A Report for the period 2017-2023

Group B: Atomic, Nuclear and High Energy Physics

SANKAR DE
Associate Professor F

Current research and developmental activity: Experiments have been performed with multilevel Rb atoms to understand the quantum interference effect in the light-atom interactions. The interplay of the electromagnetically induced transparency (EIT), absorption (EIA) and Autler-Townes splitting in an *N*-type system has been studied to demonstrated how the atomic states can be engineered just by tunning the laser intensity and we can address the transient dynamics of the population along with steady-state behaviors. Utilizing the dispersive property of the EIT, subluminal light propagation and group velocity dispersion have been studied in a V-type EIT. The characteristic behaviors have been derived analytically considering the response function theory. An atom-based vector magnetometry experiment has been performed in a Λ-type system. The different coherence pathways contributing to the possible EIT resonances and how the amplitudes of these resonances are affected by the σ and π transitions as determined by the arbitrary quantization axis direction have been ventured. Moreover, the direction, along with the strength of the unknown magnetic field, have been derived analytically. We created birefringence in the medium by forming an EIT in a V-type system and used polarization rotation spectroscopy, combining D1 and D2 transitions for Rb isotopes. This technique, named as polarization rotation with EIT (PREIT) gives a non-linear characteristic variation of the rotation angle with the pump intensity and estimate the amount of anisotropy in the refractive index. We further studied the dependence of the angle of PREIT on the angular mismatch between the probe and pump beams. Effects of optical depth and spot size of the pump beam on the PREIT phenomenon have been explored. We now know that the parameters, ellipticity of the probe beam and the external longitudinal magnetic field can modify PREIT. We recently experimentally demonstrated with analytical calculations that an interactive four-level tripod system in the Zeeman sublevels of Rb leads to power broadening immune EIT because the stronger Λ system dominates over the weaker one.

Future Plans :- (1) We are developing a 2D+ + 3D magneto-optical trap (MOT) to produce cold Rb atoms to investigate controlled localization and storage of light pulses in cold atomic vapor with time sequence experiments. We shall employ orbital angular momentum of light to encode quantum information for quantum memory/repeater applications.
(2) In a ladder configuration of Rydberg EIT, we shall use 3-photon transitions and MW fields in the GHz range to drive transitions between high-lying Rydberg states to realize highly sensitive, calibration-free quantum microwave sensors for electrometry applications.
(3) We shall explore the dipole forbidden transitions in Rb atoms by studying radiative decay channels. To look beyond the electric dipole approximation, we plan to use the longitudinal field gradient of the electric field for allowing electric quadrupole (E2) transitions.
(4) We plan to work on a spin exchange relaxation free optical atomic magnetometer sensor in the transient Hanle regime where we can exploit the precision of the unpaired electron of alkali metal atoms and measure magnetic fields in the orders of femto-Tesla.

Post M.Sc. Teaching :- Delivered partial lecture course on Experimental Techniques and Advanced course on Light-Matter Interaction and Quantum Optics almost every year.

NAYANA MAJUMDAR
Senior Professor H

Current research and developmental activities: It involves R&D of an imaging setup that utilizes cosmic ray muons for non-destructive evaluation of unknown objects by studying the scattering of cosmic muons due to their electromagnetic interaction with the constituent matter of a targeted object. The scattering depends upon the atomic number and density of the object for given muon momentum and thus its measurement enables the evaluation. It can be accomplished by tracking the muons before and after the object. The work encompasses different physics topics, software, detectors and analysis for its realization. The hardware part includes fabrication and characterization of suitable gaseous detectors and associated multi-channel readout and DAQ system. The software part involves simulation on design optimization of the setup, detector dynamics for their performance optimization, and image formation of different target objects using the proposed setup. The development of suitable image processing algorithms based on statistical and basic Machine Learning (ML) techniques for image analysis is another important aspect. In addition, R&D on an Active Target Time Projection Chamber (ATTPC) is underway for its application in cross-section measurement of nuclear reactions. The device serves as a single compact system for 3D tracking of charged particles and offer several advantages over the traditional setup of solid target and detector arrays. The design optimization of the ATTPC using numerical simulation and characterization of micro-pattern gaseous detectors for integration with the ATTPC are two major tasks. Numerical simulation on space charge effect and development of suitable tracking algorithm for reaction products are other important aspects for studying in-beam performance of the ATTPC.sa

Future plan: Building a prototype of compact, robust, portable, cost-effective, eco-friendly muon imaging system is planned to carry out monitoring of civil structures and archaeological monuments for their defects and degradation. Design and fabrication of suitable gaseous detectors using components from local industries, cost-effective readout and DAQ are planned. The detection technique using TPC will be explored to replace the layers of muon trackers that will reduce readout electronics and improve compactness. The modern generation of solid state detectors will also be investigated for their performance and cost. The measurement of muon momentum using additional layers of detectors will be explored. The improvement of image processing algorithms with advanced ML techniques will be exercised for real-time processing and reducing exposure duration. A prototype ATTPC will be built and characterized using radiation source followed by in-beam performance for tracking using the accelerator facilities. The device will be used for studying nuclear reactions with astrophysical relevance.

Post M.Sc. teaching: Following courses were conducted and the students were evaluated through home assignments, written examination, project report, open seminar, viva-voce.

- Basic course on Numerical Methods & Analysis in 2017 - 2022, except 2020 and 2023, with lessons on solutions of equations in one variable, interpolation and polynomial approximation, numerical differentiation and integration, direct methods of solving linear systems.
- Advanced course on Topics of Detection and Measurement of Radiation in 2017.
- Review projects in 2017, 2018, 2019, 2021 and 2022.

P. M. G. NAMBISSAN
Senior Professor H

Current Research Activities:

The current research and developmental activities are centred on the defect characterisation studies of multiferroic (mainly $BiFeO_3$-based) and semiconductor (mainly CdO-based) nanomaterial systems through positron annihilation lifetime spectroscopy and coincidence Doppler broadening spectroscopy measurements. Besides, ultraviolet and visible light absorption measurements are also carried out. In addition to these experiments, a few collaborative experiments for external institutions are also going on intermittently. The in-situ vacuum annealing furnace has been upgraded with provision for injecting gases from outside for annealing of solid samples in gaseous atmosphere.

Future plan

Experiments on more systems, preferably multiferroic and semiconductor samples, will be continued. There are also plans to study a few polymer-based samples for free volume analysis and a few detailed experiments on inert gas nanoclusters in metals. A few up-gradation work will be required for which new scintillation and semiconductor detectors along with photo multiplier tubes and nuclear electronic modules need to be purchased. New data acquisition and analysis software may also be procured.

Post M.Sc. teaching

Two laboratory courses were offered in the academic year 2018-19. One seminar on the topic “From Infinitesimal to Infinity - The Indian Legacy of Scientific Research” was delivered for the batches of the years 2021-22 and 2022-23. A course consisting of five lectures on the topic “Positron Solid State Physics and Spectroscopy” had been given in the year 2022-23.

DEBASISH DAS
Associate Professor F

Current Research Activities: My present research is based on exploring the strong interaction. As explained by Quantum Chromo-Dynamics (QCD), the strong interaction is the governing interaction in the subatomic world. Under such extreme conditions the quarks tend to lose their confinement and a phase transition to a new form of matter, known as the Quark-Gluon Plasma (QGP) is formed. Heavy quarks which I study, while traversing the QGP, are expected to lose a significant fraction of their energy, which interact via the strong interaction. Understanding the heavier quarks like top and Heavy-Flavour (HF) Electro-weak Z boson production also add on the perspective of estimates based on heavy quark state production. Interpretations of heavy-quark resonances at forward rapidity at Large Hadron Collider (LHC) energies towards the understanding of production mechanisms and their correlations are pursued, keeping in view of the new avenues of small system collisions. The very early universe was apparently filled with primordial QGP and hence the studies on dark matter and astrophysics of nuclei help to probe the fundamental symmetries and astrophysical environments like neutron stars.

Future Plans: Using two-particle correlations along with the comparative studies in quarkonia and Heavy-Flavour (HF) production in forward rapidity regions of LHC, for probing the matter that filled the early universe and experimentally produced in ALICE (A Large Ion Collider Experiment) at LHC. Involvement in new software methodologies and upgrade project studies, to look into the quarkonia states and their production ratios with more precision. Further broaden the interpretations with varied Monte-Carlo Models to understand critically the production mechanisms of quarkonia, heavy-quarks and correlations, as well as fluctuations with more stress on deciphering the varied features of small systems. Connecting the search of QGP understanding with the other astrophysical epochs and exploring the links between the QCD theory and nuclear physics observables, as well as to study astrophysical objects, like neutron star.

Post M.Sc. Teaching: Taught courses on “Error propagation and Monte Carlo techniques” (in 2017, 2018, 2019, 2021, 2022, 2023), on “Basic detector concepts and Gas detector functionalities” (in 2017) and on “Physics, Signatures and Astrophysics of Quark-Gluon Plasma (QGP)” (in 2022) for SINP Post M.Sc (pre-PhD) programme.

SATYAKI BHATTACHARYA

Professor - G

Current Research (2017-2023):

My primary involvement has been in the CMS experiment at the LHC. Higgs physics using its di-photon decays, search for dark matter (DM), photon reconstruction and identification (id), calibration of the Hadron Calorimeter, and R&D of future end-cap High Granularity Calorimeter (HGCal) for CMS have been my focus areas. Main outcomes are:

a) observation of a ~3 sigma excess in the search for a Higgs like low mass resonance decaying to two photons (Phys. Lett. B 793(2019)320-347). Using the diphoton decay mode of Higgs.

b) a major publication on electron photon reconstruction and id in which my group contributed significantly and took leadership roles (JINST 16 (2021) P05014).

c) simulation of HGCal test beam and detailed shower-shape studies using HGCal test beam data (JINST, Volume 17, May 2022)

d) participation in **R&D for indigenous fabrication of Front End electronics boards of the HGCal** in collaboration with TIFR and CERN that led to selection of two Indian companies for making low density Hexaboards.

e) Phenomenological study on monoHiggs + MET signal at LHC using machine learning (ML) methods (Eur. Phys. J. C (2022) 82: 914)

f) Simulation studies on applications of deep networks in photon identification from electromagnetic calorimeter images (JINST 14 P01011), and pulse shape discrimination in underground DM detection experiments (JINST 18 (2023) 03, P03038).

Publications with major contributions: **11**

I was elected as a fellow of the Indian Academy of Sciences, Bengaluru in 2022.

Four former students, Shilpi Jain (Reader F, TIFR), Bhawna Gomber (Assistant Professor, University of Hyderabad), Ashim Roy (Asstt. Prof. B.N. Mandal University) and Shamik Ghosh (Physicist and Engineer, LLR, France) secured permanent positions in academia and five students obtained their Ph.D. degrees under my supervision during this period.

Future research plans: Continuation with Higgs physics and dark matter searches in CMS. Participation in building of High Granularity Calorimeter of the CMS - through the installation and commissioning period. Complete development for testing the HGCal front-end boards and Si-PM studies. Develop ML based methods for electron, photon reconstruction and identification. Contribute towards underground DM direct detection experiments in India.

Teaching in Post M-SC courses: I have taught full semester-long Post MSc courses every year during this period:

a) Statistical methods in High Energy Physics during the years 2017, 2019-20 and

b) Quantum Mechanics in 2018, 2021, 2022, and 2023.

PRADIP KUMAR ROY
Senior Professor H

Current Research Activities

It is well-known that in QCD there is no evidence of P and CP violations. However, at finite temperature due to sphaleron transition there might be local domains in QGP with non-zero topological charge leading to chiral imbalance due to QCD axial anomaly. This chiral imbalance can be characterized by introducing a chiral chemical potential. The chiral imbalance, in the presence of strong magnetic field lead to various exotic effects, viz chiral magnetic effect, chiral charge separation, chiral vortical effect and so on. Apart from this, the chiral imbalance also affects the phase structure of the strongly interacting matter, collective oscillations and transport coefficients (energy loss, diffusion, chiral magnetic conductivity etc.) Presently, we have been studying the phase structure, mesonic excitations, transport coefficients (e.g. electrical conductivity, viscosity etc.) dilepton productions from the chirally asymmetric strongly interacting thermo-magnetic medium. Future studies include (i) the calculations of photon/fermion damping rates in a magnetized strongly interacting matter with the inclusion of anomalous magnetic moment (AMM), (ii) bosonic and fermionic collective oscillations in a chirally imbalanced magnetized medium, damping rates, and energy loss of fermions, (iii) collective oscillations, phase structure in a rotating strongly interacting magnetized medium**.**

Total no. of Publications: 27 (phenomenology)

Future plans

Future studies include

(i) the calculations of photon/fermion damping rates in a magnetized strongly interacting matter with the inclusion of anomalous magnetic moment (AMM),
(ii) bosonic and fermionic collective oscillations in a chirally imbalanced magnetized medium, damping rates, and energy loss of fermions,
(iii) collective oscillations, phase structure in a rotating strongly interacting magnetized medium.

Post M.Sc. Teaching

Review on “Some Aspects of Field Theory in Presence of Background Magnetic Field”
Student: Souvik Dey, Year: 2020

SUBIR SARKAR

Professor G

Current Research and Developmental Activity

- Search for the SM Higgs Boson at the LHC
- Search for Higgs boson pair production at the LHC
- Triggering rare physics at the LHC
- Study of multi-jet production at the LHC
- Grid computing and core software development

Future Plans

- I shall continue to take active part in construction of the CMS tracker for LHC Phase-2 and work on tracker related software development.
- I shall continue to work on implementation of physics algorithms on the FPGAs for CMS Phase-2 L1 Trigger
- I plan to work on the Next Generation Trigger (NGT) system development in CMS for Phase-2. In particular, I plan to work on the L1 Scouting at 40MHz.

Post M.Sc. Teaching

- I have regularly taught Post M.Sc. courses on C++, Python, and ROOT

SUCHANDRA DUTTA
Professor G

Current Research Activities

- Involvement in the development of high precision and radiation hard silicon micro-strip detectors for the CMS experiment starting.
- Analysis of CMS Phase-II tracker beam test data. Analysis of Bs → $\phi\phi$→kkkk to design the Level 1 trigger for the CMS experiment using Level 1 tracks.
- Expertise on Data Quality Monitoring software; small scale DAQ software used in laboratory to test silicon detectors; Digitization software to simulate physics processes taking place during passage of particles through matter and behavior of readout electronics to make event simulation as realistic and comparable to actual data as possible. Bad Channel calibration of CMS Tracker using data collected during collision and cosmic runs.

Future Plans

- Continue to participate in building and qualifying ~1200 detector modules for the barrel part of the outer tracker at NISER, Bhubaneswar. The detector modules will be fully tested in the standalone Data Acquisition Setup as well as in the climatic chamber under thermal cycle to assure long term functionality. The qualified modules will be integrated in a mechanical structure and finally shipped to CERN. I have been actively participating since the beginning of this work and plan to continue in future as well.

- Search for exotic physics at the LHC in collaboration with Indian phenomenologists.

- Continue working on the estimation of level 1 trigger performance using the newly proposed Track Trigger of CMS is another area where I shall continue working.

- The digitization software for the Phase-II Tracker has been my responsibility since the beginning. As the on-detector electronics get more advanced, realistic implementation in the digitization software becomes more challenging. I plan to continue working on this software project.

Post M.Sc. Teaching

Post MSc Project Guidance : 4 [during 2018, 2020 and 2022]

TINKU SINHA SARKAR
Scientist G

Current Research Work: The thrust area of my research is the development of hardware and construction of infrastructure in National and International projects. However, I am also involved in the experiment, data-analysis and paper writing in nuclear physics arena. Simulation and Data analysis of physics problems regarding JUSL (National) & ALICE (International) projects are the two areas of my current research work. Besides this, I have done phenomenological works also.

I. ALICE Experiment: (Run-II Physics Studies) [**International Project**]

The two physics analyses carried out from SINP using the Grid infrastructure are:

1. DiMuon Quarkonia (DQ):

The work on "Forward rapidity J/ψ production as a function of charged-particle multiplicity in pp collisions at $\sqrt{s}$ = 5.02 and 13 TeV" has been studied. Relative J/ψ yield as a function of the relative charged-particle density measured at forward rapidity in pp collisions at $\sqrt{s}$ = 5.02, 7 and 13 TeV compared with similar measurements at midrapidity at $\sqrt{s}$ = 13 TeV.

2. Heavy Flavor Decay Muon (HFM):

A detailed analysis of ALICE data in p-p collisions at the highest available energy $\sqrt{s}$ = 13 TeV (LHC-Run 2) has been done to measure the production cross-section of single muons decaying from heavy-flavour hadrons (HFM) using Muon Spectrometer (MS) of ALICE detector. This study provides the important test for perturbative Quantum Chromodynamics (pQCD) comparing with earlier published results of ALICE.

II. Two phenomenological works were done using SINP computing cluster facility:

The production of heavy-flavor decay muons (HFM) and also primary charged-particles have been studied in the collision systems: pp ($\sqrt{s}$ = 0.9, 2.76, 5.02, 7 and 13 TeV), Xe–Xe ($\sqrt{s_{NN}}$ = 5.44 TeV) and Pb–Pb ($\sqrt{s_{NN}}$ = 2.76 and 5.02 TeV) using Angantyr model in PYTHIA8. This model adds physics regarding the multiple parton interaction based color re-connection (CR) mechanism to make an agreement with collectivity encoded in the published ALICE data.

III. Study of Angular Distribution of Atmospheric muons using a Cosmic Ray Telescope at Kolkata and JUSL **[National Project**]:

The measurements of the atmospheric cosmic muons flux is studying for background estimations in the search of dark matter using JUSL underground facility. The measurement of the integral vertical intensity is done studying angular distribution of atmospheric cosmic muons using simulation packages (Pythia8 and CORSIKA) and also experimentally using plastic scintillator tiles coupled with silicon photo multipliers (SiPM) at SINP, Kolkata (surface) where preliminary result of the integral vertical flux (~10^{-3}cm^{-2}s^{-1}sr^{-1}) agrees our published result.

Future Research Work:

- The physics analysis on 'Study of Heavy Flavor decay leptons as a function of charged particle multiplicity in small systems (p-p and p-Pb collisions) using ALICE Run3 data and also the Phenomenological work on the same topic.
- Study of Angular Distribution of Atmospheric muons using a Cosmic Ray Telescope at a depth of 555 m (1554 ± 45 m.w.e.) at JUSL.

Post M.Sc. Teaching (For learning High Energy Physics Experimental Techniques):

1. An investigation for the effect of Zenith and Azimuth angles on the flux of Cosmic ray muons using plastic scintillator with PMT/SiPM Using a Cosmic Ray Telescope.
2. The Gain & Energy Resolution measurement using the micro pattern gas detector thick GEM.

M.S. JANAKI
Senior Professor H

Study of nonlinear structures generated by charged space debris objects:

Due to various natural as well as artificial space activities like rocket and spacecraft launching, the amount of space debris particles are continuously increasing in the near earth space. Space debris objects that originate from dead satellites, meteoroids, destroyed spacecrafts and other inactive space objects become charged due to various processes like photo-emission, electron and ion collection, secondary electron emission etc., and behave like a plasma medium. The charged debris objects excite various types of linear and nonlinear oscillations in the plasma. Nonlinear structures excited by charged space debris objects such as pinned and accelerated solitons, curved solitons, distorted lumps etc are studied in a variety of plasmas such as unmagnetized, magnetized, inhomogeneous, and dusty plasmas. Such studies are relevant for tracking, detection and removal of space debris objects existing in the near earth space that are hazardous for moving spacecraft.

Chaos in Plasmas:

Theoretical studies: Characterization of chaotic magnetic field lines in Beltrami fields in the perspective of transport and energization of charged particles, Studies of partial and complete measure synchronization in a system of three nonlinearly coupled oscillators, order to chaos transitions in Jerk-like equations. Studies in Experimental devices: Characterization of floating potential fluctuations with respect to various control parameters using various nonlinear dynamical techniques in toroidal currentless assembly (SINP tokamak), double layer experimental device, and glow discharge plasma device. Experimental results have been corroborated using theoretical models derived from basic plasma equations.

Post M.Sc. Teaching:

During this period, I took active interest in teaching Advanced Plasma Physics Courses as well as guiding Post M.Sc. review work.

PRATIK MAJUMDAR
Associate Professor 'F' (July 2017 - till date)
pratik.majumdar@saha.ac.in

Research Activities Currently involved in :

Pratik Majumdar has more than 20 years of experience (including PhD) in the field of GeV-TeV gamma-ray astrophysics, High Energy Neutrino Astronomy and multiwavelength and multimessenger astrophysics leading to publications in many reputed journals of high impact factor. His broad research focus is on probing the origin of high energy cosmic rays via analysis of GeV-TeV data from Fermi-LAT, MAGIC and MACE telescopes through observations of supernova remnants, pulsar wind nebulae and active galactic nuclei. Additionally Pratik Majumdar also performs multiwavelength and multimessenger data analysis to foster synergies between very high energy gamma rays (MAGIC/MACE/CTA), X-rays (ASTROSAT, *Swift* and other X-ray detectors), radio waves (GMRT) and HCT (optical) and also peforms multiwavelength modelling of the spectral energy distributions of high energy astrophysical sources. He is the Principal Investigator of the gamma-ray follow up of the neutrino target of opportunity (NToO) program between MAGIC and IceCube and is the Co-Investigator of several multiwavelength proposals involving ASTROSAT, Himalayan Chandra Telescope (HCT) and GMRT. Another area of research in which Pratik Majumdar focusses on is the analysis of data from dwarf spheroidal galaxies and galaxy clusters using Fermi-LAT detector and radio observations using GMRT and Very Large Array (VLA) in order to probe dark matter using indirect detection techniques. On the technical side, Prof. Majumdar works on the absolute light calibration of imaging telescopes using muons and performs Monte-Carlo (MC) comparisons with real data to ascertain the point spread function of the telescope. He has been the principal investigator for the design and development of a calibration system for the optical calibration of the camera of the prototype Large Size Telescope for future generation of an array of imaging Cerenkov telescopes (Cerenkov Telescope Array).

Pratik Majumdar is the recepient of Stanislaw Ulam Fellowship in 2020 by Polish National Academy for Academic Exchange and spent 9 months in University of Lodz, Poland from August 2021 till March 2022 He currently holds the positions of Deputy Software Co-ordinator of the MAGIC telescope collaboration, Speaker's Bureau Co-Chair of Cherenkov Telescope Array (CTA) consortium and is also the drafting member of the MegaScience Vision Document 2035 for High Energy Physics document initiated by Office of PSA, Govt of India.

Future Research Plans: Perform regular observations of high energy gamma-ray sources using atmopsheric Cherenkov telescopes (MAGIC/MACE/CTA) and foster multiwavelength (X-rays, optical, radio) and multimessenger Astrophysics (neutrino triggers from IceCube and KM3Net) as mentioned above to establish sources of hadronic accelerators. Augment the research on observations of astrophysical sources for indirect detection of dark matter. Plans to develop a novel dual mirror telescope Schwarzchild-Couder type which facilitate the study of high energy gamma-ray sources of big extensions in our galaxy. Perform Monte-Carlo simulations for MACE stereoscopic observations at Hanle and continue participation and analysis of data taken with the MACE telescope at Hanle.

Post MSc Teaching Activities : Regularly taking post MSc classes for two topics : High Energy Particle and Astroparticle Physics detectors and A Basic and Advanced Course on Astroparticle Physics. I take these course almost every alternate years, if not every year.

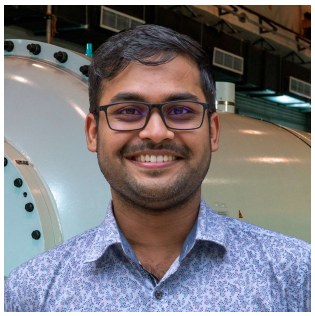
MALA DAS
Associate Professor F

Current Research and Developmental activities: Experimental studies and simulation are carried out on the gamma ray, neutron and alpha particle induced bubble nucleation in superheated droplet detector at SINP-lab and study of bubble nucleation by non-linear analysis technique has been established. We have initiated the low mass dark matter search below 30 GeV with superheated liquid detector (SLD) technique at 555 m deep underground, JUSL (Jaduguda Underground Science Laboratory), UCIL, Jaduguda. The research and development effort has already been started at the laboratories of SINP where detector R & D, instrumentation, DAQ fabrication and calibration experiments are performed. The test run and the first phase of experiment have been started at JUSL lab with the superheated droplet detectors, fabricated at SINP lab and the preliminary result is established. This is the first DM search direct detection experiment in India. There is also participation to the PICASSO (Project In Canada to Search for Supersymmetric Objects), presently PICO (PICASSO+COUPP) dark matter search experiment at the SNOLab, Canada, involving in data analysis, detector simulation. I took the major role in fabricating few PICASSO detectors with the improved technique at Univ. of Montreal, installed at the SNOLab for PICASSO experiments which were used in the publication from PICASSO.

Future Plan: The systematic investigations into detector performance fabricated at SINP lab and response including simulation, detector shielding for the backgrounds will be conducted in near future, and the details for the design of the next generation detectors will be developed. In parallel, the underground physics program will run with operating detectors that will collect valuable physics data and will allow the detector technology to be further refined. The ultimate goal is to build a large scale low background detector in successive steps with low threshold sensitivity that will probe the phase space for low mass dark matter interactions. Calculation shows that the active liquid $C_2H_2F_4$ has the potentiality to probe the sub-GeV dark matter while operated at low threshold. Once the technology is defined for the operation at very low threshold, it can be modified in future to detect the electron recoil caused by the light mass dark matter interactions which can probe the competitive results even in the shallow depth of the laboratory.

Post M.Sc. teaching: Conducting the theory (Experimental techniques in Astrophysics) and laboratory courses (Background study at surface lab for dark matter search experiment) and orientation lectures on regular basis for the PMSc-Phys (Expt) batch every year.

AKASHRUP BANERJEE
Associate Professor E

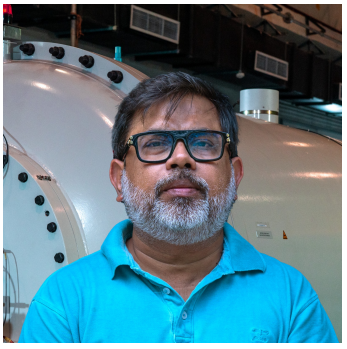


Current Research and Development activities: The 3 MV high current tandem accelerator housed at FRENA will be used for investigating nuclear astrophysics problems. At present, I am leading a program to calibrate the accelerator's terminal voltage using various known proton-induced reactions with low-mass targets. As a follow-up of the calibration program, several experiments will be performed by the national collaboration to understand abundance scenarios of low-mass elements, relevant to a wide variety of astrophysical scenarios. I have also initiated a program to train FRENA members in the field of accelerator operations.

Future Plan: I have secured a SERB-SRG grant to develop a specialized low-background setup to investigate carbon-carbon reaction rates. The setup will use a cosmic-veto technique, coupled with particle-gamma-gamma coincidences to enable carbon fusion studies at the overground laboratory. These studies will lead to a better understanding about the reaction rates, shedding more light on the evolution of massive stars and also various explosive astrophysical scenarios.

Post M.Sc. Teaching: Experimental course related to accelerator-based technologies and Physics.

CHINMAY BASU
Professor G
Email:chinmay.sinp@gmail.com



Research interests are mainly in the field of experimental nuclear astrophysics and associated developments. Indirect measurements to study low energy astrophysical reactions have been carried out in the framework of the asymptotic normalisation technique using transfer reactions. Mainly the $^{12}C(\alpha,\gamma)$ reaction at Gamow energy is studied via this technique through cross-section measurements of $^{12}C(^{6/7}Li,d/t)$, $^{12}C(^{11}B,^{7}Li)$ reactions at higher energies. These works were carried out using both national and international collaborations. Another field that has been pursued are low energy measurements that pertain to astrophysical interest. In this regard a major activity has been the development of the FRENA facility and its utilization. In this regard the first calibration experiment using the neutron threshold of $^{7}Li(p,n)$ reaction has been performed successfully. A 1 m scattering chamber has been designed and fabricated for charged particle measurements in +15 degree beamline of FRENA. Studies of nucleosynthesis of p nuclei has been another major activity. These studies involve $^{113}In(\alpha,\gamma)$, $^{144}Sm(p,\gamma)$ and $^{108}Cd(p,\gamma)$ cross-section measurements in the Gamow window by offline activation method. Besides, $^{113}In(a,a)$ elastic scattering angular distributions have been measured for studies on alpha optical potentials which is important for statistical model predictions. $^{108}Cd(p,p)$ and $^{85}Rb(p,n)$ studies are in progress. The 19F(p,a) an important astrophysical reaction has been studied in the context of direct reaction contribution in the astrophysical s-factor and angular distributions measured at 11 and 12 MeV. CFD simulations in the framework of Engineering software ANSYS has been carried out to study the thermal profiles of target interaction with high current ion beams. A target cooling setup is planned.

Future plan is to explore measurements of astrophysical reaction cross-sections using the FRENA accelerator. In this regard sub-Coulomb transfer measurements to extract astrophysical cross-section is of prime importance. Besides, setting up of AMS facility to study radioactive nuclei in relation to p-nuclei synthesis is also a future goal. This facility may be also useful for ^{14}C dating of archaeological samples.

Post MSc teaching carried out for advanced course in nuclear physics.

MAITREYEE NANDY
Senior Professor H

Current research activities: Design simulation of the neutron shield for the Superheated Drop Detector to be used in JUSL, Jaduguda has been carried out. Part of the team to analyse the elemental and isotopic composition of rock and soil samples from the Sung Valley, West Jaintia Hills, Meghalaya. The natural radioactivity content of the samples was determined and hazard indices assessed.
Response of an array of CeBr detectors to gamma radiation was simulated for application in angular correlation studies.
Radiation level survey and radiation safety surveillance of the radiation facilities of the Institute carried out.

Future plan: Design of the shield for low background measurement with Superheated Drop Detector will be finalised and the shield fabricated. Radiation field mapping around the accelerator in FRENA will be carried out.

Post M.Sc. teaching: Following courses were conducted and the students were evaluated through home assignments, written examination, open seminar, viva-voce.

- Experimental Techniques in Astrophysics – Advanced course, Post M.Sc Experimental Physics taught jointly with Prof. Mala Das, HENPP Division (2018 -2024 except 2020)
- Advanced course on Topics of Detection and Measurement of Radiation in 2017.
- One review project in 2019

Ushasi Datta

Academic Profile:

- Senior Professor-H at Saha Institute of Nuclear Physics, Kolkata (2019)
- Professor at the Homi Bhabha National Institute (HBNI), Munbai (2019)
- Fellow of West Bengal Academy of Science, West Bengal (2019)
- H-index: 30, Since 2017 Journal pub:19 (three letters), Conference:21+,
- Invited talks/talks at Lansing, California, Tokyo, Erice, Legnaro, Glasgow, Mumbai :21

Since 2017 Ph.D. Students: Thesis work completed: 3, Presently working: 2 and supervised review projects and summer projects: 12

Research and development:

A couple of experiments were performed to address forefront topics of nuclear physics, nuclear astrophysics and particle-nuclear astrophysics. Those experiments were performed at international laboratories, national laboratories and SINP laboratory. Some measurements were performed as a spokesperson and some were performed as a collaborator and the results are published in PRL, PLB, PRC, J.Phys. G, NIMA etc.

- Showed direct evidence of merging of nuclear magic shell gap at N~20 and 28 from the data at GSI, Darmstadt.
- Measured (n.g) captture cross-section of seed nuclei, relevant for r-process
- From β-decay measurement , an evidence of sterile neutrino was shown. Appeared in Journal coverage page. Experiment was performed as SINP laboratory.
- Studied Quasifree scattering at N=29 using AcTAR and ReA3 at NSCl, MSU
- Studied ^{47}Ar, proton distribution using cryogenic target and MUST, AGATHA at GANIL
- Unbound states of ^{115}Xe were studied via a novel method of exotic decay of ^{115}Cs, near proton drip line and Byasian analysis. The experiment was performed at ISOLDE, CERN.
- A dedicated chamber and detector array were built for performing experiment at FRENA.
- Took partial responsibility and performed expt. At INGA, VECC and IUAC

Future plan:

- Understanding strong and weak interaction in atomic nuclei at limits of existence
- Novel phenomena at isospin degrees of freedom of atomic nuclei using stable and unstable nuclear beam and its impact on cosmology
- Physics beyond standard model using both nuclear physics and particle physics input

Academic responsibility: Thesis examiner of University of Delhi, Banaras Hindu University, Visva Bharati University, Kalyani University. External examiner in Master degree examination at Visva Bharati University, Jadavpur University (Instrumentation) etc. Screening committee of faculty selection at UEM, Kolkata. Expert for faculty promotion at Central University. Member of international adv. Committee in a number of conferences at India and abroad, act as chair of the session. Reviewer of national and international journals and external funds like Marie Curie fellowship etc.

Teaching: I have taken Post M.Sc. Classes regularly, delivered lectures on research methodology, coordinated advanced nuclear physics course, delivered advance nuclear physics and nuclear astrophysics course and short experiments in the laboratory, Colloquiums and supervised several Post M.Sc. review projects. I have also supervised several summer projects and project assistants and M.Sc students from various Indian university. Took online classes at Allahabad University. Invited lecture at Erice International School and delivered colloquium at Presidency University, INFN, Legnato, Visva Bharati, RIKEN etc.

ANJALI MUKHERJEE
Senior Professor H and Head - Group B

Current Research Activities (2017-2023): Research interests are mainly experimental Nuclear Reactions and Nuclear Astrophysics. During this period, I have carried out studies on

- quasi-elastic scattering of heavy systems at near-barrier energies,
- deep sub-barrier fusion of heavy systems.
  The primary motivations behind these studies were primarily two-fold: i) understanding the reaction mechanisms, and ii) investigate the nuclear potential.
  The measurements were carried out using the 14 MV Pelletron-Linac facility at TIFR, Mumbai. Two students have done their Ph.D. based on these works. The work on deep sub-barrier fusion was primarily initiated to study the phenomenon of fusion hindrance at very low energies. The phenomenon of fusion hindrance, especially for light systems, has great ramifications in the field of Nuclear Astrophysics.
- Very recently, I have also started a systematic study of (p,γ) reactions on p-nuclei and near-p nuclei at very low energies, using the activation technique. Two students are working in this area. The FRENA facility at SINP is most suited for such measurements. But till the machine delivers beam for proper experiments, such studies have been initiated using the Pelletron-Linac facility at TIFR, Mumbai. In these studies, at very low energies, obviously the beam has to be degraded at the cost of energy resolution.
- Besides, I was largely involved in the FRENA facility till 2020. I was involved in writing accelerator safety reports. I took initiative in designing of small chambers, planning for experiments, etc. I was also actively involved during the commissioning of the accelerator.

Future plans: I shall continue with my works on deep sub-barrier fusion and nuclear astrophysics. A systematic study on deep sub-barrier fusion needs to be carried out for systems ranging from light to heavy mass region to get a deeper insight into the phenomenon of fusion hindrance at deep sub-barrier energies.
Once the FRENA facility starts delivering beams for proper experiments, many such (p,γ) reactions can be studied, using both in-beam and off-beam methods. Measurement of such reaction cross sections are very important for abundance calculations. Also, once the ^{12}C beam becomes available from the machine, I would like to study the $^{12}C+^{12}C$ reaction in the energy domain of astrophysical interest, as already proposed in the 'Physics with FRENA' meeting held at SINP in August 2018.

Post M.Sc. teaching: Taught a part of the Nuclear Physics Advanced course in 2021

Two Post M.Sc. projects: 2018, 2019

Staff profile since 2017

Sl. No.	Name	Designation	Responsibilities
1.	Arindam Das	Engineer	In FRENA, he is the Technical Activities Coordinator: Responsible for executing all service section activities to ensure smooth accelerator operations. He is also involved in ALICE collaboration for maintenance and service of electronics readout of Muon detectors at CERN.
2.	Santanu Chaudhuri (Retd.)	Engineer	Was engaged in Plasma Physics laboratories and TOKAMAK machine
3.	Sujib Chattopadhyay (Retd.)	Scientific Officer	Was fully engaged in FRENA activities
4.	Soma Roy	Scientific Assistant	Was engaged in FRENA activities and was also an Accelerator Operator till 2023. Since 2023, she is involved in technical assistance in the activities of three laboratories
5.	Lipy Das	Scientific Assistant	She is involved in ALICE collaboration for maintenance and service of electronics readout of Muon detectors at CERN.
6.	Chandranath Marick	Scientific Assistant	In FRENA, he is responsible for designing and fabricating soft control based electronic systems. He is also an Accelerator Operator.
7.	Dipankar Das	Scientific Assistant	In FRENA, he is responsible for maintenance and functioning of all vacuum pumps and related components.
8.	Dwijendra Das	Scientific Assistant	In FRENA, he is responsible for maintenance and repair of electronic modules and electrical components. He is also an Accelerator Operator. He is involved in ALICE collaboration for maintenance and service of electronics readout of Muon detectors at CERN.
9.	Umesh Kumar Gond	Scientific Assistant	In FRENA, he is responsible for upkeep and coordination of thin film fabrication facility; Health Physics Unit certified. Also helps in radiation safety work for other facilities in the Institute
10.	Nilanjan Biswas	Scientific Assistant	He is involved in superheated liquid drop detector fabrication and testing at SINP laboratory. Also involved in experimental work at JUSL facility.
11.	Soumya Sankar Basu	Scientific Assistant	In FRENA, he is Health Physics Unit certified. Also helps in radiation safety work for other facilities in the Institute
12.	Manik Kujur	Scientific Assistant	In FRENA, he is responsible for overall maintenance and functioning of HVAC section. HPU certified-standby appointee.
13.	Dipankar Das	Technician	In FRENA, he is responsible for designing and fabricating various mechanical components, including

			liasoning with the central workshop. He is also an Accelerator Operator. He is also involved in ALICE collaboration for maintenance and service of mechanical parts of Muon detectors at CERN.
14.	Rizwan Ahmed	Lower Division Clerk	He carries out all office work of the Group.
15.	Rakesh Kumar Ram	Work Assistant	He assists in handling of all official files. He handles all contingency bills and payment. He also helps in organizing events like seminars, official visits etc.
16.	Sudam Bagdi	Work Assistant	He assists in handling of official files. He also helps in liquid nitrogen filling of detectors in laboratories. He helps in organizing events like seminars, official visits etc.
17.	Prabir Das	Work Assistant	He assists in handling of official files. He also helps in liquid nitrogen filling of detectors in laboratories. He helps in organizing events like seminars, official visits etc.
18.	Suro Mahato	Work Assistant	She is involved in office work – handling of files

List of Instruments and facilities in the Group

Sl no	Instrument	Whether in working condition	Number of students and faculty members sharing the instrument/facility	Responsibility of faculty members for maintaining the instrument/facility
1	3MV high current tandem accelerator (FRENA).	Yes	FRENA is a national facility and all the instruments are available for use by the national community of nuclear physicist (and in near future by other disciplines)	As the Convenor of FRENA, Prof. Akashrup Banerjee is responsible for day-to-day activities, future planning, scientific infrastructure development, as well as accelerator facility augmentation to perform internationally competitive experiments. Prof. Akashrup Banerjee (Convener) and Prof. Chinmay Basu are the members of Facility Management Committee, FRENA, SINP
2	Target laboratory with sputter coater and high vacuum thin film deposition machine.	Yes		
3	Jaduguda Underground Science Laboratory (JUSL) at UCIL, Jaduguda, Jharkhand. This underground laboratory is maintained by SINP and UCIL and funded by SINP.	Yes	Students – 5 (SINP) Faculty – 25 (SINP – 9, VECC, BARC, UCIL)	Presently Prof. Mala Das is the In-Charge of the JUSL facility and responsible for maintaining the overall smooth running of the facility by providing the basic infrastructure for running the experiments at JUSL, maintaining the schedule of the experiments for the users, organizing JUSL monthly discussion meeting and yearly collaboration meeting.
4	TOKAMAK Machine, Make: TOSHIBA			Prof. M.S. Janaki
5	MAPLE (Magnetized Plasma Linear Device);	Yes		Prof. M.S. Janaki

	Power Supply, Make: DANFYSIK.			
6	Double Layer Plasma Device; RF Generator 13.66 MHz.			Prof. M.S. Janaki
7	Glow Discharge Plasma Device	No		Prof. M.S. Janaki
8	RF (13.56 MHz.) Discharge Device	No		Prof. M.S. Janaki
9	Integrated High Power External Cavity Diode Laser (ECDL) + Tapered Amplifier (TA) system operating @ 780 nm	Yes	Students – 2, Postdoc – 1, Faculty member - 1	Prof. Sankar De
10	Silicon Surface barrier detectors, Sodium-Iodide and Plastic Scintillator detectors with PMT.	Yes	Students – 5 Faculty members – 2	Prof. Chinmay Basu, Dr. Tinku Sinha Sarkar
11	Turbomolecular pumping system	Yes	Student - 1 Faculty member - 1	Prof. Anjali Mukherjee
12	Muon imaging or tomography - Imaging setup that utilizes cosmic ray muons for non-destructive evaluation of unknown objects.	Yes	Students – 4 Faculty member – 1	Prof. Nayana Majumdar
13	Positron Annihilation Lifetime Spectrometer	Yes	Students – 2 Faculty member - 1	Prof. P. M. G. Nambissan
14	Coincidence Doppler Broadening Spectrometer	Yes		
15	Optical calibration system developed for imaging Cerenkov telescope.	Yes	Faculty member - 1	Prof. Pratik Majumdar
16	Velocity, lifetime and angular distribution measurement of cosmic-ray muon using plastic scintillator detector coupled with PMT / SIPM at JUSL	Yes	Student – 1 + Post MSc training Faculty member - 1	Dr. Tinku Sinha Sarkar

17	Digitizer: DT5725 (8 Ch. 14 Bit 250MS/s) Cable Adapter	Yes	Faculty member - 1	Prof. Maitreyee Nandy
18	Digitizer: DT5725 (8 Ch. 14 Bit 250MS/s) Cable Adapter	Yes	Students: 4 Faculty member - 1	Prof. Mala Das
19	Sensors and Amplifiers, Make/Brand: MISTRAS Sensors: WSA (1Pc.), R3A(1Pc.) Amplifier: AE2A Amplifier Ship Kit (2Pcs.)	Yes		
20	Function Generator (Tektronix, Model – AFG1022)	Yes		
21	LabView based DAQ system for JUSL experiments	Yes		
22	BC501A Liquid scintillation neutron detector	Yes	Faculty member - 1	Prof. Maitreyee Nandy
23	Radiation survey meters	Yes	Used for radiation safety surveillance	Prof. Maitreyee Nandy
24	Clover detectors	Yes	Students - 6 Faculty Members – 2 Also used in INGA collaboration	Prof. Ushasi Datta Prof. Anjali Mukherjee
25	BEGe detector	Yes	Students – 2 + project students Faculty Member - 1	Prof. Anjali Mukherjee
26	BEGe detector	No		
27	BGO shields	Yes	Faculty members – 2 Also used in INGA collaboration	Prof. Ushasi Datta Prof. Anjali Mukherjee
28	LaBr3 scintillation detectors	Yes	Students - 3 Faculty members -1	Prof. Ushasi Datta

List of students working in group since 2017

Sl. No.	Student's Name	Supervisor	Ph.D./Status
1	Sourav Pramanik	Nikhil Chakrabarti (Retd.)	2017
2	Pankaj Kumar Shaw	M. S. Janaki	2017
3	Abhijit Ghosh	M. S. Janaki	2017
4	Rajani Raman	Sandip Sarkar (Retd.)	2017
5	Sayanee Jana	Nikhil Chakrabarti (Retd.)	2018
6	Satyajit Chowdhury	Nikhil Chakrabarti (Retd.)	2018
7	Mithun Karmakar	Nikhil Chakrabarti (Retd.)	2018
8	Sabuj Ghosh	M. S. Janaki	2018
9	Debajyoti Saha	M. S. Janaki	2018
10	Ashim Roy	Satyaki Bhattacharya, Manoj Sharan (Retd.)	2018
11	Sourav Kumar De	Chandi Charan De (Retd.)	2018
12	Abhik Jash	Nayana Majumdar	2018
13	Subha Samanta	M. S. Janaki	2019
14	Kalyanmoy Chatterjee	Subir Sarkar, Suchandra Dutta	2019
15	Sourav Dey	Sunanda Banerjee (Retd.), Subir Sarkar	2019
16	Kuntal Mondal	Suchandra Dutta, Sunanda Banerjee (Retd.)	2019
17	Anshu Chatterjee	Pratik Majumdar	2019
18	Ashok Kumar Mondal	Chinmay Basu	2020
19	Biswajit Banerjee	Pratik Majumdar	2020
20	Suvankar Roy Chowdhury	Subir Sarkar, Sunanda Banerjee (Retd.)	2020
21	Saswati Nandan	Subir Sarkar, Sunanda Banerjee (Retd.)	2020
22	Shamik Ghosh	Satyaki Bhattacharya	2020
23	Bankim Chandra Das	Sankar De	2020
24	Arghya Mukherjee	Pradip Kumar Roy	2020
25	Aritra Das	Pradip Kumar Roy	2021
26	Arpita Das	Sankar De	2021
27	Sangeeta Das	Maitreyee Saha Sarkar (Retd.)	2021
28	Sathi Sharma	Maitreyee Saha Sarkar (Retd.)	2021
29	Rajkumar Santra	Subinit Roy (Retd.)	2021
30	Jaydeep Datta	Nayana Majumdar	2021
31	Sunita Sahoo	Mala Das	2021
32	Wadut Shaikh	Sukalyan Chattopadhyay (Retd.)	2021
33	Jhuma Ghosh	Sukalyan Chattopadhyay (Retd.)	2021
34	Rajarshi Bhattacharya	Subir Sarkar, Suchandra Dutta	2021
35	Piyasi Biswas	Anjali Mukherjee	2022
36	Prithwijita Roy	Asimananda Goswami (deceased) Anjali Mukherjee	2022
37	Sridhar Tripathy	Nayana Majumdar	2022
38	Samsul Islam	Tinku Sinha Sarkar	2022

39	Arnab Purohit	Satyaki Bhattacharya	2022
40	Prashant Kumar Rout	Supratik Mukhopadhyay (Retd.), Satyaki Bhattacharya	2022
41	Anil Kumar	Supratik Mukhopadhyay (Retd.)	2022
42	Ram Sewak	Chandi Charan De (Retd.)	2022
43	Debabrata Bhowmik	Satyaki Bhattacharya	2023
44	Gourab Saha	Suchandra Dutta	2023
45	Pritam Palit	Subir Sarkar	2023
46	Tanmoy Ghosh	Manoj Sharan (Retd.)	2023
47	Promita Roy	Supratik Mukhopadhyay (Retd.)	2023
48	Vishal Kumar	Supratik Mukhopadhyay (Retd.)	2023
49	Saikat Bhattacharya	Anjali Mukherjee	2023
50	Tanmay bar	Chinmay Basu	Thesis submitted
51	Dipali Basak	Chinmay Basu	Thesis submitted
52	Lalit Kumar Sahoo	Chinmay Basu	Synopsis submitted
53	Subhendu Das	Nayana Majumdar	Thesis submitted
54	Suraj Ali	Mala Das (Co-Guide)	Continuing
55	Pralay Kumar Das	Nayana Majumdar	Continuing
56	Saikat Ghosh	Nayana Majumdar	Continuing
57	Shubhabrata Dutta	Nayana Majumdar	Continuing
58	Sukhendu Saha	Chinmay Basu	Continuing
59	Nadira Sultana	Chinmay Basu	Continuing
60	Vimal Kumar	Mala Das	Continuing
61	Susmita Das	Mala Das	Continuing
62	Maudud Ahmed	PMG Nambissan	Continuing
63	Shubharaj Mukherjee	PMG Nambissan	Continuing
64	Priyabrata Seth	Sankar De	Continuing
65	Manisha Samal	Sankar De	Continuing
66	Habib Mondal	Pratik Majumdar	Continuing
67	Chitranshi Bakshi	Pratik Majumdar	Continuing
68	Sanjeev Maurya	Tinku Sinha Sarkar	Continuing
69	Priyabrata Das	Ushasi Datta	Continuing
70	Joydeep Dey	Ushasi Datta	Continuing
71	Writabrata Sengupta	Ushasi Datta	Continuing
72	Ashish Gupta	Anjali Mukherjee	Continuing
73	Munmun Twisha	Anjali Mukherjee Co-guide: Nayana Majumdar	Continuing
74	Siba Prasad Acharya	M. S. Janaki	Continuing
75	Anindita Karmakar	Sukalyan Chattopadhyay (Retd.) Co-guide: Gopal Mukherjee (VECC)	Continuing
76	Shubham Dutta	Satyaki Bhattacharya	Continuing
77	Sweta Baradia	Subir Sarkar	Continuing
78	Suman Das Gupta	Satyaki Bhattacharya	Continuing

Year-wise distribution of Students

Year	2017	2018	2019	2020	2021	2022	2023
Total no. of students	43	57	56	58	51	40	32

Faculty wise distribution of Students since 2017

Faculty Name	No. of students graduated since 2017	No. of students continuing
Prof. Akashrup Banerjee	0	0
Prof. Debasish Das	0	0
Prof. Pratik Majumdar	2	2
Prof. Pradip Kumar Roy	2	0
Prof. Mala Das	1	1 (Co-Guide from SINP)+ 2 continuing
Prof. Sankar De	2	2
Prof. Satyaki Bhattacharya	4	2
Prof. Nayana Majumdar	3	4
Prof. Chinmay Basu	1	2 (thesis submitted) + 1(synopsis submitted) + 2 continuing
Dr. Tinku Sinha Sarkar	1	1
Prof. Suchandra Dutta	2	0
Prof. Subir Sarkar	6	1
Prof. Ushasi Datta Pramanik	1	2
Prof. Maitreyee Nandy	1 (Co-guide from SINP)	0
Prof. PMG Nambissan	0	2
Prof. Anjali Mukherjee	3	2
Prof. M. S. Janaki	5	1
Prof. Manoj Sharon (Retd.)	1	0
Prof. Supratik Mukhopadhyay (Retd.)	4	0
Prof. Sukalyan Chattopadhyay (Retd.)	2	1
Prof. Nikhil Chakrabarti (Retd.)	4	0
Prof. Chandi Charan De (Retd.)	2	0
Prof. Maitreyee Saha Sarkar (Retd.)	2	0
Prof. Subinit Roy (Retd.)	1	0
Prof. Sandip Sarkar (Retd.)	1	0

Placement of students since 2017

Name of student	Name of supervisor	Placement
Anshu Chatterjee	Prof. Pratik Majumdar	Teaching Physics in a college in Visakapatanam
Biswajit Banerjee	Prof. Pratik Majumdar	Postdoctoral fellow at Gran Sasso Science Institute (GSSI), Italy working on electromagnetic counterparts of gravitational wave objects
Ashok Kumar Mondal	Prof. Chinmay Basu	Assistant Professor at the Department of Physics, Manipal University, Jaipur
Lalit Kumar Sahoo	Prof. Chinmay Basu	Technical Officer, Bhabha Atomic Research Centre
Sunita Sahoo	Prof. Mala Das	Faculty at Women Govt College, Odisha
Suraj Ali	Prof. Mala Das	Faculty at Muralidhar Girls' College, Kolkata
Bankim Chandra Das	Prof. Sankar De	Senior Research Postdoc Fellow at Department of Physics of Complex Systems, Weizmann Institute of Science, Israel.
Arpita Das	Prof. Sankar De	Postdoc in the Department of Physics, Durham University, UK as Newton International Fellow (Royal Society).
Kalyanmoy Chatterjee	Prof. Subir Sarkar, Prof. Suchandra Dutta	Part-time Teacher
Saikat Bhattacharya	Prof. Anjali Mukherjee	Postdoctoral Fellow at Louisana State University
Piyasi Biswas	Prof. Anjali Mukherjee	Assistant Professor at Matangini Hazra College for Women
Prithwijita Roy	Prof. Anjali Mukherjee	Assistant Professor at ABN Seal College
Sourav Dey	Prof. Sunanda Banerjee, Prof. Subir Sarkar	Post Doctoral Fellow
Ashim Roy	Prof. Satyaki Bhattacharya, Prof. Manoj Sharan (Retd.)	Asst. Professor at B N Mandal University
Kuntal Mondal	Prof. Suchandra Dutta, Prof. Sunanda Banerjee	Post Doctoral Fellow
Suvankar Roy Chowdhury	Prof. Subir Sarkar, Prof. Sunanda Banerjee	Post Doctoral Fellow
Saswati Nandan	Prof. Subir Sarkar, Prof. Sunanda Banerjee	Post Doctoral Fellow
Arnab Purohit	Prof. Satyaki Bhattacharya	Post Doctoral Fellow, IPN, Lyon, France

Shamik Ghosh	Prof. Satyaki Bhattacharya	Staff scientist (permanent) at LLR, France
Rajarshi Bhattacharya	Prof. Subir Sarkar, Prof. Suchandra Dutta	Post Doctoral Fellow
Debabrata Bhowmik	Prof. Satyaki Bhattacharya	Post Doctoral Fellow
Gourab Saha	Prof. Suchandra Dutta	Post Doctoral Fellow
Pritam Palit	Prof. Subir Sarkar	Post Doctoral Fellow
Arghya Mukherjee	Prof. Pradip Kumar Roy	Lecturer, Narendrapur R. K. Mission
Aritra Das	Prof. Pradip Kumar Roy	One PDF completed at NISER, will join Univ. of West Timisoara, Romania
Samsul Islam	Dr. Tinku Sinha Sarkar	Post-doc (ALICE) at IIT-Mumbai.
Abhik Jash	Prof. Nayana Majumdar	Software Support Engineer, CAENSpa India Pvt. Ltd.
Jaydeep Datta	Prof. Nayana Majumdar	Post Doctoral Fellow, Center for Frontiers in Nuclear Science, Department of Physics and Astronomy, Stony Brook University, New York, USA
Sridhar Tripathy	Prof. Nayana Majumdar	Post Doctoral Fellow, Department of Physics and Astronomy, University of California, Davis, USA
Pankaj Kumar Shaw	Prof. M. S. Janaki	Assistant Professor, Raja Peary Mohan College
Abhijit Ghosh	Prof. M. S. Janaki	Assistant Professor, Department of Applied Sciences and Humanities, Invertis University, Bareilly, U.P.
Sabuj Ghosh	Prof. M. S. Janaki	Credit Risk Analyst at Citicorp Services India Pvt Ltd
Debajyoti Saha	Prof. M. S. Janaki	Senior Geoscientist at GSI, Kolkata
Subha Samanta	Prof. M. S. Janaki	Assistant Professor, Kamarpukur College
Sayanee Jana	Prof. Nikhil Chakrabarti (Retd.)	Assistant Professor, Department of Physics, Bangabasi College, Kolkata
Sourav Pramanik	Prof. Nikhil Chakrabarti (Retd.)	Assistant Professor, IIEST Shibpur
Satyajit Chowdhury	Prof. Nikhil Chakrabarti (Retd.)	Assistant Project Scientist, UCLA, California.
Mithun Karmakar	Prof. Nikhil Chakrabarti (Retd.)	Assistant Professor, Sardar Vallabhbhai National Institute of Technology, Surat.

Prashant Kumar Rout	Prof. Supratik Mukhopadhyay (Retd.), Prof. Satyaki Bhattacharya	Post Doctoral Fellow, Department of Physics, National Central University, Taiwan
Promita Roy	Prof. Supratik Mukhopadhyay (Retd.)	Post Doctoral Fellow, Centre for Neutrino Physics, Department of Physics, Virginia Tech, Virginia, USA
Anil Kumar	Prof. Supratik Mukhopadhyay (Retd.)	Post Doctoral Fellow, Neutrino and Astroparticle Physics Department, DESY, Zeuthen, Brandenburg, Germany
Vishal Kumar	Prof. Supratik Mukhopadhyay (Retd.)	Post Doctoral Fellow, Center for Cosmology, Particle Physics and Phenomenology, Université Catholique de Louvain, Louvain-la-Neuve, Belgium
Wadut Shaikh	Prof. Sukalyan Chattopadhyay (Retd.)	Assistant Professor at Mugberia Gangadhar Mahavidyalaya under Vidyasagar University.
Jhuma Ghosh	Prof. Sukalyan Chattopadhyay (Retd.)	Curator at National Council of Science Museums, Ministry of Culture
Sourav Kumar De	Prof. Chandi Charan De (Retd.)	Postdoctoral Fellow at High Energy Accelerator Research Organization (KEK), Japan.
Ram Sewak	Prof. Chandi Charan De (Retd.)	Project Scientist at IIT Bhubaneshwar
Rajani Raman	Prof. Sandip Sarkar (Retd.)	Post Doctoral Fellow at KU Leuven, Belgium
Rajkumar Santra	Prof. Subinit Roy (Retd.)	Post Doctoral Fellow
Sangeeta Das	Prof. Maitreyee Saha Sarkar (Retd.)	Visiting Assistant Professor at IIEST, Shibpur
Sathi Sharma	Prof. Maitreyee Saha Sarkar (Retd.)	Assistant Professor at the Dept. of Physics, Manipal University, Jaipur

List of Broad Research areas:

1) Experimental Nuclear Physics and Nuclear Astrophysics
2) Experimental Atomic Physics and Quantum Optics
3) Experimental High Energy Physics (International collaborations: CMS, ALICE)
4) Applied Nuclear and High Energy Physics
5) Computational Neuro-Science
6) Observational and Experimental Astroparticle Physics
7) Experimental Neutrino Physics (National collaboration: INO)
8) Phenomenology: High Energy Nuclear Physics at finite temperature/density/magnetic field, Transport phenomena, Collective modes, phase transitions in strongly interacting thermo-magnetic medium, QCD, QGP and Heavy Quarks
9) Non- Linear Phenomena in Plasmas

In addition, the group is responsible for commissioning and utilization of two national facilities:

1) Facility for Research in Experimental Nuclear Astrophysics (FRENA)
2) Jaduguda Underground Science Laboratory (JUSL)

Research area wise distribution of faculty members

Broad Research Area	Names of faculties
Experimental Nuclear Physics and Nuclear Astrophysics (FRENA Facility)	Prof. Akashrup Banerjee Prof. Chinmay Basu Prof. Maitreyee Nandi (RSO) Prof. Ushasi Dutta Prof. Anjali Mukherjee Prof. Subinit Roy (Retd.) Prof. Maitreyee Saha Sarkar (Retd) Prof. Asimananda Goswami (deceased)
Applied Nuclear Physics: Radiation Physics and Dosimetry	Prof. Maitreyee Nandy (RSO)
Experimental Atomic Physics and Quantum Optics	Prof. Sankar De
Phenomenology: High Energy Nuclear Physics at finite temperature/ density/ magnetic field; Collective modes, phase transitions in strongly interacting thermo-magnetic medium; QCD, QGP and Heavy Quarks	Prof. Pradip Kumar Roy Dr. Tinku Sinha Sarkar Prof. Debasish Das

Experimental High Energy Physics (ALICE/CMS)	Dr. Tinku Sinha Sarkar Prof. Debasish Das Prof. Satyaki Bhattacharya Prof. Suchandra Dutta Prof. Subir Sarkar Prof. Nayana Majumdar Prof. Manoj Sharan (Retd.) Prof. Sukalyan Chattopadhyay (Retd.) Prof. Supratik Mukhopadhyay (Retd.)
Applied Nuclear and High Energy Physics	Prof. Nayana Majumdar Prof. PMG Nambissan Prof. Supratik Mukhopadhyay (Retd.) Prof. Chandi Charan Dey (Retd.)
Computational Neuro-Science	Prof. Sandeep Sarkar (Retd.)
Observational and Experimental Astroparticle Physics; JUSL facility	Prof. Pratik Majumdar Prof. Mala Das Prof. Satyajit Saha (Retd.)
Experimental Neutrino Physics	Prof. Nayana Majumdar Prof. Supratik Mukhopadhyay (Retd.)
Non- Linear Phenomena in Plasmas	Prof. M.S. Janaki Prof. Nikhil Chakraborty (Retd.)

Research area wise distribution of students since 2017

Research Area	No. of students awarded Ph.D.	No. of students continuing
Experimental Nuclear Physics and Nuclear Astrophysics	4 + 2 (thesis submitted)	7 + 1 (synopsis submitted; joined BARC)
Experimental Atomic Physics	2	2
Experimental High Energy Physics	13	3
Applied Nuclear and High Energy Physics	3	4
Observational and Experimental Astroparticle Physics	3	5
Experimental Neutrino Physics	3	3
Phenomenology	2	0
Non- Linear Phenomena in Plasmas	9	1

Other points

Key areas in which the Group can make impact in the coming 3 to 5 years:

- Nuclear Astrophysics using FRENA
- Nuclear Physics at intermediate energies: Novel phenomena at isospin degrees of freedom of atomic nuclei using intermediate energies nuclear beam and its impact on cosmology
- Multiwavelength and Multimessenger astrophysics
- Quantum Sensors and Metrology
- ALICE Physics analysis on DiMuon Quarkonia (DQ) & Heavy Flavor Decay Muon (HFM) using Run III data & Phenomenological work.
- Maintenance of Hardware of Station 2 (Muon-Spectrometer) at CERN for smooth running of ALICE experiment
- Detector building for CMS experiments - inner tracker and high granularity calorimeter; calibration, test beam, software development activities for hadron calorimeter, tracker, HGCal
- Contribution to Higgs Physics and Dark Matter search with CMS detector and related phenomenological studies
- Dark Matter search using JUSL facility
- Applied high energy physics experiments pertaining to the non-destructive evaluation of objects using muon tomography.
- Thermodynamics, phase structure, transport phenomena in Rotating magnetized QCD plasma/Hadronic matter

Key areas in which the Group is planning to expand in next 3 to 5 years:

- Nuclear Physics and Nuclear Astrophysics
- Atomic Physics using FRENA, Quantum Sensors and Metrology, Many-Body Physics with Cold and Ultra-cold Atoms.
- High Energy Astroparticle Physics
- Dark Matter search
- High Energy Physics - ALICE Physics analysis on DiMuon Quarkonia (DQ); Heavy Flavor Decay Muon (HFM) using Run III data; Phenomenological work.
- New physics and detector development in CMS experiment during high luminosity LHC run
- Applied High Energy Physics - societal application of muon tomography
- Applied nuclear physics

Faculty members (with their research areas) retired since 2017:

1) Prof. Subinit Roy (Nuclear Physics and Nuclear Astrophysics)
2) Prof. Maitreyee Saha Sarkar (Nuclear Physics and Nuclear Astrophysics)
3) Prof. Asimananda Goswami (Nuclear Physics and Nuclear Astrophysics; deceased)
4) Prof. Nikhil Chakraborty (Non- Linear Phenomena in Plasmas)
5) Prof. Satyajit Saha (Dark Matter search: JUSL facility)

6) Prof. Sandeep Sarkar (Computational Neuro-Science)
7) Prof. Chandi Charan Dey (Applied Nuclear Physics)
8) Prof. Sukalyan Chattopadhyay (Nuclear and High Energy Particle Physics)
9) Prof. Manoj Sharan (High Energy Particle Physics)

Faculty members (with their research areas) recruited since 2017:

1) Dipak Samuel (Applied Nuclear Physics; resigned)
2) Chandan Ghosh (Nuclear Physics and Nuclear Astrophysics; resigned)
3) Akashrup Banerjee (Nuclear Physics and Nuclear Astrophysics)

Number of seminars organized since 2017: 82

Number of summer trainee (SINP / Academies) since 2017: 78

Number of undergraduate trainee (SINP / Academies) since 2017: 21

Number of outreach programs since 2017: 1 (organized) + 37 (participated)

Number of invited talks given by Group members since 2017: 190

Number of publications from Group since 2017: **780+** (including publications from all collaborations)

Instruments/facilities which the Group is planning to install/develop in next 3 to 5 years:

- The plastic scintillator detector coupled with Silicon PhotoMultiplier (SiPM) which can have provision for measuring energy and time of the signals from cosmic-muon particles.
- Digital data acquisition
- Design and Development of Schwarzchild-Couder Telescope, a novel telescope to facilitate improvement in sensitivity in particular to the extended sources in order to study the origin of cosmic raysbeyond hundreds of TeV energies
- Design and development of portable, robust, eco-friendly and cost-effective imaging setup for muon tomography
- Development of (1) Magneto-optical trap (MOT) of cold Rubidium atoms, (2) Rydberg atom-based microwave sensor, and (3) Optical Atomic Magnetometry setup
- Development of large mass superheated liquid detector for Dark Matter search

Number of courses offered by the Group in teaching since 2017: Most of the faculty members teach regularly in Post M.Sc. Course (Basic & Advanced courses, Experimental lab courses, Review projects)

Number of conferences/workshops/schools organized since 2017: 40

List of RA's since 2017

Sl. No.	Name	Research area
1.	Dr. Vishal Srivastava	Nuclear Physics
2.	Dr. Nikit N. Deshmukh	Nuclear Physics
3.	Dr. Dipayan Chattopahyay	Nuclear Physics
4.	Dr. Priya Sharma	Nuclear Physics
5.	Dr. Shareef M.	Nuclear Physics
6.	Dr. Anwesha Basu	Nuclear Physics
7.	Dr. Abhijit Ghosh	Plasma Physics
8.	Dr. Sourav Pramanik	Plasma Physics
9.	Dr. Kanishka Rawat	Detector Development
10.	Dr. Sunil Singh	Atomic Physics
11.	Dr. Nawaz Sarif Mallick (continuing)	Atomic Physics
12.	Dr. Snigdha Ghosh	High Energy Physics
13.	Dr. Indranil Das	High Energy Physics
14.	Dr. Subikash Chowdhury (continuing)	High Energy Physics
15.	Dr. Hushnud Jahan	High Energy Physics
16.	Dr. Surasree Mazumder	High Energy Physics

List of institutions collaborating with the Group:

National

TIFR, Mumbai

BARC, Mumbai

VECC, Kolkata

IUAC, New Delhi

Delhi University

UGC-DAE Consortium Centre for Scientific Research, Kolkata

Institute for Plasma Research

Jadavpur University

University of Calcutta

A.P.C. Roy Government College, Siliguri, West Bengal.

University of Burdwan, Burdwan, West Bengal.

Devamatha College, Kuravilangad, Kottayam, Kerala.

CSIR - Central Glass and Ceramic Research Institute, Jadavpur, Kolkata.

Mahatma Gandhi University, Kottayam, Kerala.

C.M.S. College, Kottayam, Kerala.

University of Mysore, Karnataka.

Indian Institute of Technology, Chennai

Sourashtra University, Rajkot, Gujarat.

Swami Vivekananda Institute of Science and Technology, Kolkata.

Siliguri Institute of Technology, Darjeeling, West Bengal.

Karnataka University, Dharwad, Karnataka.

St. Joseph College, Moolamattam, Kottayam, Kerala.

Aligarh Muslim University, Aligarh, Uttar Pradesh.

Periyar University, Salem, Tamil Nadu.

St. Joseph's College, Devagiri, Kozhikode, Kerala.

Guru Gobind Singh Indraprastha University, New Delhi.

Vidyasagar University, Midnapore, West Bengal.

Regent Educational Research Foundation, Kolkata.

Catholicate College, Patthanamthitta, Kerala.

CSIR – National Metallurgical Laboratory, Dhanbad, Bihar.

National Institute of Technology, Karnataka.

SVKM-NMIMS University, Mumbai.

Marian College Kuttikkanam, Peermade, Kerala.

Santipur College, Nadia

Visva-Bharati, Santiniketan

IIEST Shibpur

IISER, Kolkata

NISER, Bhubaneswar

Khalsa College, Delhi

ADAMAS University, Barasat, Kolkata

Government General Degree College Kharagpur-II

Kalna Govt. College

International

China Institute Atomic Energy, Beijing, China

Ioffe Institute, Saint Petersburg, Russia

GSI, Darmstadt

ISOLDE, CERN

NSCL, USA

MSU, USA

INFN Legnaro

CSIC, Spain

University of Kolon, Germany

JAEA, Japan

Tokyo Metropolitan University, Japan

IPN, Orsay

GANIL, France

Brookhaven National Laboratory (BNL, USA)

Carnegie Mellon University (CMU, USA)

SNOLab, Canada

Laurentian University, Canada

University of Montreal, Canada

Queen's University, Canada

FermiLab, USA

University of Chicago, USA

and several other institutions abroad

Besides these, all participating institutions in **ALICE, CMS and MAGIC collaborations**

Main difficulties faced by the Group since 2017:

- Reduction in Faculty strength. Rate of retirement of faculties is much faster than the rate of recruitment
- Lack of sufficient technical staff in certain laboratories
- Slow purchase procurement process
- Delayed fund arrival for CMS and ALICE projects

List of extramural projects with PI's names since 2017:

1. Prof. Sankar De: PI of a project (Chanakya PDF) under I-HUB Quantum Technology Foundation, IISER, Pune, funded by DST, GOI
2. Prof. Sankar De: Co-PI of approved project under ISRO. Prof. Sangram Bagh of B&SG, SINP is the PI
3. Prof. Sankar De: Co-PI of a DAE-BRNS Project with PI Dr. Subhadeep De of IUCAA, Pune
4. Prof. Pratik Majumdar: Principal Collaborator for a DAE-BRNS Project with PI Dr. Soumyadip Samui of Presidency University
5. Prof. Subir Sarkar & Prof. Suchandra Dutta: Co-PIs of a SERB project, PI: Prof. Prolay Mal, NISER, Bhubaneswar

List of patents since 2017: NIL