disposal	Accumulated Depreciation at the year end	Net Book value at the year end
		%	Rs. P	Rs. P	Rs. P	Rs. P	Rs. P	Rs. P	Rs. P	Rs. P	Rs. P
Fixed Assets											
1	Leasehold Land	Nil	2498280.27			2498280.27	0.00	0.00		0.00	2498280.27
2	Building	10%	229439538.59			229439538.59	138031975.85	6220663.95		144252639.79	85186898.80
3	Building- Housing	5%	88750926.00			88750926.00	35427435.89	2643118.23		38070554.12	50680371.88
4	Building- Hostel	5%	2467171.00			2467171.00	1288147.24	58951.15		1347098.39	1120072.61
5	Electrical Installation	10%	65853456.65	3389310.00	5,18,320	68724446.65	27271276.76	2516764.01	61,911.00	29726129.77	38998316.88
6	Plant, Machinery & Equipment	15%	3276565259.04	161633637.67	5,33,580	3437665316.71	1886688490.47	158499528.62		2045188019.09	1392477297.62
7	Motor Vehicles	15%	4486602.51			4486602.51	1330174.46	133009.81		1463184.27	3023418.24
8	Furniture & Fixture	10%	33636111.91	390888.00		34026999.91	14487005.35	1262486.07		15749491.43	18277508.48
9	Office Equipments	15%	28429653.90	1118419.00		29548072.90	14351788.95	1265078.95		15616867.90	13931205.00
10	Computer/Peripherals	40%	415682347.85	9347228.00	1,54,910	424874665.85	369694364.75	6166325.93	154656.00	375706034.68	49168631.17
11	Library Books	15%	30365418.64	342902.00		30708320.64	13544895.29	906732.81		14451628.10	16256692.54
12	Other Fixed Assets	15%	125122.48			125122.48	8303.53	157.06		8460.59	116661.89
			4178299888.84	**176222384.67**	**1206810.00**	**4353315463.51**	**2502123858.55**	**179672816.58**	**216567.00**	**2681580108.13**	**1671735355.38**
	Previous year		4107123110.91	71673679.93	496902.00	4178299888.84	2319377171.23	183038467.31	291780.00	2502123858.54	1676176030.30

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

		2017-18	2016-17
Schedule : 9	**Investments-from earmarked / endowment funds**		
Schedule : 10	**Investments- Others**		
	Short Term deposits with Scheduled Banks:-		
	A.P. Patra Prize Fund Investment	50,000.00	50,000.00
	Stitchtung Fund Research Grant	14,06,880.00	5,43,000.00
	Short Term Deposits	17,16,07,316.00	0.00
		17,30,64,196.00	**5,93,000.00**
Schedule : 11	**Current Assets, Loans & Advances**		
A.	**Current Assets**		
	Cash balance in hand	30.00	90.00
	Bank balances on Current Account with Scheduled Banks	31,05,12,088.22	47,48,85,271.52
		31,05,12,118.22	**47,48,85,361.52**
B.	**Loans, Advances & Other Current Assets**		
1	**Loans**		
	Interest bearing Loan to Staff :-		
	House Building Advances	36,55,229.00	40,07,344.00
	Motor Car Advance	4,50,725.00	5,22,545.00
	Motor Cycle/Scooter Advance	1,29,028.00	2,00,187.00
	Bi-Cycle Advance	3,216.00	14,283.00
	Computer Advance	4,50,454.00	5,48,830.00
		46,88,652.00	**52,93,189.00**
2	**Advances & Other Amounts Recoverable in cash or in kind or for value to be received**		
a)	**Deposits**		
	Deposit for Gas Cylinders	17,17,626.05	19,55,626.05
	Deposit with Vodafone		5,500.00
	Deposit with Bharti Mobile Limited	8,000.00	8,000.00
	Deposit with Calcutta Telephones	62,000.00	62,000.00
	Deposit with CESC (Belgachia)	1,37,969.00	1,37,969.00
	Deposit with CESC (KMDA)	6,84,000.00	6,84,000.00
	Deposit with DAVP, GOI	2,431.80	2,431.80
	Deposit with Salt Lake Service Station	16,000.00	16,000.00
	Deposit for Custom Duty	99,378.58	99,378.58
	Deposit for Margin Money against L/C	9,73,27,964.00	16,62,34,456.00
	Deposit with DCSEM	37,65,00,000.00	37,65,00,000.00
	Deposit for Electricity with VECC	1,00,00,000.00	1,00,00,000.00
		48,65,55,369.43	**55,57,05,361.43**

		2017-18	2016-17
b)	**Advance to Staff for Expenses:-**		
	Travelling Advance	12,07,000.00	30,42,000.00
	Leave Travel Concession Advance	9,25,000.00	1,50,100.00
	Festival Advance	9,825.00	3,38,325.00
	Medical Advance	48,159.00	73,551.00
	Miscellaneous Advance	4,22,139.86	13,43,899.86
	Contingency Advance	28,117.00	15,000.00
		26,40,240.86	**49,62,875.86**
c)	**Advances to Others:-**		
	Advance to Suppliers	2,27,169.00	19,57,554.00
		2,27,169.00	**19,57,554.00**
d)	**Pre-payments:-**		
	Prepaid Insurance	0.00	1,43,203.66
		0.00	**1,43,203.66**
e)	**Expenditure incurred for Projects and Recoverable from Sponsors:-**		
	CSIR- A.N.S Iyenger	9,997.00	9,997.00
	CSIR- Banani Mukhopadhyay	44,082.00	44,082.00
	CSIR- Buddhadev Mukherjee	1,830.00	1,830.00
	CSIR- Dhruba Gupta	500.00	500.00
	CSIR- Kakoli Banerjee	2,96,743.00	2,96,743.00
	CSIR- Kamalika Roy	40,528.00	40,528.00
	CSIR- Malabika Sen	1,74,200.00	1,74,200.00
	CSIR- Pool(Moumita Maity)	2,119.00	2,119.00
	CSIR- Partha Saha(1)	59,312.50	59,312.50
	CSIR- Puneet Mishra	1,17,594.00	1,17,594.00
	CSIR- Rajib Sarkar	11,453.00	11,453.00
	CSIR- Sreyasi Dutta	26,431.00	26,431.00
	CSIR- Satya Ranjan Halder	71,422.00	71,422.00
	CSIR- Suchandra Bandopadhya	500.00	500.00
	CSIR- Tanwi Ghosh	11,545.00	11,545.00
	DAE-INO	1,35,929.80	1,35,929.80
	DAE- Raja Ramanna Fellowship	5,850.00	5,850.00
	DAE- RRF- Naba Kumar Mondal	3,90,000.00	
	DBT- Anindita Das		224.00
	DBT-Sampa Biswas	12,997.00	12,997.00
	DST- AUS- INDO- AUS (MKS)		5,05,421.00
	DST- Debi Choudhuri 3	17,244.00	17,244.00
	DST- Helium 2		
	DST- Helium (J&K)	5,43,182.29	5,43,182.29
	DST- Helium (ONGC)	30,715.03	30,715.03
	DST- IINDO-Brazil (BS)		22,150.00

Contd.

K. S. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

SAHA INSTITUTE OF NUCLEAR PHYSICS

	2017-18	2016-17
Expenditure incurred for Projects and Recoverable from Sponsors:- (Contd.)		
DST- Partha Saha	1,13,242.00	1,13,242.00
DST- SERB- Debashis Mukhopadhyay	40,000.00	
INDUS-II (MKS)	60,78,181.08	60,78,181.08
SINP-VECC	43,06,028.00	43,06,028.00
UGC- Consolidated Grant	53,556.90	53,556.90
UGC - D. Mukhopadhyay	43,500.00	43,500.00
	1,26,38,682.60	**1,27,36,477.60**
GRAND TOTAL	**81,72,62,232.11**	**1,05,56,84,023.07**

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

SAHA INSTITUTE OF NUCLEAR PHYSICS

	2017-18		2016-17	
Schedule : 12 Income from Sales/Services				
Processing Charges for Liquid Nitrogen		12,270.00		18,630.00
Auditorium Rent				1,10,000.00
Accommodation Charges Received		3,02,475.00		2,48,970.00
		3,14,745.00		**3,77,600.00**
Schedule : 13 Grant / Subsidies				
i) *Revenue Expenditure incurred from :-*				
Non-Recurring Grant	7,83,27,840.58		18,12,05,478.44	
Recurring Grant-Salaries	98,07,24,058.16		67,51,41,163.00	
Recurring Grant-General	18,16,87,082.36		14,92,50,937.93	
		1,24,07,38,981.10		1,00,55,97,579.37
		1,24,07,38,981.10		**1,00,55,97,579.37**
Schedule : 14 Fees / Subscriptions				
Schedule : 15 Income from Investments				
Schedule : 16 Income from Royalty, Publication				
Schedule : 17 Interest Earned				
On Margin Money Deposit (against Letter of Credit) and Short Term Deposit with Scheduled Banks		0.00		58,11,907.00
		0.00		**58,11,907.00**
Schedule : 18 Other Income				
Hostel Rent		32,150.00		9,930.00
Standard Licence Fees		10,01,768.00		5,64,788.00
Contr. Medical Benefit Scheme Premium		1,07,78,224.00		24,15,892.00
Misc Income		3,50,114.00		8,94,919.32
Income from Projects		23,80,471.00		15,75,000.00
		1,45,42,727.00		**54,60,529.32**
Schedule : 19 Increase / Decrease in stock of finished goods and works-in-progress				

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

		2017-18		2016-17
Schedule : 20 Establishment Expenses				
Salaries, Allowances, Fellowship, Associateship and Contribution to CPF & Pension Fund		64,24,92,544.16		45,95,91,083.00
Gratuity		10,39,54,238.00		4,76,95,619.00
Leave Encashment		4,70,09,484.00		7,13,70,000.00
Pension, Family Pension and Ex-gratia				
Payment during the year	25,00,96,674.00		15,74,66,163.00	
Add : Closing Provision made	3,49,72,33,755.00		2,08,48,29,550.00	
	3,74,73,30,429.00		2,24,22,95,713.00	
Less : Opening Provision written off	2,08,48,29,550.00	1,66,25,00,879.00	1,66,35,65,043.00	57,87,30,670.00
Honorarium to Visiting Professor		3,99,231.00		2,74,000.00
Children's Tution Fees		26,88,686.00		25,48,802.00
Overtime Allowance		18,136.00		62,940.00
Consolidated Pay		21,33,222.00		5,89,907.00
Leave Travel Concession		46,23,835.00		34,80,171.00
Medical Expenses		2,36,65,824.00		2,57,37,712.00
Staff Uniform & Liveries		2,10,961.00		3,00,007.00
Student Contingency Expenses		29,02,556.00		7,21,909.00
Ph.D. Registration Fees		3,51,500.00		2,34,770.00
Telephone Charges Reimbursement		13,03,839.00		17,84,807.00
Stipend		3,40,809.00		3,26,359.00
		2,49,45,95,744.16		**1,19,34,48,756.00**
Schedule : 21 Other Administrative Expenses				
Consumables, Stores and Spare Parts		4,75,91,151.40		4,69,69,545.94
Electricity Charges		4,35,62,541.00		4,32,13,555.00
Repairs & Maintenance		3,67,98,102.96		4,47,86,169.17
Rent, Rates & Taxes		3,022.00		1,16,822.00
Vehicle Running, Maint., Insurance & Taxes		4,37,799.00		6,26,216.00
Transport Charges		7,86,000.00		11,82,387.00
Postage, Telephone and Internet Charges		11,15,314.00		15,50,787.00
Printing & Stationery		35,29,306.43		54,36,418.96
Travelling & Conveyance		2,19,77,817.00		1,94,81,807.00
Seminar, Conference & Workshop		21,06,530.00		9,37,675.00
Subscription & Contribution		60,46,592.81		30,77,791.49
Auditor's Remuneration		34,000.00		31,500.00
Hospitality Expenses		20,65,138.00		18,46,404.00
Legal Charges		6,77,100.00		14,59,400.00
Freight Charges		17,337.00		90,085.00
Insurance Charges		1,43,203.66		
Advertisement & Publicity		11,63,982.00		20,35,904.00
Misc. Other Expenses		2,50,54,020.00		2,27,27,898.00
Software		20,38,889.84		65,14,357.62
Journals		5,99,84,303.72		6,24,91,914.41
Book Binding Charges		5,700.00		25,425.00
Professional Fees		2,47,516.00		7,54,445.00
Accommodation Charges Paid		67,012.00		1,15,891.00
NPS Uploading Charges		17,965.00		23,519.00
Loss on Sale of Lab Equipment		3,71,780.00		
Loss on Sale AC Machine		3,93,209.00		1,80,391.00
		25,62,35,332.82		**26,56,76,308.59**
Schedule : 22 Expenditure on Grants, Subsidies				
Schedule : 23 Interest				
Bank Charges		7,963.12		19,774.10
		7,963.12		**19,774.10**

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

Statement of Utilisation of Grant during 2017-18

	Grant from Deptt of Atomic Energy			
	Recurring			Non-Recurring
	Salaries	General	Total	
Opening Balance of Unspent Grant	2,39,49,786.30	5,33,74,644.92	7,73,24,431.22	26,75,64,507.31
Add: Grant Received during the year	97,98,00,000.00	18,58,00,000.00	1,16,56,00,000.00	16,57,00,000.00
Less: Interest on Deposits refunded		-58,11,907.00	-58,11,907.00	
Total Grant	**1,00,37,49,786.30**	**23,33,62,737.92**	**1,23,71,12,524.22**	**43,32,64,507.31**
Less: Grant Utilised during the year :-				
Capital Expenditure:				
Fixed Assets		1,76,13,277.71	1,76,13,277.71	15,74,02,296.96
Margin Money Deposit		3,58,71,000.00	3,58,71,000.00	-10,41,68,791.00
Revenue Expenditure:				
Expenses	99,15,02,282.16	18,25,21,273.36	1,17,40,23,555.52	8,19,78,609.58
Less: Income	-1,07,78,224.00	-40,79,248.00	-1,48,57,472.00	
Current Assets, Loans & Advances:				
Deposit with Vodafone				-2,33,000.00
Cylinder Deposit		-2,97,411.00	-2,97,411.00	-7,24,349.00
Misc. Advance		18,117.00	18,117.00	-15,000.00
Advance for Contingency		5,80,512.00	5,80,512.00	-20,65,512.00
TA Advance		-11,17,477.00	-11,17,477.00	-6,12,908.00
Advance to Suppliers		-3,28,500.00	-3,28,500.00	
Festival Advance		7,74,900.00	7,74,900.00	
LTC Advance		-25,392.00	-25,392.00	
Medical Advance		36,25,308.00	36,25,308.00	
Prov for Elec Charges		15,000.00	15,000.00	
Prov for Audit Fees				
Sub-total	**98,07,24,058.16**	**18,16,87,082.36**	**1,16,24,11,140.52**	**7,83,27,840.58**
Transfer from HBA & Other Fund		-21,09,766.00	-21,09,766.00	
Total Utilisation	**98,07,24,058.16**	**23,30,61,594.07**	**1,21,37,85,652.23**	**13,15,61,346.54**
Closing Balance of Unspent Grant	**2,30,25,728.14**	**3,01,143.85**	**2,33,26,871.99**	**30,17,03,160.77**

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

SAHA INSTITUTE OF NUCLEAR PHYSICS

Schedules forming part of the accounts for the period ended 31st March, 2018

Schedule : 24 Significant Accounting Policies

1. ACCOUNTING CONVENTION

The financial Statements are prepared on the basis of historical cost convention unless otherwise stated and on the accrual method of accounting w.e.f. 1st April, 2002

2. INVENTORY VALUATION

Consumables, Stores, Spare Parts & Stationery etc. are valued at cost and charged off to the Revenue in the year of purchase.

3. INVESTMENTS

Investments are carried at cost and cost includes acquisition expenses like brokerage, transfer stamps, bank charges, etc. Incomes on investments are accounted on accrual basis.

4. FIXED ASSETS

4.1 Fixed Assets are stated at cost of acquisition inclusive of inward freight, insurance, packing and forwarding charges, delivery expenses, duties, taxes and all other incidental and direct expenses related to acquisition. In respect of projects involving construction, related pre-operational expenses form part of the value of the assets capitalized.

4.2 Fixed Assets received by way of non-monetary grants (other than towards the Capital Fund), were used to capitalize at values stated, by corresponding credit to capital reserve. However, as per directives given by administrative ministry all such reserves are now transferred to Capital Fund.

SAHA INSTITUTE OF NUCLEAR PHYSICS

Schedules forming part of the accounts for the period ended 31st March, 2018

5. DEPRECIATION

Depreciation on Fixed Assets has been provided on Written Down Value Method as per rates specified in the Income Tax Act , 1961:

A	Land	:	Nil
B	Building (Housing)	:	5%
C	Building (Office & Laboratory)	:	10%
D	Plant & Machinery	:	15%
E	Electrical Installation	:	10%
F	Computer / Peripherals	:	40%
G	Office Equipments	:	15%
H	Vehicles	:	15%
I	Furniture	:	10%
J	Books	:	15%
K	Other Fixed Assets	:	15%

Depreciation has been charged for the full year on additions made during the year. No depreciation is charged on assets which are sold during the year.

Book Value of assets purchased before 01.04.2002 and sold are written off to the Income & Expenditure Account in the year of sale. Realizations made from sale of scrap are taken as miscellaneous income in the year of receipt in case of assets purchased before 01.04.2002.

Full depreciation is provided on assets costing Rs. 5,000/= or less. Such provision for depreciation is charged to Income & Expenditure Account every year since 2002-03 which has a consequential effect on surplus/deficit of that year.

SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

Schedules forming part of the accounts for the period ended 31st March, 2018

6. GOVERNMENT GRANTS & SUBSIDIES

Recurring (Non Plan) and Non Recurring (Plan) grants received from Department of Atomic Energy (DAE), Government of India are treated as follows:

a) The grants are accounted for on realization basis.

b) That portion of Plan and Non Plan Funds utilised for Revenue Expenditure is taken to Income & Expenditure Account as Income.

c) That portion of Plan and Non Plan Funds utilized for Capital Expenditure is added to as Capital Fund.

d) The balance available under Plan & Non Plan Grants is exhibited as Unspent Balance carried forward in the Liabilities side of the Balance Sheet under the head Current Liabilities & Provision.

(e) Amount of Recurring (Non-Plan) and Non-Recurring (Plan) Grant received from Ministries/Departments/Agencies other than Department of Atomic Energy, Govt. of India and utilized for Capital and Revenue expenditure have been treated as expenditure for the specific projects.

7. FUNDS FOR PROJECTS/SCHEMES:

All grants in respect of Projects/Schemes are accounted on realization basis.

The unspent amount of grants received in respect of the Projects/Schemes is shown under Current Liabilities in the Balance Sheet under the head 'Receipts against ongoing sponsored projects/schemes' and excess of payments made over the grants received in respect Projects/Schemes are shown under Current Assets in the Balance Sheet under the head 'Payments against ongoing sponsored projects/schemes'.

8. FOREIGN CURRENCY TRANSACTIONS

Transactions denominated in Foreign Currency are accounted at the exchange rate prevailing on the date of the transactions.

Schedules forming part of the accounts for the period ended 31st March, 2018

9. RETIREMENT BENEFITS

Provision for Gratuity and Leave Encashment are made on the basis of actuarial valuation of accrued liability towards Gratuity, Leave Encashment of existing employees after deducting opening provision.

Similar provision is also made for Pension of employees covered under Institute's old pension scheme on the basis of actuarial valuation of accrued liability towards pension.

This year it has resulted in significant deficit of expenditure over income as the closing provision is more than the opening provision.

Schedule : 25 CONTINGENT LIABILITIES AND NOTE ON ACCOUNTS

1. CONTINGENT LIABILITIES

In respect of Letters of Credit opened by Bank on behalf of the Institute Rs.9,73,27,964 /- (Previous year Rs.16,62,34,456/-) for which similar amount has been kept under Margin Money Deposit Account with the Scheduled Bank .

Contingent liability for court cases filed against Institute pending for decision is not ascertainable at the moment.

2. CURRENT ASSETS, LOANS AND ADVANCES

In the opinion of the Management, the Current Assets, Loans and Advances have a value on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet.

3. TAXATION

In view of there being no taxable income under the Income Tax Act, 1961, no provision for Income Tax has been considered necessary.

Schedules forming part of the accounts for the period ended 31st March, 2018

4. FOREIGN CURRENCY TRANSACTIONS

	(Amount. in Rs.) Current year	previous year
Value of Imports Calculated on CIF basis		
a) Capital Equipments including in-transit	12,77,78,377.14	4,13,12,800.23
b) Stores, Spare and Consumables Including in-transit	80,35,099.22	1,60,00,944.91
c) Journals	6,95,55,868.12	6,23,98,827.53

5. Corresponding figures for the previous year have been regrouped / rearranged, wherever necessary.

6. Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March, 2018 and the Income and Expenditure Account for the year ended on that date.

7. FIXED ASSETS

Fixed Assets have been regrouped on 31st March, 2002 for the purpose of charging Depreciation. The Fixed Assets are subject to physical verification and updating of Fixed Assets Register.

8. DEPRECIATION

Depreciation of Assets has been brought to the Accounts only from 2002-03 as per the uniform format of accounts in Central Autonomous Bodies recommended by the Ministry of Finance, Government of India. Depreciation has been provided only from the additions made during the year from. 1st April 2002. Depreciation for earlier years shall be provided in subsequent years after completion of Asset Inventory.

SAHA INSTITUTE OF NUCLEAR PHYSICS

Schedules forming part of the accounts for the period ended 31st March, 2018

9. RETIREMENT BENEFITS

Provision for accrued liability towards Gratuity, Leave Encashment and Pension has been made on actuarial valuation basis.

10. REVOLVING FUND FOR HBA & OTHER ADVANCES

Recurring Grant (Plan) received in earlier years from Department of Atomic Energy, Government of India, towards House Building and other interest bearing advances and Interest received on House Building and Other Advances are the corpus of Revolving HBA Fund from which advances are made to the employees for the purpose of House Building, Motor Car, Personal Computer, Motor Cycle/Scooter, Bi-cycle and Table Fan purchases. Recoveries made and Interest received during the year are added to the Revolving HBA Fund. Surplus amount, if any, are transferred to Recurring Grant for that year.

11. The excess of expenditure over income has been shown in the Balance Sheet on the Assets side from F.Y 2016-17. Earlier it has been adjusted against Capital A/c. The change in policy has been done as it would result in negative Capital A/c due to the charging of provisions on depreciation and actuarial valuation of retirement liability.

Signatures to Schedules 1 to 25

(V. P. Mishra)
Accounts Officer

(N. Sanyal)
Dy. Controller of Accounts

(Anirban Banerjee)
Registrar

For K. Sharma & Co.
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No.005313
1/B, Old Post Office Street, Room No.8, (First Floor),
Kolkata 700 001
Dated – 12th September, 2018

(Ajit Kumar Mohanty)
Director

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

K. SHARMA & CO.

CHARTERED ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT TO THE MANAGEMENT OF SAHA INSTITUTE OF NUCLEAR PHYSICS PENSION ACCOUNT

1. Report of the Financial Statements
We have audited the attached Receipts and Payments account of SAHA INSTITUTE OF NUCLEAR PHYSICS PENSION ACCOUNT as at March 31, 2018.

2. Management's Responsibility for the Financial Statements
Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.

3. Auditor's Responsibility
Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances , An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our audit opinion.

4. Opinion
In our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India.

In the case of Receipts and Payments Account of the transactions for the year ended on that date.

For K. Sharma & Co.
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No.005313

Place : Kolkata
Date : 12th September, 2018

1/B, Old Post Office Street, Room No. 8, (First Floor), Kolkata – 700001
Phone : 2248-7902, E-mail : kks67@vsnl.net

SAHA INSTITUTE OF NUCLEAR PHYSICS

PENSION ACCOUNT

Receipt & Payment Account for the year ended 31st March, 2018

Receipts	2016-17 Rs.	2017-18 Rs.	Payments	2016-17 Rs.	2017-18 Rs.
To Opening Balance : In Current Account with State Bank of India, Manicktala Br.	10,003,942.60	24,169,747.10	By Pension Account	113,550,894.00	168,059,776.00
To Amount Transfered from Saha Instutute of Nuclear Physics General Account	160,700,000.00	244,600,000.00	By Family Pension	23,610,204.00	35,715,842.00
To Amount adjusted on account of Medical Allowance & contribution	1,124,586.00	5,141,948.00	By Ex-gratia	121,344.00	125,241.00
To Income Tax recovery	8,770,133.00	17,087,439.00	By New Pension Scheme Account	444,803.00	3,327,424.00
			By Commutation of Pension	9,907,385.00	52,332,012.00
			By Income Tax Payment	8,770,133.00	17,087,439.00
			By Bank Charges	632.00	649.00
			By NPS (Uploading charges)	23,519.00	17,965.00
			By Closing Balance : In Current Account with State Bank of India, Manicktola Branch	24,169,747.10	14,332,786.10
	180,598,661.60	**290,999,134.10**		**180,598,661.10**	**290,999,134.10**

(Ajit Kumar Mohanti)
Director

(Anirban Banerjee)
Registrar

(N. Sanyal)
Dy. Controller of Accounts

(V. P. Mishra)
Accounts Officer

FOR **K. Sharma & Co.**
CHARTERED ACCOUNTANTS
FRN 302045E

(K. K. Sharma)
Partner
Membership No. 005313
1/B, Old Post Office Street
Room No.8 (First Floor)
Place : Kolkata-700001
Dated: 12/09/2018

K. SHARMA & CO. ★ KOLKATA-1 ★ CHARTERED ACCOUNTANTS

K. SHARMA & CO.

CHARTERED ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT TO THE MANAGEMENT OF SAHA INSTITUTE OF NUCLEAR PHYSICS PROVIDENT FUND ACCOUNT

1. Report of the Financial Statements
We have audited the attached Receipts and Payments account of SAHA INSTITUTE OF NUCLEAR PHYSICS PROVIDENT FUND, which comprise the Balance Sheet as at March 31, 2018, and the Revenue Account for the year ended, and a summary of significant accounting policies and other explanatory information.

2. Management's Responsibility for the Financial Statements
Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.

3. Auditor's Responsibility
Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances , An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our audit opinion.

4. Opinion
In our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India.

a) In the case of Balance Sheet, of the state of affairs of the fund as at 31st March, 2018.
b) In the case of Revenue Account, of the surplus for the year ended on that date.

For K. Sharma & Co.
Chartered Accountants
FRN 302045E

(K. K. Sharma)
Partner
Membership No.005313

Place : Kolkata
Date : 12th September, 2018

1/B, Old Post Office Street, Room No. 8, (First Floor), Kolkata – 700001
Phone : 2248-7902, E-mail : kks67@vsnl.net

Saha Institute of Nuclear Physics Provident Fund
Balance Sheet as on 31st March, 2018

2016-2017 Rs. P.	LIABILITIES		2017-2018 Rs. P.	2016-2017 Rs. P.	ASSETS	2017-2018 Rs. P.
	MEMBERS' ACCOUNT :				**INVESTMENT :**	
415,427,080.00	*Balance as per last Account*		454,452,543.00	480,348,000.00	As per Schedule - A	512,650,000.00
	Add :					
10,399,662.00	*Members' subscription during the year*	42,800,560.00				
31,290,201.00	*Voluntary subscription during the year*	32,495,964.00				
457,116,943.00						
32,880,653.00	*Interest credited to members account*	35,107,337.00				
32,880,653.00		***110,403,861.00***				
	Less:					
11,029,739.00	*Non Refundable Withdrawals*	23,717,207.00				
24,512,030.00	*Final Settlement during the year*	66,360,316.00		14,325,196.00	Loan to members	13,086,497.00
35,541,769.00		***90,077,523.00***				
			20,326,338.00			
	Dues to SINP		263,040.00			
	REVENUE ACCOUNT :			23,372,025.00	Interest accrued but not due on investment	20,218,387.00
	Undistributed Balance :					
66,286,200.80	Opening Balance		74,294,733.39	115,682.00	Interest Receivable on Investment	92,656.77
8,008,532.59	Add : Surplus during the year		10,455,315.47			
74,294,733.39				10,589,659.39	Balance in Current Account with State Bank of India, Main Branch	13,744,429.09
528,750,560.39			**559,791,969.86**	**528,750,562.39**		**559,791,969.86**

(Ajit Kumar Mohanty)
Director

(Anirban Baherjee)
Registrar

(N. Sanyal)
Dy. Controller of Accoaunts

(V.P. Mishra)
Accounts Officer

For K. SHARMA & Co.
Chartered Accountants, FRN 302045E

(K. K. Sharma)
Partner, Membership No. 005313.
1/B, Old Post Office Street, Room No. 8, (First Floor),
Kolkata: 700 001
Dated: 12th September, 2018

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

Saha Institute of Nuclear Physics Provident Fund
Revenue Account for the year ended 31st March, 2018

2016-2017	EXPENDITURE	2017-2018	2016-2017 Rs. P.	INCOME	2017-2018 Rs. P.
32,416,744.00	Interest credited to members' Account	34,523,426.00	41,357,649.84	Interest on Investment	45,308,185.47
929,500.00	Premium on purchase of Bonds	325,500.00			
2,873.25	Bank Charges	3,944.00			
8,008,532.59	Surplus carried forward	10,455,315.47			
41,357,649.84		**45,308,185.47**	**41,357,649.84**		**45,308,185.47**

(Ajit Kumar Mohanty)
Director

(Anirban Banerjee)
Registrar

(N. Sanyal)
Dy. Controller of Accounts

(V.P. Mishra)
Accounts Officer

K. SHARMA & Co.
Chartered Accountants.
FRN 302045E

(K.K. Sharma)
Partner, Membership No. 005313.
1/B, Old Post Office Street
Room No. 8, (First Floor)
Kolkata: 700 001.
Dated: 12th September, 2018

K. SHARMA & CO. CHARTERED ACCOUNTANTS KOLKATA-1

SAHA INSTITUTE OF NUCLEAR PHYSICS PROVIDENT FUND

Schedule of Investment as on March, 2018

Central Government Securities (CGS)/ State Development Bonds (SDL)

Schedule-A

Sl. No.		Date of Investment	Date of Maturity	Rate of Interest	Face Value Rs.	Rs.
	Central Government Securities/SDL					
1	Government Securities 2023	16/12/2009	10/11/2023	8.20%	5,500,000.00	
2	Government Securities 2024	18/03/2010	15/09/2024	8.20%	3,500,000.00	
3	Government Securities 2026	16/08/2010	23/03/2026	8.00%	5,000,000.00	
4	Government Securities 2027	22/12/2010	2/8/2027	8.26%	6,500,000.00	
5	Government Securities 2022	7/9/2011	21/09/2022	8.13%	18,500,000.00	
6	Government Securities 2020	31/10/2013	16/01/2020	8.19%	28,790,000.00	67,790,000.00
7	West Bengal State Development Loan (SWBSDL) 2021	23/11/2015	23/11/2021	9.28%	10,660,000.00	
8	West Bengal State Development Loan (SWBSDL) 2021	23/11/2015	14/09/2021	8.65%	6,000,000.00	
9	West Bengal State Development Loan (SWBSDL) 2026	11/3/2016	24/02/2026	8.88%	10,000,000.00	
10	UP SDP SPL 2023	8/9/2016	2/6/2023	8.25%	10,000,000.00	
11	Himachal Pradesh UDAY SDL 2028	15/03/2017	28/02/2028	8.17%	30,000,000.00	66,660,000.00
						134,450,000.00
	State Guranted Bonds					
1	West Bengal Financial Coprotion (WBFC)	30/11/2009	30/12/2019	8.60%	4,000,000.00	
2	West Bengal Financial Coprotion (WBFC)	10/5/2013	30/01/2023	9.65%	6,000,000.00	
3	West Bengal Financial Coprotion (WBFC)	8/7/2014	8/7/2022	9.80%	15,000,000.00	
4	West Bengal Infrastructure Development Boand (WBIDFC)	22/04/2010	7/2/2020	9.20%	15,000,000.00	
5	West Bengal Infrastructure Development Boand (WBIDFC)	16/06/2010	7/4/2020	9.20%	10,000,000.00	
6	West Bengal Infrastructure Development Boand (WBIDFC)	24/09/2010	6/4/2020	9.20%	12,000,000.00	
7	West Bengal Infrastructure Development Boand (WBIDFC)	21/09/2015	6/4/2020	9.20%	4,000,000.00	
8	Andhra Pradesh Power Finance Corporation Bond (APPFCL)	15/11/2010	15/11/2022	8.74%	7,000,000.00	
9	Rajasthan State Road Transport	26/11/2012	1/11/2022	9.70%	10,000,000.00	
10	Rajasthan State Road Transport	26/11/2012	1/11/2022	9.70%	5,000,000.00	
11	Punjab Financial Corportiaon	24/01/2013	16/11/2022	9.80%	14,700,000.00	
12	Tamil Nadu Power Finance & Infructure Development Corporation Ltd. (TNPFID) 2023	30/07/2013	29/05/2023	9.19%	19,000,000.00	
13	Tamil Nadu Generation and Distribution Corporation Ltd. (TANGEDCO Ltd.) 2024	20/02/2015	18/12/2024	9.20%	9,000,000.00	
14	Rajasthan Rajya Vidyut Utpadan Nigam Limited	21/09/2015	24/12/2026	9.00%	3,000,000.00	
15	UP Power Corporation Limited	30/01/2018	20/10/2026	9.75%	15,000,000.00	148,700,000.00
						283,150,000.00

Schedule-A

Sl. No.	Debt Securities / Securities of Public Financial Institutions	Date of Investment	Date of Maturity	Rate of Interest	Face Value	
1	IFCI Limited 2020	28/07/2010	28/07/2020	9.25%	12,000,000.00	
2	IFCI Limited 2018	30/05/2011	30/05/2018	10.40%	10,000,000.00	
3	IFCI Limited 2026	5/12/2012	1/8/2026	10.75%	6,000,000.00	
4	IFCI Bonds 2021	11/28/2014	1/11/2021	9.90%	20,000,000.00	
5	IFCI Bonds 2021	26/05/2016	3/11/2021	8.55%	15,000,000.00	
6	IFCI Bonds 2021	14/07/2016	3/11/2021	8.55%	10,000,000.00	
7	State Bank of India (Perpetual) Bonds 2020	11/2/2010	27/01/2020	9.05%	5,000,000.00	
8	Power Finance Corporation Ltd. 2018	12/5/2013	10/7/2018	9.81%	50,000,000.00	
9	Power Finance Corporation Bonds 2019	9/25/2014	7/10/2019	9.15%	10,000,000.00	
10	Industrial Development Finance Corporation Bond 2020	20/01/2011	2/12/2020	8.89%	2,000,000.00	
11	Industrial Development Finance Corporation Bond 2026	20/04/2011	15/04/2026	9.28%	8,000,000.00	
12	IDFC LTD NCD (IDFC PP 11/2016) 06/01/2023	20/07/2015	6/1/2023	8.73%	15,000,000.00	
13	REC 2019	25/07/2014	18/06/2019	9.02%	10,000,000.00	
14	Nuclear Power Corporation Ltd. (NPCIL) 2019	9/7/2012	16/11/2019	10.77%	7,000,000.00	
15	West Bengal State Electricity Transmission Company Limited (WBSETCL)	5/18/2015	7/26/2021	10.29%	12,000,000.00	
16	NTPC-SAIL Power Co. Ltd.	26/07/2017	11/7/2022	7.72%	10,000,000.00	
17	Union Bank Perp	11/9/2017	30/03/2022 (Call date)	9.10%	10,000,000.00	
18	West Bengal State Electricity Transmission Company Limited (WBSETCL)	30/01/2018	26/07/2021	10.29%	15,000,000.00	227,000,000.00

Sl. No.	INVESTMENT IN MUTUAL FUND	Date of Investment	Rate of Interest	Face Value	
	SBI Magnum Balance Growth	18/09/2017		2,500,000.00	2,500,000.00

Total Portfolio = 512,650,000.00

K. SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

SCHEDULE - B

SAHA INSTITUTE OF NUCLEAR PHYSICS PROVIDENT FUND
31ST MARCH, 2018.

ACCOUNTING POLICIES & NOTES TO ACCOUNTS

1. SIGNIFICANT ACCOUNTING POLICIES :

(a) Accounting convention :

The accompanying financial statements have been prepared in accordance with the historical cost convention.

(b) Investments:

Investments are valued at cost.

2. Members' Accounts Balance is Rs. 474,778,881.00.

3. Am amount of Rs. 2,63.040.00 (Rupees Two lakh Sixty Three thousand Forty) only received excess from Saha Institute of Nuclear Physics toward members contribution for September, 2017 and shown as due to SINP.

4. Previous year's figures have been regrouped and / or rearranged wherever necessary.

(Ajit Kumar Mohanty)	(Anirban Banerjee)	(N. Sanyal)	(V.P. Mishra)
Director	Registrar	Dy. Controller of Accounts	Accounts Officer

K. SHARMA & CO.
CHARTERED ACCOUNTANTS

(K.K. SHARMA)
Partner
Membership No. 005313.
1/B, Old Post Office Street, Room No. 8,
(First Floor)
Kolkata – 700 001.
Dated: September 12, 2018.

SHARMA & CO. KOLKATA-1 CHARTERED ACCOUNTANTS

Action Taken Report on Auditor's Report

2017 – 2018

Action Taken Report on Auditor's Report
On Annual Accounts for 2017-18

Name of the Institute: **SAHA INSTIUTE OF NUCLEAR PHYSICS**

Sl. No.	Auditors' Comments	Action Taken
1.	We have audited the accompanying financial statements of SAHA INSTITUTE OF NUCLEAR PHYSICS, which comprise the Balance Sheet as at March 31, 2018 and the Income & Expenditure Account and Receipts & Payments Account for the year ended, and a Summary of significant accounting policies and other explanatory information.	Noted
2.	Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.	Noted
3.	Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement. An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit	Noted

	also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our audit opinion.	
4.(a)	Management has started maintaining Fixed Assets Register from 2002-03 to 2017-18. All columns of the Fixed Assets Register has not been filled e.g. date of installation, identification, location etc. Furthermore there is no column for depreciation. The proper record is not maintained. There has been addition of Fixed Assets valued at Rs.17,62,22,384/- during the year. Proper record for Disposal of Assets should be maintained. Memorandum Book should be maintained for movement of Assets used for outside projects. Physical verification of Fixed Assets has not been done, In view of the forgoing comments, it is not possible to opine on correctness or otherwise of the Fixed Assets.	Due to non-availability of earlier records particularly those pertaining to old period (before 1980), complete updating could not be effected during the year. However, Asset Register as per GFR has already been prepared for the financial year 2002-03 to 2017-18. Physical verification has been commenced w.e.f. 2016-17. It is proposed to undertake the balance soon.
(b)	The balance in Miscellaneous Advance of 13.43 lacs in 2016-17 has come down to Rs.4.22 lacs in 2017-18, includes some of the advances which are more than 10 years old. Efforts should be made to adjust very old balances.	Noted and action is being taken to settle older cases.
(c)	Advance to suppliers includes advance of Rs.44,269/- to foreign suppliers which are more than five years old should be adjusted.	Action is being taken to adjust the same during the current financial year.
(d)	Medical Advance are outstanding beyond 6 month are stated to be due to death / dispute of successor.	Noted
(e)	Books and periodicals were last verified in 2014. Usually physical verification is done once in every three years. In 2018 no verification was done. However, it is now being done and stated to be completed soon.	Physical verification is going on.
(f)	Substantial amount is recoverable from sponsors of project. Such recoverable includes 28 projects sponsored by CSIR, DST, UGC, DAE. The value of which is 1.26 crores approx. Efforts should be made to realise the same.	Noted and action is being taken to complete in current financial year.
(g)	Unspent grants under current liabilities for ongoing projects remained static / unadjusted for 3 years or more. Necessary steps to be taken to adjust the same.	Noted and action is being taken to complete in current financial year.

(h)	We refer to the Accounting Policy No.11 wherein the deficit in Income & Expenditure Account has been separately shown as debit balance in Asset side. This is a deviation from the prevailing practice. Had this been adjusted against Corpus Fund. It should have shown a negative balance of Rs.1,67,49,15,403.00.	Noted
(i)	Balance confirmation should be taken from the parties for Security Deposit, Electricity Deposit, Cylinder Deposit, Service station etc. every year.	Noted and action will be initiated.
5.	Subject to the above observations in our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India. i. In the case of Balance Sheet, of the state of affairs of the Institute as at 31st March, 2018. ii. In the case of Income of Expenditure Account, of the surplus for the year ended on that date. iii. In the case of Receipt & Payments Account, of the transactions during the year ended on that date.	Noted
6.	REPORT ON OTHER LEGAL AND REGULATORY REQUIREMENTS:-	
(a)	We have sought and obtained all the information and explanation which to the best of our knowledge and belief were necessary for the purpose of our audit.	Noted
(b)	In our opinion proper books of accounts as required by law have been kept by Institute so far as appears from our examination of those books.	Noted
(c)	The Balance Sheet and the statements of Income and Expenditure dealt with by this report are in agreement with the books of account.	Noted

Action Taken Report on Auditor's Report
On Provident Fund Account 2017-18

No.	Auditors' Comments	Action Taken
1.	We have audited the attached Receipts and Payments account of SAHA INSTITUTE OF NUCLEAR PHYSICS PROVIDENT FUND, which comprise the Balance Sheet as at March 31, 2018, and the Revenue Account for the year ended, and a summary of significant accounting policies and other explanatory information.	Noted
2.	Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.	Noted
3.	Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement. An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements.	Noted

	We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis of our audit opinion.	
4.	In our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India. a) In the case of Balance Sheet, of the state of affairs of the fund as at 31st March, 2018. b) In the case of Revenue Account, of the surplus for the year ended on that date.	Noted

Action Taken Report on Auditor's Report
On Pension Account 2017-18

Sl. No.	Auditors' Comments	Action Taken
1.	We have audited the attached Receipts and Payments account of SAHA INSTITUTE OF NUCLEAR PHYSICS PENSION ACCOUNT as at March 31, 2018.	Noted
2.	Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance of the Institute in accordance with the generally accepted accounting practices followed in India. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.	Noted
3.	Our responsibility is to express an opinion on these financial statements based on our audit. We conduct our audit in accordance with the Standard in Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement. An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgement, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error, In making those risk assessments, the auditor considers internal control relevant to the Institute's preparation and fair representation to the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by the management as well as evaluating the overall presentation of the financial statements. We believe that the audit evidence we have	Noted

	obtained is sufficient and appropriate to provide a basis of our audit opinion.	
4.	In our opinion and to the best of our information and according to the explanations given to us, the financial statements give a true and fair view in conformity with the accounting principles generally accepted in India. a) In the case of Receipts and payments Account of the transactions for the year ended on that date.	Noted

AUTHOR INDEXES

(Serial number of without collaboration publication lists)