CENTRE FOR
S. N. BOSE NATIONAL
BASIC SCIENCES 1986
1894-1974
विज्ञानेन परिपश्यन्ति धीराः

# Satyendra Nath Bose National Centre for Basic Sciences

# ANNUAL REPORT
## 2023-2024

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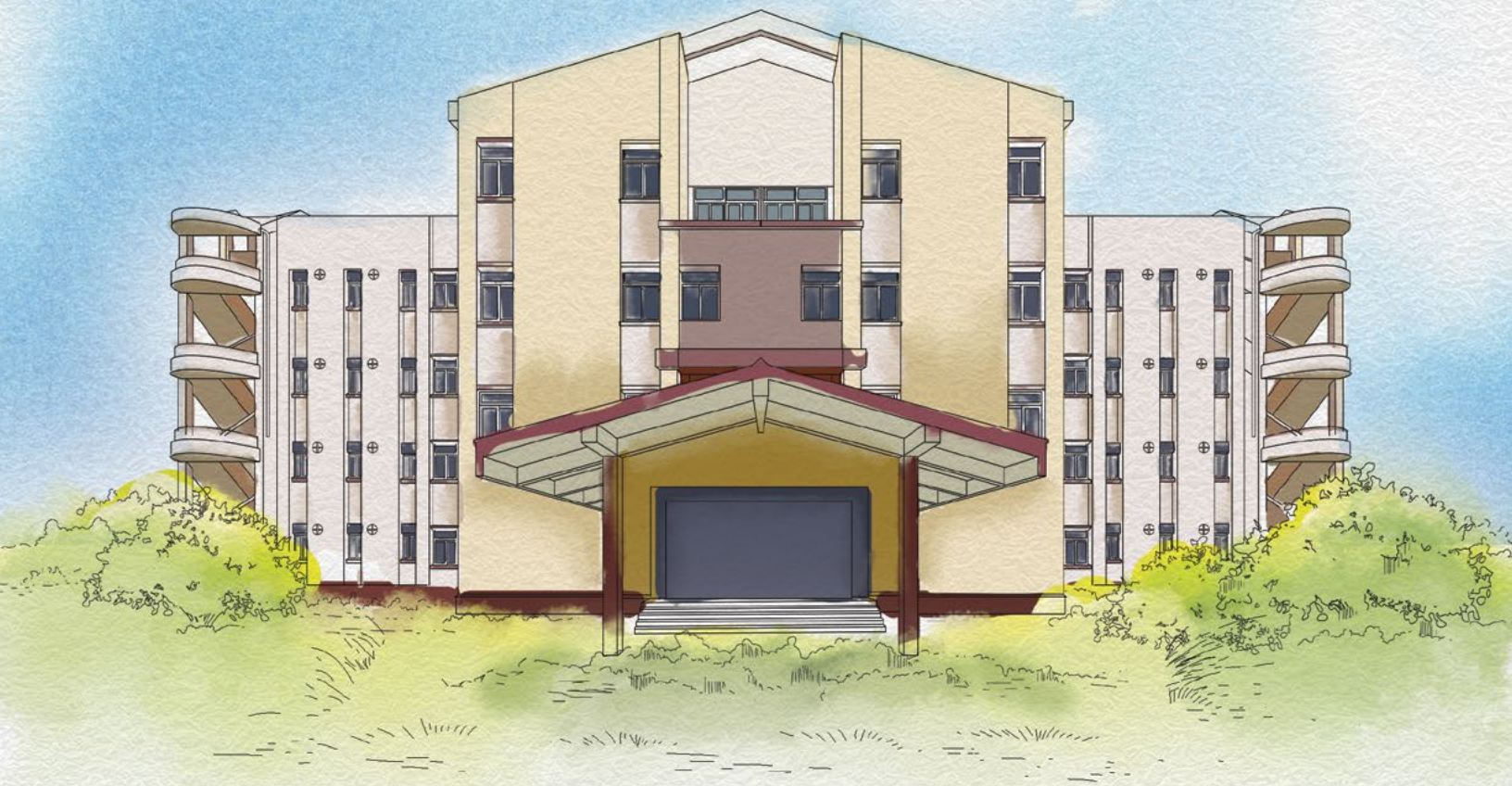
# Satyendra Nath Bose National Centre for Basic Sciences



# ANNUAL REPORT
## 2023-2024

# Academic Highlights

## Areas of focus:

(a) Research on quantum materials and devices
(b) Research on quantum information and communication
(c) Computational study of materials, machine learning
(d) Translational research
(e) Research on observational astrophysics
(f) Research on quantum field theory, statistical physics and non-linear dynamics
(g) Networked research programmes through the visitor and associateship programme.

## Major national facilities created:

**Computational facilities** : S. N. Bose Centre hosts the state-of-the-art and unique supercomputing facilities. Establishment of 838 TF Supercomputing Facility under the National Supercomputing Mission (NSM) jointly steered by the Ministry of Electronics and Information Technology (MeitY) and the Department of Science and Technology (DST).

## Important collaborations (national and global) established:

i) 33 Sponsored projects (INR 2,49,73,471.00)
ii) Collaborative research publications with 92 institutions.

## Objective achieved and future target:

### Objectives achieved:

» Development and advancement of knowledge base, and manpower training in the domain of quantum science and technologies.
» Breakthroughs in advanced materials research from synthesis, characterization and machine learning assisted predictions.
» Connecting translational research with materials and spectroscopic knowledge base.
» Initiation of observational astronomy program in Purulia.

### Future target:

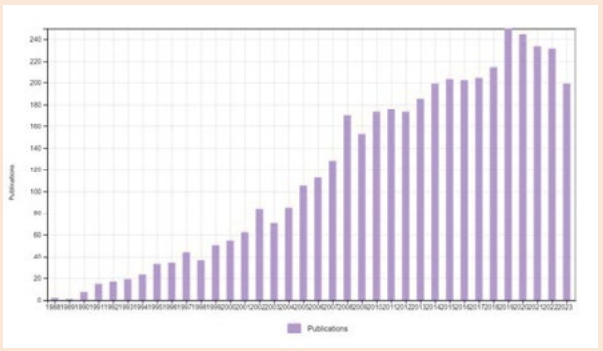
» Strengthening of observational astronomy program.
» Focused research program in areas of quantum devices and advanced materials.
» Connecting to Indian diaspora.

## Important output indicators:

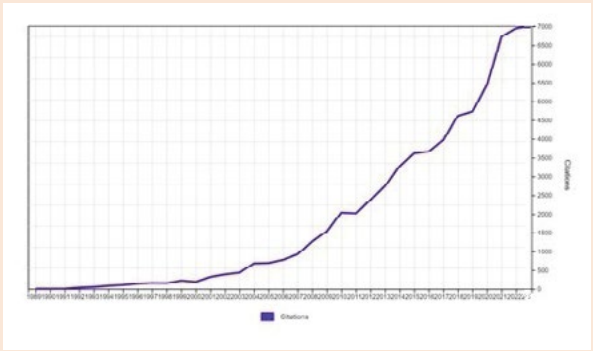
| Sl. No. | Parameters | Output |
|---|---|---|
| 1. | Papers in refereed journals | 249 |
| 2. | Chapters in books | 2 |
| 3. | Papers in conferences | 15 |
| 4. | Number of PhDs | 32 |
| 5. | Indian patents filed / Granted | 13 |
| 6. | Number of Technology leads awaiting transfers | 6 |
| 7. | Number of Technologies / Designs and other IP commercialized | 7 |
| 8. | Technical manpower trained | 16 |
| 9. | Research Manpower trained (other than Ph.D) | 40 |
| 10. | B.Tech / UG Project guided | 1 |
| 11. | M.Tech / M.Sc / M.Phil. project guided | 26 |

## Citation Report Year wise

Time span = All years. Database =SCI-EXPANDED, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC.

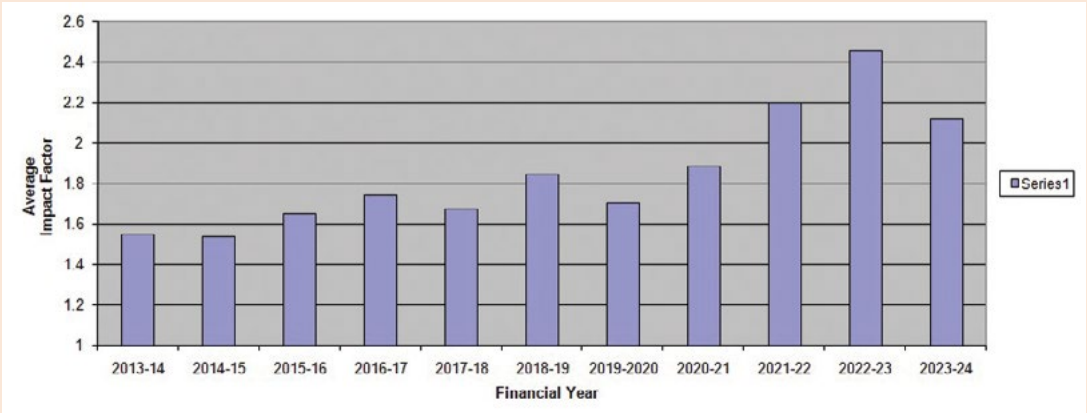


Publications



Citations

Financial Year wise Average Impact Factor Chart




| Total no. of Papers published | Total no. of Citation received | Citations per paper | Citation per year* | h-index |
|---|---|---|---|---|
| 4229 | 68721 | 68721/4229 = 16.25 | 68721 / 37 =1857.32 | 88 |

* Year of establishment of the Centre is 1986. Citations received after 1987 to 2024= 37 years

Source: web of science (as on 03.04.2024)

**Annual Report 2023-2024**
Satyendra Nath Bose National
Centre for Basic Sciences

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# Acknowledgement

Annual Report of the 'Satyendra Nath Bose National Centre for Basic Sciences' is a brief representation of its activities of a financial year. The report reflects research activities, administrative activities, academic progress and achievement of young research scholars, development of infrastructure and facilities, and establishment of network with advanced research groups around the world. It's 14th time I have been assigned the job of compilation of Annual Report of the Centre. To prepare the Annual Report, all the faculty members and sections of the Centre have spent their valuable time to provide respective data. It is a time bound work to be completed within a short span of time. This is the 8th time the Annual Report is translated and typed in Hindi within the Centre. The Office Assistant (Hindi), Renu Singh has given sincere fatigueless effort to translate the entire Annual Report in Hindi and library staff - Amit Roy, Gurudas Ghosh and Ananya Sarkar typed the Annual Report in Hindi within a very limited time period. Words won't be suffice to describe the painstaking labour of Hindi translation team. I would like to acknowledge the sincere efforts and labour of my Library staff - Gurudas Ghosh, Ananya Sarkar and Amit Roy without whom the work could not be completed within the stipulated time. Finally, I would like to thank all the members of the Centre for their cooperation in preparation of the Annual Report of the Centre.


**Saumen Adhikari**
Librarian – cum – Information Officer

# Contents

# Message from the **Director**

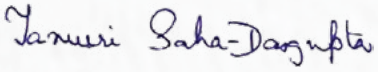
It is my privilege to present the Annual Report of the Satyendra Nath Bose National Centre for Basic Sciences for the year 2023-2024.

This year has been a landmark year for S.N.Bose Centre, as this year marks the beginning of centenary year of famous Bose's statistics, the path breaking paper being published in 1924. The pioneering work of Bose on quantum statistics paved the way for the development of modern quantum technologies including Bose-Einstein condensation, quantum superconductivity, and quantum information theory. Half the fundamental particles in the Universe are named after him – BOSON. Although Bose himself did not get Nobel prize, several Nobel Prizes were later awarded for work related to the boson e.g. 2001 Nobel Prize in physics for 'the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates' and the 2013 Prize 'for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles', namely, the Higgs Boson. On this occasion, S.N. Bose National Centre for Basic Sciences which was established to honor the life and work of Prof. S. N. Bose, is celebrating the centenary of Bose's seminal work by organizing three International Conferences and several Outreach Program throughout the year. The first international conference on this series on the topic of Photonics, Quantum Information, and Quantum Communication took place during Jan 29 - Feb 02, 2024. The conference had 5 plenary sessions, 18 invited talks, 10 contributory talks and almost a hundred posters that brought out theoretical aspects as well as possibilities of practical applications of 'new quantum mechanics. Among the speakers there was a judicious mixture of ace researchers and budding researchers. It was well attended by students and young researchers. The Conference brought out different facets of the exciting new developments in the domain of Ultrafast Photonics, Network Quantum information processing, Quantum network, Quantum Interference. The inaugural session was attended by the Principal Scientific Advisor to the Govt. of India, Prof. Ajay Good and Secretary, DST, Prof. Abhay Karandikar. The conference was followed by outreach program organized by S.N. Bose National Centre in collaboration with Bangiya Vijnan Parishad at Science City. Prof. Charles Bennet, one of the founding fathers of quantum information theory and presently associated with IBM Research, gave the public lecture on 'Occam's Razor, Boltzman's Brain and Wigner's Friend'. The event was attended by science enthusiasts, scientists, science popularizers, science teachers and students. In addition, Centre is organizing several outreach events in partnership with Indian Physics Association and with Bangiya Vijnan Parishad.

Like previous years, the Centre continues to strive for the research excellence in the areas of Quantum Information, Quantum Materials and Devices, Computational Materials Science, Observational Astronomy, Statistical Physics, Physical and Quantum Chemistry interfacing with Biological Molecules, Ionic Liquids. The Centre maintains its high level of productivity with about 8 publications/faculty in the year 2023-2024, and with 32 students graduating. Based on the research carried out by the different groups, several of the scientific stories have been highlighted in DST media cell, as well as covered in their news magazine. The high-level research by faculties has earned several recognitions. Dr. Suman Chakrabarty has been awarded the CRSI Bronze Medal, Dr. Saquib Shamim, has been inducted into the Early Career Researcher Advisory Board of the Physical Review B. Prof. Samir Kumar Pal has been elected as a Fellow of the West Bengal Academy of Science & Technology (WAST), Dr. Shubhasis Haldar has become a member of the International Union of Pure & Applied Biophysics (IUPAB) and elected as INSA ASSOCIATE FELLOWS, Prof. Ranjit Biswas, Senior Professor of the Centre has been elected as a Fellow of the National Academy of Sciences, India (NASI). Seven of the Centre's researchers have been listed in top 2% of the scientists list by Stanford University. The Cenre's excellence in research and development has been recognized with "Ananda Shiksha Shrestha Samman 2024" by ABP Ananda.

As a major national facility, the supercomputing facility has been installed with peak performance of ~ 800 TF under the national supercomputing mission of GOI in collaboration with CDAC. This year the Centre has also embarked on a joint PhD program with IFW Dresden.

I thank all my colleagues, staff and students of the Centre for lending their support in maintaining the high standard that has been set up. I also put on record my gratitude to the members of the Governing body and academic advisory committee for their guidance. I look forward to an even brighter future of the Centre in coming days.



**Tanusri Saha-Dasgupta**
Director
Satyendra Nath Bose National Centre for Basic Sciences

# Dean Faculty

In the year 2024-25, the Centre is celebrating the 100 years of Bose Statistics. To celebrate this occasion, one major International Conference was held during the January 2024 and two more upcoming conferences will be held in the July and November 2024. Besides it, the Centre was involved in several academic activities related to scientific collaborations, hosting various national conferences, workshops, schools, organizing outreach programmes, signing of MOU with various Universities / Institutes. Our faculty members continued to publish in top quality international journals and delivered lectures/seminars in national and international conferences/schools. In this fiscal year, the total number of publications is 249.

Throughout the year, the centre organized numerous seminars, several (sixteen) nos. of Bose & Institute Colloquium and 2 (two) nos. distinguished lectures, namely 26$^{th}$ S. N. Bose Memorial Lecture by Prof. Deepak Dhar on 11.05.2023 and 6$^{th}$ G N Ramachandran Memorial Lecture by Prof. Chandrima Saha on 01.09.2023. Our ongoing collaborations with various institutions in India and abroad in terms of academic visits and exchange programmes including collaborations in conferences, as well as involvement in projects supported by extramural funding further bolstered the research activities of the Centre. During the F.Y. 2023-24, the total number of externally funded projects were 33 which includes 05 no of newly sanctioned projects in that financial year.

## Awards / Recognitions received by Faculty members (both regular and contract)

1. **Prof. Anjan Barman, Senior Professor**
   - » Recipient of Royal Society Wolfson Visiting Fellow ship by the Royal Society, UK in 2023
   - » Featured in top 2% most cited scientists' list released by Stanford University in 2023.
   - » Patent granted on "A Micro or nanoscale Magnetic Material for Filtering Microwave or Submillimeter Waveband Signals".
   - » Invited to join as Associate Editor of the Journal npj Spintronics (Springer – Nature).
2. **Dr. Atindra Nath Pal, Associate Professor**
   - » Recipient of Young Applied Physicist award at the NPC 2024, organized by SRM Chennai
3. **Dr. Pradip S Pachfule, Assistant Professor**
   - » Featured in top 2% most cited scientists' list released by Stanford University in 2023.
4. **Prof. Ranjit Biswas, Senior Professor**
   - » Elected as a Fellow at National Academy of Sciences, Allahabad

**5. Dr. Sakuntala Chatterjee, Associate Professor**

» Invited to join Editorial Board of the Journal of Biosciences

**6. Prof. Samir Kr Pal, Senior Professor**

» Filed Patent for "A portable point-of-care LOPA-Device (Loading of Pathogen Analyzer) for quantitative detection of pathogens".

» Abdul Kalam Technology Innovation National Fellowship 2018 (Indian National Academy of Engineering: INAE) : Extension for another two years.

» Elected as Fellow of the West Bengal Academy of Science & Technology (WAST) 2023.

**7. Dr. Saquib Shamim, Assistant Professor**

» Inducted into the Early Career Advisory Board of the journal Physical Review B

**8. Dr. Shubhasis Haldar, Associate Professor**

» Filed Patent for "Digital cytometric approach, ACSCEND".

» Elected as the Member of Editorial Advisory Board of Biochemistry (American Chemical Society)

» Selected as Associate Fellow in Indian National Science Academy (2023)

» Elected as Member of National Committee for International Union of Pure & Applied Biophysics (IUPAB).

**9. Prof. Soumen Mondal, Professor**

» Filed Patent for "Developing Spectroscopy-based Loading of Parasite Analyzer (LOPA) for Dairy Products".

**10. Dr. Suman Chakrabarty, Associate Professor**

» Selected as the Editorial Board member of Dialogue: Science, Scientists, and Society published by the Indian Academy of Sciences, Bengaluru

**11. Prof. Tanusri Saha Dasgupta, Senior Professor**

» Interview featured in Communication physics [Communications Physics volume 7, Article number: 71 (2024)]

**12. Dr. Tapas Baug, Associate Professor**

» Recognized for excellent contribution to the review of Journal of Astrophysics and Astronomy (September 2023).

**13. Dr. Barnali Ghosh (Saha), Ex- Scientist 'F'& Visiting Scientist**

» Patent granted on "Flexible Thin Film Transistor using Electric Double layer as gate dielectric and a method of fabricating thereof."

» Recipient of Best Paper award for invited lecture presentation in the 'International Conference on Recent Trends in Materials Science & Devices, 2023, (ICRTMD-2023)'.

» Recipient of OUTSTANDING SCIENTIST AWARD in the International Conference for Award Winners in Engineering, Science and Medicine, held on 15 & 16-Apr-2023, Pondicherry.

» Recipient of 'Distinguished Scientist Award ASTRA 2023'under Asia International Science, Technology Research Awards, in Experimental Condensed Matter Physics and Materials Sciences, Nano science and Nanotechnology.

» Recipient of ACS Publication Peer Reviewer Certificate of Recognition & Appreciation, 2023

## New Faculty members joined last year (including Inspire, Ramanujan etc.)

» Dr. Sanku Paul, DST Inspire Faculty, Dept. of PCS – 22.05.2023.

» Dr. Shubhasis Haldar, Associate Professor, Dept. of CBS – 16.06.2023.

» Dr. Parijat Dey, Assistant Professor, Dept. of AHEP – 26.10.2023.

## Faculty members left / retired last year (including Inspire, Ramanujan etc.)

» Dr. Dipanwita Majumdar, DST Inspire Faculty, CMMP – 16.04.2023 (Termination of contract).

» Dr. Suman Chowdhury, DST Inspire Faculty, CMMP – 08.06.2023 (Resigned).

» Dr. Sujoy Ghosh, DST Inspire Faculty, CMMP – 12.01.2024 (Resigned).

» Dr. Manoj Mandal, Ramalingaswami Re-entry Fellow, CBS – 07.02.2024 (Resigned).

» WDr. Rajeswari Roy Chowdhury, DST Inspire Faculty, CMMP – 10.02.2024 (Resigned).

» Dr. Anup Ghosh, DST Inspire Faculty, CMMP – 13.03.2024 (Resigned).

» Dr. Goutam De, Visiting Professor, CBS – 31.03.2024 (Termination of contract).

## Total numbers of Regular / Inspire / Ramanujan / Visiting / Emeritus Faculty etc. as on date [30.06.2024]

- Regular Faculty - 32
- Inspire Faculty – 1
- Ramanujan Fellow – 1
- Emeritus Professor – 1
- Visiting Hon. Faculty – 2
- Visiting Scientist - 1
- Adjunct Faculty / Fellow – 5

## Total no. of PDRA / RA / Project Scientists etc. as on date [30.06.2024]

- PDRA (SNB Funded) – 28
- RA / NPDF / SRA etc. – 3
- Bridge Fellow (SNB Funded) - 10

**Anjan Barman**
Dean (Faculty)

# Dean, Academic Programme

Preparing young scientists for research is an important part of the mandate of the S.N.Bose National Centre for Basic Sciences. The vibrant research atmosphere which pervades the Centre is responsible for producing many distinguished alumni, working in research and training, and also in other fields.

Students who wish to do their PhD research at the Centre must complete their MSc with high scores in the relevant subject, qualify through either a National Eligibility Test such as CSIR-NET or similar, or pass JEST or GATE with a high rank, and then pass an interview taken at the Centre. Students who have provisionally qualified for the DST-INSPIRE Fellowship may also appear for the interview if they satisfy other required academic criteria, but must win the Fellowship and also qualify in a National Level Test in order to continue their PhD. Students who wish to join the Integrated PhD programme after their BSc degree have to qualify through JEST or NGPE and then an interview at the Centre.

In the academic year 2023-24, a total of 26 scholars joined the PhD programme of the Centre. Of these, 3 joined Astrophysics and High Energy Physics, 8 joined Chemical and Biological Sciences, 11 joined Condensed Matter and Materials Physics, and 4 joined Physics of Complex Systems. Theoretical Sciences. Of the total, 4 came from the Centre's own Integrated PhD programme. Apart from these, 14 students joined the Integrated PhD programme of the Centre.

The Centre has recently signed MoUs with the Leibniz Institute for Solid State and Materials Research (IFW) at Dresden, Germany, with Indian Institute of Technology, Bombay, with Presidency University, Kolkata, with Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, and also with the Sidho-Kanho-Birsha University, West Bengal. A total of 5 students from the Centre visited the IFW for 3-6 months, working on joint projects agreed upon under the MoU, from which a few research papers have appeared. A few students will visit the IFW in 2024-25 as well. A few students have also visited IIT Bombay as part of joint projects. The MoU with Presidency University allows students to register there for their PhD, in addition to the current choices, University of Calcutta and Jadavpur University. The MoUs with ARIES and Sidho-Kanho-Birsha University have so far led to a few joint projects on observational astronomy.

A total of 32 students was awarded their PhD degrees during this academic year and another 22 submitted their PhD theses. Several conferences were organized by the Centre, including the International Conference on Photonics, Quantum Information, and Quantum Communication. This was the first of the BoseStat@100 series, three conferences which celebrate the centenary of the epoch-making paper on photon statistics by Satyendranath Bose. The Centre also held many colloquia and seminars, all of them in hybrid mode. The annual students' conference of the Centre, BOSE FEST, was done in physical mode this year and was a resounding success.

Finally, it is a great pleasure to acknowledge enthusiastic cooperation provided by my faculty colleagues, the administrative staff members of the Academic section, and the students, in every official academic work of the Centre. Our achievements would not have been possible without their constant support and hard work.

## COURSES TAUGHT IN 2023-2024

### Integrated Ph.D. Programme in Physical Sciences (IPhD-Ph)

**1st Semester:**

» PHY 401, Mathematical Methods, Sunandan Gangopadhyay & Rabin Banerjee;

» PHY 403, Classical Dynamics, Tapas Baug;

» PHY 405, Quantum Mechanics I, Manik Banik & Sanku Paul;

» PHY 407, Computational Methods in Physics, Suman Chakrabarty;

» PHY 491, Basic Laboratory I, Samir Kumar Pal & Soumen Mondal.

**2nd Semester:**

» PHY 402, Electromagnetic Theory, Amitabha Lahiri;

» PHY 404, Statistical Mechanics, Punyabrata Pradhan;

» PHY 406, Quantum Mechanics II, Arijit Haldar;

» PHY 408, Electronics & Instrumentation, Kalyan Mandal & Avijit Chowdhury;

» PHY 492, Basic Laboratory II, Kalyan Mandal & Avijit Chowdhury.

**3rd Semester:**

» PHY 501, Atomic & Molecular Physics, Anjan Barman & Rajib Kumar Mitra;

» PHY 503, Condensed Matter Physics, Thirupathaiah Setti & Nitesh Kumar;

» PHY 505, Advanced Quantum Mechanics & Applications, Amitabha Lahiri;

» PHY 507, Nuclear & Particle Physics, Ramkrishna Das & Parijat Dey

» PHY 509, Project Research II, Faculty Supervisors;

**4th Semester:**

» PHY 502, Project Research III, Faculty Supervisors;

» PHY 592, Methods of Experimental Physics, Nitesh Kumar, Pradip S Pachfule, Ramkrishna Das & Kalyan Mandal (Coordinator)

» PHY 504, Astrophysics & Astronomy, Ramkrishna Das & Soumen Mondal;

» PHY 512, Advanced Quantum Field Theory, Sunandan Gangopadhyay;

» PHY 528, Mesoscopic Physics, Saquib Shamim;

» PHY 530, Soft Matter, Jaydeb Chakrabarti;

### Ph.D. Course Work Programme

» PHY 601, Research Methodology, Atindra Nath Pal & Prabhat Mandal;

» PHY 602, Review of the Topical Research, Faculty Supervisors;

» PHY/CB 691, Project Research, Faculty Supervisors;

» PHY 603, Condensed Matter Physics, Thirupathaiah Setti & Nitesh Kumar;

» PHY 604, Astrophysics, Soumen Mondal & Ramkrishna Das;

» PHY 607, Nuclear & Particle Physics, Ramkrishna Das & Parijat Dey;

» PHY 622, Correlated Electrons & Disorder, Priya Mahadevan & Manoranjan Kumar;

» PHY 628, Mesoscopic Physics, Saquib Shamim;

» PHY 630, Soft Matter; Jaydeb Chakrabarti

» CB 627, Molecular Physics & Spectroscopy, Rajib Kumar Mitra & Anjan Barman;

» CB 635, Non-equilibrium Statistical Mechanics, Urna Basu;

» CB 640, Study of Biomacromolecules, Suman Chakrabarty & Subhasis Haldar;

» CB 641, Surfaces & Interfaces, Pradip S Pachfule & Ali Hossain Khan;

**Note: Conducted partially in combination with IPhD Programme.**

## Ph.D. THESIS SUBMITTED

1. ***Ultrafast Spin Dynamics in Continuous and Confined Magnetic Thin Film***, Amrit Kumar Mondal, Supervisor: Anjan Barman, in the University of Calcutta, in April, 2023

2. ***Femto and Picosecond Spin Dynamics of Low Dimensional Magnetic Structures***, Koustuv Dutta, Supervisor: Anjan Barman, in the University of Calcutta, in April, 2023

3. ***Investigation of Hybrid Opto-electronic Devices Based on Graphene-Transition Metal Dichalcogenides Heterostructures***, Shubhrasish Mukherjee, Supervisors: Samit Kumar Ray & Atindra Nath Pal, in the University of Calcutta, in May 2023

4. ***A Study Of Cosmology With Gravitational Waves And Primordial Black Holes***, Arnab Sarkar, Supervisors: Archan S Majumdar & Rajesh Kumble Nayak (IISER-K), in the University of Calcutta, in June, 2023

5. ***High-Resolution Spectroscopic Investigations Of Various Trace Gases And Their Isotopologues Using Cavity Ring-Down Spectroscopy***, Biswajit Panda, Supervisor: Manik Pradhan, in the University of Calcutta, in June, 2023

6. ***Investigation of Magnetoelectric Properties in Transition Metal Oxides and Their Applications***, Swarnali Hait, Supervisor: Kalyan Mandal, in the University of Calcutta, in July, 2023
7. ***Investigation on transport and magneto-transport properties of 3d transition metal based compounds***, Sudipta Chatterjee, Supervisors: Kalyan Mandal & Barnali Ghosh (Saha), in the University of Calcutta, in September, 2023
8. ***Spectroscopic Studies On Functional Nanohybrids and Their Potential Biological Applications***, Susmita Mondal, Supervisor: Samir Kumar Pal, in the University of Calcutta, in July, 2023
9. ***Bacterial chemotaxis in a noisy environment***, Shobhan Dev Mandal, Supervisor: Sakuntala Chatterjee, in the University of Calcutta, in August, 2023
10. ***Spectroscopic Studies On Some Biologically Important Systems***, Sumana Pyne, Supervisor: Rajib Kumar Mitra, in the University of Calcutta, in July, 2023
11. ***Investigation of geodesics and shadows of black hole spacetimes***, Anish Das, Supervisor: Sunandan Gangopadhyay, in the University of Calcutta, in July, 2023
12. ***Studies Of Hydrodynamics And Fluctuations In Sandpiles***, Anirban Mukherjee, Supervisor: Punyabrata Pradhan, in the University of Calcutta, in July, 2023
13. ***Duality In Lattice Gauge Theory***, Atul Rathor, Supervisor: Manu Mathur, in the University of Calcutta, in August, 2023
14. ***Magnetic and Microwave Properties of Transitional Metal Oxide Based Nanostructures***, Anupam Gorai, Supervisor: Kalyan Mandal, in the University of Calcutta, in October, 2023
15. ***Structural, Physical, and Electronic Properties Studies of Topological Materials***, Susmita Changdar, Supervisor: Thirupathaiah Setti, in the University of Calcutta, in September, 2023
16. ***Thermodynamic Aspects of Black Holes***, Neeraj Kumar, Supervisor: Sunandan Gangopadhyay, in the University of Calcutta, in December, 2023
17. ***Investigating Electronic and Structural Properties of Hybrid Materials***, Debayan Mondal, Supervisor: Priya Mahadevan, in the University of Calcutta, in December, 2023
18. ***Quasistatic and Ultrafast Magnetization Dynamics in Ferromagnetic Nanostructures***, Arundhati Adhikari, Supervisor: Anjan Barman, in the University of Calcutta, in February, 2024
19. ***Coherent And Incoherent Optical Source Based Cavity Enhanced Absorption Spectroscopy For Trace Molecule Sensing***, Ardhendu Pal, Supervisor: Manik Pradhan, in the University of Calcutta, in February, 2024
20. ***Quantum Phases in Quasi-One Dimensional Frustrated Spin Systems***, Sk Saniur Rahaman, Supervisor: Manoranjan Kumar, in the University of Calcutta, in March, 2024
21. ***Structure and dynamics of modulated colloids: Theoretical studies***, Suravi Pal, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in March, 2024
22. ***Study Of Low Frequency Noise And Electronic Transport in 2D Van-d Atindra Nath Pal er Waals Material And Their Functional Devices***, Shubhadip Moulick, Supervisor: Atindra Nath Pal, in the University of Calcutta, in March, 2024

## Ph.D. AWARD RECEIVED

1. C***ertification And Preservation Of Quantum Correlations***, Shashank Gupta, Supervisor: Archan S Majumdar, in the University of Calcutta, in April, 2023
2. ***Electronic, structural and optical properties of transition metal dichalcogenides heterostructures***, Sumanti Patra, Supervisor: Priya Mahadevan, in the University of Calcutta, in April, 2023
3. ***Studies of Some Biophysical Processes Using Ultrafast Spectroscopic Techniques***, Partha Pyne, Supervisor: Rajib Kumar Mitra, in the University of Calcutta, in April, 2023
4. ***Study of Novae Properties***, Ruchi Pandey, Supervisor: Ramkrishna Das, in the University of Calcutta, in May, 2023
5. ***The electronic and structural properties of semiconductor heterostructures***, Joydeep Chatterjee, Supervisor: Priya Mahadevan, in the University of Calcutta, in July, 2023
6. ***Spectroscopic Studies On Functional Nanohybrids and Their Potential Biological Applications***, Arpan Bera, Supervisor: Samir Kumar Pal, in the University of Calcutta, in July, 2023
7. ***Understanding the Atmosphere of Brown Dwarfs and Low Mass Stars***, Samrat Ghosh, Supervisors: Soumen Mondal, in University of Calcutta, in August, 2023
8. ***Applications of the functional renormalization group in cosmology and black hole thermodynamics***, Rituparna Mandal, Supervisor: Sunandan Gangopadhyay, in the University of Calcutta, in August, 2023
9. ***Relativistic quantum systems in the framework of quantum information and quantum foundations***, Riddhi Chatterjee, Supervisor: Archan S Majumdar, in University of Calcutta, in August, 2023

10. ***Generalised Entropy In Dynamical System And Information Theory***, Souma Mazumdar, Supervisor: Partha Guha, in the University of Calcutta, in September, 2023

11. ***Various Aspects Of Positive Maps In Quantum Information Theory***, Bihalan Bhattacharya, Supervisor: Archan S Majumdar, in the University of Calcutta, in September, 2023

12. ***Understanding Physical Properties Of M-dwarfs: Optical And Near-IR Spectroscopic Studies***, Dhrimadri Khata, Supervisors: Soumen Mondal & Ramkrishna Das, in the University of Calcutta, in September, 2023

13. ***Properties of materials at interfaces***, Edwine Tendong, Supervisors: Tanusri Saha Dasgupta & Jaydeb Chakrabarti, in the University of Calcutta, in September, 2023

14. ***Synthesis, Characterization, Transport and Electronic Structure Studies of Transition Metal Dichalcogenides***, Indrani Kar, Supervisor: Thirupathaiah Setti, in University of Calcutta, in September, 2023

15. ***Investigation On Nanostructured Piezoelectric Materials For Energy Harvesting***, Snehamoyee Hazra, Supervisor: Barnali Ghosh (Saha), in the University of Calcutta, in September, 2023

16. ***A Multiwavelength Study Of Galactic Star-forming Regions***, Alik Panja, Supervisor: Soumen Mondal, in the University of Calcutta, in October, 2023

17. ***Theoretical Investigations of Superconducting Pairing Mechanisms in Correlated Fermionic Systems***, Koushik Mandal, Supervisors: Ranjan Chaudhury & Manoranjan Kumar, in the University of Calcutta, in October, 2023

18. ***Growth, Characterization, Optoelectronic And Thermal Properties Of Novel Germanium Nanostructures***, Vishal Kumar Aggarwal, Supervisors: Manik Pradhan & Arup K Raychaudhuri, in the University of Calcutta, in October, 2023

19. ***Opto-electronic, Electrical and Spectroscopic Studies of Some Two-Dimensional Materials***, Didhiti Bhattacharya, Supervisors: Samit Kumar Ray & Rajib Kumar Mitra, in the University of Calcutta, in October, 2023

20. ***Studies of hydrodynamics and uctuations in mass transport processes***, Dhiraj Tapader, Supervisor: Punyabrata Pradhan, in the University of Calcutta, in December, 2023

21. ***Aspects of Quantum Correlations in Information Processing***, Shounak Datta, Supervisor: Archan S Majumdar, in the University of Calcutta, in December, 2023

22. ***Optical Spectroscopy and Ab-Initio Study on Biocompatible Nanohybrids for Their Potential Biomedical and Environmental Applications***, Md Nur Hasan, Supervisors: Samir Kumar Pal & Debjani Karmakar (BARC), in the University of Calcutta, in December, 2023

23. L***arge Magneto-functional responses in transition metal-based alloys: Protocol dependence across martensitic phase transition***, Saheli Samanta, Supervisor: Kalyan Mandal, in the University of Calcutta, in January, 2024

24. ***Synthesis, Characterization, Physical Property Studies & Applications Of Perovskite Halide***, Avisek Maity, Supervisor: Barnali Ghosh (Saha), in the University of Calcutta, in January, 2024

25. ***Growth, Structure And Physical Properties Of Strained NdNiO3 Films***, Parushottam Majhi, Supervisors: Barnali Ghosh (Saha) & Arup K Raychaudhuri, in the University of Calcutta, in January, 2024

26. ***Some Applications of Quantum Field Theoretic Dualities to Superconducting Systems***, Shantonu Mukherjee, Supervisor: Amitabha Lahiri, in the University of Calcutta, in January, 2024

27. ***Microscopic insights to relaxation phenomena in proteins***, Abhik Ghosh Moulick, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in January, 2024

28. ***Manipulation Of Soft Matter System In Nonequilibrium Conditions***, Rahul Karmakar, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in January, 2024

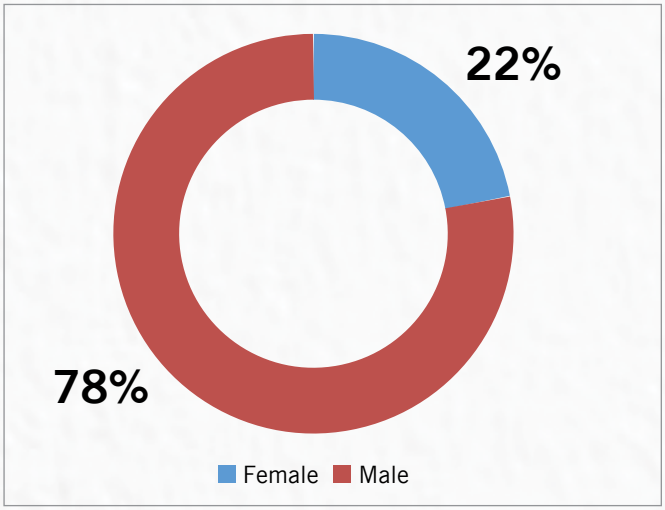
29. ***Some Physical And Mathematical Aspects Of Non-commutative Geometry***, Anwesha Chakraborty, Supervisor: Biswajit Chakraborty, in the University of Calcutta, in January, 2024

30. ***Application of the Gauge/Gravity Duality in Physical Systems***, Ankur Srivastav, Supervisor: Sunandan Gangopadhyay, in the University of Calcutta, in February, 2024

31. ***Computation Based Understanding And Prediction Of Technologically Important Indigenous Materials***, Shiladitya Karmakar, Supervisor: Tanusri Saha Dasgupta, in the University of Calcutta, in February, 2024

32. ***Influence of molecular orientation on the electronic transport of a metal-molecular-metal junction***, Biswajit Pabi, Supervisor: Atindra Nath Pal, in the University of Calcutta, in March, 2024

## Gender Ratio of Students




(As on date 31.03.2024)

## POST-PhD PLACEMENT

Shashank Gupta – Postdoctoral Fellow at OIST,JAPAN

Sumanti Patra - Post Doctoral Research Associate, Universitat Hamburg, Germany

Partha Pyne - Postdoctoral Fellow, Max Planck Institute for Multidisciplinary Sciences, Gottingen, Germany

Ruchi Pandey - Post-doctoral Fellow at Physical Research Laboratory, Ahmedabad

Arpan Bera - Post-doctoral Fellow at School of Physical Sciences, Indian Association for the Cultivation of Science (IACS), Jadavpur

Samrat Ghosh – Postdoctoral Researcher, ARIES, Nainital

Rituparna Mandal - Post-doctoral Researcher, University of Hyderabad

Riddhi Chatterjee - Visiting Researcher (PostDoc), Indian Institute of Science Education and Research Kolkata

Bihalan Bhattacharya - Research Associate, IISER, Berhampur, Orisha

Dhrimadri Khata - Postdoctoral Fellow, Indian Institute of Astronomy (IIA), Bangalore

Edwine Tendong – Research Assistant, African Institute for Mathematical Sciences (AIMS), Cameroon

Indrani Kar - ICTP-TRIL postdoctoral fellowship, CNR-IOM Institute, Italy

Snehamoyee Hazra- Post Doctoral Research Assistsnt, IISc. Bangalore

Koushik Mandal - Post-Doctoral Fellow, Institute of Physics, Bhubaneswar

Vishal Kumar Aggarwal - Assistant Professor, Department of Physics, K L P College, Rewari, Haryana

Dhiraj Tapader - SME (Applied science), ZURU Tech

Md Nur Hasan - Postdoctoral researcher, Uppsala University, Sweden

Saheli Samanta – Post Doctoral Research Assistsnt, TIFR

Avisek Maity - Research Assistant, University of Texas at Dallas

Abhik Ghosh Moulick - Visiting Research Scholar, City University of New York, USA

Rahul Karmakar - Post Doctoral Research Scholar, IIT-Madras

Anwesha Chakraborty – Post Doctoral Research Assistsnt, University of Melbourne, Australia

Ankur Srivastav – Post Doctoral Research Assistsnt, Theoretical Physicist at Vahrenwalder Str. Hannover

Biswajit Pabi - Postdoctoral Fellow, Kiel University, Germany

Koustuv Dutta – Reliance Infotech, Jamnagar

Shubhrasish Mukherjee – Scientist C, TRC Project, SNBNCBS

Susmita Changdar - Postdoctoral Fellow, IFW Dresden, Germany

Ardhendu Pal - Post-doctoral Researcher, CNRS, GSMA, UMR, France

Biswajit Panda - Senior Technical Services & Support Engineer, New Age Instruments & Materials, Gurgaon, Hariyana

Anirban Mukherjee – Post Doctoral Research Assistsnt, Institute of Physics, Academic Sinica, Taiwan

Arundhati Adhikari – NPDF, IISER, Bhopal

Shantonu Mukherjee - Postdoctoral Fellow, Indian Institute of Technology, Bombay

Alik Panja – Post Doctoral Research Assistsnt, IIA, Bangalore

Didhiti Bhattacharya - – Scientist C, TRC Project, SNBNCBS

Shiladitya Karmakar - Post Doctoral Research Assistsnt, Institute of physics of the Czech Academy of Sciences

Amrit Kumar Mondal - Post Doctoral Research Assistsnt, University of Delaware, USA

Swarnali Hait – Post Doctoral Research Assistsnt, Universite de Bourgogne, France

Sudipta Chatterjee - Post Doctoral Research Assistsnt, University of Princeton, USA

Arundhati Adhikari – NPDF, IISER, Bhopal

Sk Saniur Rahaman – Post Doctoral Research Assistsnt, IMSc., Chennai

Suravi Pal - Postdoctoral Researcher, Nagoya University, Japan

## PhD and Integrated PhD Research Scholars of the Centre

(values within brackets indicate source of external funding)

(names marked with * indicates scholars under Integrated PhD programme)

| Name | Designation | Batch (JRF) | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Anupam Gorai* | SRF | 2017-18 | Kalyan Mandal | 31.10.2023 |
| Atul Rathod* | SRF | 2017-18 | Punyabrata Pradhan (O) | 31.07.2023 |
| Sudip Majumdar* | SRF | 2017-18 | Anjan Barman & Rajib Kumar Mitra | 23.08.2023 |
| Swarnali Hait* | SRF | 2017-18 | Kalyan Mandal | 31.07.2023 |
| Abhik Ghosh Moulik (INSPIRE) | SRF | 2017-18 | Jaydeb Chakrabarti | 13.04.2023 |
| Amrit Kumar Mondal | SRF | 2017-18 | Anjan Barman | 30.04.2023 |
| Anirban Mukherjee | SRF | 2017-18 | Punyabrata Pradhan | 31.07.2023 |
| Biswajit Pabi (INSPIRE) | SRF | 2017-18 | Atindra Nath pal | 19.05.2023 |
| Dhrubajyoti Majhi (INSPIRE) | SRF | 2017-18 | Ranjit Biswas | 13.03.2024 |
| Jayanta Mondal (INSPIRE) | SRF | 2017-18 | Ranjit Biswas | 13.03.2024 |
| Rafiqul Alam (INSPIRE) | SRF | 2017-18 | Atindra Nath Pal | 13.03.2024 |
| Rahul Karmakar (INSPIRE) | SRF | 2017-18 | Jaydeb Chakrabarti | 13.04.2023 |
| Samir Rom* | SRF | 2017-18 | Tanusri Saha Dasgupta | |
| Shiladitya Karmakar | SRF | 2017-18 | Tanusri Saha Dasgupta | 11.08.2023 |
| Siddhartha Biswas (INSPIRE) | SRF | 2017-18 | Soumen Mondal | |
| Sk Saniur Rahaman (UGC) | SRF | 2017-18 | Manoranjan Kumar | |
| Sudipta Chatterjee | SRF | 2017-18 | Kalyan Mandal and Barnali Ghosh (Saha) | 18.09.2023 |
| Achintya Low* | SRF | 2018-19 | Thirupathaiah Setti | |
| Ankur Srivastav* | SRF | 2018-19 | Sunandan Gangopadhyay | 31.07.2023 |
| Anwesha Chakraborty* | SRF | 2018-19 | Biswajit Chakraborty | 31.07.2023 |
| Neeraj Kumar* | SRF | 2018-19 | Sunandan Gangopadhyay | 25.11.2023 |
| Sayan Routh* | SRF | 2018-19 | Thirupathaiah Setti | |
| Anish Das | SRF | 2018-19 | Sunandan Gangopadhyay | 31.07.2023 |
| Biswajit Panda | SRF | 2018-19 | Manik Pradhan | 31.07.2023 |
| Debayan Mondal (CSIR) | SRF | 2018-19 | Priya Mahadevan | 18.12.2023 |
| Deepsikha Das | SRF | 2018-19 | Punyabrata Pradhan & Sakuntala Chatterjee | |
| Jyotirmoy Sau (UGC) | SRF | 2018-19 | Manoranjan Kumar | |
| Md Nur Hasan (CSIR) | SRF | 2018-19 | Samir Kumar Pal | 01.08.2023 |
| Monalisa Chatterjee (INSPIRE) | SRF | 2018-19 | Manoranjan Kumar | |
| Narayan Chandra Maity (CSIR) | SRF | 2018-19 | Ranjit Biswas | |
| Prasun Boyal (CSIR) | SRF | 2018-19 | Priya Mahadevan | |
| Pratap Kumar Pal (CSIR) | SRF | 2018-19 | Anjan Barman | |
| Premashis Kumar | SRF | 2018-19 | Gautam Gangopadhyay | 31.01.2024 |
| Shobhan Dev Mandal (CSIR) | SRF | 2018-19 | Sakuntala Chatterjee | 31.08.2023 |
| Sumana Pyne | SRF | 2018-19 | Rajib Kumar Mitra | 31.07.2023 |

| Name | Designation | Batch (JRF) | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Suravi Pal | SRF | 2018-19 | Jaydeb Chakrabarti | 27.12.2023 |
| Susmita Changdar (UGC) | SRF | 2018-19 | Thirupathaiah Setti | 30.09.2023 |
| Susmita Mondal | SRF | 2018-19 | Samir Kumar Pal | 01.08.2023 |
| Tanmoy Chakraborty (CSIR) | SRF | 2018-19 | Punyabrata Pradhan | |
| Manjari Dutta* | SRF | 2019-20 | Sunanadan Gangopadhyay | |
| Nivedita Pan* | SRF | 2019-20 | Samir Kumar Pal | |
| Riju Pal* | SRF | 2019-20 | Atin pal | |
| Shubham Purwar* | SRF | 2019-20 | Thirupathaiah Setti | |
| Abhinandan Das | SRF | 2019-20 | Suman Chakrabarty | |
| Amrita Mondal | SRF | 2019-20 | Ranjit Biswas | |
| Anirban Paul (CSIR) | SRF | 2019-20 | Jaydeb Chakrabarti | |
| Ardhendu Pal | SRF | 2019-20 | Manik Pradhan | |
| Arun Kumar Das | SRF | 2019-20 | Archan S. Majumdar | |
| Gesesew Reta Habtie (TWAS-BOSE) | SRF | 2019-20 | Ramkrishna Das | |
| Kanchan Meena (CSIR) | SRF | 2019-20 | Prosenjit Singha Deo | |
| Krishnendu Patra | SRF | 2019-20 | Priya Mahadevan | |
| Krishnendu Sinha | SRF | 2019-20 | Suman Chakraborty | |
| Manodip Routh | SRF | 2019-20 | Manoranjan Kumar | |
| Ria Saha | SRF | 2019-20 | Rajib Kumar Mitra | |
| Soma Dutta | SRF | 2019-20 | Anjan Barman | |
| Sreya Pal (CSIR) | SRF | 2019-20 | Anjan Barman | |
| Subhajit Kar | SRF | 2019-20 | Ramkrishna Das | |
| Subhankar Bera | SRF | 2019-20 | Archan S. Majumdar | |
| Animesh Hazra * | SRF | 2020-21 | Punyabrata Pradhan | |
| Anirban Roychowdury * | SRF | 2020-21 | Sunandan Gangopadhyay | |
| Arnab Chakraborty * | SRF | 2020-21 | Amitabha Lahiri | |
| Avik Sasmal * | SRF | 2020-21 | Jaydeb Chakrabarti | |
| Ishita Jana * | SRF | 2020-21 | Kalyan Mandal | |
| Rajdeep Biswas * | SRF | 2020-21 | Tanusri Saha Dasgupta | |
| Soham Saha * | SRF | 2020-21 | Kalyan Mandal | |
| Soumen Mandal * | SRF | 2020-21 | Manik Pradhan | |
| Aishwaryo Ghosh (INSPIRE) | SRF | 2020-21 | Tanusri Saha Dasgupta | |
| Ankit Mandal (INSPIRE) | SRF | 2020-21 | Prasanta Panigrahi (IISER-K) & Sunandan Gangopadhyay | |
| Ariful Hoque (CSIR) | SRF | 2020-21 | Tapas Baug | |
| Chandradip Khamrai (CSIR) | SRF | 2020-21 | Sakuntala Chatterjee | |
| Indrajit Ghose | SRF | 2020-21 | Amitabha Lahiri | |
| Koushik Pradhan | SRF | 2020-21 | Tanusri Saha Dasgupta | |
| Manoj Gupta (CSIR) | SRF | 2020-21 | Tanusri Saha Dasgupta | |
| Rajib Kumbhakar (INSPIRE) | SRF | 2020-21 | Soumen Mondal | |

| Name | Designation | Batch (JRF) | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Ramesh Pramanik (CSIR) | SRF | 2020-21 | Sakuntala Chatterjee | |
| Rik Niranjan Mukherjee (INSPIRE) | SRF | 2020-21 | Ranjit Biswas & Pradip K Ghorai (IISER-K) | |
| Ritwick Sarkar (CSIR) | SRF | 2020-21 | Urna Basu | |
| Riya Barick | SRF | 2020-21 | Amitabha Lahiri | |
| Sanuja Kumar Khuntia (UGC) | SRF | 2020-21 | Priya Mahadevan | |
| Shashank Shekhar Pandey (CSIR) | SRF | 2020-21 | Archan S. Majumdar | |
| Shinjini Paul (INSPIRE) | SRF | 2020-21 | Priya Mahadevan | |
| Suchetana Mukhopadhyay (INSPIRE) | SRF | 2020-21 | Anjan Barman & Chiranjit Mitra (IISER-K) | |
| Sudipta Mitra | SRF | 2020-21 | Ranjit Biswas | |
| Ajay Sharma * | SRF | 2021-22 | Sakuntala Chatterjee and Debanjan Bose | |
| Arnab Paul * | SRF | 2021-22 | Tanusri Saha Dasgupta | |
| Banik Rai * | SRF | 2021-22 | Nitesh Kumar | |
| Dibyendu Maity * | SRF | 2021-22 | Suman Chakrabarty | |
| J Sridhar Mohanty * | SRF | 2021-22 | Kalyan Mandal | |
| Jayarshi Bhattacharya * | SRF | 2021-22 | Gautam Gangopadhyay | |
| Sagar Kumar Maity * | SRF | 2021-22 | Amitabha Lahiri | |
| Saurav Kantha*# | JRF | 2021-22 | Amitabha Lahiri | 10.08.2023 |
| Soham Sen * | SRF | 2021-22 | Sunandan Gangopadhyay | |
| Arnab Mukherjee | SRF | 2021-22 | Archan S. Majumdar | |
| Avijit Mandal | SRF | 2021-22 | Ramkrishna Das | |
| Bikash Chandra Mishra (CSIR) | SRF | 2021-22 | Pradip S. Pachfule | |
| Bivas Mallick (INSPIRE) | SRF | 2021-22 | Archan S. Majumdar | |
| Chandan Kumar | SRF | 2021-22 | Anjan Barman | |
| Nishant Garg # | JRF | 2021-22 | Tapas Baug | 8.07.2023 |
| Rupayan Saha# | JRF | 2021-22 | Punyabrata Pradhan | 29.02.2024 |
| Saheli Mukherjee | SRF | 2021-22 | Archan S. Majumdar | |
| Saikat Mitra | SRF | 2021-22 | Avijit Chowdhury and Barnali Ghosh (Saha) | |
| Sayan Ghosh (INSPIRE) | SRF | 2021-22 | Manoranjan Kumar | |
| Shivam Jani | SRF | 2021-22 | Priya Mahadevan | |
| Soumya Ghorai (UGC) | SRF | 2021-22 | Thirupathaiah Setti | |
| Soumyadipta Chakraborty | SRF | 2021-22 | Manik Pradhan | |
| Sourabh Saha (INSPIRE) | SRF | 2021-22 | Manoranjan Kumar | |
| Sourav Sarkar (INSPIRE) | SRF | 2021-22 | Kalyan Mandal | |
| Ananya Chakraborty * | JRF | 2022-23 | Manik Banik | |
| Devangshu Roy *# | JRF | 2022-23 | Prosenjit Singha Deo | 10.05.2023 |
| Pritam Roy * | JRF | 2022-23 | Archan S. Majumdar | |

| Name | Designation | Batch (JRF) | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Sudip Chakrabarty * | JRF | 2022-23 | Archan S. Majumdar | |
| Aman Das (UGC) | JRF | 2022-23 | Tapas Baug | |
| Anusree Sen | JRF | 2022-23 | Rajib Kumar Mitra and Jaydeb Chakrabarti | |
| Anutosh Biswas | JRF | 2022-23 | Manoranjan Kumar and Tanusri Saha Dasgupta | |
| Anyesh Saraswati | JRF | 2022-23 | Nitesh Kumar | |
| Aritra Marick (UGC) | JRF | 2022-23 | Rajib Kumar Mitra | |
| Bidhan Kumbhakar (UGC) | JRF | 2022-23 | Pradip S. Pachfule | |
| Bikram Baghira (UGC) | JRF | 2022-23 | Anjan Barman | |
| Dayal Das (UGC) | JRF | 2022-23 | Atindra Nath Pal | |
| Dorothy Museo Mwanzia (TWAS-BOSE) | JRF | 2022-23 | Soumen Mondal | |
| Govind Lal Sidhardh (CSIR)# | JRF | 2022-23 | Manik Banik | 27.05.2023 |
| Indrayani Patra (UGC) | JRF | 2022-23 | Manik Pradhan | |
| Madhurita Das (INSPIRE) | JRF | 2022-23 | Priya Mahadevan | |
| Muhammad Usman Shehu (TWAS-BOSE) | JRF | 2022-23 | Tapas Baug | |
| Mukul Biswas (UGC) | JRF | 2022-23 | Avijit Chowdhury | |
| Pallabi Roy | JRF | 2022-23 | Sakuntala Chatterjee and Gautam Gangopadhyay | |
| Prosanta Sarkar (UGC) | JRF | 2022-23 | Tanusri Saha Dasgupta and Goutam Dev Mukherjee (IISER-K) | |
| Rajesh Jana | JRF | 2022-23 | Avijit Chowdhury | |
| Sabuj Mandal | JRF | 2022-23 | Jaydeb Chakrabarti | |
| Sahil Gopalkrishna Naik (CSIR) | JRF | 2022-23 | Manik Banik | |
| Shah Imtajul Haque (UGC) | JRF | 2022-23 | Rajib Kumar Mitra | |
| Sk Sahil # | JRF | 2022-23 | Ramkrishna Das | 13.09.2023 |
| Sreyan Bhowmick | JRF | 2022-23 | Suman Chakrabarty | |
| Subhajit Mondal (UGC) | JRF | 2022-23 | Saquib Shamim | |
| Subhankar De (INSPIRE) | JRF | 2022-23 | Atindra Nath Pal | |
| Sudip Pramanik | JRF | 2022-23 | Soumen Mondal | |
| Sutanu Mukhopadhyay (INSPIRE) | JRF | 2022-23 | Suman Chakrabarty | |
| Swapnamoy Pramanik (UGC) | JRF | 2022-23 | Avijit Chowdhury | |
| Anish Chaudhuri * | JRF | 2023-24 | Arijit Haldar | |
| Debraj Dutta * | JRF | 2023-24 | Urna Basu | |
| Sayari Bhattacharya * | JRF | 2023-24 | Suman Chakrabarty | |
| Souvik Paul * | JRF | 2023-24 | Sunandan Gangopadhyay | |
| Anuradha Sett | JRF | 2023-24 | Manik Pradhan | |
| Asesh Bera | JRF | 2023-24 | Rajib Kumar Mitra | |
| Avanti Chakraborty (CSIR) | JRF | 2023-24 | Pradip S. Pachfule | |

| Name | Designation | Batch (JRF) | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Avirup Chakraborty | JRF | 2023-24 | Soumen Mondal | |
| Debangshu Kalita# | JRF | 2023-24 | | 07.10.2023 |
| Debashruti Maity | JRF | 2023-24 | Shubhasis Haldar | |
| Debojit Sen | JRF | 2023-24 | Sakuntala Chatterjee | |
| Dhritisundar Paramanik | JRF | 2023-24 | Atindra Nath Pal | |
| Dinesh Chandra Dey | JRF | 2023-24 | Manik Pradhan | |
| Kakan Deb | JRF | 2023-24 | Nitesh Kumar | |
| Modhumita Sariket | JRF | 2023-24 | Nitesh Kumar | |
| Najrul Islam | JRF | 2023-24 | Saquib Shamim | |
| Sayan Mathur | JRF | 2023-24 | Anjan Barman | |
| Sayanti Mondal | JRF | 2023-24 | Anjan Barman | |
| Subhadeep Mukherjee (CSIR) | JRF | 2023-24 | Archan S. Majumdar | |
| Supriti Dutta | JRF | 2023-24 | Pradip S. Pachfule | |

#Left without completing the programme

## Research Scholars of under Extramural Projects

| Name | Designation | Batch | Supervisor | Date of Leaving |
|---|---|---|---|---|
| Suranjana Chakraborty (Project) | Project Assistant | 2020-21 | Anup Ghosh | |
| Ria Ghosh (Project) | SRF | 2021-22 | Samir Kumar Pal | |

## Integrated PhD Scholars of the Centre

| Name | Designation | Batch | Date of Leaving |
|---|---|---|---|
| Debendra Meher | IPhD Student | 2021-22 | 20.07.2023 |
| Partha Patra | IPhD Student | 2021-22 | 20.07.2023 |
| Prapti Mukherjee | IPhD Student | 2021-22 | 28.07.2023 |
| Prerak Gupta | IPhD Student | 2021-22 | 20.07.2023 |
| Shrabasti Banerjee | IPhD Student | 2021-22 | 19.07.2023 |
| Arpita Jana | IPhD Student | 2022-23 | |
| Dipyendu Dhar | IPhD Student | 2022-23 | |
| Keshav Saw | IPhD Student | 2022-23 | |
| Najrul Ansary | IPhD Student | 2022-23 | |
| Rakesh Ghosh | IPhD Student | 2022-23 | |
| Rudra Prosad Sarkar | IPhD Student | 2022-23 | |
| Sakshi Chaudhary | IPhD Student | 2022-23 | |
| Shaheerah Shahid | IPhD Student | 2022-23 | |
| Sourav Mandal | IPhD Student | 2022-23 | |
| Sumit Yadav | IPhD Student | 2022-23 | |
| Trisha Mishra | IPhD Student | 2022-23 | |
| Anol Bandyopadhyay | IPhD Student | 2023-24 | |
| Bipasa Hazra | IPhD Student | 2023-24 | |
| Dhananjoy Ghosh | IPhD Student | 2023-24 | |

| Name | Designation | Batch | Date of Leaving |
|---|---|---|---|
| Indrajit Banerjee | IPhD Student | 2023-24 | |
| Kapil Gope | IPhD Student | 2023-24 | |
| Koushik Das | IPhD Student | 2023-24 | |
| Md Sanowaz Molla | IPhD Student | 2023-24 | |
| Ritam Mahanta | IPhD Student | 2023-24 | |
| Sauptik Sadhukhan | IPhD Student | 2023-24 | |
| Shibcharan Mahato | IPhD Student | 2023-24 | |
| Subhanker Dutta | IPhD Student | 2023-24 | |
| Subhransu Dey | IPhD Student | 2023-24 | |
| Sudip Ghorai | IPhD Student | 2023-24 | |
| Thansingh Jankawat | IPhD Student | 2023-24 | |

## Part Time PhD Scholars of the Centre

| Name | Designation |
|---|---|
| Sukanta Bhattacharyya, West Bengal State University, under Sunandan Gangopadhyay | Research Scholar (Part Time) |
| Soumita Chakraborty, under Prof. Soumen Mondal | Research Scholar (Part Time) |

**Amitabha Lahiri**
Dean, Academic Programme

# Extended Visitors and Linkage Programme

## General Activities:

### Foundation Day

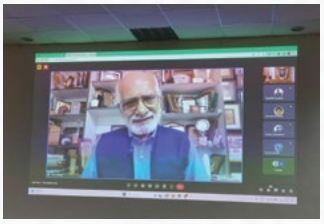
The Centre celebrated its 37th Foundation Day on 13th June, 2023. The programme was inaugurated by Prof. B. N. Jagatap, IIT Bombay and Chairman, Governing Body, SNBNCBS followed by welcome address by Prof. Tanusri Saha Dasgupta, Director, SNBNCBS. On this auspicious occasion, the virtual tour of the Bose Archive and Museum was inaugurated (link https://www.bose.res.in/bosearchive). Dr. Manik Banik, Associate Professor delivered scientific talk on "The Nature is Nonlocal Ultimately". The toppers of Integrated PhD (M.Sc.) from last 5 years were awarded with medals and two best teachers were awarded with memento and book grant. The programme ended with classical musical performance by external artist.

## IMPACT-2023: The Alumni Meet

The Centre organized IMPACT-2023: The Alumni Meet on 28th December, 2023 with the aim to renew and reinvigorate the bonding between the past and present researchers. The alumni members shared their academic journey through online and offline mode. There were four dedicated panel discussions namely:

- Career opportunities beyond academia
- Career opportunities in IITs, IISERs and Universities
- Career opportunities in Research & Development
- Overseas career opportunities

Research scholars, postdoctoral fellows and faculty members actively participated in the programme.




## Interactive Session

Ms. Sheena Misra Ghosh, Consultant Psychologist interacted with the research scholars on 06.10.2023 and discussed on orientation to mental health and well-being.

## Awareness Programme

The Centre organized one day sensitization workshop on 8th December, 2023 to commemorate the 10th anniversary of notification of the landmark legislation. The workshop was a part of commemoration of Sexual Harassment at Workplace Prevention Week. Approx. 120 nos. of students, faculty and staff members from the Centre participated in the programme.

Dr. Suchetana Chatterjee, Presiding Officer, Internal Complaints Committee, SNBNCBS and Assistant Professor, Presidency University delivered the welcome address as well as provided detailed guideline to ensure strict compliance of each provision of Sexual Harassment act for creating a safe working environment.

Dr. M. P. Chengappa, Assistant Professor (Law) from The West Bengal National University of Juridical Sciences, Kolkata attended the programme and provided guideline on the legal matters associated with the act.

The lecture session was followed by question & answer session and discussion from the audience.

## Report on Summer Research Programme

| Name of the Student | Project Guide | Affiliation |
|---|---|---|
| Abha Mahato | Manik Pradhan | University of Calcutta |
| Adway Majumdar | Suman Chakrabarty | NISER Bhubaneswar |
| Adwitiya Das | Anjan Barman | Jadavpur University |
| Akash Maity | Suman Chakrabarty | NIT Durgapur |
| Anandu Vinod | Urna Basu | IISER Kolkata |
| Anubhab Rudra | Thirupathaiah Setti | IIT Madras |
| Archisman Sinha | Pradip S Pachfule | Savitribai Phule Pune University |
| Ashutosh Mahalik | Suman Chakrabarty | NISER Bhubaneswar |
| Ayandip Roy | Archan S Majumdar | IIT Madras |
| Bhagirathi Patra | Barnali Ghosh (Saha) | IIEST Howrah |
| Gautam Kumar | Sujoy Kr. Ghosh | NIT Warangal |
| Junik Sengupta | Ramkrishna Das | University of Calcutta |
| Kazi Abu Rousan | Archan S Majumdar | IACS Kolkata |

| Name of the Student | Project Guide | Affiliation |
|---|---|---|
| Mahe-Noor Fatima | Manik Banik | Delhi Technological University |
| Mallika Rani Prusty | Manoj Mandal | IISER Berhampur |
| Mariom Mamtaj | Ali Hossain Khan | RKMVERI Belur |
| Mitali Thorat | Manoranjan Kumar | Bombay College of Pharmacy |
| Nibedita Sen | Barnali Ghosh (Saha) | RKMVERI Belur |
| Niti Singh | Soumen Mondal | NISER Bhubaneswar |
| Pamarthi Dimple Sneha | Anjan Barman | Central University of Karnataka |
| Parama Ghosh | Rajib Kumar Mitra | Jadavpur University |
| Poulami Sadhukhan | Urna Basu | Presidency University |
| Pramit Bhattacharyya | Rabin Banerjee | IIT Madras |
| **Punam Barman** | **Saquib Shamim** | **IIT Kharagpur** |

## Seminar and Colloquia Programme (SCOLP): 2023-2024 [01.04.2023 – 31.03.2024]

### Bose Fest

The inaugural session of Bose Fest 2024 started with lighting the lamp at Silver Jubilee Hall, SNBNCBS, on 22nd February 2024, and then a Welcome Address by the Director, Prof. Tanusri Saha-Dasgupta, Prof. Amitabha Lahiri, Dean (Academic Programme) and Prof. Rajib Kumar Mitra. The Research Scholars, Faculty Members, and Staff of the Centre celebrated the 'Bose Fest' (22 to 24 February 2024) with lots of scientific talks, research poster presentations, Photo Fest and finally, a cultural program.


| Seminar Type | Date | Speaker & Affiliation | Title |
|---|---|---|---|
| **26th S.N. Bose Memorial Lecture** | 11.05.2023 | Prof. Deepak Dhar<br>An Indian theoretical physicist and a distinguished professor at the department of physics of Indian Institute of Science Education and Research, Pune. | **Phase Transition In Hard Rigid Rods On A D-Dimensional Lattice** |
| **6th G N Ramachandran Memorial Lecture** | 01.09.2023 | Prof. Chandrima Saha<br>J. C. Bose Chair Distinguished Professor at the Indian Institute of Chemical Biology, Kolkata. She is the former Director and former Professor of Eminence at the National Institute of Immunology | **Our Cells To Our Rescue: The Revolution In Cell Sciences** |
| **Bose Colloquium** | 28.04.2023 | Prof. Uday Bandyopadhyay<br>Director, Bose Institute<br>Unified Academic Campus | **Impact Of Acute Mental Stress On Gastropathy/Gastric Ulcer: Mind – Mitochondria Relation In Stomach** |
| | 16.06.2023 | Prof. Rupmanjari Ghosh<br>Former Vice Chancellor of Shiv Nadar University Delhi-NCR, Former Professor of Physics & Dean of School of Physical Sciences at Jawaharlal Nehru University | **The Making Of A Private Research University: Leadership Challenges In Higher Education** |
| | 21.07.2023 | Prof. Tarun Souradeep<br>Director, Raman Research Institute, C V Raman Avenue, Bangalore | **Tests Of The Foundations Of 'Standard' Cosmological Model** |
| | 01.12.2023 | Prof. Martin Aeschlimann<br>Professor in the Physics Department of the University of Kaiserslautern | **Laser-Induced Intersite Spin Transfer** |
| **Bose Colloquium** | 20.12.2023 | Prof. Prashant V. Kamat<br>Professor of Chemistry and Biochemistry and a principal scientist of the radiation laboratory, University of Notre Dame. | **Semiconductor Architectures: Nano-Scale Solutions For Macro-Scale Carbon Challenges** |
| | 09.01.2024 | Prof. Dipankar Banerjee<br>Director, Aryabhatta Research Institute of Observational Sciences (ARIES)<br>An autonomous research institute under DST, Government of India Manora peak, Nainital, Uttarakhand | **Aditya L1 Mission** |
| | 28.03.2024 | Dr. Vincent Cros<br>CNRS Senior Researcher and deputy Director, Laboratoire Albert Fert, CNRS Thales, Universite Paris - Saclay | **Spintronics with magnetic skyrmions** |

| Seminar Type | Date | Speaker & Affiliation | Title |
|---|---|---|---|
| Institute Colloquium | 05.04.2023 | Prof. Arun K Grover<br>Hony. Prof., Punjab Engineering College (Deemed to be University), Chandigarh & Ex-Vice Chancellor, Panjab University | **Partnership Between Meghnad Saha And Shanti Swarup Bhatnagar In The Conception Of Plans In All Domains In Post-World War-II India** |
| | 10.04.2023 | Prof. David Logan<br>Coulson Professor of Theoretical Chemistry & an Infosys Visiting Chair at the Indian Institute of Science, Bengaluru and is a Foreign Fellow of the National Academy of Sciences, India | **Many-Body Localisation, Multifractality And All That: A Fock-Space Perspective** |
| | 11.04.2023 | Dr. Manoranjan Mohanty<br>Scientist-G and Head, Autonomous Institute Division | **R&D Support Programs Of DST** |
| Institute Colloquium | 24.04.2023 | Dr. Angshuman Nag<br>Associate Professor, Department of Chemistry, Indian Institute of Science Education and Research (IISER) Pune | **Layered Hybrid Perovskites: Molecular Design And Optoelectronics** |
| | 02.06.2023 | Prof. Supriyo Bandyopadhyay<br>Department of Electrical and Computer Engineering, Virginia Commonwealth University, Richmond | **Energy-Efficient Information Processing In Our Information Hungry World** |
| | 05.06.2023 | Prof. Kanishka Biswas<br>Ph.D, FRSC, FASc, Professor<br>New Chemistry Unit (NCU) & School of Advanced Materials (SAMat), International Centre of Materials Science (ICMS), JNCASR | **Metavalent Chemical Bond Holds Key To Enhance The Thermoelectric Performance In Quantum Materials** |
| Institute Colloquium | 14.08.2023 | Prof. Bharat Ratra<br>Professor of Physics, Kansas State University | **The Accelerating Expanding Universe: Dark Matter, Dark Energy, And Einstein's Cosmological Constant** |
| | 28.11.2023 | Prof. Christian Maes<br>Professor, Department of Physics and Astronomy, KU Leuven | **Zig-Zag Dynamics In A Stern-Gerlach Spin Measurement** |
| | 11.01.2024 | Prof. P. B. Sunil Kumar<br>Chair Professor, Department of Physics & Centre for Soft and Biological Matter, IIT Madras | **Collective Motion Of Self-Propelled Ring Polymers On Circularly Patterned Substrates** |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 1. | Departmental Seminar | AHEP | 06.04.2023 | Mr. Indranil Chakraborty<br>Ph. D student from IIT, Kharagpur | A Study Of Gravitational Wave Memory Effects In Radiative Geometries And Wormholes |
| 2. | Departmental Seminar | CBS | 13.04.2023 | Dr. Rajesh Dutta<br>Postdoctoral Fellow, Department of Chemical and Biological Physics, Weizmann Institute of Science, Israel | Understanding Transition Path Dynamics For Protein Folding And Unfolding |
| 3. | Departmental Seminar | AHEP | 13.04.2023 | Prof. M. Sivakumar<br>Professor, School of Physics<br>University of Hyderabad | How Effective, Field Theory Is? |
| 4. | Departmental Seminar | AHEP | 20.04.2023 | Dr. Chiranjeeb Singha<br>Research Associate<br>Theory Division, Saha Institute of Nuclear, Physics | Strong Cosmic Censorship Conjecture For A Charged BTZ Black Hole |
| 5. | Departmental Seminar | AHEP | 24.04.2023 | Dr. Jayanta Dutta<br>Post-Doctoral Fellow, Harish-Chandra Research Institute (HRI) | Formation Of The Very FIRST STARS (Primordial Stars) In The Universe, And Their Survival Possibility |
| 6. | Departmental Seminar | CMMP | 24.04.2023 | Dr. Kausik Majumdar<br>Associate Professor, Department of Electrical Communication Engineering<br>Indian Institute of Science, Bangalore | Van Der Waals Heterojunctions For Quantum Device Applications |
| 7. | Departmental Seminar | CBS | 25.04.2023 | Dr. Rajeswari Basu<br>Postdoctoral Scientist Boehringer Ingelheim, PhD, Chemistry, Stony Brook University | Drug Discovery: The Use Of Mass Spectrometry And Other Analytical Tools |
| 8. | Departmental Seminar | CMMP | 27.04.2023 | Dr. Dhiman Bhowmick<br>Postdoc at Nanyang Technological University Singapore | Discrete Time Crystal Made Of Topological Edge Magnons In Kagome Ferromagnet |
| 9. | Departmental Seminar | CMMP | 27.04.2023 | Dr. Poulami Chakraborty<br>Postdoctoral Researcher, Basque Center for Applied Mathematics, Bilbao, Spain | Hydrogen Interplay With Defects In Al Alloys |
| 10. | Departmental Seminar | PCS | 01.05.2023 | Dr. Himadri Shekhar Dhar, Assistant Professor, IIT Bombay | Transfer And Protection Of Quantum Information In Hybrid Systems |
| 11. | Departmental Seminar | PCS | 04.05.2023 | Ms. Kanchan Meena,<br>Ph. D student, SNBNCBS | Time Reversed States In Barrier Tunneling |
| 12. | Departmental Seminar | PCS | 18.05.2023 | Dr. Raj Kumar Manna,<br>Postdoctoral Research Associate at the Department of Physics at Syracuse, University | Shape Morphing Of Chemically Active Elastic Sheets, And Tissues |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 13. | Departmental Seminar | CMMP | 19.05.2023 | Dr. Abhishek Samanta<br>Postdoctoral Researcher, Ohio State University | Hall Coefficient Of Multi-Band And Interacting Systems |
| 14. | Departmental Seminar | AHEP | 25.05.2023 | Dr. Piyali Saha<br>Project Researcher. ALMA Project, East Asian ALMA Regional Center (EA-ARC), National Astronomical Observatory of Japan | Magnetic Fields In Massive Star-Forming Regions (Magmar) |
| 15. | Departmental Seminar | AHEP | 29.05.2023 | Prof. Rukmini Dey<br>Professor, ICTS-TIFR, Bengaluru | Berezin-Type Quantization On Compact Even Dimensional Manifolds And Pullback Coherent States |
| 16. | Departmental Seminar | PCS | 06.06.2023 | Mr. Anjishnu Bose<br>Ph. D student, University of Toronto | Field-Induced Quantum Spin Liquids In Honeycomb J 1 -J 3 XY Models |
| 17. | Departmental Seminar | PCS | 15.06.2023 | Dr. Indranil Paul<br>Research Director at CNRS, Laboratoire MPQ, Université Paris Cité | Pseudogap And Exceptional Van Hove Singularity In The Cuprates |
| 18. | Departmental Seminar | CBS | 20.06.2023 | Dr. Prabir Khatua\<br>Postdoctoral Research Associate, Department of Chemistry, College of Staten Island, City University of New York | Exploring Nucleosome Dynamics And Protein Folding/Aggregation Mechanism Through Molecular Simulations |
| 19. | Departmental Seminar | AHEP | 22.06.2023 | Prof. Rabin Banerjee<br>Raja Ramanna Fellow, SNBNCBS | From Lorentz To Non-Lorentz Theories |
| 20. | Departmental Seminar | PCS | 26.06.2023 | Prof. Parthanil Roy<br>Professor, Theoretical Statistics and Mathematics Division, ISI Bengaluru | Branching Random Walks: Two Conjectures And A Theorem |
| 21. | Departmental Seminar | AHEP | 27.06.2023 | Dr. Debashis Saha | Quantum Correlations That Are Incompatible With Absoluteness Of Measurement |
| 22. | Departmental Seminar | AHEP | 28.06.2023 | Dr. Chayan Mondal<br>Post-Doctoral Fellow, IUCAA, Pune | Astrosat UV Deep Field - A Unique View Of The Distant Galaxies |
| 23. | Departmental Seminar | PCS | 28.06.2023 | Dr. Manabendra Nath Bera<br>Assistant Professor, Physical Sciences, IISER- Mohali | Quantum Bayes' Rule Affirms Consistency In Measurement Inferences In Quantum Mechanics |
| 24. | Departmental Seminar | PCS | 07.07.2023 | Dr. Raj Kumar Sadhu<br>Post-Doctoral Researcher, Physical Approach of Biological Problems, Physical Chemistry Curie, Institut Curie, Paris | Cellular Spreading And Migration On Curved Surfaces |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 25. | Departmental Seminar | AHEP | 13.07.2023 | Dr. Sujoy Modak<br>Assistant Professor of Physics, Universidad de Colima | Revisiting The Enigmatic Early Universe With T-Vacuum State |
| 26. | Departmental Seminar | AHEP | 13.07.2023 | Dr. Souvik Bera<br>Ph. D Scholar, Indian Institute of Science, Bengaluru | Epsilon Expansion Of Multivariate Hypergeometric Functions In Terms Of Multiple Polylogarithms |
| 27. | Departmental Seminar | PCS | 25.07.2023 | Dr. Ashutosh Rai<br>Research Assistant Professor, Korea Advanced Institute of Science and Technology | Non-Local And Quantum Advantages In Network Coding For Multiple Access Channels |
| 28. | Departmental Seminar | AHEP | 02.08.2023 | Dr. Ananda G. Maity<br>PDRA, Networked Quantum Devices Unit, Okinawa Institute of Science and Technology, Japan | Noise Can Be Resource In Quantum Communication |
| 29. | Departmental Seminar | CMMP | 04.08.2023 | Dr. Nilanjan Mitra<br>Associate Research Professor, Hopkins Extreme Materials Institute (HEMI), Department of Mechanical Engineering, Johns Hopkins University | Materials @ Extremes |
| 30. | Departmental Seminar | CMMP | 08.08.2023 | Prof. Jay Deep Sau<br>Professor, Department of Physics and Condensed Matter Theory Center, Co-director, Joint quantum Institute, University of Maryland | Search For Non-Abelian Majorana Modes As A Route To Topological Quantum Computation |
| 31. | Departmental Seminar | PCS | 08.08.2023 | Dr. Anupam Kundu<br>Associate professor, International Centre for Theoretical Sciences, Bangalore | Integrability, Chaos And Thermalization In A Collection Of Hard Rods |
| 32. | Departmental Seminar | CMMP | 16.08.2023 | Dr. Veer P.S. Awana<br>CHIEF SCIENTIST: CSIR-NPL INDIA, FInstP (Fellow IOP-UK) | Absence Of Superconductivity In LK-99 At Ambient Conditions |
| 33. | Departmental Seminar | PCS | 16.08.2023 | Dr. Ion Santra<br>Post Doc, Theoretical Physics, RRI, Bangalore | Activity Driven Energy Transport |
| 34. | Departmental Seminar | CBS | 22.08.2023 | Dr. Dibyendu Das<br>Associate Professor, Department of Chemical Sciences, IISER Kolkata | Adaptive Life Inspired Objects Via Systems Chemistry |
| 35. | Departmental Seminar | CMMP | 31.08.2023 | Dr. Aveek Bid<br>Associate Professor, Department of Physics Department of Physics Indian Institute of Science | Tuning Topological Bands In Graphene |
| 36. | Departmental Seminar | AHEP | 04.09.2023 | Dr. Dibya Chakraborty<br>Post-Doc, Ashoka University | The Conspiracy Of Ds Space In String Theory (?) |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 37. | Departmental Seminar | CMMP | 11.09.2023 | Prof. Joy Mitra<br>Professor, School of Physics IISER - Thiruvananthapuram, Kerala | Engineering Strain Inhomogeneities In Mos2 Flakes |
| 38. | Departmental Seminar | PCS | 25.09.2023 | Dr. Arnab Saha<br>Assistant Professor, Department of Physics, University Of Calcutta | Self-Organisation and Flow of Information Within Confined Flock |
| 39. | Departmental Seminar | PCS | 27.09.2023 | Prof. Parthanil Roy<br>Professor, Theoretical Statistics and Mathematics Division, ISI Bengaluru | How Does Memory Affect Random Walks? |
| 40. | Departmental Seminar | CMMP | 03.10.2023 | Dr. Bhaskar Mukherjee<br>Research Fellow. Dept of Physics & Astronomy, University College London | Is Kinetic Constraint Sufficient To Generate Quantum Many-Body Scars ? |
| 41. | Departmental Seminar | PCS | 27.10.2023 | Dr. Amit Mukherjee<br>Assistant Professor, IIT Jodhpur | Application of Bell Nonlocality In Vehicle Routing Problems |
| 42. | Departmental Seminar | PCS | 01.11.2023 | Dr. Sudip Mukherjee<br>Assistant Professor, Post-Graduate Physics Department, Barasat Government College | Nonequilibrium Steady States In Coupled Asymmetric and Symmetric Exclusion Processes |
| 43. | Departmental Seminar | AHEP | 02.11.2023 | Dr. Sagnick Mukherjee<br>Ph. D student, Dept of Astronomy, The University of California Santa Cruz | Constraints On Atmospheric Mixing In Brown Dwarf and Exoplanet Atmospheres in the *JWST* Era |
| 44. | Departmental Seminar | PCS | 03.11.2023 | Dr. Naqueeb Warsi<br>Assistant Professor, Indian Statistical Institute Kolkata | Quantum Intersection With Applications To Communication In The Presence Of An Adversary |
| 45. | Departmental Seminar | CBS | 07.11.2023 | Prof. Analabha Basu<br>Professor, National Institute Of Biomedical Genomics (NIBMG) | Our Footprints On The Sands of Time |
| 46. | Departmental Seminar | AHEP | 10.11.2023 | Dr. Arpan Ghosh<br>Post-Doctoral Fellow, ARIES, Nainital | Monitoring Of Episodically Accreting Young Stellar Objects |
| 47. | Departmental Seminar | AHEP | 23.11.2023 | Dr. Ruchika<br>Post-Doctoral Fellow, INFN (La Sapienza University of Rome), Rome, Italy | Investigating Cosmological Tensions In Low And High Redshift Observational Data |
| 48. | Departmental Seminar | AHEP | 28.11.2023 | Dr. Ayan Mitra<br>Post-Doctoral Fellow, IUCAA, India | Using Photometric Redshifts To Improve Dark Energy Constraints With Type Ia Supernova In The LSST Era |
| 49. | Departmental Seminar | PCS | 01.12.2023 | Prof. Christian Maes<br>Professor, Department of Physics and Astronomy, KU Leuven | The Sun Within: Heat Engines From Active Particle Models |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 50. | Departmental Seminar | PCS | 01.12.2023 | Dr. Kishor Bharti<br>Research Scientist, IHPC@A*STAR, Singapore | Graph-Based Approach To Self-Testing Via Contextuality And Bell Nonlocality |
| 51. | Departmental Seminar | AHEP | 05.12.2023 | Dr. Arka Santra<br>Post-Doctoral Fellow, Weizmann Institute of Science, Israel | Probing New Physics At The LUXE Experiment |
| 52. | Departmental Seminar | CMMP | 06.12.2023 | Dr. Golam Haider<br>A Group Leader, Institute for Metallic Materials of IFW-Dresden | Scalable 2D Heterostructures For Quantum Optoelectronics |
| 53. | Departmental Seminar | AHEP | 08.12.2023 | Prof. T.R. Govindarajan<br>Retired Professor, Theoretical Physics, Institute of Mathematical Sciences and Krea University | Fuzzy Dark Matter - Bose Connection! |
| 54. | Departmental Seminar | CBS | 13.12.2023 | Prof. Prabal K Maiti<br>Professor, Department of Physics, Indian Institute of Science | 2-TIPS And Ordering In Various Active Matter Systems |
| 55. | Departmental Seminar | CMMP | 15.12.2023 | Dr. Susmita Roy<br>Postdoctoral Research Fellow, Condensed Matter Physics Division<br>Max-Planck Institute for the Structure and Dynamics of matter, Hamburg, Germany | Conventional And Time-Resolved Raman Scattering Of Strongly Correlated Materials |
| 56. | Departmental Seminar | PCS | 15.12.2023 | Dr. Vikash Pandey<br>Assistant Professor of Applied Mathematics, Department of Computing and Data Sciences, FLAME University, Pune. | Dead Matter Has Memory |
| 57. | Departmental Seminar | CBS | 21.12.2023 | Dr. Partha Pratim Roy<br>Postdoctoral Research Associate, The Fleming group Lawrence Berkeley National Laboratory, University of California | Ultrafast Energy And Electron Transfer In Natural And Synthetic Light Harvesting Investigated By Coherent Multidimensional Spectroscopy |
| 58. | Departmental Seminar | CMMP | 22.12.2023 | Dr. Himadri Chakraborti<br>Postdoc at SPEC, CEA, CNRS, Universite Paris-Saclay,France | Electron Quantum Optics In Graphene |
| 59. | Departmental Seminar | PCS | 28.12.2023 | Dr. Suchismita Das<br>Post-Doc. Max Planck Institute for the Physics of Complex Systems, Dresden | Flocking By Turning Away |
| 60. | Departmental Seminar | PCS | 03.01.2024 | Prof. Sanjib Sabhapandit<br>Professor, Theoretical Physics, Raman Research Institute | Noval Features Of Direction Reversing Active Brownian Particle |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 61. | Departmental Seminar | AHEP | 04.01.2024 | Dr. Rajorshi Bhattacharya<br>Ph. D at Physics with Astrophysics Concentration, University of New Mexico | Evolved Stars: Distance Estimates Using Infrared Data and Machine Learning |
| 62. | Departmental Seminar | CBS | 05.01.2024 | Dr. Debashish Adhikari<br>Associate Professor, Chemical Sciences, IISER Mohali | Exploring Super-Reducing Behavior of Simple Organic Molecules and Their Application In Photocatalysis |
| 63. | Departmental Seminar | CMMP / CBS | 08.01.2024 | American Chemical Society | 01. An Introduction to ACS<br>02. Tips On Scholarly Publishing |
| 64. | Departmental Seminar | CMMP | 08.01.2024 | Prof. Deshdeep Sahdev<br>Formar Member, Technology Development Board, Govt. of India<br>Member, Expert Advisory Group, DST<br>Former Professor, Dept. of Physics, IIT, Kanpur<br>Director, Quazar Technologies, New Delhi | Cutting-Edge Physics at the Interface Of Academia & Industry In India |
| 65. | Departmental Seminar | CMMP | 10.01.2024 | Dr. Shubhadeep Biswas<br>Post Doc at SLAC National Accelerator Laboratory,Stanford University, CA, USA | Attosecond Vision and Control of Electron Dynamics In Quantum Systems |
| 66. | Departmental Seminar | AHEP | 11.01.2024 | Dr. Upamanyu Moitra<br>Postdoctoral Fellow, High Energy, Cosmology and Astroparticle Physics Section<br>The Abdus Salam International Centre for Theoretical Physics Strada Costiera, Trieste, Italy | Entanglement Entropy in String Compactifications |
| 67. | Departmental Seminar | AHEP | 12.01.2024 | Dr. Nirmalya Kajuri<br>Assistant Professor, IIT Mandi | Bulk Reconstruction and Symmetries |
| 68. | Departmental Seminar | PCS | 15.01.2024 | Dr. Pranay Mandal<br>Post Doc at Max-Planck Institute of Molecular Cell Biology and Genetics | Dynamics of Helix at Nanoscale: From Active Matter to DNA Protection |
| 69. | Departmental Seminar | AHEP | 16.01.2024 | Dr. Sk Minhajur Rahaman<br>Post-Doctoral Fellow, University of Israel | Role Of Internal Shocks in Astrophysics |
| 70. | Departmental Seminar | CMMP | 16.01.2024 | Dr. Suryoday Prodhan<br>Post-Doctoral Research Associate, Prof. Alessandro Troisi's group<br>Department of Chemistry, University of Liverpool | Effective Model and Efficient Algorithm: A Tale of Two Tools for Plastic Semiconductor Discovery |

| Sl. No. | Seminar Type | Department | Date | Speaker & Affiliation | Title |
|---|---|---|---|---|---|
| 71. | Departmental Seminar | PCS | 17.01.2024 | Dr. Nishchhal Verma<br>Postdoc, Columbia University | Chiral Textures In Magnetic Materials And Moire Heterostructures |
| 72. | Departmental Seminar | AHEP | 06.02.2024 | Dr. Souradeep Sasmal<br>Research Associate, Department of Physics, Indian Institute of Technology Hyderabad | Unbounded Sharing of Nonlocality Using Projective Measurements |
| 73. | Departmental Seminar | CBS | 07.02.2024 | Dr. Saumik Sen<br>Researcher at Condensed Matter Theory Group, Laboratory for Theoretical and Computational Physics, Division of Scientific Computing, Theory and Data, Paul Scherrer Institute, Villigen PSI, Switzerland | Understanding the retinal isomerization reaction using hybrid QM/MM simulations |
| 74. | Departmental Seminar | CMMP | 12.02.2024 | Dr. Dhani Nafday<br>Post Doctoral Fellow, Department of Applied Physics, KTH Royal Institute of Technology, Stockholm, Sweden | Stacking of Charge Density Waves in 2H NbSe2 Bilayers |
| 75. | Departmental Seminar | CBS | 13.02.2024 | Dr. Soumya De<br>Associate Professor, Department of Bioscience and Biotechnology, IIT Kharagpur | Intrinsically disordered proteins: Functionality of chaos |
| 76. | Departmental Seminar | CMMP | 16.02.2024 | Dr. Kartik Samanta<br>Postdoctoral Research Associate, Department of Physics and Astronomy & Nebraska Center for Materials and Nanoscience, University of Nebraska, USA | Magnetic tunnel junctions with spin-split collinear antiferromagnets |
| 77. | Departmental Seminar | AHEP | 20.02.2024 | Dr. Subhajit Mazumdar<br>Postdoctoral Scholar, Okinawa Institute of Science and Technology Graduate University, Japan | Kite and Triangle diagrams through Symmetries of Feynman Integrals |
| 78. | Departmental Seminar | CBS | 27.02.2024 | Dr. Alexander Hautke<br>Postdoctoral Researcher, Ebbinghaus lab, Ruhr-Universität Bochum and Research Center, Germany | Conformation, Localization and Condensation of CAG Repeat RNAs in vitro and inside living cells |
| 79. | Departmental Seminar | AHEP | 21.03.2024 | Dr. Aritra Ghosh<br>Prime Minister's Research Fellow, School of Basic Sciences, Indian Institute of Technology Bhubaneswar | Contact Geometry and Thermodynamics |

## Visitor's & Associates & Student's Programme (VASP):

### Associates and Short Term Visitors

| Name of the Visitor | Affiliation | Period of stay | | Host Faculty |
|---|---|---|---|---|
| | | Date From | Date to | |
| Ms. Sahana Das (Student Associate) | Indian Institute of Technology, Kharagpur | 01.05.2023 | 31.07.2023 | Prof. Manoranjan Kumar |
| Ms. Suma Das (Student Associate) | National Institute of Technology, Silchar, Assam | 19.05.2023 | 18.08.2023 | Dr. Avijit Chowdhury |
| Dr. Anjishnu Bose (Academic Visitor) | The University of Toronto, Ontario, Canada | 05.06.2023 | 06.06.2023 | Dr. Arijit Haldar |
| Ms. Vibeizonuo Rupreo (Student Associate) | National Institute of Technology, Nagaland | 19.06.2023<br>04.01.2024 | 30.08.2023<br>21.01.2024 | Prof. Rajib Kumar Mitra |
| Mr. Shreyansh Priyadarshi (Student Associate) | Ashoka University, Sonipat, Haryana | 27.12.2023 | 23.01.2024 | Dr. Shubhasis Haldar |
| Mr. Jose Ignacio Hernandez Garcia (Student Associate) | Universidad de La Laguna Instituto Uniniversitario de Bio-Organica Antonio Gonzalez, Tenerife, Spain | 08.01.2024 | 06.04.2024 | Dr. Pradip S Pachfule |
| Professor Rajiv R P Singh (Distinguished Lecturer) | University of California, UC Davis, USA | 04.09.2023 | 06.09.2023 | Prof. Manoranjan Kumar |
| Professor Guruprasad Kar (Distinguished Lecturer) | Physics and Applied Mathematics Unit, Indian Statistical Institute (ISI), Kolkata | 24.11.2024<br>28.11.2024<br>30.11.2024 | 30.11.2024 | Dr. Manik Banik |
| Professor Sanjay Puri (Distinguished Lecturer) | Jawaharlal Nehru University, New Delhi | 06.03.2024 | 07.03.2024 | Prof. Punyabrata Pradhan |

## Outreach Activities

### Open Day 2024

On the occasion of the 130th birth day of Prof. Satyendra Nath Bose, the Centre organized an "Open Day" programme to give exposure of the cutting-edge scientific research work conducted by the scientists and research scholars of the SNBNCBS. The participants varying from school students to postgraduate science students, budding research scholars and teachers enthusiastically participated in the event.

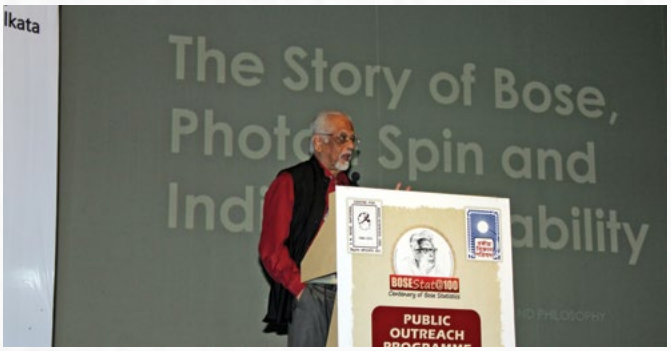
Director Prof. Tanusri Saha Dasgupta gave an overview of the diverse areas of research being carried out at the Centre. Dr. Saquib Shamim gave an idea on the central laboratory facilities of the Centre. The visitors visited to the Bose archive, where they were taken through glimpses of Bose's life and work through pictures, letters, published papers, and artifacts, and also taken to the three laboratories.

The visitors were taken to the laboratories. At the Nano lab, they saw how nanostructures are made using pulse laser deposition method, at the Scanning Electron Microscope lab, they saw how electron beams are used to 'paint' super magnified images of tiny objects, and at the X-Ray crystallography lab, they saw how X-Ray diffraction method is used for understanding arrangements of atoms in a crystal.

The last item in the day's itinerary was a sky watch through the 8-inch telescope with a roll-off roof. The four celestial items on the menu were the moon, Jupiter and its four moons, Mars and Saturn. Most of the young visitors sighted craters of the Moon and the planets of Jupiter for the first time in their life.

## Public Outreach Programme celebrating BoseStat@100

An outreach program was held followed by the ICPQIQC 2024 on 3rd February, 2024 at the Mini Theatre of Science City, Kolkata. The program began with the welcome address of Prof. B N Jagatap, IIT Bombay, and it was then followed by the talk of Prof. Palash Baran Pal, Calcutta University, on "Planck's Formula, Bose's Derivation, Einstein's Generalization". The film 'Dear Master', an hour-long documentary on the relationship between Bose and Einstein, was screened. Prof. Partha Ghose, a student of S. N. Bose, told 'The Story of Bose, Photon Spin and Indistinguishability', explained how Bose arrived at the idea of indistinguishability of the light quanta from his statistical calculations. Prof. Charles Bennet, one of the founding fathers of quantum information theory and presently associated with IBM Research, took the centre-stage to deliver the talk 'Occam's Razor, Boltzman's Brain, and Wigner's Friend'.


## National Science Day 2024

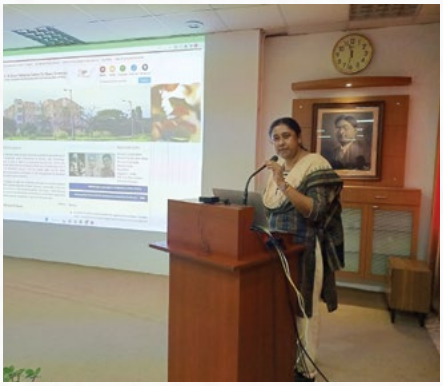
National Science Day 2024 has been observed in the Centre on 28th February 2024. Total 105 science enthusiastic students from four different colleges - Guru Nanak Institute of Technology, Sodepur; Ramkrishna Mission Vivekananda Centenary College, Rahara; St. Paul's Cathedral Mission College, Kolkata; and Ramkrishna Mission Vivekananda Educational and Research Institute, Belur, have participated in the programme. The theme of the Science Day is "Indigenous Technologies for Viksit Bharat".

The programme started at 11 AM with Inaugural Address by Prof. Amitabha Lahiri, Dean (Academic Program). Prof. Anjan Barman, Dean (Faculty), also addressed the audience. Prof. Rajib Kumar Mitra conveyed the message given by Prof. Tanusri Saha Dasgupta, Director, SNBNCBS. Dr. Manik Banik and Dr. Saquib Shamim faculty members of the Centre delivered popular talks to the audience. Participants visited S N Bose Archive and different laboratories in the campus. They also participated in an Inter-college Quiz Contest arranged by the Centre.

## Educational Visits

» Undergraduate students and teachers from Santipur College, Nadia visited the Centre on 12.04.2024 as part of their educational visit. Dr. Tapas Baug, Assistant Professor delivered scientific talk. They were given overview of the research activities of the Centre. They visited different laboratories and the Bose Archive. The documentary film on "Illustrious Indian Scientists in Pre-independence Era" was screened.



» High school girl students from Jawahar Navodaya Vidyalaya, Purba Medinipur visited the Centre on 22.09.2023 under the Vigyan-Jyoti scheme. Prof. Sakuntala Chatterjee delivered the welcome speech. Prof. Tanusri Saha Dasgupta, Director interacted with the students and discussed on their future plan. Women scholars and postdoctoral fellows namely Ms. Anwesha Chakraborty, Ms. Shinjini Paul, Dr. Mahima Singh, Dr. Gargee Bhattacharyya shared their research experience. The students were given exposure to different laboratory facilities of the Centre and they also visited the S. N. Bose Archive.








» The undergraduate (BSc) students from the College of Basic Science & Humanities, Bhubaneswar (affiliated with Odisha University of Agriculture & Technology (OUAT)) visited the Centre as part of their academic visit. The students visited different laboratory facilities and they were demonstrated cutting edge research facilities like Optical Lab, Transmission Electron Microscope (TEM), Pulsed Laser Deposition (PLD), X-ray Diffractometer (XRD), Physical Property Measurement System (PPMS). They also visited the Archive to experience the biographical sketch and work of S N Bose.






## Outreach Activities (off campus)

» The faculty members of the S N Bose Centre Dr Manik Banik & Prof. Rajib Kumar Mitra attended a workshop at Singur, West Bengal organized by Singur Bigyan Charcha Kendra. The objective is to encourage and nurture scientific thinking among the young and inquisitive minds towards the cutting edge research. Dr Banik has delivered a lecture on "Strange rule of the Atomic and Molecular World, Debate between Einstein and Bohr, and Bell's test". Students interacted with great enthusiasm.



» An One-Day Program "Horizon-23 Where Young Minds Tryst With Science" was organized at Ranaghat College, Nadia, WB, on 26th May 2023. Around 150 participants (about 60 participants were from backward categories) from the departments of Physics, Chemistry and Mathematics of the Sai College participated in the program. After the inauguration, three talks were delivered by Profs. Ranjit Biswas, Manik Banik and Ramkrishna Das. In the afternoon, two experiments were demonstrated by Prof. Arijit Haldar and the students (Pritam Roy, Keshav Shaw, Dipyendu Dhar and Sourav Mandal) from SNBNCBS. The program ended with a sky-watching program by Prof. Ramkrishna Das and Mr. Avijit Mandal. The students were very happy and interacted with us to know more. Overall, the program was a great success.

» The Centre successfully hosted an outreach programme 'ASTRO-QUEST' on 4th August 2023 at Panchakot College, Purulia, in association with Panchakot College and Sidho-Kanho-Birsha University (SKBU), Purulia. Around 210 people (about 65% participants were from backward categories) including a large number of students of classes IX-XII of the nearby schools, a few teachers of the respective schools and the members of the science departments of the said college participated in the program. The program comprised of three scientific talks, a quiz competition and a sky-watching program, besides the inaugural and valedictory sessions. The resource persons (Profs. Soumen Mondal, Tapas Baug, Ramkrishna Das, Chiranjib Barman, Sanjay Kumar Mondal and Sushanta Kumar Mandal; Mr. Rajib Kumbhakar and Mr. Avijit Mondal from SNBNCBS and SKBU) explained various facets of modern Astronomy and the importance of S N Bose Astronomical Observatory on Panchet hilltop, Purulia. The views expressed and explored on this platform by the resource persons made the audience highly motivated.

» The S N Bose Centre has participated in the "26th National Science Exhibition" organized during 24 - 27 August 2023 at Central Park Maidan, Salt Lake, W.B.

» An outreach program "Contributions of Scientists and Scientific Institutions in Indian Freedom Struggle: Professor S. N. Bose" program was organized by the Vigyan Bharati (Rajasthan) under the auspices of the Ministry of Culture, Government of India, on 19th August, 2023, at the Sobhasaria group of Institutions, Sikar, Rajasthan. Prof. Ranjit Biswas was present as a nominated representative from the S N Bose Centre, and delivered a talk entitled, " Satyendra Nath Bose : Brilliance Meets Compassion".

» A one-day outreach program on "Wonders of science: Explore and Learn" was held at Tarakeswar Degree College on 25th August 2023 in collaboration with S N Bose National Centre of Basic Sciences (SNBNCBS). The symposium was attended by almost 200 students, out of which 120 were from neighboring schools and colleges. After the inaugural session, talks were delivered by Dr. Manik Banik on 'The Nature is Nonlocal Ultimately', Dr. Ali Hossain Khan on "Why Nano is so special?", Dr. Manoj Mandal on "the Role of Biological Sciences in Society" and Dr. Ramkrishna Das on the topic of "Chandraloke Obhijan" (Missions to the Moon). In the afternoon session, The Ph.D. students from SNBNCBS held the quiz competition which was a huge success and encouraged participants to learn more about science. It was followed by demontration of simple experiments by Dr. Arijit Haldar and the PhD Scholars of SNBNCBS, that explained physics concepts like the laws of motion, the conservation of energy, and the characteristics of light. The students enjoyed the demonstrations to learn about scientific principles. The highly motivated participants stayed back till the evening to observe the sky through the telescope. They found the sky watching to be very much fascinating. The symposium was a huge success and it contributed to increasing awareness of the value of science in everyday life as well as to encourage attendees to discover the wonders of science and to pursue careers as scientists and innovators in the future.




» A one-day outreach program under India International Science Festival (IISF), 2023 was organized at Sir Rajendra Nath Mukherjee Govt. Polytechnic, Basirhat, West Bengal on 21st December 2023 by S N Bose National Centre of Basic Sciences (SNBNCBS). Scientific lectures, model demonstration, and sky watching were the part of the event. Approximately 275 persons including students and teachers participated in the programme.


» S. N. Bose Centre has participated in the IISF 2023 during 17 - 20 January, 2024 at Faridabad. Prof. Abhay Karandikar, Secretary, Dept. of Science and Technology, with other dignitaries, visited the stall on 18th January 2024.


» The Centre participated in the 'Acharya Satyendra Nath Basu Smarak Bijnan O Prajukti Mela' at Hedua Park, Kolkata, during 19 - 23 January, 2024. Prof. Tanusri Saha-Dasgupta, Director of the Centre has inaugurated the programme.


» A One-Day Program was organized at the Department of Chemistry, Burdwan University, Burdwan, West Bengal, on 25th January 2024. Around 185 students (about 35% of participants were from backward categories) from the science departments of the University and nearby schools, and 35 faculty members participated in the program. Three scientific talks were delivered by Profs. Ranjit Biswas, Ali Hossain Khan and Ramkrishna Das. In the afternoon, two experiments were demonstrated by Prof. Arijit Haldar and the research scholars (Pritam Roy, Koushik Das, Dipyendu Dhar and Sourav Mandal) from SNBNCBS. The program ended with a sky-watching program by Prof. Ramkrishna Das and Mr. Ariful Hoque.

## A BRIEF REPORT OF CONFERENCES, WORKSHOPS AND EXTENSION PROGRAMMES (CWEP) HELD DURING 01.04.2023 TO 31.03.2024

As per available records, during the period under reference, the following conferences / workshops/discussion meetings held at Centre and outside of Centre. A brief report of the programmes are as below:

1) **C.K. Majumdar Memorial Summer Workshop in Physics 2023** held at the Centre jointly organized by Indian Association of Physics Teachers (Regional Council-15) and S.N. Bose National Centre for Basic Sciences during 18th to 28th July, 2023. Convener: Ms. Sukla Chakraborty, Deptt. of Physics, Ananda Mohan College, Kolkata and Co-Convener: Dr. Manik Banik, Associate Professor, S.N. Bose National Centre for Basic Sciences.

   The participating group in the workshop comprises of about 40 students from the outgoing final year (outgoing 3rd year) of B.Sc (Physics) and 1st year M.Sc (Physics) from different colleges and universities of India. They were given exposure to some of the research areas by the experts from the different fields. The CKM Lab at the Centre was the venue of experimental activities; and some interesting experiments were also shown to them. The programme was a grand success.

2) **Five-days Discussion Meeting on "Novel Magnetic and Topological Quantum Materials" held at the Centre during 25-29 November, 2023.**

   The Conveners of the discussion meeting were Prof. Tanusri Saha Dasgupta, Director and Dr. Thirupathaiah Setti, Associate Professor.

   **Aim of the Meeting:** The meeting was aimed to review and discuss the progress of ongoing collaborative scientific projects between IFW (Germany) and SNBNCBS (India) under the IFW-SNB MoU.

   **Topics Covered in the Discussion Meeting:** Several speakers from both sides of IFW and SBNCBS have presented their ongoing research work on the topics of Novel Magnetism and Topological Quantum Materials.

   **Details of the Speakers:** The meeting had a total of 20 talks, out of which 5 talks were given by the students who visited IFW, and 1 talk was given by a student who will be visiting IFW. Out of 20 talks, 3 were given by the woman speakers and 3 speakers are from the reserved category. All speakers attended the conference physically. Also, there was a city tour provided to the visitors (speakers) from IFW, Germany. One morning session was fully dedicated to the lab visits at SNBNCBS.

**Details of the Participants:** 6 students and 15 faculty attended the conference. Overall 21 participants, including the speakers and local faculty from SNBNCBS have participated in the conference physically.

**3) International Conference on "STATPHYS-Kolkata XII" held during 18-22 December, 2023 held at Centre in collaboration with IISER, Kolkata.**

The Convener of the conference was Dr. Urna Basu, Associate Professor and the Co-Convener was Prof. Sakuntala Chatterjee, Professor from the Centre.

The international conference StatPhys Kolkata XII was organized at the Centre in collaboration with IISER, Kolkata during 18-22 December, 2023. The focus areas were Transport phenomena, Biological systems, Many-body physics, Hydrodynamics and fluctuations and Machine learning. There were 24 invited talks, 32 oral contributions and 39 poster presentations. A total of 115 registered participants attended the conference. Apart from various Indian institutes and universities, there were participation from many different countries including Germany, Portugal, Luxembourg, Italy, France, Poland, Denmark, UK, South Korea, Japan and USA. The enthusiastic and active contribution of all the participants made the conference a huge success.

4) **Discussion Meeting on Hybrid Halide Perovskite (HyPe-2023) held during 21-23 December, 2023 at IACS, Kolkata.**

The Convener of this discussion meeting was Prof. Narayan Pradhan, Professor, IACS, Kolkata and Co-Convener: Prof. Priya Mahadevan, Senior Professor, SNBNCBS.

The conference was organized jointly by IACS, SNBNCBS and IISER, Kolkata in association with Perovskite Society of India. The conference was aimed to flash the latest developments and possible new directions of research for halide perovskites in synthesis, photovoltaics, LEDs, photophysical and photochemical studies, theorical predictions and possible interdisciplinary applications.

5) **Workshop on Exploring Quantum and Thermal Fluctuations in Frustrated Magnets at Low Temperature held at Centre during 26-27 December, 2023**

The Convener of this workshop was Prof. Manoranjan Kumar, Professor.

The main objective of this workshop was to bring together Kolkata-based scientists working on Quantum Condensed Matter (molecular to solid state systems) and related topics. The conference focussed on recent developments in quantum condensed matter physics with special emphasis on topics such as frustrated magnetism, topological states of matter, cold atomic systems and their applications in devices.

6) **Discussion Meeting on "Novel Quantum Materials: Magnetism and Topology" held during 03-05 January, 2024 at IIT Goa in collaboration with SNBNCBS.**

The Conveners of this discussion meeting was Dr. Sudipta Kanungo, Associate Professor of Physics, IIT Goa and Dr. Nitesh Kumar, Assistant Professor, SNBNCBS. The meeting aimed to interact with the Russian partners and review the progress of the ongoing Indo-Russian collaborative project.

7) **Two-days Discussion Meeting on "Stochastic and Nonlinear Dynamics in Chemistry and Biology" held at Centre during 04-05 January, 2024.**

The Convener of the Discussion Meeting was Prof. Gautam Gangoadhyay, former Senior Professor, SNBNCBS and Co-Convener was Dr. Pulak Kumar Ghosh, Assistant Professor, Presidency University, Kolkata.

The two-days discussion meeting on stochastic and nonlinear dynamics was very fruitful. Researchers of different age groups, starting from PhD students, senior emeritus professors interacted to exchange their thoughts, ideas and shared their new research findings. The discussion meeting had 60 registered participants (as Invited Speakers, Poster Presenters, Chair Persons and Organizers and Other Participants) along with a few unregistered participants from different parts of India (IIT Mumbai, IIT Kanpur, IIT Tripura, IIT Mandi, IITG, JNU, Delhi University, IISER Thiruvananthapuram, Raman Research Institute to mention but a few). The organizers found some bright Indian students studying abroad returning home to attend the discussion meeting. Participants belonging to different categories viz., SC/Weaker Sections/Male/Female, etc participated.

8) **Four-days National Conference on "Star Formation Studies in India" held at Centre during 08-11 January, 2024.**

The Convener of this national conference on "Star Formation Studies in India" was Dr. Tapas Baug, Assistant Professor and the Co-Conveners were Prof. Soumen Mondal, Professor and Dr. Ramkrishna Das, Associate Professor.

The main aim of this conference was to expose young researchers to the current development in the observational star formation studies in the context of Indian and world observational facilities. Another aim was to enhance the scope of collaborative works with theoretical, computational and observational projects.

Formation of stars is a complex process of collapsing of large-scale low-density molecular clouds to small-scale dense star forming cores and interplay of gravity, turbulence and magnetic fields. It is still unknown how exactly do stars form from a low-density molecular cloud and which mechanism plays the important role during the formation process. During the last decade star formation studies got a substantial boost by identification of ubiquitous network of filamentary structures of molecular clouds that are believed to play a pivotal role in star formation. In addition, recent observatories like, Atacama Large Milimeter and Submillimeter Array (ALMA) and James Webb Space Telescope (JWST) is now probing star forming regions at an unprecedented resolution. In this conference, the main aim was to discuss the observational aspects of star formation studies in the context of Indian and world observational

facilities and the cope of collaborative works with theoretical, computational and observational projects.

In this conference there were about 18 invited speakers. There were 66 selected abstracts for oral and poster presentations. There were around 120 participants. The conference was very fruitful.


**9) Discussion Meeting on 2D Materials held at Centre during 18-19 January, 2024**

The Convener of this discussion meeting was Prof. Priya Mahadevan, Senior Professor.

The aim of the meeting was to bring together experts primarily in and around Kolkata working on 2d materials and provide a platform to discuss their work. There were about 40 participants in this meeting.

**10) International Conference on "Photonics, Quantum Information and Quantum Communication" held at Biswa Bangla Convention Centre, New Town, Kolkata during 29th January to 2nd February, 2024**

On the occasion of Centenary of Bose Statistics, the Centre plans to organize three international conferences & outreach programmes in this respect the first International Conference titled "Photonics, Quantum Information and Quantum Communication" held at Biswa Bangla Convention Centre, New Town, Kolkata.



A brief Summary of the International Conference on Photonics, Quantum Information, and Quantum Communication (ICPQIQC-2024) is as below:

**Date:** 29th January – 02nd February 2024

**Place:** Biswa Bangla Convention Centre. The conference was organized by the S. N. Bose National Centre for Basic Sciences to celebrate the centenary of Bose's seminal 1924 paper.

**Topics:** Quantum Entanglement; Bell Non-locality; Quantum Computing; Quantum Key Distribution; Multipartite Quantum Correlations; Quantum Resource Theory; Quantum Thermodynamics; Relativistic Protocols; Implementation of Quantum Information Protocols.

**Total number of participants (including speakers):** 175 (among them around 30 are women)

**Number of Talks:** 4 (plenary talk) + 21 (invited talk) + 10 (contributory talk)

**Poster Session:** 2 poster sessions (total 93 posters are presented)

**Convenors:** Dr. Manik Banik (convenor) and Prof. Sunandan Gangopadhyay (Co-convenor).

## ADVANCED POST DOCTORAL RESEARCH PROGRAMME (APRP) : 2023-2024 [ as on 31.03.2024]

| Sl. No. | Name | Status | Dept. | Mentor |
|---|---|---|---|---|
| 1 | Ajit Kumar Sahoo | PDRA – I (Till 29.02.2024) | CMMP | Prof. Anjan Barman |
| 2 | Akhtar Alam | PDRA – I (from 15.11.2022 --) | CBS | Dr. P. S. Pachfule |
| 3 | Alik Panja | PDRA – SNBNCBS (Till 14.09.2023) | AHEP | Dr. Tapas Baug |
| 4 | Amrit K Mondal | PDRA – SNBNCBS (Till 22.08.2023) | CMMP | Prof. Anjan Barman |
| 5 | Anish Das | PDRA – SNBNCBS (from 26.09.2023 --) | AHEP | Dr. Tapas Baug |
| 6 | Anupam Gorai | PDRA – SNBNCBS (from 23.11.2023 --) | CMMP | Prof. Kalyan Mandal |
| 7 | Anwesha Chakraborty | PDRA – SNBNCBS (Till 30.01.2024) | PCS | Dr. Manik Banik |
| 8 | Aravindan V | PDRA – I (Till 08.03.2024) | CMMP | Prof. Tanusri Saha Dasgupta |
| 9 | Arijit Mondal | PDRA – II (Till 29.02.2024) | PCS | Prof. Jaydeb Chakrabarti |
| 10 | Arun Kumar Maurya | PDRA – I (from 01.12.2022 --) | CMMP | Prof. Tanusri Saha Dasgupta |
| 11 | Ashadul Halder | PDRA – I (from 18.05.2022 --) | AHEP | Prof. Archan Majumdar |
| 12 | Ashmita Das | PDRA – III (Till 03.05.2023) | AHEP | Prof. Sunandan Gangopadhyay |
| 13 | Ashis Saha | PDRA – I (from 10.10.2023 --) | AHEP | Prof. Sunandan Gangopadhyay |
| 14 | Asmita Kumari | PDRA – II (from 03.04.2023 --) | PCS | Dr. Arijit Haldar |
| 15 | Atul Rathore | PDRA – SNBNCBS (from 26.09.2023 --) | PCS | Prof. P. S. Deo |
| 16 | Bijoy N | PDRA – I (Till 22.01.2024) | CMMP | Prof. Priya Mahadevan |
| 17 | Bikash Gajar | PDRA – I (from 09.08.2023) | CMMP | Dr. Atindra Nath Pal |
| 18 | Biswajit Pabi | PDRA - SNBNCBS (Till 28.03.2024) | CMMP | Dr. Atindra Nath Pal |
| 19 | Chandan Patra | PDRA – I (from 21.02.2024) | CMMP | Dr. Nitesh Kumar |
| 20 | Debayan Mondal | PDRA – SNBNCBS (from 02.02.2024) | CMMP | Prof. Priya Mahadevan |
| 21 | Dibyashree Chakraborti | PDRA – I (from 26.10.2023) | CMMP | Dr. Saquib Shamim |
| 22 | Didhiti Bhattacharya | PDRA – SNBNCBS (Till 23.08.2023) | CMMP | Dr. Avijit Chowdhury |
| 23 | Jayeta Banerjee | PDRA – II (from 01.02.2023 --) | CBS | Prof. Ranjit Biswas |
| 24 | Koushik Mondal | PDRA – I (from 30.10.2022 --) | CBS | Prof. Manik Pradhan |
| 25 | Mahima Singh | PDRA – I (Till 31.10.2023) | CMMP | Dr. Nitesh Kumar |
| 26 | Milan Sil | PDRA – I (Till 05.05.2023) | AHEP | Dr. Ramkrishna Das |
| 27 | Mily Kundu | PDRA – I (from 03.02.2023 --) | CMMP | Prof. Kalyan Mandal |

| Sl. No. | Name | Status | Dept. | Mentor |
|---|---|---|---|---|
| 28 | Md. Nur Hasan | PDRA – SNBNCBS (Till 28.12.2023) | CBS | Prof. S. K. Pal |
| 29 | Paramita Banerjee | PDRA – II (Till 08.03.2024) | CMMP | Prof. Priya Mahadevan |
| 30 | Parushottam Majhi | PDRA – SNBNCBS (Till 18.01.2024) | CMMP | Dr. Saquib Shamim |
| 31 | Prasanta Kundu | PDRA – II (Till 25.04.2023) | CBS | Prof. Gautam Gangopadhyay |
| 32 | Pratik Ghosal | PDRA – I (from 05.02.2024 --) | PCS | Dr. Manik Banik |
| 33 | Puspendu Barik | PDRA – III (Till 09.05.2023) | CBS | Prof. Manik Pradhan |
| 34 | Ramu K Yadav | PDRA – I (from 03.07.2023 --) | PCS | Prof. Sakuntala Chatterjee |
| 35 | Ritamay Bhunia | PDRA – III (from 09.02.2023 --) | CMMP | Dr. Avijit Chowdhury |
| 36 | Rituparna Mandal | PDRA – SNBNCBS (Till 28.06.2023) | CBS | Prof. Gautam Gangopadhyay |
| 37 | Saheb Dutta | PDRA – II (from 01.06.2023--) | CBS | Dr. Suman Chakrabarty |
| 38 | Saheli Samanta | PDRA – SNBNCBS (Till 30.11.2023) | CMMP | Prof. Manoranjan Kumar |
| 39 | Samrat Ghosh | PDRA – SNBNCBS (Till 24.08.2023) | AHEP | Prof. Soumen Mondal |
| 40 | Sk. Md. Obaidulla | PDRA – II (from 01.12.2022--) | CMMP | Dr. Atindra Nath Pal |
| 41 | Sk. Samir Ahamed | PDRA – I (from 01.02.2023--) | CBS | Dr. Suman Chakrabarty |
| 42 | Shantonu Mukherjee | PDRA – SNBNCBS (Till 05.12.2023) | PCS | Dr. Arijit Haldar |
| 43 | Shibendu Gupta Choudhury | PDRA – I (Till 13.02.2024) | AHEP | Prof. Amitabha Lahiri |
| 44 | Shiladitya Karmakar | PDRA – SNBNCBS (Till 01.03.2024) | PCS | Dr. Arijit Haldar |
| 45 | Shobhan Dev Mandal | PDRA – SNBNCBS (from 01.11.2023--) | PCS | Prof. Sakuntala Chatterjee |
| 46 | Shubhrasish Mukherjee | PDRA – SNBNCBS (Till 23.08.2023) | CMMP | Dr. Atindra Nath Pal |
| 47 | Soumi Das | PDRA – I (from 20.06.2022--) | PCS | Prof. Jaydeb Chakrabarti |
| 48 | Souvik Manna | PDRA – I (from 01.06.2023) | AHEP | Dr. Tapas Baug |
| 49 | Sourav Chakraborty | PDRA – I (from 01.12.2023) | CMMP | Prof. Manoranjan Kumar |
| 50 | Subhash Ch. Makhal | PDRA – II (Till 05.09.2023) | CBS | Prof. Rajib K Mitra |
| 51 | Sudipta Chatterjee | PDRA – SNBNCBS (from 13.10.2023--) | CMMP | Prof. Kalyan Mandal |
| 52 | Sumana Pyne | PDRA – SNBNCBS (from 15.09.2023--) | CBS | Prof. Rajib K Mitra |
| 53 | Suman K Mandal | PDRA – I (from 01.06.2023) | AHEP | Prof. Soumen Mondal |
| 54 | Sumaiya Parveen | PDRA – I (Till 16.11.2023) | CMMP | Prof. Anjan Barman |
| 55 | Susmita Mondal | PDRA – SNBNCBS (from 01.09.2023--) | CBS | Prof. S. K. Pal |
| 56 | Sutapa Saha | PDRA – I (from 01.03.2023--) | AHEP | Prof. Archan S Majumdar |
| 57 | Swarnali Hait | PDRA – SNBNCBS (from 01.09.2023 --) | PCS | Prof. P. S. Deo |
| 58 | Tanushree Das | PDRA – I (from 06.03.2024 --) | CBS | Prof. Rajib K Mitra |
| 59 | Tapas Sahoo | PDRA – III (Till 09.05.2024) | CBS | Prof. Gautam Gangopadhyay |
| 60 | Tonima Nandy | PDRA – I (from 06.05.2022 --) | CBS | Prof. Ranjit Biswas |
| 61 | Tirthendu Sinha | PDRA – I (from 01.11.2022--) | AHEP | Dr. Tapas Baug |
| 62 | Tridib Roy | PDRA – I (from 17.01.2023--) | AHEP | Dr. Ramkrishna Das |
| 63 | Tushar Kanti Bhowmik | PDRA – I (from 02.02.2023--) | CMMP | Dr. T. Setti |

## NPDF / RESEARCH ASSOCIATE (EXTERNAL FUND) / DST (INSPIRE) / RAMANUJAN FELLOW etc: 2023-2024

| Sl. No. | Name | Designation | Status | Dept. | Mentor / Host | Title of the Project |
|---|---|---|---|---|---|---|
| 1 | Dr. Aayatti Mallick Gupta | RA | From 02.08.2021 | PCS | Prof. Jaydeb Chakrabarti | CSIR |
| 2 | Dr. Amit Mukherjee | SRA | Till 26.09.2023 | PCS | Dr. Manik Banik | CSIR |
| 3 | Dr. Anup Ghosh | DST INSPIRE FACULTY | Till 13.03.2024 | CMMP | Prof. Anjan Barman | Ultrafast 2D-IR spectroscopy on the structural dynamics of DNA/G Quadruplex |
| 4 | Dr. Ali Hossain Khan | Ramanujan Fellow | From 01.11.2021 | CBS | Prof. Rajib K Mitra | Doped 2D Nanocrystals for Photonic Applications |
| 5 | Dr. Dipayan Sen | Research Associate – III | Till 31.01.2024 | CMMP | Prof. Tanusri Saha Dasgupta | J.C. Bose Award (Fellowship) |
| 6 | Dr. Indrani Bhattacharyya | National Post-Doctoral Fellow | From 28.12.2022 | CBS | Prof. Rajib K Mitra | Exploring Hydration Dynamics of Protein Aggregation and Its Connection with Liquid-Liquid Phase Separation Triggered by Modulation in Local Environmental Parameters Employing Terahertz Spectroscopy and Complementary Experimental Techniques |
| 7 | Dr. Gargee Bhattacharyya | National Post-Doctoral Fellow | From 06.01.2023 | CMMP | Prof. Priya Mahadevan | Proximity induced spin-orbit coupling and magnetism on graphene from magnetic topological quantum matter (MTQM) |
| 8 | Dr. Manoj Mandal | Ramalingaswami Re-entry Fellowship | Till 07.02.2024 | CBS | Prof. Rajib K Mitra | Exploring the water-oxidation mechanism and proton coupled electron transfer reactions in photo system II: An approach towards clean fuel |
| 9 | Dr. Mir Alimuddin | Chanakya PDF | From 13.06.2022 | PCS | Dr. Manik Banik | Devising Practically implementable enhanced means of communication with the aid of quantum resources |
| 10 | Dr. Rajeswari Roy Chowdhury | DST INSPIRE FACULTY | Till 10.02.2024 | CMMP | Dr. T. Setti | Spectroscopy and imaging down to sub-nanometer length scales on topological systems and their heterostructure devices |
| 11 | Dr. Sanku Paul | DST INSPIRE FACULTY | From 22.05.2023 | PCS | Dr. Arijit Haldar | Hidden quantum criticality and its application in data hiding |
| 12 | Dr. Soumendu Datta | Research Associate – III | Till 24.08.2023 | CMMP | Prof. Tanusri Saha-Dasgupta | J.C. Bose Award (Fellowship) |
| 13 | Dr. Sujoy Ghosh | DST INSPIRE FACULTY | Till 12.01.2024 | CMMP | Dr. Atindra Nath Pal | Self-powered bio-resorbable Implantable device |
| 14 | Dr. Suman Chowdhury | DST INSPIRE FACULTY | Till 08.06.2023 | CMMP | Prof. Tanusri Saha-Dasgupta | Exploration of Thermochromism in 2D transition-metal oxides |
| 15 | Dr. Sumaiya Parveen | Chanakya PDF | From 17.11.2023 | CMMP | Prof. Anjan Barman | Two-dimensional Ferromagnetic and Organic Molecule Spinterfaces as Molecular Spin Qubits for Quantum Technologies and Energy Harvesting Applications |
| 16 | Dr. Soumya Bhattacharya | Research Associate – I | From 04.04.2022 | AHEP | Prof. Rabin Banerjee | Gauge and Gravitational Symmetries in Nonrelativistic Theories : Formalism and Applications |
| 17 | Dr. Sourav Chakraborty | Research Associate – I | Till 30.11.2023 | CMMP | Prof. Manoranjan Kumar | Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature |

| Sl. No. | Name | Designation | Status | Dept. | Mentor / Host | Title of the Project |
|---|---|---|---|---|---|---|
| 18 | Dr. Tusita Sau | Research Associate – I | From 03.04.2023 | CMMP | Prof. Tanusri Saha Dasgupta | Search for Novel Magnetic and Topological Materials |
| 19. | Dr. Upasana Das | National Post-Doctoral Fellow | Till 26.12.2023 | CBS | Dr. P. S. Pachfule | Development of a Group of Crystalline Framework-based Magnetic Nanocomposites as Theranostics for Targeting Breast Cancer Stem Cells |

## EMERITUS / Others Contractual Faculty: 2023-2024

| Sl. No. | Name | Status | Dept. |
|---|---|---|---|
| 1 | Prof. Rabin Banerjee | Raja Ramanna Fellow | AHEP |
| 2 | Prof. Gautam De | Visiting Professor, till 31.03.2024 | CBS |
| 3 | Prof. Prabhat Mandal | Emeritus Professor | CMMP |
| 4 | Prof. Samit Kr. Ray | Adjunct Faculty | CMMP |
| 5 | Prof. Partha Guha | Adjunct Faculty | PCS |
| 6 | Dr. Goutam Sheet | Adjunct Fellow | CMMP |
| 7 | Dr. Subhro Bhattacharjee | Adjunct Fellow | CMMP |
| 8 | Dr. Indranil Sarkar | Adjunct Faculty | CMMP |

Nibedita Konar

Debashish Bhattacharjee

Rupam Porel

# Theoretical Physics Seminar Circuit

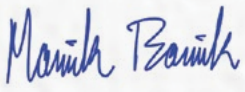
## Outreach activities under TPSC

SNBNCBS will sponsor and co-organize the following outreach activities in College/Universities of West Bengal as well as in Northeast under the Theoretical Physics Seminar Circuit (TPSC) programme.

» 12th Vidyasagar Satyendra Nath Bose National Workshop on "Advances in Physics: Theories & Applications (APTA-2023)"
Venue: Vidyasagar University, Midnapore, WB
Date: From 28.02.2023 to 02.03.2023

» Topical Research School on "Quantum Foundation and Quantum Information 2023"
Venue: A B N Seal College, Cooch Behar, WB
Date: From 14.03.2023 to 16.03.2023

» Topical Research School on "Current Trends in Theoretical and Experimental Physics"
Venue: Gurucharan College, Silchar, Assam
Date: From 20.03.2023 to 23.03.2023



**Manik Banik**
Convener, Theoretical Physics Seminar Circuit

# Report on Administrative Matters

The Centre has rendered administrative support to its academic activities through its administrative and technical staff members who have professionally and sincerely carried out their duties for making the various events held in the Centre in year 2023-2024 successful. The Centre has 22 permanent staff, 9 in temporary status and 25 staff members in contractual category as on 31st March 2024, who have performed their duties efficiently under the able leadership of the Director and the Registrar. The smooth running of the day to day activities of the Centre including guest house (Bhagirathi), creche (Kishalay), security, EPABX, transport, canteen, electrical maintenance, AC maintenance, campus maintenance and various other facilities have been made possible due to the professional services provided by the various service agencies working closely with the administration of the Centre. The Centre has maintained close liasion with the Department of Science and Technology and other ministries and have complied to all time-bound queries and reports sought. All parliament information/reports, compliance reports, queries regarding Audit Paras, different kinds of reports regarding GEM, LIBMS etc. have been submitted on time to DST. The Centre has also successfully handled several visits of the CAG Audit Team, carrying out different types of Audits and replied to Audit Queries. The Hindi Cell of the Centre has been functioning effectively and the Centre has undertaken substantial administrative work in hindi and made sincere efforts to implement and follow the provision of Official Language Act in the year 2023-24, which are separately reported here.

## Meetings of the Statutory Committees of the Centre held during FY 2023-24 :

(i) The 66th, 67th, 68th and 69th Governing Body (GB) meetings of the Centre were held on 11.04.2023, 28.06.2023, 22.09.2023 and 27.03.2024 respectively.

(ii) The 44th, 45th and 46th Finance Committee (FC) meetings of the Centre were held on 03.04.2023, 18.09.2023 and 18.03.2024 respectively.

(iii) The 32nd and 33rd Academic & Research Programme Advisory Committee (ARPAC) meetings of the Centre were held on 16-17 May 2023 and 29th February to 1st March 2024 respectively.

## Right to Information (RTI) Act:

The Centre has adhered to the norms of the Right to Information Act and received 10 (ten) cases under the said Act in the last financial year, all of which have been processed within stipulated time and successfully disposed off. All quarterly / annual progress reports pertaining to Rajbhasha, Vigilance & RTI have been submitted to the concerned authorities timely.

## Vigilance Matters:

As part of Vigilance Awareness Week 2023 during 30th October 2023 to 5th November 2023, the Centre organised Vigilance Pledge, an Essay Competition and Poster Making Competition

(Topic: "Say no to Corruption commit to the Nation"). The essay competition carried a cash award of Rs.5,000/- (1st prize), Rs.3,000/- (2nd prize) and Rs.1,000/- (3rd prize) with winners as:

» 1st Prize – Mr. Sreyan Bhowmick, Junior Research Fellow.

» 2nd Prize – Mr. Rupayan Saha, Senior Research Fellow.

» 3rd Prize – Ms. Bidisha Sarkhel, TRC & Ms. Madhurita Das, Junior Research Fellow.

The Poster Making Competition carried a cash award of Rs.5,000/- (1st prize), Rs.3,000/- (2nd prize) and Rs.1,000/- (3rd prize) with winners as:

» 1st Prize – Mr. Rupam Porel, Office Assistant.

» 2nd Prize – Ms. Ria Saha, Senior Research Fellow.

» 3rd Prize – Ms. Soma Dutta, Senior Research Fellow.

No cases related to vigilance have been reported during 2023-2024.

## Swachhta Pakhwada:

The Centre celebrated 'Swachhta Pakhwada' from 1st May 2023 to 15th May 2023. As a part of the Pakhwada on 01.05.2023 the Centre organised Swachhta pledge taking ceremony and carried out mass cleaning of Main Office Building, Guest House, Students' Hostels and other Centre premises. Collection of wastes at different points and awareness campaign about no use of plastics was carried out. Posters titled "Zero Plastic, Green Campus" were pasted on all notice boards and all prominent places of the Centre. Weeding out of old records was done. A motivational talk/lecture on the occasion of 'National Technology Day' titled "Cleanliness must start with yourself" was delivered by Prof. S.K.Pal, Senior Professor of the Centre. An Essay and Poster Competition on "E-Waste Se Raksha, Swacchata Hi Suraksha" was organised alongwith an invited lecture by Shri Sisir Mondal, Assistant Environment Engineer, West Bengal Pollution Control Board on 'E-waste Management'. Short dramas titled "Aartanaad" on the theme "Awareness of Cleanliness", "Trapped as a slave in E-waste Empire" on the theme "E-waste se Raksha, Swachhata Hi Suraksha" was also organised by the staff and students of the Centre.

## International Yoga Diwas:

The Centre also celebrated the International Yoga Day; Theme: "Yoga for Vasudhaiva Kutumbakam" on 21st June 2023 at Dining Hall of the Basundhara with enthusiastic participation from the staff and students of the Centre.

## Special Days of Celebration:

The Centre celebrated the following events:

» The national flag was hoisted by the Director on 75th Republic Day on 26th January 2024 and 77th Independence Day on 15th August 2023. Both the occasions were attended by staff and students of the Centre and national anthem was sung to mark the occasions.

» On 1st January 2024, the Centre celebrated 130th Birth Anniversary of Prof. Satyendra Nath Bose by garlanding the bust of the eminent scientist. The Centre organised 'Open Day' on 2nd January 2024 to commemorate the 130th Birth Anniversary of Prof. Satyendra Nath Bose. Around --- visitors from outside attended the 'Open Day' Programme. The Centre organised visits in the Science Labs, SNBose Archive and Planet & Star watching in the evening to mark the occasion.

» Swachhta Pledge on 1st May 2023;

» Vigilance Pledge on 30th October 2023;

» Rashtriya Ekta Diwas Pledge on 31st October 2023;

## Facilities

The Centre has the Contributory Medical Scheme (CMS) under which the Centre extends medical facilities (both outdoor and indoor) to all its staff members and their dependents (for permanent staff members) and to the scholars and contractual staff members (as individuals) and reimburses medical bills as per CGHS rates. The Centre has its own medical unit to cater to the requirements of the staff members where Allopathic and Homeopath physicians are available for regular consultation. Facilities like oxygen, wheel chair, stretcher, rest bed etc. are readily available apart from First Aid treatments. The Centre also has cashless tie ups with some of the renowned hospitals in Kolkata viz. B.M. Birla Heart Research Centre, Medica Superspeciality Hospital, Peerless Hospitex Hospital and Research Centre Limited, Desun Hospital & Heart Institute, AMRI Hospitals, Apollo Gleneagles Hospital Ltd, Institute of Neurosciences, Kolkata etc. for indoor hospitalisation facility. Outdoor treatments are also extended under CMS as per CGHS rates.

The Centre houses a modern Guest House by the name of 'Bhagirathi' comprising of 57 air conditioned rooms (including Single Bed, Double Bed & Transit rooms), 5 air conditioned suites and a fully AC Seminar cum Dining Hall and Kitchen with modern facilities and Seminar room. 'Bhagirathi' also has an equipped Doctor's chamber and two Air Conditioned office rooms. The Centre has two hostels by the name 'Radhachura' and 'Krishnachura' and an Essential Staff Quarter (Subarnarekha) which provides hostel accommodation to approximately 154-160 students respectively. Subarnarekha also provides accommodation facilities for its staff. The students residing in the Centre run their own mess and the hostels have facilities like dining rooms, common rooms etc. There is a gymnasium in the Centre which has been inaugurated on 15th August 2023. The Centre provides accommodation to Post Doctoral Fellows, on request. The Integrated Hostel Building and Transit Quarter by the name 'Basundhara' is being put into use through its dining hall facilities and housing of few faculty members, summer

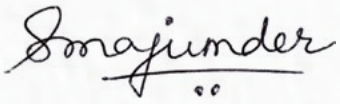
students, administrative offices, Offices of Post Docs etc. 'Basundhara' also houses the Bose Archive which has personal artefacts and collection of Prof. S.N. Bose as donated by the family of S.N.Bose. It also exhibits the life story of Prof. Bose.

The Centre has modernly equipped Lecture Halls / Seminar Halls namely : Silver Jubilee Hall (120 sitting capacity), BOSON (60 sitting capacity) and FERMION (80 sitting capacity) with latest lecture facilities to cater to the various events organised viz. Lectures, Seminars, Colloquiums, Symposiums, Training programmes, Cultural Programmes, etc. These facilities are also available for external users on rental basis.

## Activities of 'Muktangan':

- World Blood Donor Day "Raktdaan Amrit Mahotsav" on 9th June 2023 in collaboration with Medical College and Hospital, Calcutta Medical College. The staff and students of the Centre enthusiastically participated in the programme;
- An Intra-Institute Carrom Tournament on 20-21 June 2023 & Intra-Institute Table Tennis Tournament on 22-23 June 2023;
- Fresher's Welcome on 15.09.2023;
- An Intra-Institute Cricket Tournament on 10-11 February 2024;
- An Intra-Institute Badminton Tournament on 17-18 February 2024;
- On the occasion of 'BOSE FEST 2024' held during 22nd February 2024 – 24th February 2024, Family Day was celebrated on the evening of 24th February 2024. On 24th February 2024, the Performing Arts Group of 'Muktangan' organised an in-house programme comprising of individual and group performances of singing, recitation and play. The programmes were attended by friends and family members of staff and students. The In-house Bose Fest programme was followed by a gala dinner for family members of the staff and students of the Centre. On the evening of 23rd February 2024, renowned Bengali Singer Shri Manomay Bhattacharya performed on the occasion of Bose Fest. An Art & Photography Fest consisting of photography and paintings / creative work by the students and staff was held during the Fest. Oral & Poster presentations by the students were also held during the above period.

While concluding, I express my sincere thanks to the three Deputy Registrars of Administration, Finance and Academic Sections, all the Section Incharges and all the administrative and academic staff members of the Centre for their unfailing dedication and cooperation in successfully organising the programmes held in the Centre and for facilitating day to day smooth functioning of the administration. I am also grateful to Prof. Tanusri Saha-Dasgupta, Director for her valuable guidance and advice on administrative matters.



**Shohini Majumder**
Registrar

Staff members of the Centre

Staff members, Administrative Section

Staff members, Purchase Section

Staff members, Computer Services Cell

# Hindi (Rajbhasha) Implementation in the Centre

## Activities of the Hindi Cell

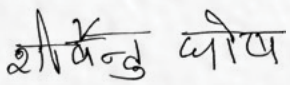
The Centre implemented the provisions of the Official Language Act in the year 2023-24. According to Rajbhasha Rule 5, reply to Hindi letters was given in Hindi only. All the official registers, forms, visiting cards, letter heads, and seals are in bilingual format. Advertisements, tender notices, office orders and notices were circulated in Hindi also and uploaded in the Centre's website. Internal notings and signing in the Attendance Register (on the first of every month) are done in Hindi. The Centre has its official website in Hindi where all the information and important policy documents of the Centre are available. The Centre has also carried out correspondences in Hindi with the Ministry and other government organisations. The Centre is a member of Town Official Language Implementation Committee (Office-2), Kolkata and has a Hindi Implementation Committee which meets regularly. All the administrative staff and many of the academic staff members possess working knowledge of Hindi and the administrative staff have been successfully trained in the 'Praveen' and 'Pragya' courses of the Department of Official Language, Government of India. The Centre has also initiated training of staff in the 'Parangat' course. The Centre timely submits quarterly progress report in hindi to the Dept of Official languages. The Centre carries out many of its routine administrative jobs in hindi eg. notings, letters etc.

'Hindi Mahina' was celebrated by organising Hindi Essay Competition & Hindi Quiz in September 2023. The essay competition carried a cash award of Rs.3,000/- (1st prize), Rs.2,000/- (2nd prize) and Rs.1,000/- (3rd prize). The winners of Essay Competition were:

**Essay Competition:**

- 1st Prize – Ms. Urmi Chakrabarty, Technical Assistant.
- 2nd Prize – Ms. Sakshi Chowdhury, IPhd.
- 3rd Prize – Mr. Ajay Sharma, Senior Research Fellow.
- On 14th September 2023 "Hindi Diwas Samaroh" was organised; Guest Lecturer, Shri Rampravesh Rajak, Calcutta University and Shri L.K.Singh, Pradhyapak, Rajbhasha Bibhag, Kolkata delivered a talk on the said occasion followed by a cultural programme by the students of the Centre. A Hindi extempore competition was also organised.

The Centre also organised the following 'Hindi Workshops' pertaining to each quarter during 2023-2024: i) Talk on "Rajbhasha Hindi Ka Manak Swarup Aur Hone Wale Bhashagat Samanya Trutiya" by Shri Manindra Nath Viswakarma, Assistant Director (Rajbhasha), Akhil Bharatiya Swasthya Vigyan Aur Jana Swashthya Sansthan, Kolkata, West Bengal on 22.06.2023; ii) Talk on "Karyalin Hindi Aur Tippan & Alekhan" by Shri. Vinay Shukla, Anubad Adhikari (Rajbhasha), Rajya Bima Nigam, Kolkata, West Bengal on 08.09.2023; iii) Talk on "Kendriya Sarkar ke Karyalay me Rajbhasha Karyavyan se Sambandhit Rajbhasha Niti" by Shri. Kamakhya Narayan Singh, Assistant Director (Rajbhasha), DST, New Delhi on 22.11.2023; iv) Talk on "Hindi me Vigyan Se Sambandhit Lokpriya Vishay" by Dr. Nitish Kumar, Assistant Professor, S.N.Bose National Centre for Basic Sciences, Kolkata on 28.03.2024.



**Sirsendu Ghosh**
In-charge, Hindi Cell

# Committees (as on 31.03.2024)

| Governing Body | |
|---|---|
| Prof. B.N. Jagatap<br>Professor, Department of Physics<br>IIT Bombay, Mumbai | Chairman |
| Secretary<br>Department of Science & Technology<br>Government of India, New Delhi | Member |
| Prof. Prasanta K Panigrahi,<br>Professor, Department of Physical Sciences (DPS)<br>Indian Institute of Science Education and Research, Kolkata | Member |
| Prof. Pallab Banerjee<br>Professor, Materials Science Centre, IIT, Kharagpur | Member |
| Dr. D.S. Ramesh<br>Director, IIG, Navi Mumbai | Member |
| Prof. Manoj Kumar Harbola<br>Professor, Dept. of Physics, IIT, Kanpur | Member |
| Shri Vishvajit Sahay<br>Additional Secretary & Financial Advisor<br>Department of Science & Technology, Government of India, New Delhi | Member |
| Shri H.K. Dwivedi, IAS<br>The Chief Secretary, Govt. of Wets Bengal | Member |
| Prof. Tanusri Saha-Dasgupta<br>Director, S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Director<br>Bose Institute, Kolkata | Member |
| Director<br>Indian Association for Cultivation of Science, Kolkata | Member |
| Ms. Shohini Majumder<br>Registrar, S. N. Bose National Centre for Basic Sciences, Kolkata | Non-Member Secretary |
| **Finance Committee** | |
| Prof. Tanusri Saha-Dasgupta<br>Director, S. N. Bose National Centre for Basic Sciences, Kolkata | Chairperson |
| Shri Vishvajit Sahay<br>Additional Secretary & Finance Advisor<br>Department of Science & Technology, New Delhi | Member |
| Prof. Somak Raychaudhury<br>Vice-Chancellor, Ashoka University<br>(One Nominee of the Academic & Research, Programme Advisory Committee) | Member |
| Prof. Pallab Banerjee<br>Professor, Materials Science Centre, IIT, Kharagpur | Member |
| Ms. Shohini Majumder<br>Registrar<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member Secretary |

| Academic & Research Programme Advisory Committee | |
|---|---|
| Prof. D.D.Sarma<br>Professor, Indian Institute of Science, Bengaluru | Chairman |
| Prof. Shobhana Narasimhan<br>Professor, Jawaharlal Nehru Centre<br>For Advanced Scientific Research, Bengaluru | Member |
| Prof. Arindam Ghosh<br>Professor, Indian Institute of Science, Bengaluru | Member |
| Prof. Annapurni Subramaniam<br>Director, Indian Institute of Science, Bengaluru | Member |
| Prof. Jayanta Kumar Bhattacharjee<br>Distinguished Visiting, Professor, IACS, Kolkata | Member |
| Prof. Srabani Taraphder<br>Professor, IIT, Kharagpur | Member |
| Prof. Amitava Raychaudhuri<br>Professor Emeritus, University of Calcutta, Kolkata | Member |
| Prof. Kaushik Biswas<br>Professor, Bose Institute, Kolkata | Member |
| Prof. Bushra Ateeq<br>Joy Gill Chair Professor, IIT, Kanpur | Member |
| Prof. Tanusri Saha-Dasgupta<br>Director<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Anjan Barman<br>Dean (Faculty)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Amitabha Lahiri<br>Dean (Academic Programme)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Ms. Shohini Majumder<br>Registrar<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Non –Member Secretary |
| Dr. Sunandan Gangopadhyay<br>Head, Department of Astrophysics and High Energy Physics<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Permanent Invitee |
| Prof. Punyabrata Pradhan<br>Head, Department of Physics of Complex Systems<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Permanent Invitee |
| Prof. Manoranjan Kumar<br>Head, Department of Condensed Matter and Materials Physics<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Permanent Invitee |
| Dr. Suman Chakrabarty<br>Head, Department of Chemical and Biological Sciences<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Permanent Invitee |

| Building Committee | |
|---|---|
| Prof. Tanusri Saha-Dasgupta<br>Director<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Chairperson |
| Mr. Asim Sinha<br>Chief Engineer (Retired), Electrical, CPWD | Member |
| A nominee of the Department of Science & Technology<br>Autonomous Institution Division<br>Department of Science & Technology, New Delhi | Member |
| Dr. Tapash Kr. Roy<br>Associate Professor, Dept. of Civil Engineering and Superintending Engineer (Acting),<br>Indian Institute of Engineering Science and Technology, Shibpur. | Member |
| Ms. Shohini Majumder<br>Registrar<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member- Secretary |
| Mr. Mithilesh Kumar Pande<br>Campus Engineer cum Estate Officer, SNBNCBS, Kolkata | Special Invitee |
| Mr. Suman Saha<br>Deputy Registrar (Finance), SNBNCBS, Kolkata | Special Invitee |
| **Consultative Advisory Committee** | |
| Prof. Tanusri Saha-Dasgupta<br>Director<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Chairperson |
| Prof. Anjan Barman<br>Dean (Faculty)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Amitabha Lahiri<br>Dean (Academic Programme)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Punyabrata Pradhan<br>Head, Department of Physics of Complex Systems<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Dr. Sunandan Gangopadhyay<br>Head, Department of Astrophysics and High Energy Physics<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Dr. Suman Chakrabarty<br>Head, Department of Chemical and Biological Sciences<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Manoranjan Kumar<br>Head, Department of Condensed Matter and Materials Physics<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Ms. Shohini Majumder<br>Registrar<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Mr. Debashish Bhattacharjee<br>Deputy Registrar (Administration)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |

| | |
|---|---|
| Mr. Suman Saha<br>Deputy Registrar (Finance)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Ms. Nibedita Konar<br>Deputy Registrar (Academic)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member - Secretary |
| **Official Language Implementation Committee** | |
| Prof. Tanusri Saha-Dasgupta<br>Director<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Chairperson |
| Ms. Shohini Majumder<br>Registrar<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Prof. Manoranjan Kumar<br>Professor<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Dr. Nitesh Kumar<br>Assistant Professor<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Mr. Debashish Bhattacharjee<br>Deputy Registrar (Administration)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Ms. Nibedita Konar<br>Deputy Registrar (Academic)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Mr. Suman Saha<br>Deputy Registrar (Finance)<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Mr. Mithilesh Kumar Pande<br>Campus Engineer cum Estate Officer<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |
| Mr. Sirsendu Ghosh<br>In-charge, Hindi Cell<br>S. N. Bose National Centre for Basic Sciences, Kolkata | Member |

# Academic Members 2023-24

## ACADEMIC MEMBERS (REGULAR FACULTIES) : 2023-2024

| Sl. No. | Name of the faculty | Designation |
|---|---|---|
| 1 | Tanusri Saha Dasgupta | Director & Senior Professor : CMMP |
| 2 | Archan S Majumdar | Senior Professor : AHEP |
| 3 | Kalyan Mandal | Senior Professor : CMMP |
| 4 | Amitabha Lahiri | Senior Professor : AHEP |
| 5 | Priya Mahadevan | Senior Professor : CMMP |
| 6 | Ranjit Biswas | Senior Professor : CBS |
| 7 | Samir Kumar Pal | Senior Professor : CBS |
| 8 | Anjan Barman | Senior Professor : CMMP |
| 9 | Gautam Gangopadhyay | Senior Professor : CBS [ Retired on 29.02.2024] |
| 10 | Jaydeb Chakrabarti | Senior Professor : PCS |
| 11 | Rajib Kumar Mitra | Senior Professor : CBS |
| 12 | Prosenjit Singha Deo | Professor : PCS |
| 13 | Soumen Mondal | Professor : AHEP |
| 14 | Manik Pradhan | Professor : CBS |
| 15 | Punyabrata Pradhan | Professor : PCS |
| 16 | Barnali Ghosh (Saha) | Scientist 'F' [Retired on 31.08.2023] |
| 17 | Manoranjan Kumar | Professor : CMMP |
| 18 | Sakuntala Chatterjee | Professor : PCS |
| 19 | Sunandan Gangopadhyay | Professor : AHEP |
| 20 | Ramkrishna Das | Associate Professor : AHEP |
| 21 | Suman Chakrabarty | Associate Professor : CBS |
| 22 | Atindra Nath Pal | Associate Professor : CMMP |
| 23 | Thirupathaiah Setti | Associate Professor : CMMP |
| 24 | Manik Banik | Associate Professor : PCS |
| 25 | Urna Basu | Associate Professor : PCS |
| 26 | Shubhasis Haldar [From 16.06.2023] | Associate Professor : CBS |
| 27 | Sanjoy Choudhury | Scientist 'E' |
| 28 | Tapas Baug | Assistant Professor : AHEP |
| 29 | Nitesh Kumar | Assistant Professor : CMMP |
| 30 | Avijit Chowdhury | Assistant Professor : CMMP |
| 31 | Pradip S Pachfule | Assistant Professor : CBS |
| 32 | Arijit Haldar | Assistant Professor : PCS |
| 33 | Saquib Shamim | Assistant Professor : CMMP |
| 34 | Parijat Dey [From 26.10.2023] | Assistant Professor : AHEP |

**AHEP:** Department of Astrophysics and High Energy Physics

**PCS:** Department of Physics of Complex Systems

**CBS:** Department of Chemical and Biological Sciences

**CMMP:** Department of Condensed Matter and Materials Physics

# Administrative and Technical Staff Members

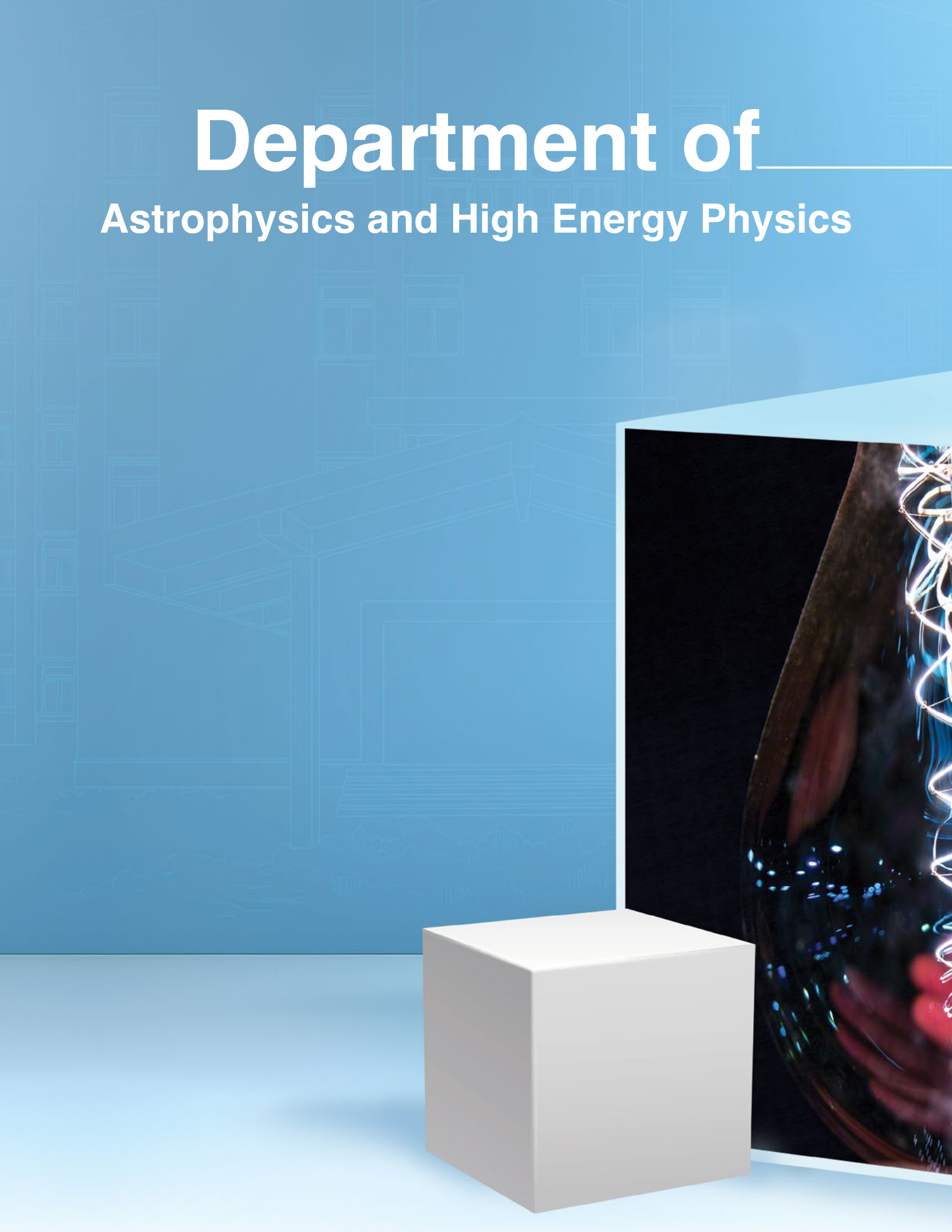
| Administrative and Technical Staff Members | |
|---|---|
| Shohini Majumder | Registrar |
| Kalyan Mandal | Vigilance Officer |
| Debashish Bhattacharjee | Public Information Officer |
| **Other Members** | |
| Nibedita Konar | Deputy Registrar (Academic) |
| Debashish Bhattacharjee | Deputy Registrar (Administration) |
| Suman Saha | Deputy Registrar (Finance) |
| Saumen Adhikari | Librarian cum Information Officer |
| Mithilesh Kumar Pande | Campus Engineer cum Estate Officer |
| Santosh Kumar Singh | Assistant Registrar (Purchase) |
| Sirsendu Ghosh | Programme Coordinating Officer |
| Achyut Saha | Personal Assistant to Director |
| Swapnamoy Datta | Stenographer |
| Sanchari Dasgupta | Assistant (General) |
| Jaydeep Kar | Programme Assistant |
| Prosenjit Talukdar | Programme Assistant |
| Subham Paul | Pump Operator |
| Bijoy Kumar Pramanik | Junior Assistant (Guest House) |
| Bhupati Naskar | Library Stack Assistant |
| Siddhartha Chatterjee | Upper Division Clerk |
| Swarup Dutta | Project Assistant |
| Amit Ghosh | Attendant |
| Swapan Ghosh | Attendant |
| Rajarshi Barman | Attendant |
| Suprobhat Naskar | Attendant |
| **Personnel with temporary status** | |
| Dulal Chatterjee | Attendant (Maintenance) |
| Sudhanshu Chakraborty | Attendant (Technical Cell) |
| Hiralal Das | Cleaner |

| | |
|---|---|
| Kartick Das | Cleaner |
| Motilal Das | Cleaner |
| Prakash Das | Cleaner |
| Ramchandra Das | Cleaner |
| Biswanath Das | Gardener [resigned w.e.f. 21.02.2024] |
| Nimai Naskar | Gardener |
| **Personnel on contractual appointment** | |
| A.K.Sarkar | Advisor (Finance) |
| B.S.Panda | Consultant (Legal) |
| Ayan Deb | Assistant Engineer (Electrical) [resigned w.e.f. 29.06.2023] |
| Sutapa Basu | PS to Registrar |
| Abhijit Ghosh | Junior Computer Engineer [resigned w.e.f. 08.08.2023] |
| Sagar Samrat De | Junior Computer Engineer [resigned w.e.f. 15.06.2023] |
| Amit Roy | Technical Assistant (Library) |
| Gurudas Ghosh | Technical Assistant (Library) |
| Ananya Sarkar | Technical Assistant (Library) |
| Shakti Nath Das | Technical Assistant |
| Urmi Chakraborty | Technical Assistant |
| Amit Kumar Chanda | Technical Assistant |
| Joy Bandopadhyay | Technical Assistant |
| Ganesh Gupta | Junior Engineer (Electrical) |
| Supriyo Ganguly | Junior Engineer (Electrical) |
| Amitava Palit | Junior Engineer (Civil) |
| Lakshmi Chattopadhyay | Junior Engineer (Civil) |
| Chandrakana Chatterjee | Office Assistant |
| Rupam Porel | Office Assistant |
| Mitali Bose | Office Assistant |
| Suvodip Mukherjee | Office Assistant |
| Suvendu Dutta | Office Assistant [resigned w.e.f. 09.02.2024] |
| Sonali Sen | Office Assistant |
| Lina Mukherjee | Jr. Office Assistant |
| Debasish Mitra | Telephone Operator |
| Sani Amed Ali Molla | Technician (AC & Refrigeration) |
| Suranjan Deb | Telephone Technician |
| Harishikesh Nandi | Glass Blower (Part-time) |

| | |
|---|---|
| **Staff of outsourced agency working in administration:** | |
| Mr. Krishnendu Patra | Clerk (Accounts) |
| Ms. Sanchari Chatterjee | Clerk (Accounts) |
| Mr. Ajay Kumar Shaw | Office Assistant (Hindi) |
| Mr. Arnab Saha | Project Associate II |
| Mr. Jagadish Prasad Sahoo | Project Associate II |
| Mr. Debarghya Ghosh | Project Associate II |
| Mr. Sourav Sinha | Technical Assistant |
| Mr. Aditya Maitra | Technical Assistant |
| Mr. Subhabrata Das | Mechanic |
| Mr. Gobinda Das | Driver |
| Mr. Pintu Saha | Driver |
| Mr. Jayanta Barman | Peon |
| Mr. Prabir Patra | Caretaker |
| **Medical cell (consultant physicians)** | |
| Dr. Chayan Bhattacharya | Authorised Medical Officer |
| Dr. Sarbani Bhattacharya | Medical Officer |
| Dr. Tridib Kumar Sarkar | Doctor of Homeopathy |

# Department of

## Astrophysics and High Energy Physics




## Amitabha Lahiri

Senior Professor

Astrophysics and High Energy Physics

amitabha@bose.res.in


### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Shantonu Mukherjee; Some applications of quantum field theoretic dualities to superconducting systems; Awarded
2. Indrajit Ghose; Effect of space-time torsion on fermion dynamics; Under progress
3. Riya Barick; Neutrino mixing and oscillation via torsional four-fermi interaction; Under progress
4. Arnab Chakraborty; Spacetime geometry, quantum fields and discrete symmetries; Under progress
5. Sagar K. Maity; Collapse and singularity in Einstein-Cartan gravity; Under progress

#### b) Post-Docs

1. Shibendu Gupta Choudhury; Gravitation and Cosmology

### Teaching

1. Autumn semester; PHY 505: Advanced Quantum Mechanics and Applications; Integrated PhD; 13 students
2. Spring semester; PHY 402: Electromagnetic Theory; Integrated PhD; 14 students
3. Autumn semester; PHY 509: Project Research II; Integrated PhD; 1 student
4. Spring semester; PHY 502: Project Research III; Integrated PhD; 1 student

### Publications

#### a) In journals

1. Riya Barick, Indrajit Ghose, and **Amitabha Lahiri**, Neutrino *Oscillations Induced by Chiral Torsion,* Letters in High Energy Physics, 2023, 362, 2023
2. **Amitabha Lahiri**, Palash B. Pal, and Marina Shokova, *Discrete Symmetry Transformations on Non-Abelian Gauge Fields,* The Physics Educator, 5, 2, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. Fermions, geometry, and a novel interaction; March 14, 2024; Jadavpur University; 1 hr
2. "First order gravity and connections on frame bundles", University of Connecticut, Hartford, USA, June 22, 2023, 1 hr

### Administrative duties

1. Dean (Academic Programme), ex-officio chair/member of several committees
2. Chair: Grivance committee; Computer Cell Advisory Committee; Project and Patent Cell

## Conference / Symposia / Schools organized

1. International Conference on Photonics, Quantum Information, and Quantum Communication: BoseStat@100; January 29, 2024; Kolkata; 6 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Physics Department, University of Calcutta; Sl. No. 2; National
2. L. N. Gumilyov Eurasian National University, Astana, Kazakhstan; Sl. No. 2; International

## Areas of Research

Quantum Field Theory, Gravitation, Mathematical Physics

As part of a continuing programme of understanding the dynamics of fermions in curved spacetime, we considered a first order formulation of gravity using tetrads and spin connection. Then the gravity part of the theory is analogous to a Yang-Mills gauge theory, and the fermions are coupled to gravity via the spin connection, which has a torsion component in the presence of fermions. We proposed that the fermions are chirally coupled to this torsion, which is nondynamical and thus can be integrated out of the theory. The resulting theory is the usual torsion-free Einstein gravity, but with an additional four-fermion interaction which involves the left and right chiral fermions differently. This is a new interaction, fundamentally geometrical in nature, but not known in the Standard Model of particle physics. One important application of this is in neutrino oscillations in matter. This year, my students and I reported a method of calculating the conversion amplitudes and probabilities in the two family approximation, and then going to the full theory of three families, we calculated the general formula of the mixing matrix and thus the amplitude of $\nu_e \to \nu_\mu$. This was published in [1]. Several other results based on this interaction were circulated in preprint form and will be reported next year after publication.

In another work, my collaborators and I investigated the transformation properties of non-Abelian gauge bosons under discrete symmetries. All gauge bosons of a non-Abelian gauge theory do not transform the same way under time-reversal and charge-conjugation. Moreover, the transformation rules depend on how the generators are chosen. We showed how well-defined rules pertain only to specific choices of generators, and also showed how unified rules could be constructed, using matrix forms of the gauge bosons, which are completely independent of the choice of generators. These results were published in [2].

## Plan of Future Work Including Project

1. Quantum Field Theory: We will continue our investigations into the four fermion geometrical interaction which appears from the dynamics of fermions on curved spacetime. We will use it to calculate oscillation probabilities between different species of neutrinos in the case of current and upcoming experiments such as the Deep Underground Neutrino Experiment (DUNE), the KamLAND-LBL reactor neutrino experiment, and the Jiangmen Underground Neutrino Observatory (JUNO), which all have different baselines. We will show the effect of the geometrical couplings on the neutrino oscillation and survival probabilities. We will also consider how they combine with the CP phase of the mixing matrix and thus affect CP violating part of the neutrino oscillations. I also plan to investigate, with my students and collaborators, the effect of this interaction on other experiments involving neutrinos, on supernova neutrinos, and on several other processes involving fermions other than neutrinos.
2. Gravity and Cosmology: I plan to investigate the first-order formulation of gravity, which is relevant in the presence of fermions in curved spacetime. Gravitational waves in the presence of fermions, as well as fermions in the background of gravitational waves, will be studied. Cosmological solutions in the presence of the geometrical four-fermion interaction will be studied as well.
3. Mathematical Physics: I am writing a book, with colleagues elsewhere, on using Mathematica to solve certain classes of problems in Group Theory and another book on using Mathematica to assist in learning Differential Geometry. Both are expected to be completed this year. I also plan to continue, with colleagues elsewhere, a long running programme of investigation of categorical geometry, in particular categorical fiber bundles based on fiber bundles on the space of directed paths on a manifold, and connections on them. A monograph on these topics is in progress.

## Any other Relevant Information including social impact of research

1. Member, Editorial Board, Physics News (Indian Physical Association)
2. Social impact of research: Like all research in basic science, my work will add to what we know about the universe and the theories that describe it. It will lead to a new perspective on neutrino oscillations which may affect the setup of future experiments. The new interaction is also likely yo affect our understanding of the dynamics of particles through matter. During the course of my research, many new students are trained who in turn will train more students in future and carry forward scientific research in the country.


## Archan Subhra Majumdar

Senior Professor

Astrophysics and High Energy Physics

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Riddhi Chatterjee; Relativistic Quantum Mechanics; Awarded
2. Shounak Datta; Quantum Foundations; Awarded
3. Bihalan Bhattacharya; Quantum Foundations; Awarded
4. Arnab Sarkar; Gravitation and Cosmology; Thesis submitted; K. R. Nayak, IISER Kolkata (Co-supervisor)
5. Arun Kumar Das; Quantum Information; Under progress
6. Subhankar Bera; Quantum Information; Under progress
7. Shashank Sekhar Pandey; Gravitation and Cosmology; Under progress
8. Bivas Mallik; Quantum Information; Under progress
9. Saheli Mukherjee; Quantum Foundations; Under progress
10. Arnab Mukhopadhyay; Gravitation and Cosmology; Under progress; Sunandan Gangopadhyay (Co-supervisor)
11. Pritam Roy; Quantum Information; Under progress
12. Sudip Chakrabarty; Quantum Information; Under progress
13. Subhadeep Mukherjee; Gravitation and Cosmology; Under progress

#### b) Post-Docs

1. Ashadul Halder; Gravitation and Cosmology
2. Sutapa Saha; Quantum Information

#### c) External Project Students / Summer Training

1. Sayantan Sarkar; An introduction to general relativity and cosmology
2. Ayandip Roy; Introduction to quantum information
3. Kazi Abu Rousan; Time crystal in non-commutative quantum mechanics

### Teaching

1. Spring semester; Project Research III PHY 502; Integrated PhD; 2 students
2. Autumn semester; Project Research PHY 691; PhD; 1 student

### Publications

#### a) In journals

1. Arnab Sarkar, Amna Ali, K. Rajesh Nayak, and **Archan S. Majumdar**, *Enhanced power of gravitational waves and rapid coalescence of black hole binaries through*

*k-essence dark energy accretion,* Physical Review D, 107, 084038, 2023

2. Shashank Shekhar Pandey, Arnab Sarkar, Amna Ali & **Archan S. Majumdar**, *Viscous attenuation of gravitational waves propagating through an inhomogeneous background,* The European Physical Journal C, 83, 435, 2023
3. Debashis Saha, Debarshi Das, Arun Kumar Das, Bihalan Bhattacharya, and **Archan S. Majumdar**, *Measurement incompatibility and quantum advantage in communication,* Physical Review A, 107, 062210, 2023
4. Ashadul Halder, Shashank Shekhar Pandey and **Archan S. Majumdar**, *Future deceleration due to backreaction in a Universe with multiple inhomogeneous domains,* Journal of Cosmology and Astroparticle Physics, 2023, 064, 2023
5. Arnab Mukherjee, Sunandan Gangopadhyay, and **Archan S. Majumdar**, *Fulling-Davies-Unruh effect for accelerated two-level single and entangled atomic systems,* Physical Review D, 108, 085018, 2023
6. Shruti Aggarwal, Satyabrata Adhikari, and **Archan S. Majumdar**, *Entanglement detection in arbitrary-dimensional bipartite quantum systems through partial realigned moments,* Physical Review A, 109, 012404, 2024
7. Shounak Datta, Shiladitya Mal, Arun K. Pati & **Archan S. Majumdar**, *Remote state preparation by multiple observers using a single copy of a two-qubit entangled state,* Quantum Information Processing, 23, 54, 2024
8. Bivas Mallick, Saheli Mukherjee, Ananda G. Maity, and **Archan S. Majumdar**, *Assessing non-Markovian dynamics through moments of the Choi state,* Physical Review A, 109, 022247, 2024

### b) Independent publications of student/s

1. Tathagata Gupta, Subhendu B. Ghosh, Ardra A V, Anandamay Das Bhowmik, Sutapa Saha, Tamal Guha, Ramij Rahaman, and Amit Mukherjee, *Hierarchical activation of quantum nonlocality: Stronger than local indistinguishability,* Physical Review A, 107, 052418, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. International Workshop on Quantum Information and quantum technology; May 10, 2023; IISER Kolkata; 60 mins
2. 2nd QuEST Theme -I Workshop; May 13, 2023; CSKHPU Palampur; 45 mins
3. International Symposium on quantum computing and innovation; July 14, 2023; IIT BHU; 30 mins
4. International Raman Conference on light and matter physics; August 16, 2023; RRI Bangalore; 40 mins
5. 3rd Hermann Minkowski Meeting; September 12, 2023; Albena, Bulgaria; 30 mins
6. 3rd QuEST Theme -I Workshop; September 23, 2023; IISER Kolkata; 45 mins
7. International Workshop on Quantum Information Processing and Applications; December 7, 2023; HRI Allahabad; 45 mins
8. Frontier Symposium in Physics; January 19, 2024; IISER Thiruvnanthapuram; 45 mins
9. International Conference on Exploring the Universe from near to far; February 17, 2024; ICSP Kolkata; 40 mins
10. National Seminar on recent trends in Applied Mathematics; March 14, 2024; CU Applied Maths; 45 mins
11. International Workshop on engineering and integration challenges in quantum communication and quantum computing; March 21, 2024; CDAC Pune; 30 mins

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Applications of quantum information; DST; 2019-2024; PI
2. Free space quantum communication; DST; 2019-2024; Co-PI
3. Quantum heat engines; DST; 2019-2024; Co-PI

## Conference / Symposia / Schools organized

1. International Conference on Quantum Information and Quantum Communication; Jan 29, 2024; Biswa Bangla Convention Centre, Kolkata; January 29 - February 02, 2024

## Scientific collaborations with other national / international institutions (based on joint publications)

1. IISER Kolkata; Sl. No. 1; National
2. Jadavpur University; Sl. No. 2; National
3. IISER Thiruvanathapuram; Sl. No. 3, 9; National
4. IISER Berhampur; Sl. No. 3; National
5. University College London; Sl. No. 3; International
6. Delhi Technological University; Sl. No. 6; National
7. Harishchandra Research Institute; Sl. No. 7; National
8. QFort, NCKU Taiwan; Sl. No. 7; International
9. Okinawa Institute of Science and Technology, Japan; Sl. No. 8; International

10. ISI Kolkata; Sl. No. 9; National

11. University of Hong Kong; Sl. No. 9; International

## Outreach program organized / participated

1. Quantum Information Science and Applications, BHU Physics Department, July 15, 2023

## Areas of Research

1. Gravitation & Cosmology; Quantum Information Science

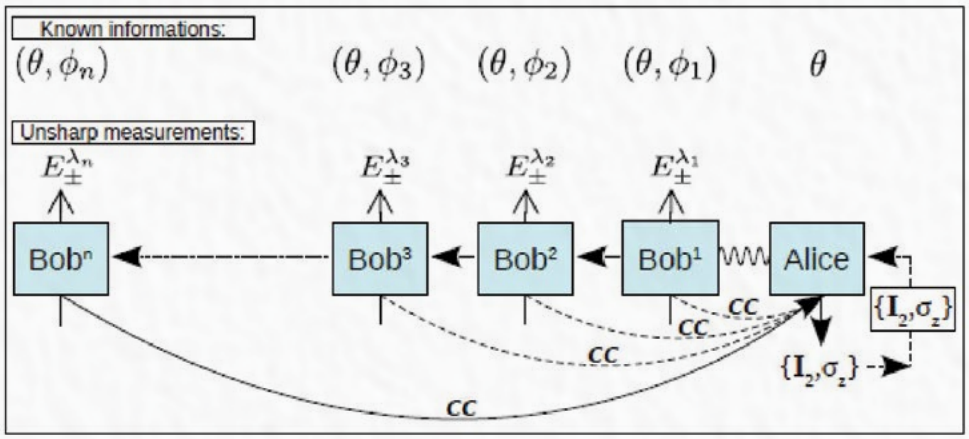


Figure 2. Schematic diagram of remote state preparation at Alice's lab by multiple Bobs. The operations, $\{\mathbb{1}_2, \sigma_z\}$ are applicable for remote states from the equatorial circle of the Bloch sphere.

| Initial masses | 10 and 20 $M_\odot$ | 10 and 60 $M_\odot$ | 50 and 60 $M_\odot$ |
|---|---|---|---|
| Initial radius of orbit $r_i$ | $8.899 \times 10^9\ m$ | $20.764 \times 10^9\ m$ | $32.628 \times 10^9\ m$ |
| $t_c$ for constant masses | $4.817\ Gy$ | $6.956\ Gy$ | $6.329\ Gy$ |
| $t_c'$ for varying masses | $4.665\ Gy$ | $4.81\ Gy$ | $4.693\ Gy$ |
| $\tau_i$ for constant masses | $66.135 \times 10^7\ y$ | $2.8\,Gy$ | $2.173\,Gy$ |
| $\tau_i'$ for varying masses | $50.99 \times 10^7\ y$ | $0.655\,Gy$ | $0.537\,Gy$ |
| Decrease in Coalescence time-interval $\Delta\tau_i = \tau_i - \tau_i'$ | $15.14 \times 10^7\ y$ | $2.146\,Gy$ | $1.637\,Gy$ |

**TABLE I:** Reduction in coalescence time-intervals due to accretion of the chosen model of dark energy.

We consider the accretion of dark energy by constituent black holes in binary formations during the present epoch of the Universe. In the context of an observationally consistent dark energy model, we evaluate the growth of black holes masses due to accretion. However, the accretion rate may turn out to be too high if this model is naively applied to supermassive black holes. We show that accretion leads to faster circularization of the binary orbits. We compute the average power of the gravitational waves emitted from binaries, which exhibits a considerable enhancement due to the effect of growth of masses as a result of accretion. This in turn, leads to a significant reduction of the coalescence time of the binaries. We present examples pertaining to various choices of the initial masses of the black holes in the stellar mass range and above, in order to clearly establish a possible observational signature of dark energy in the emerging era of gravitational wave astronomy.

We formulate a model of spacetime with inhomogeneous matter distribution in multiple domains. In the context of the backreaction framework using Buchert's averaging procedure, we evaluate the effect of backreaction due to the inhomogeneities on the late time global evolution of the Universe. Examining the future evolution of this universe, we find that it can transit from the presently accelerating phase to undergo future deceleration.

The future deceleration is governed by our model parameters. We constrain the model parameters using observational analysis of the Union 2.1 supernova Ia data employing the Markov Chain Monte Carlo method.

We investigate the transition rates of uniformly accelerated two-level single and entangled atomic systems in empty space as well as inside a cavity. We take into account the interaction between the systems and a massless scalar field from the viewpoint of an instantaneously inertial observer and a coaccelerated observer, respectively. For the two-atom system, we consider that the system is initially prepared in a generic pure entangled state. The transition rate manifests subtle features depending upon the cavity and system parameters, as well as the initial entanglement. It is shown that no transition occurs for a maximally entangled super-radiant initial state, signifying that such entanglement in the accelerated two-atom system can be preserved for quantum information procesing applications. Our analysis comprehensively validates the equivalence between the effect of uniform acceleration for an inertial observer and the effect of a thermal bath for a coaccelerated observer, in free space as well as inside a cavity, if the temperature of the thermal bath is equal to the Unruh temperature.

Measurement incompatibility stipulates the existence of quantum measurements that cannot be carried out simultaneously on single systems. We show that the set of input-output probabilities obtained from $d$-dimensional classical systems assisted with shared randomness is the same as the set obtained from $d$-dimensional quantum strategies restricted to compatible measurements with shared randomness in any communication scenario. Thus, measurement incompatibility is necessary for quantum advantage in communication, and \textit{any} quantum advantage (with or without shared randomness) in communication acts as a witness of incompatibility of the measurements at the receiver's end in a semi-device-independent way. We introduce a class of communication tasks - a general version of random access codes - to witness incompatibility of an arbitrary number of quantum measurements with arbitrary outcomes acting on $d$-dimensional systems, and provide generic upper bounds on the success metric of these tasks for compatible measurements. We identify all sets of three incompatible rank-one projective qubit measurements that random access codes can witness. Finally, we present the generic relationship between different sets of probability distributions - classical, quantum with or without shared randomness, and quantum restricted to compatible measurements with or without shared randomness - produced in communication scenarios.

Detection of entanglement through partial knowledge of the quantum state is a challenge to implement efficiently. Here we propose a separability criterion for detecting bipartite entanglement in arbitrary dimensional quantum states using partial moments of the realigned density matrix. Our approach enables the detection of both distillable and bound entangled states through a common framework. We illustrate the significance of our method through examples of states belonging to both the above categories, which are not detectable using comparable other schemes relying on partial state information. The formalism of employing partial realigned moments proposed here is further shown to be effective for two-qubit systems too, with a slight modification of our separability criterion.

Non-Markovian effects in open quantum system dynamics usually manifest backflow of information from the environment to the system, indicating complete-positive divisibility breaking of the dynamics. We provide a criterion for witnessing such non-Markovian dynamics exhibiting information backflow, based on partial moments of Choi-matrices. The moment condition determined by the positive semi-definiteness of a matrix, does not hold for a Choi-state describing non-Markovian dynamics. We then present some explicit examples in support of our proposed non-Markovianity detection scheme. Finally, a moment based measure of non-Markovianity for unital dynamics is formulated.

## Plan of Future Work Including Project

1. We explore the 21-cm signal in our Universe containing inhomogeneous matter distribution at considerably large scales. Employing Buchert's averaging procedure in the context of a model of spacetime with multiple inhomogeneous domains, we evaluate the effect of our model parameters on the observable 21-cm signal brightness temperature. Our model parameters are constrained through the Markov Chain Monte Carlo method using the Union 2.1 supernova Ia observational data. We find that a significant dip in the brightness temperature compared to the $\Lambda$CDM prediction could arise as an effect of the inhomogeneities present in the Universe.
2. We revisit the Fulling-Davies-Unruh effect in the context of two-level single and entangled atomic systems that are either uniformly accelerated or static in a thermal bath. We consider the interaction between the systems and a massless scalar field, covering the scenarios of free space as well as within a cavity. Through the calculation of atomic transition rates it is found that in free space there is an equivalence between the upward and downward transition rates of an uniformly accelerated atom with respect to an observer with that of a single atom which is static with respect to the observer and immersed in a thermal bath, as long as the temperature of the thermal bath matches the Unruh temperature. This equivalence breaks down in the presence of a cavity. For two-atom systems, considering the initial state to be in a general pure entangled form, we find that in this case the equivalence between the upward and downward transition rates of the accelerated and static thermal bath scenarios holds only under specific limiting conditions in free space, but breaks down completely in a cavity setup.

3. Finding a set of empirical criteria fulfilled by any theory that satisfies the generalized notion of noncontextuality is a challenging task of both operational and foundational importance. The conventional approach of deriving facet inequalities from the relevant noncontextual polytope is computationally demanding. Specifically, the noncontextual polytope is a product of two polytopes, one for preparations and the other for measurements, and the dimension of the former typically increases polynomially with the number of measurements. This work presents an alternative methodology for constructing a polytope that encompasses the actual noncontextual polytope while ensuring that the dimension of the polytope associated with the preparations remains constant regardless of the number of measurements and their outcome size. In particular, the facet inequalities of this polytope serve as necessary conditions for noncontextuality. To demonstrate the efficacy of our methodology, we apply it to nine distinct contextuality scenarios involving four to nine preparations and two to three measurements to obtain the respective sets of facet inequalities. Additionally, we retrieve the maximum quantum violations of these inequalities. Our investigation uncovers many novel non-trivial noncontextuality inequalities and reveals intriguing aspects of quantum contextual correlations within these contextuality scenarios.

4. The role of CP-indivisibility and incompatibility as valuable resources for various information-theoretic tasks is widely acknowledged. This study delves into the intricate relationship between CP-divisibility and channel compatibility. Our investigation focuses on the behaviour of incompatibility robustness of quantum channels for a pair of generic dynamical maps. We show that the incompatibility robustness of channels is monotonically non-increasing for a pair of generic CP-divisible dynamical maps. Further, our explicit study of the behaviour of incompatibility robustness with time for some specific dynamical maps reveals non-monotonic behaviour in the CP-indivisible regime. Additionally, we propose a measure of CP-indivisibility based on the incompatibility robustness of quantum channels. Our investigation provides valuable insights into the nature of quantum dynamical maps and their relevance in information-theoretic applications.

5. Device-independent quantum secure direct communication (DI-QSDC) is a promising primitive in quantum cryptography aimed towards addressing the problems of device imperfections and key management. However, significant effort is required to tackle practical challenges such as the distance limitation due to decohering effects of quantum channels. Here, we explore the constructive effect of non-Markovian noise to improve the performance of DI-QSDC. Considering two different environmental dynamics modeled by the amplitude damping and the dephasing channels, we show that for both cases non-Markovianty leads to a considerable improvement over Markovian dynamics in terms of three benchmark performance criteria of the DI-QSDC task. Specifically, we find that non-Markovian noise (i) enhances the protocol security measured by Bell-violation, (ii) leads to a lower quantum bit error rate, and (iii) enables larger communication distances by increasing the capacity of secret communication.

6. Schr\"{o}dinger cat states, which are superpositions of macroscopically distinct states, are potentially critical resources for upcoming quantum information technologies. In this paper, we introduce a scheme to generate entangled Schr\"{o}dinger cat states in a non-relativistic electric dipole system situated on a two-dimensional plane, along with an external potential and a uniform strong magnetic field perpendicular to the plane. Additionally, our findings demonstrate that this setup can lead to the phenomenon of collapse and revival of entanglement for a specific range of our model parameters.


## Parijat Dey

Assistant Professor

Astrophysics and High Energy Physics

parijat.dey@bose.res.in


### Teaching

1. Autumn semester; Nuclear and Particle Physics PHY507; Integrated PhD; 14 students; with Ramkrishna Das (co-teacher)
2. Autumn semester; Nuclear and Particle Physics PHY607; PhD; 1 student; with Ramkrishna Das (co-teacher)
3. Spring semester; Masters Project Marking (Durham University, England); Integrated PhD; 6 students
4. Spring semester; Dynamics Tutorial (Durham University, England); Integrated PhD; 10 students
5. Spring semester; Non-perturbative physics Tutorial (Durham University, England); Integrated PhD; 6 students
6. Spring semester; Conformal field theory Tutorial (Durham University, England); Integrated PhD; 6 students
7. Spring semester; Renormalisation Tutorial (Durham University, England); Integrated PhD; 6 students

### Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at Indian Strings Meeting; December 15, 2023; IIT, Bombay; 12-15 December, 2023
2. Invited talk in the workshop "Aspects of CFTs"; January 9, 2024; IIT, Kanpur; 9-11 January, 2024
3. Invited talk on "Critical phenomena and Conformal Field theory"; February 12, 2024; RKMVERI, Belur; 12 February, 2024
4. Talk on Current Reseach in the ARPAC meeting; February 29, 2024; SNBNCBS; 29 February, 2024
5. Talk in the Journal Club on "CFT and entanglement"; October 16, 2023; Durham University, England; 16 October, 2023
6. Talk in the Machine learning journal club on "Movie recommendation system"; Durham University, England

### Administrative duties

1. Member of the Organising Committee for BoseStat@100: Centenary of Bose Statistics, 2024
2. Co-convener: Women in Quantum Science and technologies, 2024
3. Coordinating the inauguration programme for Conference Photonics, Quantum Information, and Quantum Communication on, January 29, 2024
4. Member of ARPAC brochure committee, February 2024
5. Jury Committee for Oral Presentations at Bose Fest 22-24 February, 2024
6. Panel discussion on Women's Day on March 8, 2024 at SNBNCBS

7. Interview Committee member for the selection of CSIR JRF, on March 18, 2024 (online)
8. Member of the Syllabus Modification Committee, SNBNCBS
9. Thesis committee meeting, JRF to SRF upgradation on 14 March, 2024
10. Committee Member, Mid-term Admission interview, 4 December, 2023

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Structural chirality and its consequences on electronic properties; SERB; 3 years; Co-PI

## Outreach program organized / participated

1. Celebrating Bosestat@100, February 03, 2024 at Science City Auditorium, Kolkata
2. Participated in the Panel discussion on Women in science at Indian Strings Meeting, IIT Bombay, 14 December, 2023

## Areas of Research

### Theoretical High Energy Physics

My research involves various aspects of conformal and quantum field theory and quantum gravity. Currently, I am working on conformal field theory with defects. These are scale invariant systems with some impurities. The presence of the defects breaks some symmetries and the residual symmetry can be used as a powerful tool to study these defects. We have explored these systems using the renormalisation group framework of quantum field theory. In particular, we have shown that there exists a non-trivial defect fixed point in a cubic anisotropic conformal field theory with a line defect. We have computed the correlation functions of the low lying scalar operators on the defect using Feynman diagrams. On the other hand, we have studied how to understand defects from the perspective of symmetry using the framework of conformal bootstrap. This is independent of the Lagrangian description. The conformal bootstrap is used as a viable tool to study the one-dimensional defect operators and constrain the CFT data. We have also explored the defect conformal field theory using numerical bootstrap method.

I am also working on quantum gravity using CFT methods via the AdS/ CFT correspondence or the gauge/ gravity duality. The bulk gravity and boundary conformal field theories are formulated in terms of different spaces and operators, and we would need to know how to map all the observables of one theory to the observables of the other. The problem of bulk reconstruction is a step towards expressing operators and fields in the bulk in terms of boundary operators. Our goal is to study the bulk reconstruction program in the context of BTZ black holes. The first step is to understand how this works in two dimensions, as this is analytically more tractable. The next step would be to generalise this for higher dimensional gravity solutions.

## Plan of Future Work Including Project

1. We would like to study the critical behavior arising in a CFT near an edge-shaped geometry. This set up can be thought of as a CFT bounded by two planes meeting at an angle. Under these circumstances, new set of correlation functions emerge with new exponents. There is an interplay between the bulk, surface and edge critical exponents, or more formally, the scaling dimensions of bulk, surface and edge operators. One can set up the bootstrap constraint which relates the scaling dimensions of different operators. We would like to develop a method to compute these exponents, together with the respective OPE coefficients by solving the bootstrap equations. In addition, we would also like to explore the edge CFT in presence of a line defect using the framework of renormalisation group. The presence of an edge fixed point, when the theory is already at the bulk and surface fixed point, can be explored. In this context, we plan to study the analogue of the g-theorem which is a measure of the amount of impurities in the system. It would be interesting to see if there is any monotonicity property related to the defect entropy in the edge setup. The holographic version of this geometry can also be explored.


## Rabin Banerjee

Raja Ramanna Fellow

Astrophysics and High Energy Physics

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### Guidance of Students/Post-Docs/Scientists

#### a) Post-Docs

1. Soumya Bhattacharya; Non-relativistic symmetries in gauge theory and gravity

#### b) External Project Students / Summer Training

1. Pramit Bhattacharyya; Algebraic aspects of non Lorentzian theories
2. Antara Dey; Symmetries of carrollian physics
3. Soumyadeep Das; Symmetries of galilean physics

### Teaching

1. 1st semester; Mathematical physics; IPh.D.; 14 students; Sunandan Gangopadhyay (Co-teacher)

### Publications

#### a) In journals

1. **Rabin Banerjee**, Soumya Bhattacharya, Bibhas Ranjan Majhi, *Formulation of Galilean relativistic Born-Infeld theory,* The European Physical Journal C, 84, 141, 2024
2. **Rabin Banerjee** and Soumya Bhattacharya, *Action principle of Galilean relativistic Proca theory,* The European Physical Journal C, 83, 916, 2023
3. **Rabin Banerjee** and Anwesha Chakraborty, *Shift symmetries and duality web in gauge theories,* Nuclear Physics B, 996, 116354, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. New look at Non-Lorentzian Theories; 23-02-2024; ISI Kolkata; 1 hour

### Awards, Recognitions, if any

1. Mentioned in Stanford university list of 2% most highly cited scientists in my area (nuclear and particle physics) of research

### Scientific collaborations with other national / international institutions (based on joint publications)

1. Bibhas Ranjan Majhi; Sl. No. 1; National

### Areas of Research

#### Quantum Field Theory, Gravity

I have given a systematic formulation of Non-Lorentzian theories that includes both Galilean and Carrollian sectors. While the Galilean case involves velocities considerably less than light, the Carrollian sector deals with velocities greater than light. The Galilean sector is well known and has been well studied, contrary to the Carrollian sector. Despite its strange characteristics (lack

of causality being one of them), the Carrollian limit has provided many interesting and intriguing insights and results.

One of the motivations of the present research is to construct the Non-Lorentzian action for various theories. To a large extent we have developed this formulation that should yield consistent results in both potential and field formulations. Various scaling relations are derived.

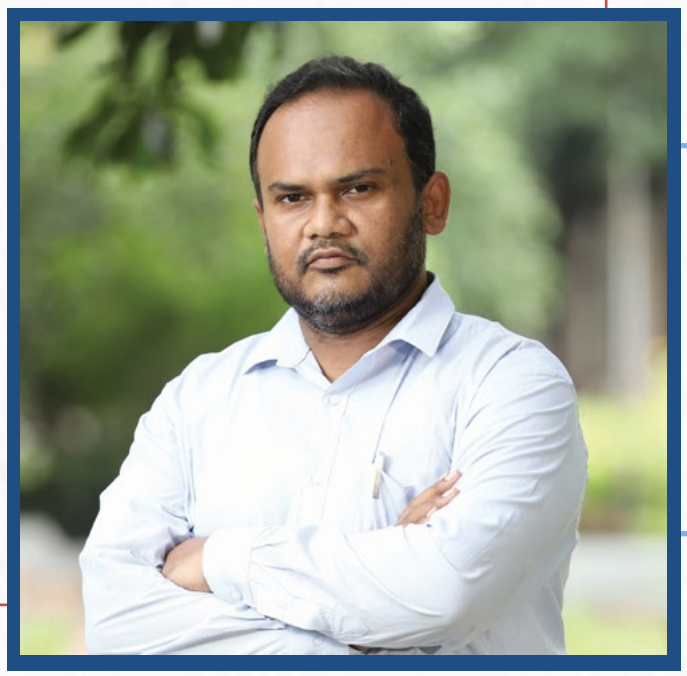
Using these, different theories have been constructed from their relativistic counterparts, in either potential or field formulation and their consistency has been demonstrated. This shows the veracity of our approach suggesting that it could be extended in other directions. Finally, some applications have been suggested.

## Plan of Future Work Including Project

Non Lorentzian theories that we have studied may be broadly classified into two parts-galilean relativistic and carrollian relativistic. While a systematic formulation is known for the Galilean sector, the same cannot be said about the carroll case.

The Galilean theory is obtained by taking the large c limit where c is the velocity of light. Galilean transformations are the c going to infinity limit of Lorentz transformations. On the other hand a similar interpretation for Carroll transformations is lacking. One cannot simply take the small c (c going to zero) limit in Lorentz transformations. This is simply because such a limit is not valid.

To take the small c limit one has to take, instead, a different set of transformations first considered by N.D. Sengupta. These transformtions, like the Lorentz ones, preserve the space time interval. The small c limit of Sengupta transformations should yield the carroll transformations. Once this is achieved it should provide a systematic route for the analysis of carrollian theories in analogy with Galilean theories. In fact it might be possible to develop a one to one correspondence between these two Non Lorentzian theories. If a duality is established then knowledge of any one sector will yield information about the other.




## Ramkrishna Das

Associate Professor

Astrophysics and High Energy Physics

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Ruchi Pandey; Study of Novae Properties; Awarded
2. Dhrimadri Khata; Understanding Physical Properties of M-dwarfs; Awarded; Prof. Soumen Mondal (Co-supervisor)
3. Gesesew H. Reta; Understanding Novae Phenomena; Under progress
4. Subhajit Kar; Study of Massive Stars; Under progress
5. Abhijit Mandal; Study of Planetary Nebulae; Under progress

### b) Post-Docs

1. Milan Sil; Formation of molecules in Novae
2. Tridib Roy; Compact objects

### c) External Project Students / Summer Training

1. Junik Sengupta; Astronomical Spectroscopy

## Teaching

1. Autumn semester; Nuclear & Particle Physics; Integrated PhD; 13 students; with Dr. Parijat Dey (Co-teacher)
2. Spring semester; Astronomy & Astrophysics; Integrated PhD; 13 students; with Prof. Soumen Mondal (Co-teacher)
3. Spring semester; Astronomical Observational Techniques; PhD; 5 students; with Dr. Tapas Baug (Co-teacher)
4. Spring semester; Advanced Laboratory Course; Integrated PhD; 12 students; with Prof. Kalyan Mondal, Dr. Nitesh Kumar, Dr. Pradip Pachfule (Co-teachers)
5. Spring semester; Astrophysics; PhD; 5 students; with Prof. Soumen Mondal (Co-teacher)

## Publications

### a) In journals


1. Gesesew R Habtie, **Ramkrishna Das**, Ruchi Pandey, N M Ashok, Pavol A Dubovsky, *Study of the fastest classical nova, V1674 Her: photoionization and morpho-kinemetic model analysis,* Monthly Notices of the Royal Astronomical Society, 527, 1405-1423, 2024
2. Rahul Bandyopadhyay and **Ramkrishna Das**, *A photodissociation region (PDR) model grid in planetary nebula paradigm: dependency of C and O fine structure line emission and PDR thermal structure on central star radiation and nebular dust composition,* Monthly Notices of the Royal Astronomical Society, 523, 498-517, 2023

3. Rahul Bandyopadhyay, **Ramkrishna Das**, Mudumba Parthasarathy, Subhajit Kar, *Morpho-kinematic and photoionization models of the multipolar structures in planetary nebula NGC 6572,* Monthly Notices of the Royal Astronomical Society, 524, 1547-1559, 2023

4. Siddhartha Biswas, Soumen Mondal, Ariful Hoque, Alik Panja, Tapas Baug, and **Ramkrishna Das**, *Star Formation in the H II Region Sh2-87: Evidence of Global Hierarchical Collapse,* The Astrophysical Journal, 961, 176, 2024

### b) Other Publications

1. GR Habtie and R Das, "Optical Photometry and Spectroscopy of Nova Sco 2024 (V1723 Sco)", The Astronomer's Telegram, 16454

## Talks / Seminars Delivered in reputed conference / institutions

1. Delivered a talk on "In Search of Another World"; May 26, 2023; Ranaghat College, Nadia, West Bengal; 1 hour
2. Delivered a talk on "Exploring the Moon"; August 25, 2023; Tarakeshwar Degree College, Hoogly, West Bengal; 1 hour
3. Delivered a talk on "Extra-Solar Planets"; December 21, 2023; Sir Rajendra Nath Mukherjee Government Polytechnic College, Basirhat, West Bengal; 1 hour
4. Delivered a talk on "Chemistry in Cosmos"; January 25, 2024; the Department of Chemistry, The University of Burdwan, Burdwan, West Bengal; 1 hour
5. Delivered a talk on "Exploring the Space and Purulia"; March 20, 2024; the Depertment of Physics, Sidho-Kanho-Birsha University, Purulia, West Bengal; 1 hour
6. Delievered a talk on "Observing the Sky: need for bigger telescopes"; March 6, 2024; Vidyasagar University, Midnapore, West Bengal; 1 hour

## Administrative duties

1. Liason Officer & Chairperson of the Reservation Cell, SNBNCBS
2. Chairperson, Outreach Programme for the students of SC/ ST community, SNBNCBS
3. Member, Conference Workshop and Extension Programmes (CWEP), SNBNCBS
4. Member, Newsletter Committee, SNBNCBS
5. Member, Media Cell, SNBNCBS
6. Member, Library Committee, SNBNCBS

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. A new Astronomical Observatory under S. N. Bose National Centre for Basic Sciences (S. N. Bose Astronomical Observatory) (submitted); Department of Science & Technology; 5 years; Co-PI
2. Astro-tourism for Socioeconomic Upliftment of Tribal People around Panchet hill, Purulia"(under process); Science for Equity Empowerment and Development (SEED) Division, Department of Science & Technology; 3 years; Co-PI

## Conference / Symposia / Schools organized

1. Star Formation Studies in India; January 8, 2024; A new Astronomical Observatory under S. N. Bose National Centre for Basic Sciences (S. N. Bose Astronomical Observatory) (submitted); 4 days
2. First Biennial Conference on Astronomy, Astrophysics, and Space Science
3. February 16, 2024; Indian Centre for Space Science, Kolkata; 4 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. N. M. Ashok, Physical Research Laboratory, Ahmedabad, India; Sl. No. 1; National
2. PA Dubovsky, Vihorlat Observatory, Slovakia; Sl. No. 1; International
3. M. Parthasarathy, IIA, Bangalore, India; Sl. No. 3; National

## Outreach program organized / participated

1. Organized an Outreach Program "Horizon 2023" at Ranaghat College, Nadia, West Bengal, on 26th May, 2023
2. Organized an Outreach Program "Astroquest" at Garpanchkot Mahavidyalaya, Purulia, West Bengal, on 4th August, 2023
3. Organized an Outreach Program "Wonders of Science: Explore and Learn" at Tarakeshwar Degree College, Hoogly, West Bengal, on 25th August, 2023
4. Organized "A One-Day Outreach Program" as a part of India International Science Festival (IISF) 2023 at Sir Rajendra Nath Mukherjee Government Polytechnic College, Basirhat, West Bengal, on 21st December, 2023
5. Organized an Outreach Program "Scientific Quest" at the Department of Chemistry, The University of Burdwan, Burdwan, West Bengal, on 25th January, 2024
6. Organized a "Science Outreach Program" at the Depertment of Physics, Sidho-Kanho-Birsha University, Purulia, West Bengal, on 20th March, 2024

## Areas of Research

(i) Spectroscopic study of Novae, Planetary Nebulae, massive stars etc.; (ii) Modeling of spectra; (iii) Telescope project of S N Bose Centre

I have been working on the spectroscopic study of different astronomical objects, e.g. Novae, Planetary Nebulae, massive stars etc. The data are analyzed and modeled using different astronomical codes. Couple of interesting results are discussed below.

1. Study of the fastest classical nova, V1674 Her: We have studied the nova V1674 Her (2021), recognized as the swiftest classical nova, with t2 ~ 0.90 days, using the spectroscopic data available on Astronomical Ring for Access to Spectroscopy (ARAS) Database. The distance to the nova is estimated to be 4.97 kpc. The mass and radius of the WD are calculated to be ~ 1.36 M⊙ and ~ 0.15 R⊕, respectively. Over the course of one month following the outburst, V1674 Her traversed distinct phases–pre-maxima, early decline, nebular, and coronal–displaying a remarkably swift transformation. The nebular lines emerged on day 10, making it the classical nova with the earliest observed nebular lines. We modeled the observed optical spectrum using the photoionization code CLOUDY. From the best-fitting model we deduced different physical and chemical parameters associated withe the system. The temperature and luminosity of the central ionizing sources are found in the range of 1.99 – 2.34 × 10^5 K and 1.26 – 3.16 × 10^38 erg s^(–1), respectively. Elements such as He, O, N, and Ne are found to be overabundant compared to solar abundance in both the nebular and coronal phases. Fe II abundance diminishes while Ne abundance increases, potentially elucidating the rare hybrid transition between Fe and He/N nova classes. Morpho-kinematic modelling utilising SHAPE revealed that the nova V1674 Her possesses a bipolar structure with an equatorial ring at the centre and an inclination angle of i = 67± 1.5◦ (Figure 1).

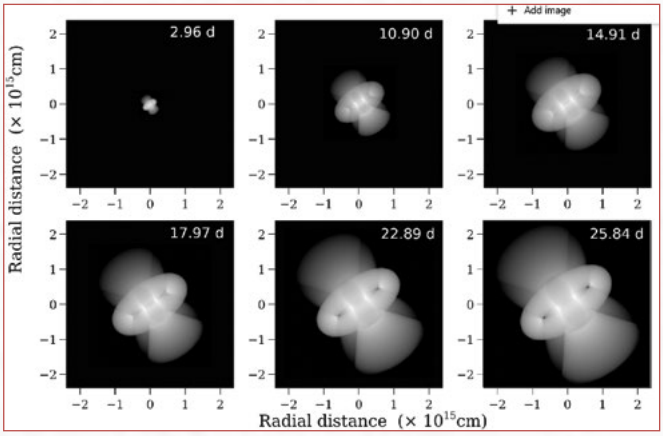


Figure 1: 2D representation of the asymmetric 3D model result, obtained for the H $\alpha$ geometry of the ejecta of V1674 Her. The model images of the ejecta are derived from the best-fit to the H $\alpha$ line profiles on the respective epochs.

2. Morpho-kinematic and photoionization models of the multipolar structures in planetary nebula NGC 6572: We have studied planetary nebula (PN) NGC 6572. The 3D morphology is reconstructed from the Hubble Space Telescope images in different narrow-band filters and position–velocity spectra (Figure 2). The PN has a multipolar morphology consisting of highly collimated outflows. The multipolar structure is modelled with two bipolar shells (axes ratios ~5.5:1 and ~3:1), having closed and open lobes, respectively. A toroidal structure (radius:height ~ 1:3) surrounds the shells at the waist. The toroidal axis aligns with the major axes of the bipolar shells. Our study reveals the nebula to have a history of collimated polar outflow perpendicular to a higher density equatorial wind with the outflow seemingly having episodes of changing direction of ejection. We construct a photoionization model of NGC 6572 using the optical spectra obtained at the 2 m Himalayan Chandra Telescope. For the photoionization model, we configure the input shell geometry in the form of a highly bipolar nebular shell with reference to the 3D morphology. Our photoionization model satisfactorily reproduces the observables. We estimate nebular elemental abundances, and important characteristic parameters of the central star (e.g. effective temperature, luminosity, gravity, mass, etc.) and the nebula (e.g. hydrogen density profiles, radii, etc.). We compare the resolved H $\beta$, [O III], and [N II] profiles obtained using the 4.2 m William Herschel Telescope with that from the photoionization model and find a good characteristic match.

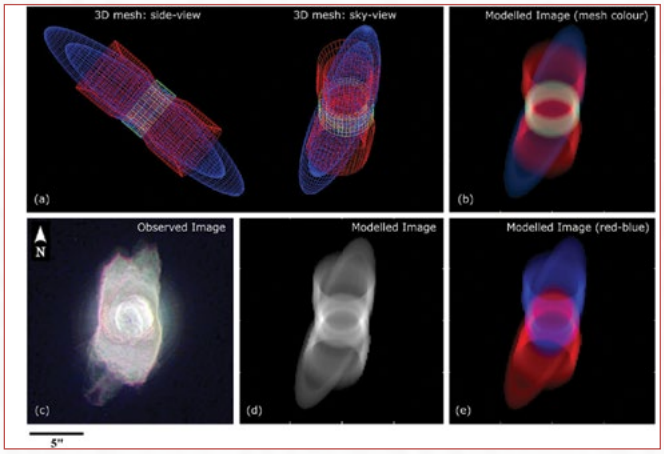


Figure 2: (a) The 3D mesh consisting of three components: an open and a closed lobed bipolar shells, and a torus around the waist of the bipolar shells. The mesh is shown in side view and sky view (as seen from the Earth). (b) The coloured 2D modelled image, where the colours correspond to the colour of

the mesh, shows the components separately. (c) The observed colour composite HST image mapped in emissions of H $\beta$, [O III], [N II], and H $\alpha$. (d) Image of the modelled nebula in grey-scale, projected in sky plane, as viewed from the Earth. (e) Modelled red–blue image is shown to depict the redward- and blueward-moving regions of the nebula.

## Plan of Future Work Including Project

1. We are studying few specific novae, planetary novae and massive stars. We already have observed and collected spectroscopic data of those objects. Currently, we are modeling the spectra to understand the system and the related phenomena. We are expecting to complete the analysis and publish the paper soon.
2. The Centre has taken an initiative to build S. N. Bose Observatory at Panchet Hilltop, Purulia, in which I am working as one of the Principal Investigators (PI). A considerable progress has already been made. An Automatic Weather Station and a Mobile Observatory along with a Telescope Control Cabin have been installed on the Panchet hilltop for detailed characterization of the weather and sky conditions. A Differential Image Motion Monitor (DIMM) system consisting of a 12-inch telescope along with necessary instruments, have been set up inside the Mobile Observatory for more precise measurement of the 'astronomical seeing' at the hilltop. We are working to start regular observation of 'astronomical seeing' from the coming observing season. We also plan to install a 14 inch telescope for scientific observations.
3. We have planned to offer a Certificate/Diploma course on Observational Astronomy jointly with Sidho-Kanho-Birsha University, Purulia.

## Any other Relevant Information including social impact of research

1. Acted as reviewer of Observational proposals submitted to Giant Metre Radio Telescope (GMRT), 2-m Himalaya Chandra Telescope (HCT) and 3.6-m Devesthal Optical Telescope (DOT).
2. Arranged Sky watching programs in the outreach programs at the above mentioned academic institutions and for a group of students from Brahmananda Keshab Chandra College on 18 April 2024.
3. Member of the PhD Committee, Presidency University, Kolkata.
4. Social impact: i. Progress in the basic sciences is required to understand the problems in the world around us and solve it. ii. Solving the basic scientific questions improves and enriches the basic knowledge. iii. Development of human resource, through teaching and supervising PhD students, helps to build the Nation. iv. Pursuing research in observational Astronomy generates manpower for worldwide astronomical projects.


## Soumen Mondal

Professor

Astrophysics and High Energy Physics

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Siddhartha Biswas; Studies of Pre-main Sequence stars in the Galactic Star-formation processes; Under progress
2. Diya Ram; Understanding Stellar Activity in M Dwarfs; Under progress
3. Rajib Kumbhakar; Studies of Atmospheric Properties of Brown Dwarfs and Low Mass Stars; Under progress
4. Sudip Paramanik; Atmospheric properties of Brown Dwarfs and Extasolar planets; Under progress
5. Aman Das; Atmospheric properties of Brown dwarfs and Extasolar planets; Under progress
6. Soumita Chakraborty; Understanding of Galactic Star forming Region with Multiwavelength Data; Under progress
7. Dorothy Museo Mwanzia; Understanding the Atmospheric Properties of Brown Dwarfs and Low Mass Stars; Under progress; Dr. Geoffrey Okeng'o and Dr. John Buers, University of Nairobi and Dr. Snehlata, ARIES (Co-supervisors)
8. Avirup Chakraborty; Machine Learning on Determination of Stellar Fundamental Parameters; Under progress
9. Alik Panja; A Multiwavelength Study of Galactic Starforming Regions; Awarded
10. Samrat Ghosh; Understanding the Atmosphere of Brown Dwarfs and Low Mass Stars; Awarded
11. Dhrimadri Khata; Understanding of Physical Properties of M-dwarfs: Optical and Near- IR Spectroscopic Studies; Awarded; Dr. Ramkrishna Das (Co-supervisor)

#### b) Post-Docs

1. Suman Mondal; Astro-chemistry in Star-forming regions

### External Project Students / Summer Training

1. Niti Singh (Summer Training); Exploring Rotation Period and Variability in Young Stellar Objects using TESS DATA
2. Mahela Munshi (M. Sc. disteration); Understanding Variability and Atmospheric Properties of Very Low Mass Stars and Brown Dwarfs using TESS data

### Teaching

1. Autumn semester; Basic Laboratory-I (PHY 504); Integrated PhD; 12 students; with Prof. S. K. Pal (Co-teacher)
2. Spring semester; Astrophysics (PHY 604); PhD; 3 students; with Dr. Ramkrishna Das (Co-teacher)

3. Spring semester; Astronomy & Astrophysics; Integrated PhD; 13 students; with Dr. Ramkrishna Das (Co-teacher)

## Publications

### a) In journals

1. Siddhartha Biswas, **Soumen Mondal**, Ariful Hoque, Alik Panja, Tapas Baug, and Ramkrishna Das, *Star Formation in the H II Region Sh2-87: Evidence of Global Hierarchical Collapse,* The Astrophysical Journal, 961, 176, 2024
2. Rajib Kumbhakar, **Soumen Mondal**, Samrat Ghosh, and Diya Ram, *TESS Photometric Variability of Young Brown Dwarfs in the Taurus Star-forming Region,* The Astrophysical Journal, 955, 18, 2023
3. Alik Panja, Lokesh K. Dewangan, Tapas Baug, Wen Ping Chen, Yan Sun, Tirthendu Sinha, and **Soumen Mondal**, *Observational Evidence of the Merging of Filaments and Hub Formation in G083.097+03.270,* The Astrophysical Journal, 958, 17, 2023

### b) Other Publications

1. Dutta, Broja G.; Mondal, Soumen, -"Origin of Soft/Hard X-ray Time Lags in Black Hole Transients and Bare-Type AGN", 42nd meeting of the Astronomical Society of India (ASI), held 31 January-04 February 2024, in Bengaluru, India. Hosted jointly by Indian Institute of Science (IISc), Indian Space Research Organisation (ISRO) and Jawaharlal Nehru Planetarium (JNP). Online at https://www.astron-soc.in/asi2024, id.043

## Administrative duties

1. Nodal Officer, Technical Research Centre (TRC), SNBNCBS
2. External Committees: (i) Member of Academic committee (Board of Studies), School of Astrophysics, Presidency University, Kolkata; (ii) Member UG Physics Board of Studies (BoS) of Sidho-Kanho-Birsha University, Purulia; Board of Studies (BoS), Integrated Ph.D., SNBNCBS
3. Internal Committees: Chairman of Technical Cell; Internal Standing Technical Committee (ISTC); member of Project and Patent Cell; PhD and IPhD selection committee members

## Patents Taken and Process Developed with Details

1. A portable point-of-care LOPA-Device (Loading of Pathogen Analyzer) for quantitative detection of pathogens; 202431039104; Applied

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Technical Research Centre (TRC); TARE, SERB-DST; Janaury 2016 to till date; PI
2. A new Astronomical Observatory under S. N. Bose National Centre for Basic Sciences (S. N. Bose Astronomical Observatory); Submitted to DST; 5 years; PI
3. Astro-tourism for Socioeconomic and Livelihood Upliftment of Tribal People around Panchet hill, Purulia; Submitted to DST; 3 years; PI

## Conference / Symposia / Schools organized

1. Star Formation Studies in India; January 8, 2024; S. N. Bose National Centre for Basic Sciences, Kolkata; 4 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Wen-Ping Chen, Institute of Astronomy, National Central University, Taiwan; Sl. No. 3; International
2. Yan Sun, Purple Mountain Observatory, Chinese Academy of Sciences, China; Sl. No. 3; International
3. Lokesh Dewangan, Physical Research Laboratory, Ahmedabad, India; Sl. No. 3; National
4. Dr. Ramkrishna Das, SNBNCBS; Sl. No. 1; National
5. Dr. Tapas Baug, SNBNCBS; Sl. No. 1, 3; National

## Outreach program organized / participated

1. Organized a SNBNCBS hosted an outreach Program, 'ASTRO-QUEST' on 4th August 2023 at Panchakot College, Purulia, in association with Sidho-Kanho-Birsha University (SKBU), Purulia and made a presentation.

## Areas of Research

i. Multi-wavelength studies on Galactic star-forming regions;

ii. Spectroscopic studies of Low-Mass dwarfs and AGB giants;

iii. Photometric variability studies of Brown dwarfs and Very Low Mass stars;

iv. Extra-solar Planets;

v. Astronomical Instrumentation

**A. Star Formation in the HII Region Sh2-87: Evidence of Global Hierarchical Collapse**

A detailed study of the Sh2-87 H II region using a multiwavelength data set in optical to radio bands. A Herschel column density map revealed that the host cloud

is filamentary, and together they formed a central dense hub. The extinction map generated using near-infrared photometric data also signifies the non-uniform distribution of the cloud and reveals its filamentary nature. We estimated a sizable variable extinction over the region up to AV = 34.4 mag, with an average value of AV = 3.4 mag. Using the various infrared color–color criteria, we identified 13 Class I and 202 Class II young stellar objects (YSOs) and 22 H$\alpha$-emitting sources toward this region. Further analysis showed that the cluster is mainly composed of low-mass YSOs with a typical age of ~3 Myr having masses in the range of 0.1–6.0 Me. The identified evolved YSOs (i.e., Class II YSOs) are primarily distributed along the filaments and in the outer parts of the cloud, while the recent star formation, inferred by the presence of Class I YSOs, ionized gas, and star-forming clumps, is observed in the hub region. The overall star formation scenario in the Sh2-87 region resembles the global hierarchical collapse model of star formation, where younger massive star formation activity is expected at the central hub along with the distribution of evolved low mass YSOs in the filaments and the outer parts of the cloud **(Biswas, Siddhartha et al., The Astrophysical Journal, 961, 176 (13 pp), 2024).**

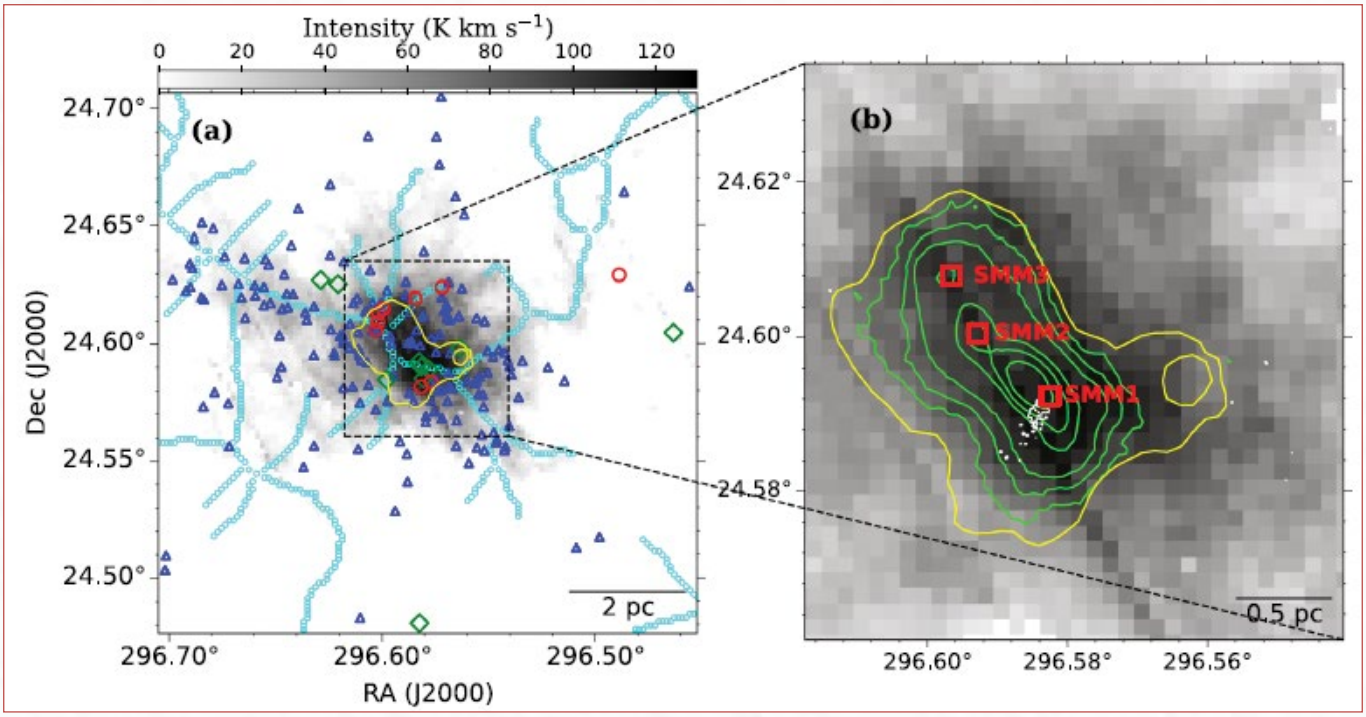


Figure 1: (a) The spatial distribution of YSOs on the integrated intensity map using 12CO. The Class I, Class II, and H$\alpha$ emission sources are marked by red circles, green diamonds, and blue triangles, respectively. The yellow contour corresponding to H2 column density of 1022 cm2 is also overlaid on the map to depict the central hub region. (b) The zoomed-in view (4.2 × 4.2 arcminute) of the central hub region overlaid with clumps SMM1, SMM2, and SMM3 identified previously. The SCUBA contours (green) are also overlaid in this image. The presence of ionized gas is also marked in white contours of CORNISH 5 GHz data.

### B. TESS Photometric Variability of Young Brown Dwarfs in the Taurus Star-forming Region

Brown dwarfs (BDs) are traditionally defined as substellar objects with enough mass to sustain deuterium burning inside their core, but not enough for hydrogen burning. They are intermediate objects between stars and planets in terms of mass, with a mass limit from 13 to 80 Jupiter masses. A comprehensive analysis of TESS high-quality light curves from sectors 43 and 44 of a few samples of young (~2–3 Myr) brown dwarfs in the Taurus molecular cloud. They are well-characterized and bona fide members of Taurus. We aim to search for the fast rotations of brown dwarfs and to picturize their dynamic atmosphere and surface features. Out of 11 young BDs, we found that 72% are periodic, in the period range of 1–7 days; among them, three BDs have periods <1.5 day and the period of one object is estimated for the first time. The sinusoidal periodic variations are related to a large spot or group of small spots corotating with the objects. Interestingly, we have detected four flare events in three young BDs, with one object, MHO 4, showing two flares

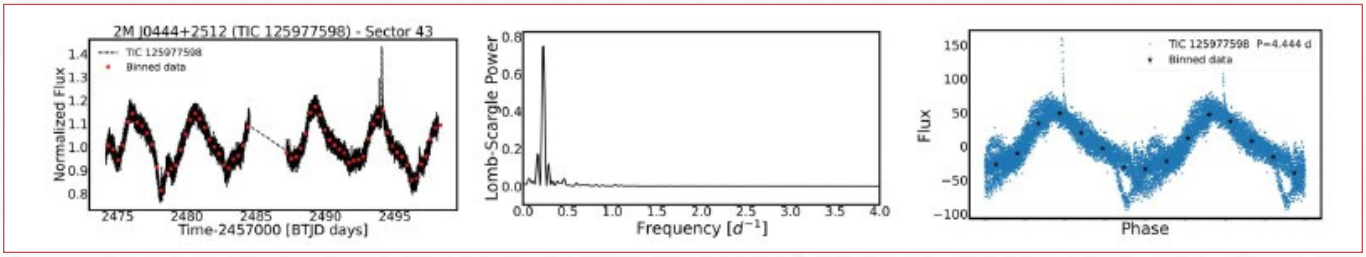


Figure 2: Upper panel: A example light curve of all selected Brown dwarfs (BDs) in the Taurus star-forming region are shown here. The left column showcases the complete light curves, displayed in black, while the binned light curves with a binning interval of 500 minutes are depicted as red dots. In the middle column, the LS periodograms are showcased, illustrating the power spectra of the BDs' rotational periods. Finally, the right column displays the phase-folded light curves, where the data are folded with the most significant peak obtained from the LS periodogram. The black stars represent the 1000-point binned data. Lower two panels: Flare events of a few BDs for MHO 4 in sector 44 (middle left), CT 11 (middle right), and 2M J0444+2512 (below).

in two different sectors. From the flared light curves, we have estimated the total bolometric flared energy in a range of 1035–1036 erg, which is close to the superflare energy range (>1034 erg). To produce such kinds of superflare events, we have calculated the required magnetic field strength, which comes out at the order of a few kilogauss. Such superflares have a strong effect on the habitability of planets around M dwarfs (Kumbhakar, Rajib, The Astrophysical Journal, 955, 18 (12pp), 2023).

## Plan of Future Work Including Project

1. Scientific programs in observational Astronomy :
   i. Low-mass stars, brown dwarfs, and extra-solar planets: Low-mass stars represent a vital test of theoretical models of stellar evolution, structure, and atmospheres. Time-domain astronomy and Optical/Near-IR spectroscopic studies of these classes of objects are undertaken to understand their atmospheres, exoplanets, and pulsation.
   ii. Multi-wavelength studies of Galactic star-forming regions: Multi-wavelength studies of such regions provide a census of Young Stellar Objects, their fundamental parameters and starformation. Variability in young Very Low Mass (VLM) objects and brown dwarfs provide information on their atmospheres.
   iii. Astronomical Instrumentation: With our expertise in the Optical/IR instrument design and development, we are working to establish an Astronomical Instrumentation Laboratory for building the state-of-art backend instruments for the telescopes.
2. Establishment of the S. N. Bose Astronomical Observatory at Panchet Hilltop, Purulia: The S. N. Bose Astronomical Observatory project, a new Astronomical telescope observing facility at the eastern part of India is planned at Panchet Hill, West Bengal to install 1.5-meter telescope, For that, two hectares of land at Panchet hill-top for this observatory site is acquired from the Forest department of Govt. of India and state Govt. of West Bengal. A project proposal for the new observatory is placed at the Department of Science and Technology (DST), Govt. of India for approval and funding. The site characterization is being conduced at hill-top. An automated weather is installed at the site, and data is collected regular basis. A small observatory with a roll-off-roof including a telescope control cabin is already installed at the site, and installation of the DIMM system with 12-inch telescope is done for measuring the Astronomical seeing of the site.

## Any other Relevant Information including social impact of research

1. A societal upliftment project on "Astro-tourism for Socioeconomic Upliftment of Tribal People around Panchet Hill, Purulia" was formulated by collaborating with Sidho-Kanho-Birsha University, Purulia and submitted to SEED, DST for funding. 2. Scientific awareness programs like "Astro-Quest" is organized for college, school students, and the public. 3. A spectroscopic-based low-cost instrument "Mil-Q-Way" is being developed under the Technical Research Centre (TRC), SNBNCBS for the detection of adulteration of milk. A prototype instrument has already been developed at the Centre, which is looking for potential technology takers. Such a project is intended for societal benefit and valuable Knowledge resources for the food sector and security.


## Sunandan Gangopadhyay

Professor

Astrophysics and High Energy Physics

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Rituparna Mandal; Applications of the functional renormalization group in cosmology and black hole thermodynamics; Awarded
2. Ankur Srivastav; Applications of gauge/gravity duality to strongly coupled systems; Awarded
3. Anish Das; Study of geodesics and shadow of black holes; Thesis submitted
4. Neeraj Kumar; Thermodynamics of black holes; Thesis submitted
5. Manjari Dutta; Noncommutative quantum mechanics; Under progress
6. Anirban Roy Chowdhury; Information theoretic quantities from gauge/ gravity correspondence; Under progress
7. Soham Sen; Quantum gravity phenomenology; Under progress
8. Arnab Mukherjee; Quantum heat engines and Unruh-DeWitt detectors; Under progress
9. Souvik Paul; Informaton theoretic quantities from gauge/gravity correspondence; Under progress
10. Sukanta Bhattacharyya; Probing quantum gravity signatures in gravitational wave detectors; Thesis submitted
11. Aslam Halder; Noncommutative quantum mechanics; Thesis submitted

### b) Post-Docs

1. Ashmita Das; Unruh-DeWitt detectors, physics of black holes
2. Ashis Saha; Informaton theoretic quantities from gauge/ gravity correspondence

### c) External Project Students / Summer Training

1. Arpita Jana; Studies in quantum optics
2. Rudra Prosad Sarkar; Studies on Unruh Effect
3. Sakshi Chaudhary; Quantum Mechanics in the generalized uncertainty principle framework

## Teaching

1. Autumn semester; Mathematical Methods; Integrated PhD; 14 students; Prof. Rabin Banerjee (co-teacher)
2. Spring semester; Advanced Quantum Field Theory; Integrated PhD; 9 students

3. Spring semester; Advanced Quantum Field Theory; PhD; 2 students
4. Spring semester; Advanced Quantum Field Theory (January 2023-April 2023); Integrated PhD; Prof. Rabin Banerjee (co-teacher)

## Publications

### a) In journals

1. Ankur Srivastav and **Sunandan Gangopadhyay**, *Vortices in a rotating holographic superfluid with Lifshitz scaling,* Physical Review D, 107, 086005, 2023
2. Diganta Parai, Suchetana Pal, and **Sunandan Gangopadhyay**, *Effects of massive gravity on s-wave holographic superconductor,* International Journal of Modern Physics A, 38, 2350032, 2023
3. Ankur Srivastav, **Sunandan Gangopadhyay** & Ashis Saha, *Born–Infeld corrections to holographic transport coefficients with spatially modulated chemical potential,* The European Physical Journal C, 83, 458, 2023
4. Anirban Roy Chowdhury, Ashis Saha, and **Sunandan Gangopadhyay**, *Mutual information of subsystems and the Page curve for the Schwarzschild–de Sitter black hole,* Physical Review D, 108, 026003, 2023
5. Jayarshi Bhattacharya, Gautam Gangopadhyay and **Sunandan Gangopadhyay**, *Entropic force for quantum particles,* Physica Scripta, 98, 085305, 2023
6. Soham Sen, Rituparna Mandal & **Sunandan Gangopadhyay**, *Near horizon approximation and beyond for a two-level atom falling into a Kerr–Newman black hole,* The European Physical Journal Plus, 138, 855, 2023
7. Soham Sen and **Sunandan Gangopadhyay**, *Minimal length scale correction in the noise of gravitons,* The European Physical Journal C, 83, 1044, 2023
8. Arnab Mukherjee, **Sunandan Gangopadhyay**, and Archan S. Majumdar, *Fulling-Davies-Unruh effect for accelerated two-level single and entangled atomic systems,* Physical Review D, 108, 085018, 2023
9. Anish Das, Anirban Roy Chowdhury and **Sunandan Gangopadhyay**, *Stability, quasinormal modes in a charged black hole in perfect fluid dark matter,* Classical and Quantum Gravity, 41, 015018, 2024
10. Soham Sen, Manjari Dutta and **Sunandan Gangopadhyay**, *Lewis and berry phases for a gravitational wave interacting with a quantum harmonic oscillator,* Physica Scripta, 99, 015007, 2023
11. Anirban Roy Chowdhury, Ashis Saha and **Sunandan Gangopadhyay**, *Mixed state entanglement measures for the dipole deformed supersymmetric Yang–Mills theory,* Annals of Physics, s460, 169565, 2024
12. Soham Sen and **Sunandan Gangopadhyay**, *Uncertainty principle from the noise of gravitons,* The European Physical Journal C, 84, 116, 2024
13. Saumya Ghosh, Arnab Acharya, **Sunandan Gangopadhyay**, and Prasanta K. Panigrahi, *Lorentzian path integral in Kantowski-Sachs anisotropic cosmology,* Physical Review D, 109, 043524, 2024
14. Soham Sen, Arnab Mukherjee, and **Sunandan Gangopadhyay**, *Entanglement degradation as a tool to detect signatures of modified gravity,* Physical Review D, 109, 046012, 2024
15. Ashmita Das, Soham Sen, and **Sunandan Gangopadhyay**, *Horizon brightened accelerated radiation in the background of braneworld black holes,* Physical Review D, 109, 064087, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Talk given in "ICTP Workshop on String theory, holography, and black holes" in 2023 on "Role of mutual information on the Page curve"; October 25, 2023; International Centre for Theoretical Physics, Trieste, Italy; 10 minutes
2. A set of 4 invited lectures given on "A short introduction to path integral approach to quantum mechanics and quantum field theory"; June 7, 2023; National Institute for Theoretical and Computational Sciences (NiTheCs), Stellenbosch, South Africa; 4 hours

## Administrative duties

1. Head of the Department of Astrophysics and High Energy Physics
2. Chairman of the Alumni and Placement cell
3. Member of the Library Committee
4. Member of the Consultative Advisory Committee (CAC)
5. Permanent Invitee of the Academic and Research Programme Advisory Committee

## Conference / Symposia / Schools organized

1. Organized "Impact 2023, The Alumni Meet"; December 28, 2023; S.N.Bose National Centre for Basic Sciences; 1 day
2. Organized an International Conference on "Photonics, Quantum Information and Quantum Communication" in Biswa Bangla Convention Centre from 29 January-02

February, 2024 as the Co-Convener; January 29, 2024; Organized an International Conference on "Photonics, Quantum Information and Quantum Communication" in Biswa Bangla Convention Centre from 29 January-02 February, 2024 as the Co-Convener; 5 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. Prasanta K Panigrahi, Indian Institute of Science Education and Research Kolkata (IISER-K); IISER-Kolkata, Sl.No. 13; National

## Areas of Research

Quantum gravity phenomenology, applications of gauge/gravity correspondence

My research work during this assessment year has primarily been in the following areas:

1. We have extended our previous work on rotating holographic superfluids to include Lifshitz scaling. The presence of this scaling breaks relativistic invariance of the boundary superfluid system and indicates the existence of a Lifshitz fixed point. We have analytically shown that we still get same vortex solutions as discovered earlier in [Phys. Rev. D 104, 126004 (2021)]. Our study indicate surprising results regarding dissipation in such a holographic superfluid. We found that higher winding number vortices increase with higher values of imaginary chemical potential. This result is remarkable because it asserts that dissipation in the rotating holographic superfluid increases in the presence of Lifshitz scaling. This work got published in Physical Review D, 107, 086005, (2023).
2. Recently, the island approach towards the resolution of the information loss paradox has been an active area of research. In this context, we show that two proposals associated with the mutual information of matter fields can be given for an eternal Schwarzschild black hole in de Sitter spacetime. These proposals also depict the status of associated entanglement wedges and their role-play in obtaining the correct Page curve of radiation. The first proposal has been given for the before Page time scenario, which shows that the mutual information between two disjoint regions in the Penrose diagram vanishes at a certain value of the observer's time. We claim that this is the Hartman-Maldacena time. The second proposal depicts the fact that just after the Page time, when the replica wormholes are the dominating saddle points, the mutual information between tow different disjoint regions vanishes at a time scale which equals the scrambling time. These two proposals lead us to the correct time evolution of the fine-grained entropy of radiation as portrayed by the Page curve. We have also shown that similar observations can be obtained for the radiation associated with the cosmological horizon. This work got published in Physical Review D, 108, 026003 (2023).
3. On the quantum gravity phenomenology side, we have considered a quantized and linearly polarized gravitational wave interacting with a gravitational wave detector in the generalized uncertainty principle (GUP) framework. Although the incoming gravitational wave was quantized, no Planck-scale quantization effects were considered for the detector in earlier literatures. We considered a GUP with a quadratic order correction in the momentum variable between the two phase space coordinates of the detector. Using a path integral approach, we obtained a stochastic equation involving the separation between two point-like objects. It was observed that random fluctuations and the correction terms due to the GUP plays a crucial role in dictating such trajectories. The solution to the stochastic equation led to time dependent standard deviation due to the GUP insertion, and for a primordial gravitational wave both the noise and the GUP effects exponentially enhance, giving a nice window for detection in future generation gravitational wave detectors. This work got published in European Physical Journal C, 83, 1044, (2023).

## Plan of Future Work Including Project

1. In future, we would like to extend our ongoing studies in the direction of looking for signatures of linearized quantum gravity in various gravitational wave detectors. In particular, we would like to look for these signatures in a Bose-Einstein condensate. We would also like to give a rigorous derivation of the generalized uncertainty relation which is lacking in the present literature.
2. We would also like to extend our proposals in the island approach of resolving the Hawking information loss paradox to the case of evaporating black holes. Such an investigation has not been carried out in the literature so far. We feel this would be a very important piece of work if we can get the correct Page curve for an evaporating black hole using the proposals that we have put forward in the literature.

## Any other Relevant Information including social impact of research

1. The areas of research in which we are engaged are related to the understanding of the fundamental laws that govern the universe. The investigations would provide deeper insights into the fundamental aspects of theoretical physics. Mysteries about quantum gravity remain one of the most important unsolved problems. Our investigations would shed light into this problem. Past experience have shown that fundamental studies usually find applications much later in technological development. Research in theoretical physics would also lead to the development of man power.


## Tapas Baug

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Ariful Hoque; Protostellar outflows in Galactic star-forming regions; Under progress
2. Muhammad Usman Shehu; Study of star-forming filaments; Under progress

### b) Post-Docs

1. Tirthendu Sinha; Young stellar objects
2. Souvik Manna; Extragalactic star formation

### c) External Project Students / Summer Training

1. Aishwarya S. Potdar; Role of Galactic filaments in star formation (M.Sc. Project)
2. Trisha Mishra; Identification of filaments using deep learning approach (Summer Project)

## Teaching

1. Autumn semester; Classical Dynamics; Integrated PhD; 15 students

## Publications

### a) In journals


1. L. K. Dewangan, O. R. Jadhav, A.K. Maity, N. K. Bhadari, Saurabh Sharma, M. Padovani, **T. Baug**, Y. D. Mayya, Rakesh Pandey, *Deciphering the hidden structures of HH 216 and Pillar IV in M16: results from JWST and HST,* Monthly Notices of the Royal Astronomical Society, 528, 3909-3926, 2024
2. Xiaofeng Mai, Tie Liu, Xunchuan Liu, Lei Zhu, **T. Baug** et al, *The ALMA-QUARKS Survey: Detection of Two Extremely Dense Substructures in a Massive Prestellar Core,* The Astrophysical Journal Letters, 961, L35, 2024
3. Siddhartha Biswas, Soumen Mondal, Ariful Hoque, Alik Panja, **T. Baug**, and Ramkrishna Das, *Star Formation in the H II Region Sh2-87: Evidence of Global Hierarchical Collapse,* The Astrophysical Journal, 961, 176, 2024
4. J. W. Zhou, S. Dib, F. Wyrowski, T. Liu, S. H. Li, P. Sanhueza, M. Juvela, F. W. Xu, H. L. Liu, T. Baug, Y. P. Peng, K. M. Menten and L. Bronfman, *Feedback from protoclusters does not significantly change the kinematic properties of the embedded dense gas structures,* Astronomy & Astrophysics, 682, 15, 2024

5. A. P. M. Towner, A. Ginsburg, P. Dell'Ova, A. Gusdorf, S. Bontemps, T. Csengeri, R. Galván-Madrid, F. K. Louvet, F. Motte, P. Sanhueza, A. M. Stutz, J. Bally, **T. Baug**, H.-R. V. Chen, N. Cunningham, M. Fernández-López, H.-L. Liu, X. Lu, T. Nony, M. Valeille-Manet, B. Wu, R. H. Álvarez-Gutiérrez, M. Bonfand, J. Di Francesco, Q. Nguyen-Luong, F. Olguin, and A. P. Whitworth, *ALMA-IMF. IX. Catalog and Physical Properties of 315 SiO Outflow Candidates in 15 Massive Protoclusters,* The Astrophysical Journal, 960, 48, 2024

6. Rakesh Pandey, Saurabh Sharma, Lokesh Dewangan, Aayushi Verma, **Tapas Baug**, Harmeen Kaur & Arpan Ghosh, *Investigating star-formation activity in Sh 2-61 H II region,* Journal of Astrophysics and Astronomy, 44, 76, 2023

7. Alik Panja, Lokesh K. Dewangan, **Tapas Baug**, Wen Ping Chen, Yan Sun, Tirthendu Sinha, and Soumen Mondal, *Observational Evidence of the Merging of Filaments and Hub Formation in G083.097+03.270,* The Astrophysical Journal, 958, 17, 2023

8. N. Cunningham, A. Ginsburg, R. Galván-Madrid, F. Motte, T. Csengeri, A. M. Stutz, M. Fernández-López, R. H. Álvarez-Gutiérrez, M. Armante, **T. Baug**, M. Bonfand, S. Bontemps, J. Braine, N. Brouillet, G. Busquet, D. J. Díaz-González, J. Di Francesco, A. Gusdorf, F. Herpin, H. Liu, A. López-Sepulcre, F. Louvet, X. Lu, L. Maud, T. Nony, F. A. Olguin, Y. Pouteau, R. Rivera-Soto, N. A. Sandoval-Garrido, P. Sanhueza, K. Tatematsu, A. P. M. Towner and M. Valeille-Manet, ALMA-IMF - VII. *First release of the full spectral line cubes: Core kinematics traced by DCN J = (3–2),* Astronomy & Astrophysics, 678, 73, 2023

9. Arpan Ghosh, Saurabh Sharma, Joe P. Ninan, Devendra K. Ojha, Bhuwan C. Bhatt, D. K. Sahu, **Tapas Baug**, R. K. Yadav, Puji Irawati, A. S. Gour, Neelam Panwar, Rakesh Pandey, Tirthendu Sinha, and Aayushi Verma, *Post-outburst Evolution of Bona Fide FU Ori-type V2493 Cygnus: A Spectro-photometric Monitoring,* The Astrophysical Journal, 954, 82, 2023

10. Hong-Li Liu, Anandamayee Tej, Tie Liu, **Tapas Baug** et al., *Evidence of high-mass star formation through multiscale mass accretion in hub-filament-system clouds,* Monthly Notices of the Royal Astronomical Society, 522, 3719-3734, 2023

11. Aayushi Verma, Saurabh Sharma, Lokesh Dewangan, Rakesh Pandey, **Tapas Baug**, Devendra K. Ojha, Arpan Ghosh & Harmeen Kaur, *Kronberger 55: A candidate for end-dominated collapse scenario,* Journal of Astrophysics and Astronomy, 44, 52, 2023

12. Saurabh Sharma, Lokesh Dewangan, Neelam Panwar, Harmeen Kaur, Devendra K. Ojha, Ramkesh Yadav, Aayushi Verma, **Tapas Baug**, Tirthendu Sinha, Rakesh Pandey, Arpan Ghosh & Tarak Chand, *Teutsch 76: A deep near-infrared study,* Journal of Astrophysics and Astronomy, 44, 46, 2023

13. Kshitiz K. Mallick, Saurabh Sharma, Lokesh K. Dewangan, Devendra K. Ojha, Neelam Panwar & **Tapas Baug**, *Investigating morphology and CO gas kinematics of Sh2-112 region,* Journal of Astrophysics and Astronomy, 44, 34, 2023

14. L. K. Dewangan, N. K. Bhadari, A. K. Maity, Rakesh Pandey, Saurabh Sharma, **T. Baug** & C. Eswaraiah, *Star-forming site RAFGL 5085: Is a perfect candidate of hub-filament system?,* Journal of Astrophysics and Astronomy, 44, 23, 2023

15. Y. Pouteau, F. Motte, T. Nony, M. González, I. Joncour, J.-F. Robitaille, G. Busquet, R. Galván-Madrid, A. Gusdorf, P. Hennebelle, A. Ginsburg, T. Csengeri, P. Sanhueza, P. Dell'Ova, A. M. Stutz, A. P. M. Towner, N. Cunningham, F. Louvet, A. Men'shchikov, M. Fernández-López, N. Schneider, M. Armante, J. Bally, **T. Baug**, M. Bonfand, S. Bontemps, L. Bronfman, N. Brouillet, D. Díaz-González, F. Herpin, B. Lefloch, H.-L. Liu, X. Lu, F. Nakamura, Q. Nguyen Luong, F. Olguin, K. Tatematsu and M. Valeille-Manet, *ALMA-IMF VI. Investigating the origin of stellar masses: Core mass function evolution in the W43-MM2&MM3 mini-starburst,* Astronomy & Astrophysics, 674, 24, 2023

16. T. Nony, R. Galván-Madrid, F. Motte, Y. Pouteau, N. Cunningham, F. Louvet, A. M. Stutz, B. Lefloch, S. Bontemps, N. Brouillet, A. Ginsburg, I. Joncour, F. Herpin, P. Sanhueza, T. Csengeri, A. P. M. Towner, M. Bonfand, M. Fernández-López, **T. Baug**, L. Bronfman, G. Busquet, J. Di Francesco, A. Gusdorf, X. Lu, F. Olguin, M. Valeille-Manet and A. P. Whitworth, *ALMA–IMF V. Prestellar and protostellar core populations in the W43 cloud complex,* Astronomy & Astrophysics, 674, 27, 2023

17. Feng-Wei Xu, Ke Wang, Tie Liu, **Tapas Baug** et al., ATOMS: ALMA *Three-millimeter Observations of Massive Star-forming regions – XV. Steady accretion from global collapse to core feeding in massive hub-filament system SDC335,* Monthly Notices of the Royal Astronomical Society, 520, 3259-3285, 2023

## b) Other Publications

1. Samrat Roy and **Tapas Baug**, "Probing the Rocket Effect: A Study of Massive Stars and Bright Rimmed Clouds", 42nd meeting of the Astronomical Society of India (ASI), P164, 01/2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Topical Research School (TRS) on the recent trends of research in theoretical and experimental physics; April 13, 2023; Gurucharan College, Silchar, India; 1 hr
2. Filaments in ALMA-IMF targets; May 30, 2023; France (Online); 20 min
3. C. K. Majumder Memorial Summer Workshop in Physics 2023; July 26, 2023; SNBNCBS, Kolkata; 1.5 hr
4. Talk on star formation durinng Outreach program at Sidho-Kanho-Birsa University (SKBU), Purulia; March 20, 2024; SKBU, Purulia; 30 min

## Administrative duties

1. Committee Member of Computer Service Cell-Working Group
2. Member of Technical Cell Working Group
3. Member of SCOLP Committee
4. Chaired the committee for "Replacing of Damaged Roof Sheet, False Ceiling and Painting Works at Furnace Lab-3, 4 and Security Change Room near Clean Room, SNBNCBS"
5. Member of "Syllabus modification Committee" (for IPhD and PhD courses)
6. Member of 2 Interview Panels (PhD and IPhD) and several other evaluation committee for promotion of JRF to SRF

## Awards, Recognitions, if any

1. Recognized for excellent contribution to the review of Journal of Astrophysics and Astronomy (September 2023)

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Astro-tourism for Socioeconomic and Livelihood Upliftment of Tribal People around Panchet hill, Purulia; DST-SEED; 3 years; Co-PI
2. Supporting fund for the conference "Star Formation Studies in India"; DST-SERB; 1 time; PI

## Conference / Symposia / Schools organized

1. Convener of the conference titled "Star Formation Studies in India"; January 8, 2024; SNBNCBS, Kolkata; 4 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. L. K. Dewangan (Physical Research Laboratory, Ahmedabad, India); Sl. No. 1, 2, 6, 7, 10, 11, 12, 13, 14; National
2. Saurabh Sharma (Aryabhatta Research Institute of Observational Sciences, Nainital, India); Sl. No. 1, 6, 9, 11, 12, 13, 14; National
3. Devendra K. Ojha (Tata Institute of Fundamental Research, Mumbai, India); Sl. No. 1, 6, 9, 11, 12, 13, 14; National
4. Soumen Mondal (S. N. Bose National Centre for Basic Sciences, Kolkata, India); Sl. No. 3, 7; National
5. Ramkrishna Das (S. N. Bose National Centre for Basic Sciences, Kolkata, India); Sl. No. 1, 2, 6, 7, 10, 11, 12, 13, 14; National
6. Tie Liu (Shanghai Astronomical Observatory, Shanghai, China); Sl. No. 2, 4, 10, 17; International
7. Adam Ginsburg (University of Florida, USA); Sl. No. 5, 8, 15, 16; International
8. Alison P. M. Towner (University of Florida, USA); Sl. No. 5, 8, 15, 16; International
9. Frédérique Motte (Univ. Grenoble Alpes, CNRS, Grenoble, France); Sl. No. 5, 8, 15, 16; International
10. Thomas Nony (Univ. Grenoble Alpes, CNRS, Grenoble, France); Sl. No. 5, 8, 15, 16; International

## Outreach program organized / participated

1. 2024 March 20, "Outreach program at Sidho-Kanho-Birsa University (SKBU)", Purulia
2. 2024 January 2, "Sky-watching Program", Open Day, SNBNCBS, Kolkata
3. 2023 August 3-4, "Outreach Program at Panchkot Mahavidyalaya", Sultandi, Purulia
4. 2023 July 12-21, "Sky-watching Program" to participants of CKM Memorial Workshop, SNBNCBS, Kolkata

## Areas of Research

Galactic star formation

Elongated filamentary structures are ubiquitous in the interstellar medium (André et al. 2010, A&A, 518, L102). Those with higher column densities (1022 cm–2) are preferred sites to initiate star formation. Filaments are often found networked where multiple units with sizes several parsecs radially merge into a central parsec-scale clump, referred to as hubs, which have low aspect ratios and high-column densities (Myers 2009, ApJ, 700, 1609). These hub–filament systems (HFSs) are considered the potential progenitors of massive young stellar associations, in which luminous (>10 L) massive stars are formed (Kumar et al. 2020, A&A 642 A87). These authors also categorized the star formation in HFSs at four evolutionary stages. Briefly, in Stage I, dense filaments move toward each other and set up the initial conditions for HFS formation. In Stage II, the approaching filaments merge and form the hub with a small twist at the overlapping zone, thereby flattening the hub. In Stage III, the density in the hub amplifies due to the initial shock followed by

self-gravity and hence drives longitudinal flows toward the hub leading to the formation of massive stars. Finally, in Stage IV, the radiation pressure and ionization feedback from the massive stars shape the remnant filaments as pillars, leaving a mass-segregated embedded cluster at the hub.

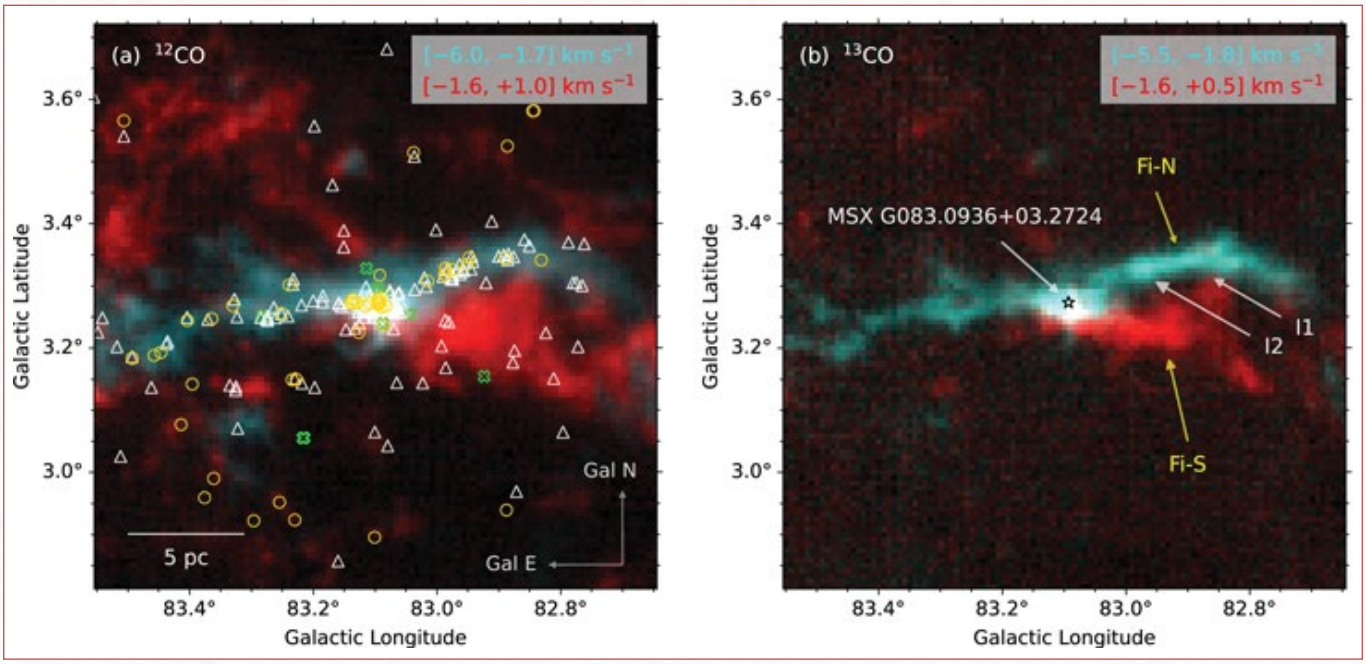



Figure 1: Two color integrated intensity CO images, revealing the merging of filaments into a common junction as the hub. (a) The young stellar objects are overlaid on the 12CO distribution. (b) The skeletons of the two filaments (Fi-N and Fi-S) are more clearly depicted by the 13CO distribution. At the hub, a massive outflow source is marked by a black asterisk symbol. A detailed kinematic study of a Galactic molecular cloud, G083.097+03.270 using CO isotopologue data revealed the presence of two large-scale filaments (length of 10.4-20.7 pc) with different velocity components (Vpeak at -3.98 and -0.83 km s–1) interacting via a common hub. A significant enhancement in the velocity dispersion at the hub (up to ~5.0 km s–1) indicates a turbulent gas motion caused by the merging of filaments. The detection of a large-scale velocity gradient (~0.084 km s–1 pc–1) along the filaments axis indicates a global motion of molecular gas feeding the central clumps. Together, the clustering of young sources, higher excitation temperature (median ~20.4 K), and higher H2 column density (~2.0 × 1022 cm–2 for 13CO) imply an HFS morphology in this region, where the star formation is similar to Stage II or III of the "filaments to clusters" model described by Kumar et al. (2020, A&A 642 A87). More details of this work can be found in Panja et al. (2023, ApJ, 958, 17).

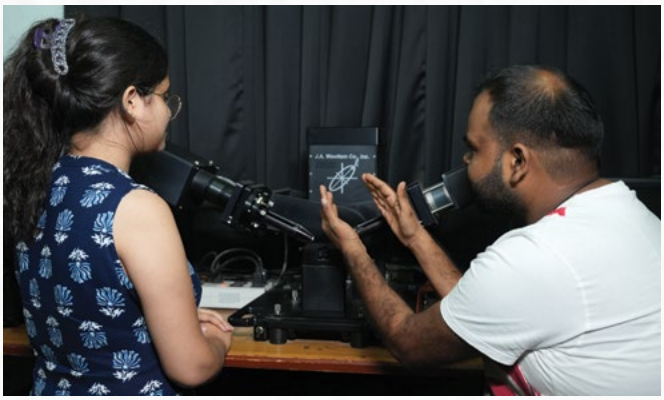
## Plan of Future Work Including Project

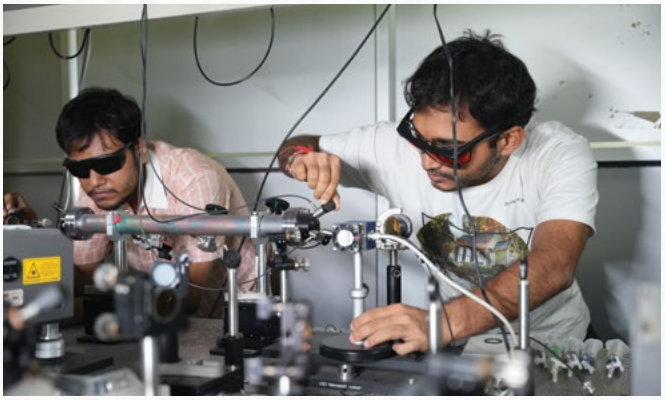
1. Herschel Observations revealed ubiquitous elongated filamentary structures in Galactic molecular clouds. Although filaments are believed to play important role in star formation, the property of filaments in transporting gas varies with their length-scale (Hacar et al., 2022). The gas flow in filaments become more streamline and rapid at the sub-parsec scale. Exact length-scale and origin of such behavior of filaments should be verified in detail. Thus, I would like to study the role of filaments at sub-parsec scale using the mm/sub-mm data from Atacama Large Millimeter/submillimeter Aarray (ALMA). Identification of filaments in molecular clouds is not trivial. I am developing a method to identify the filaments from the FITS cube data of the Galactic molecular cloud.
2. Outflows are ubiquitous phenomena in the early phase of star formation, irrespective of their mass. Probing these outflows may help us in understanding the finer details of the outflow parameters and their launching mechanisms. Additionally, observations in near-infrared bands may help us in acquiring the hotter parts (>1000 K) of the outflows while observations of the same outflows in the mm band helps us to obtain the information at the lower temperature regime (20-100 K). I would like to pursue a study several Galactic star-forming regions using data from ALMA (mm band data) and 3.6-m Devasthal Optical Telescope (optical/near-infrared data). We are characterizing the outflows using data at different wavelengths and also using different tracers.

3. The Centre has started the initial foundation to build S. N. Bose Astronomical Observatory at Panchet Hilltop, Purulia. Recently, a weather station and a mobile observatory have been installed at the hilltop. We already have gathered observational data for astronomical seeing measurements. We shall now start scientific operation of mobile observatory. I would like to keep on contributing in the development of this telescope project.

## Any other Relevant Information including social impact of research

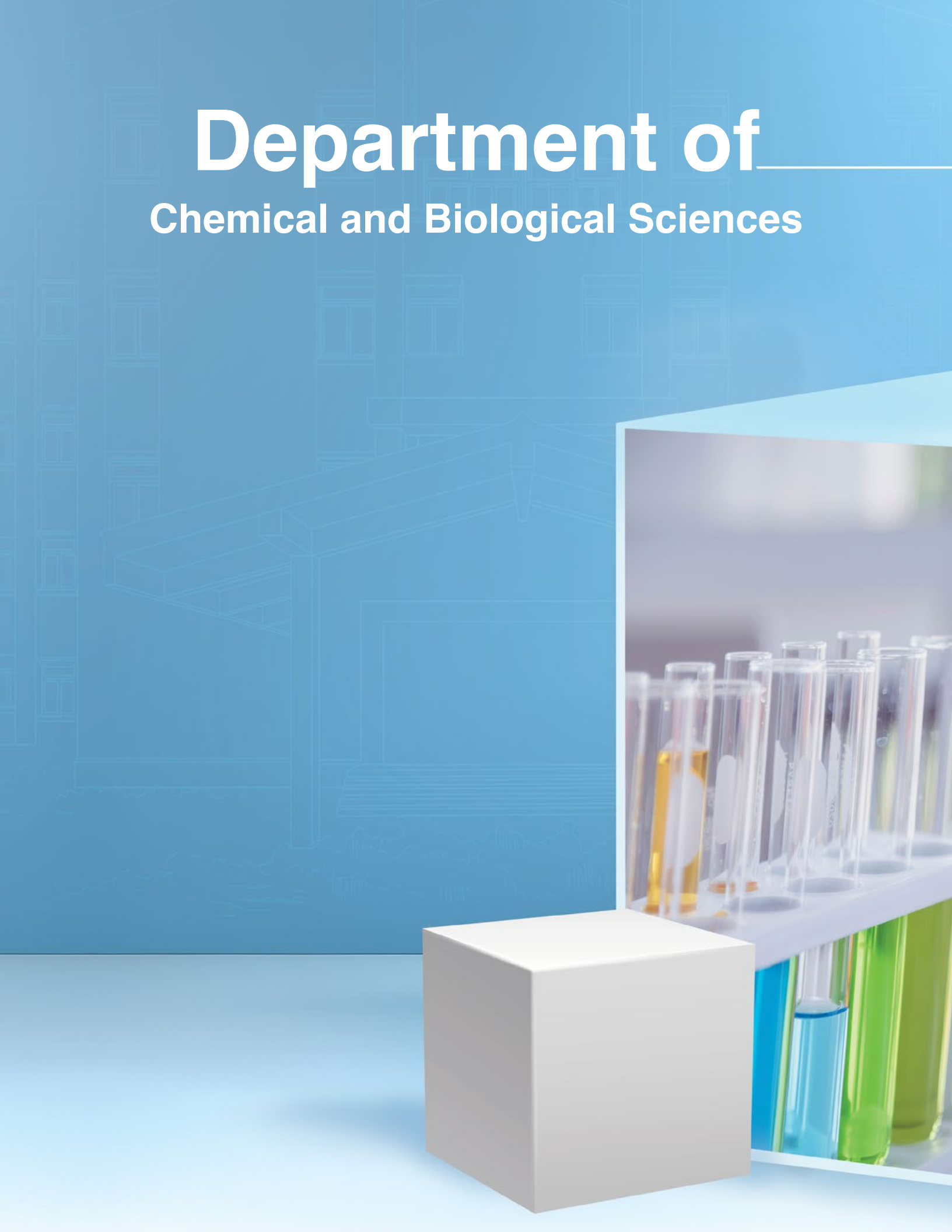
1. Co-authored "Star Formation and ISM" chapter of "25 years Vision Document" compiled by Bhaswati Mookerjea (TIFR) and Maheswar Gopinathan (IIA), to be published by Astronomical Society of India.
2. Member of national committee for the proposal of National Large Optical Telescope, leading by Indian Institute of Astrophysics.
3. Member of national committee for the proposal of National Sub-millimeter Telescope, leading by Tata Institute of Fundamental Research.
4. Reviewer of the observational proposals for 3.6-m Devasthal Optical Telescope and Giant Metrewave Radio Telescope.
5. External member of thesis evaluation committee and JRF interview committee at Presidency University.





# Department of

## Chemical and Biological Sciences




## Ali Hossain Khan

Ramanujan Fellow
Chemical and Biological Sciences
alikhan@bose.res.in


### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Sourik Dutta; Doped 2D Nanocrystals for Photonic Applications; Under progress
2. Bikram Das; Heavy-Metal-Free Photonic Colloidal 2D Nanocrystals; Under progress

#### b) External Project Students / Summer Training

1. Avanti Chakraborty (Project Student); Heterostructured and doped 2D nanoplatelets
2. Mariom Mamtaj (Summer training, 2023); Preparation and characterization of Solution- processed ultra-thin films of alumina
3. Farhin Islam (MSc Project Research Programme for the duration of 12 Months); Synthesis of Copper Indium Selenide Semiconductor Nanocrystals

### Teaching

1. Spring semester 2024; "Surfaces & Interfaces" (Code: CB 641); PhD Coursework; 5 students; Dr. Pradip S. Pachfule (Co-teacher)

### Publications

#### a) In journals

1. Ivo Tanghe, Margarita Samoli, Isabella Wagner, Servet Ataberk Cayan, **Ali Hossain Khan**, Kai Chen, Justin Hodgkiss, Iwan Moreels, Dries Van Thourhout, Zeger Hens & Pieter Geiregat, *Optical gain and lasing from bulk cadmium sulfide nanocrystals through bandgap renormalization,* Nature Nanotechnology, 18, 1423-1429, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. Synthesis of Anisotropic Nanocrystals Induced by Chloride; International Conference on Optoelectronic and Bio- inspired Nanomaterials (ICOBIN), 4-6 December, 2023; 2023-12-06; MAC Auditorium, IIT, Roorkee; 15 mins
2. Solution-Processed 2D Semiconductor Nanoplateletsfor Optoelectronic Applications. Celebration of YOUNG SCIENTISTS' DAY 2023; 2023-07-18; Silver Jubilee Hall, SNBNCBS; 30 mins

### Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Doped 2D Nanocrystals for Photonic Applications; Ramanujan Fellowship, SERB, India; 5 years (01-04-2021 - 31-03-2026); PI

2. Heavy-Metal-Free Photonic Colloidal 2D Nanocrystals; CRG, SERB, India; 3 years (08-02-2023 - 07-02-2026); PI

## Outreach program organized / participated

1. Title: Exploring the Potential of Quantum Dots in Nanotechnology; Outreach Programme, Recent Trends of Research in Theoretical and Experimental Physics; 2024-03-13; Gurucharan College, Silchar, Assam; 60 mins
2. Title: Nanoscience and Quantum Dots: Background ofthe 2023 Nobel Prize in Chemistry; Outreach Programme, Scientific Quest: Imagination, innovation and beyond; 2024-01-25; Department of Chemistry, The University of Burdwan; 45 mins
3. Title: Why Nano is so special?; Outreach Programme, The Wonder of Science: Explore and Learn; 2023-08-25; Tarakeswar Degree College, Tarakeswar; 60 mins

## Areas of Research

### Nanomaterials

At present, I am leading two research projects. The first one focuses on synthesizing doped 2D nanocrystals, funded by the Ramanujan Fellowship. The second project, funded by CRG, SERB, is centered around the non-toxic 2D nanocrystals for optoelectronic applications. Using funds from the CRG project, I purchased some small equipment and two fume hoods to establish a small laboratory for my research in the last fiscal year. Despite encountering various obstacles, we now have a functional synthesis lab. I am grateful to SNBNCBS for providing me with the lab space. I hired two Junior Research Fellows (JRF) last year, one from the Ramanujan Fellowship research fund and the other from the CRG project, as the previous project assistant had left. The findings from the last two years of research on Indium-doping have been transferred to one JRF. He has been trained enough to reproduce the results. To understand the unique optoelectronic properties of this doped 2D nanostructure, a computational study has been done in collaboration with Dr. Uttam Pal and Prof. Tanusri Saha-Dasgupta. Our current focus of this project is developing a phototransistor using this novel semiconductor material, and so we are working on thin film preparation and device fabrication (Figure 1a, 1b). The focus of the CRG project is currently on the materials InP and CuInSe. A method has been developed to produce ultrathin CuInSe nanoplatelets (Figure 1c). The thinness is evident from their absorption and emission peaks. The new target is to improve their fluorescence by creating core/shell and core/crown heterostructures for potential use in biology as a photonic material (Figure 1d). Additionally, we are working with the computational team mentioned above to analyze the band structure of these 2D materials. Research on InP is still in its early stages.

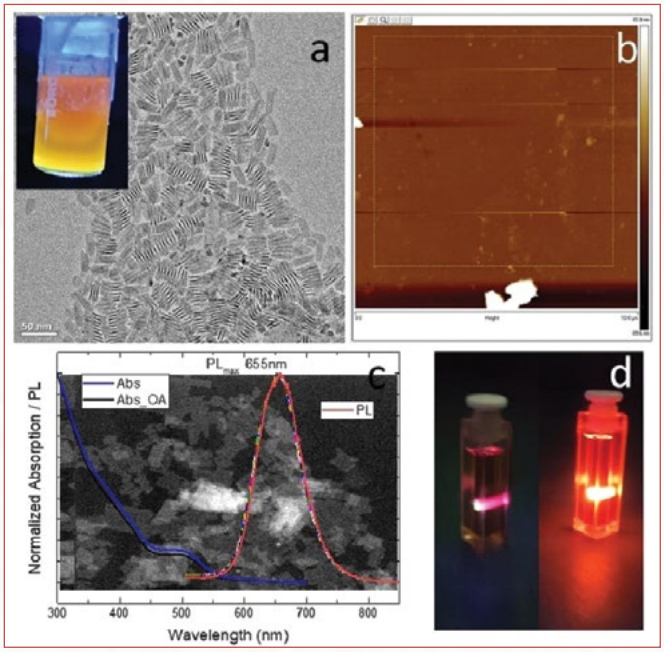
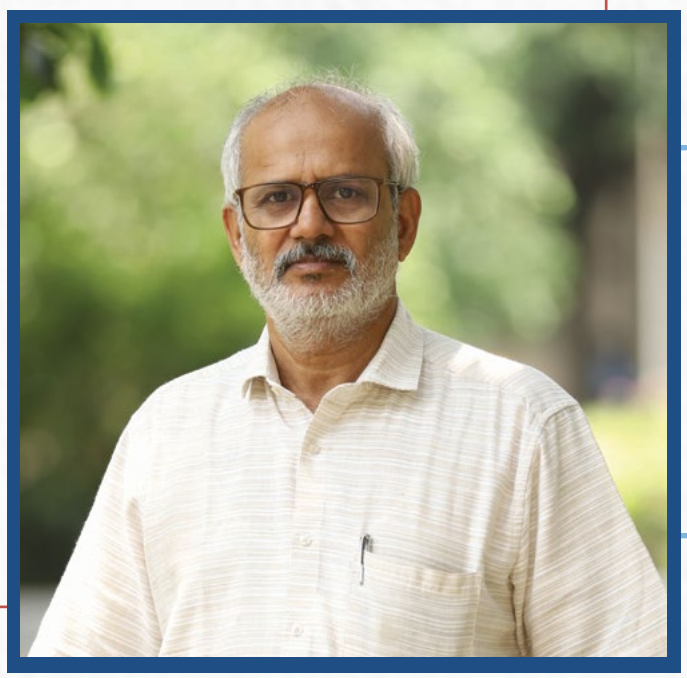



Figure 1. (a) TEM images of the 4.5 ML In:CdSe NPLs. Inset: photograph of the In:CdSe NPL solution under UV illumination. (b) AFM image of the ligand exchanged In:CdSe NPLs films prepared using spin-coating. (c) The absorbance and PL spectrum of CuInSe NPLs. Background: STEM image of CuInSe NPLs. (d) The emission of the CuInSe core and CuInSe/ZnSe core/shell sample under UV light.

## Plan of Future Work Including Project

1. Our plan is to develop a phototransistor using In:CdSe NPLs, followed by exploring co-doping strategies. We will then study the electron and hole relaxation process in these co-doped NPLs to improve their optoelectronic properties. Additionally, we aim to increase the PL QY of CuInSe NPLs by building core/shell and core/crown heterostructures for potential biomedical applications. Another focus this year will be the development of 2D InP nanocrystals.




## Gautam Gangopadhyay

Senior Professor

Chemical and Biological Sciences

gautam@bose.res.in


### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Jayarshi Bhattacharya; Quantum open system and quantum transport; Under progress; Suanandan Gangopadhyay (Co-supervisor)
2. Pallabi Roy; Ultrasensitivity and early warning signal in biochemical systems; Under progress; Sakuntala Chatterjee (Co-supervisor)

#### b) Post-Docs

1. Tapas Sahoo; Path integral approach to quantum equation of state of few molecules

### Publications

#### a) In journals

1. Prasanta Kundu, Soma Saha and **Gautam Gangopadhyay**, *A minimal kinetic model for the interpretation of complex catalysis in single enzyme molecules,* Physical Chemistry Chemical Physics, 26, 463-476, 2024
2. Tapas Sahoo and **Gautam Gangopadhyay**, *Effect of neighbouring molecules on ground-state properties of many-body polar linear rotor systems,* Molecular Physics, 121, e2242967, 2023
3. Premashis Kumar and **Gautam Gangopadhyay**, *Nonequilibrium thermodynamic signatures of collective dynamical states around chimera in a chemical reaction network,* Physical Review E, 108, 044218, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. 2Days Conference organised on Stochastic and nonlinear dynamics in Chemistry and Biology; 4-5$^{th}$ Jan2024; SNBNCBS; 2 days

### Administrative duties

1. Medical Cell, Convener
2. Member of Project and Patent Cell

### Membership of Learned Societies

1. Indian Physical Society, Kolkata (Life Member)
2. Indian Association for the Cultivation of Science, Kolkata (Life Member)

### Scientific collaborations with other national / international institutions (based on joint publications)

1. Dr. Anirban Karmakar, Taldi College, Kolkata West Bengal; Sl. No.1; National
2. Dr. Soma Saha, Presidency University; Sl. No. 1; National

## Areas of Research

We have analyzed the effect of cross-diffusion coefficients and chemostatted species concentration on dynamic and thermodynamic entities by studying Turing-Hopf overlapping and traveling waves. In this context, our findings uncover a proportional relationship between the total EPR and the global concentration dynamics of the RDS. We further investigate the emergence of a counterintuitive chimera state in a globally coupled chemical system and also identify the equivalence between chimera energetics and the Gabor representation. Extending this study to states around the chimera state, we discover some intriguing resemblances between dynamic and thermodynamic quantities. We additionally explore the interplay between dissipation, thermodynamic potential, and accuracy by implementing this framework in kinetic proofreading networks of core biological events. This powerful formalism captures arbitrarily intricate dynamics and far-from- equilibrium thermodynamics, both qualitatively and quantitatively.

Other recent works can be found below:

Stochastic response of ultrasensitivity: Optimized switching of mitogen activated protein kinase (MAPK) cascade
P Roy, S Chatterjee, G Gangopadhyay in Chemical Physics 584, 112327

Nonzero current due to coherent dynamic electrontransport through a dimer with no external bias
A Karmakar, G Gangopadhyay Physica Scripta (accepted)

Current and efficiency of bosonic systems interacting with two thermal reservoirs
J Bhattacharya, S Gangopadhyay, G Gangopadhyay
arXiv preprint arXiv:2403.12112

## Plan of Future Work Including Project

1. We shall study Nonequilibrium steady state of chemical reaction network from large Deviation theory and Dynamical phase transitions with special emphasis on
   i. Ultrasensitivity in Phosphorylation-dephosphorylation kinetics: Critical slowing down and Early warning signals(PR,SC,GG)
   ii. Dynamic phase transitions in Single and birhythmic glycolytic oscillations(PR,PK,SC,GG)
2. We are continuing our study on Quantum entropy in electron vibration interaction in electron transport problem: molecular systems with special importance on
   i. Quantum entropy and quantum osmotic force(JB,SG,GG)
   ii. Quantum molecular battery: charging and discharging through electron-vibrational entanglemet(AK,GG)

## Any other Relevant Information including social impact of research

A few talks delivered at Ramakrishna Mission, Rahara, for MSc (Physical Chemistry)students during Feb-March'2024 on Nonequilibrium Thermodynamics.


## Goutam De

Visiting Professor

Chemical and Biological Sciences

g.de@bose.res.in


## Publications

### a) In journals

1. Mohammad Adil Afroz, Anupriya Singh, Ritesh Kant Gupta, Rabindranath Garai, Naveen Kumar Tailor, Yukta, Shivani Choudhary, Bhavna Sharma, Prerna Mahajan, Bhavya Padha, Sonali Verma, Sandeep Arya, Vinay Gupta, Seckin Akin, Daniel Prochowicz, Mohammad Mahdi Tavakoli, S. P. Singh, Parameswar K. Iyer, Pankaj Yadav, Hanlin Hu, **Goutam De** and Soumitra Satapathi, *Design potential and future prospects of lead-free halide perovskites in photovoltaic devices,* Journal of Materials Chemistry A, 11, 13133-13173, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Attended International Conference on Optoelectronic and Bio-inspired Nanomaterials (ICOBIN) at IIT Roorkee during December 4-6, 2023 as one of the 'Session Chairs' and 'Poster evaluation committee member'. Also shared my experiences at the "Editors' Session" as an Associate Editor of Journal of Materials Chemistry A; 05/12/2023; IIT Roorkee; 3 hours
2. Delivered a lecture entitled "Coatings on Solar Cover Glasses to enhance Photocurrent with Sustainability: An Update" in a 'Meet the Editor' program; Also shared my experiences as an Associated Editor of Journal of Materials Chemistry A and Materials Advances; 07/12/2023; IIT Ropar; 1 hour

## Awards, Recognitions, if any

1. External Member of CRNN (Calcutta University) PhD committee

## Scientific collaborations with other national / international institutions (based on joint publications)

1. CSIR-Central Glass & Ceramic Research Institute, Kolkata

## Outreach program organized / participated

1. Attended several Webinars

## Areas of Research

### Synthesis of functional nanomaterials and coatings

1. We have successfully prepared ultra-thin alumina films using a solution process technique and measured their dielectric properties. Specifically, we have designed a parallel plate capacitor with the alumina thin film serving as the dielectric material between two conducting electrodes - ITO and aluminum. We measured the capacitance of these devices using an LCR meter to determine the dielectric constant based on the film's area and thickness. The work has been done in collaboration with Dr. Ali Hossain Khan and his group.

2. Work related to the characterization (AFM, FESEM and TEM) of coatings deposited on photovoltaic cover glasses have been done during the reporting period.

## Plan of Future Work Including Project

1. As my tenure has been completed, I shall be working on the writing of the manuscript based on the collaborative work done at SNBNCBS.
2. Our collaborative work on the synthesis of very thin dielectric alumina films on glass and silicon wafer by wet chemistry may find technological applications. Therefore we have a plan to file a patent on this work.
3. As an extension to the above work, collaborative activities (with Dr. A. H. Khan) related to the development of field effect transistor (FET) and other optoelectronic devices will be fabricated by depositing appropriate semiconductor material on this thin alumina dielectric film. The whole fabrication process of these devices will be optimized considering their optical, electrical, and structural properties.

## Any other Relevant Information including social impact of research

1. Attended the CRNN (Calcutta University) PhD committee meetings as an external member.
2. Attended the Editorial Board Meetings of RSC journals 'Journal of Materials Chemistry A' & 'Materials Advances' as an Associate Editor and Board member on 19th May 2023 at Burlington House, London.
3. Manuscript handling of the Royal Society of Chemistry (RSC) journals, Journal of Materials Chemistry A and Materials Advances as Associate Editor.
4. Nominated names of Indian researchers to the RSC journal (Journal of Materials Chemistry) as 'Emerging Investigators'.
5. A paper entitled 'Ordered Mesoporous Slippery Silica Coatings on Photovoltaic Cover Glasses to Enhance Photocurrent with Sustainability for Large-Scale Applications' has been communicated to ACS Applied Energy Materials during the reporting period.


## Manik Pradhan

Professor

Chemical and Biological Sciences

manik.pradhan@bose.res.in


## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Biswajit Panda; High-resolution Molecular Spectroscopy; Awarded
2. Vishal Agarwal; Nano Materials; Awarded; Prof. Arup Kumar Raychaudhuri (Co-supervisor)
3. Ardhendu Pal; Cavity Ring-down Spectroscopy; Thesis submitted
4. Soumen Mandal; Optical Beam Shifts; Under progress
5. Soumyadipta Chakraborty; High-resolution Molecular Spectroscopy; Under progress
6. Indrayani Patra; Molecular Spectroscopy; Under progress
7. Anuradha Sett; Weak Measurements and Optical Beam Shifts; Under progress
8. Dinesh Chandra Dey; Weak Measurements and Geometric Phase; Under progress

### b) Post-Docs

1. Koushik Biswas; Cavity-enhanced Absorption Spectroscopy
2. Puspendu Barik; Evanescent-wave Cavity Ring-down Spectroscopy

### c) External Project Students / Summer Training

1. Abha Mahato; Surface Plasmon Resonance
2. Sohela Banerjee; Quantum Weak Measurements

## Publications

### a) In journals


1. Soumen Mandal, Akash Das, and **Manik Pradhan**, *Polarization-controlled Goos–Hänchen shift by weak value amplification in total internal reflection,* Journal of the Optical Society of America B, 41, 750-755, 2024
2. Soumen Mandal, Akash Das and **Manik Pradhan**, *Weak measurement of the Goos–Hänchen shift for a Hermite-Gaussian laser beam,* Journal of Optics, 26, 045403, 2024
3. Soumyadipta Chakraborty, Jayeta Banerjee, Indrayani Patra, Ardhendu Pal, Puspendu Barik and **Manik Pradhan**, *Anomalous scattering of polystyrene microparticles revealed by evanescent wave coupled cavity ringdown spectroscopy,* Analyst, 149, 1791-1798, 2024
4. Soumyadipta Chakraborty, Indrayani Patra, Ardhendu Pal, **Manik Pradhan**, *Collision-broadening of vibration-inversion-rotation ammonia spectral lines in Q(J)-branch*

*at 6.2 μm by cavity ring-down spectroscopy,* Journal of Molecular Spectroscopy, 400, 111891, 2024

5. Akash Das, Soumen Mandal, Ricardo A. Fiallo, Mark W. Horn, Akhlesh Lakhtakia, and **Manik Pradhan**, *Geometric phase and photonic spin Hall effect in thin films with architected columnar morphology,* Journal of the Optical Society of America B, 40, 2418-2428, 2023
6. Soumyadipta Chakraborty, Ardhendu Pal, Biswajit Panda, Indrayani Patra & **Manik Pradhan**, *High-resolution rovibrational cavity ring-down spectroscopy of (1200←0200) vibrational band of* β*-site-specific N2O isotopologue near 7.8 μm region,* Journal of Chemical Sciences, 135, 113, 2023
7. Jayeta Banerjee & **Manik Pradhan**, *A combined surface plasmonic and isotope-selective spectroscopic study toward a deeper understanding of real-time enzymatic urea hydrolysis,* Journal of Chemical Sciences, 135, 53, 2023
8. Ardhendu Pal, Koushik Mondal, Biswajit Panda and **Manik Pradhan**, *Development of a compact 406 nm diode laser-based cavity-enhanced spectrometer for high-sensitive detection of NO2 levels in exhaust gas,* Laser Physics Letters, 20, 075701, 2023
9. Abhijit Maity, Sayoni Bhattacharya, Anil C Mahato, Sujit Chaudhuri, and **Manik Pradhan**, *A pattern-recognition-based clustering method for non-invasive diagnosis and classification of various gastric conditions,* European Journal of Mass Spectrometry, 29, 3, 2023
10. Soumyadipta Chakraborty, Ardhendu Pal, Biswajit Panda, Indrayani Patra, **Manik Pradhan**, *Elucidation of rotational-interaction coupling and collision-induced effects in rovibrational transitions of* β*-N2O isotopologue* at 7.8 μm mid-infrared region by cavity ring-down spectroscopy, Infrared Physics & Technology, 133, 104752, 2023
11. Puspendu Barik, Jayeta Banerjee, and **Manik Pradhan**, *Real-Time Probing of Melamine-Induced Gold Nanoparticle Aggregation Kinetics via Evanescent-Wave Coupled Cavity Ring-down Spectroscopy,* Analytical Chemistry, 95, 9357-9365, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Statistical Mechanics in Chemistry & Biology (SMCB) Seminar Series; Feb 10, 2024; Zoom Online Platform; 10th February, 2024
2. Friday Colloquium Series; Jan 19, 2024; CSIR-NPL, New Delhi; 19th January, 2024
3. International Conference in Biological Sciences for Sustainable Future (ICBSSF-2023); Dec 15, 2023; D. Y. Patil Deemed to be University, Navi Mumbai; 15-16th December, 2023
4. Inaugural Conference of Society of Physical Chemistry (SoPhyC); Oct 29, 2023; IIT Kanpur; 29-31st October, 2023
5. BRICS Workshop on BioPhotonics-2023; May 16, 2023; Saratov, Russia (Zoom Online); 16-18th May, 2023

## Administrative duties

1. Member of Works Committee
2. Member of Reservation Cell
3. Convener of Pest Control Monitoring Committee
4. Member of Project and Patent Cell
5. Member of various interview and thesis committee

## Patents Taken and Process Developed with Details

1. A Gas-sensing system for selective detection of (Nitric Oxide) NO gas and a method for fabricating the same; 452697; Granted
2. A System for monitoring hemodialysis efficacy of a subject; 431879; Granted
3. Advancement in methodology and system to control isotopic fractionations in carbon containing gases; 507919; Granted
4. A System and kit for non-invasive detection of peptic ulcer diseases, non-ulcerous dyspepsia and Helicobacter pylori infection; 428911; Granted
5. System and kit for monitoring blood glucose profile based on breath analysis; 432954; Granted

## Membership of Learned Societies

1. Fellow of the Royal Society of Chemistry (FRSC), London, UK
2. Fellow of the Institute of Physics (FInstP), London, UK
3. Fellow of Linnean Society of London (FLS), UK
4. Member of Chemical Research Society of India (CRSI)
5. Member of Indian Physics Association (IPA)
6. Member of Indian Laser Association (ILA)

7. Member of Indian Society of Chemists and Biologists (ISCB)
8. Member of Research Society for the Study of Diabetes in India (RSSDI)
9. Member of American Association for the Advancement of Science (AAAS)

## Scientific collaborations with other national / international institutions (based on joint publications)

1. A. Das, S. Mandal, R. Fillao, M. Horn, A. Lakhtakia, and M. Pradhan. "Geometric phase and photonic spin Hall effect in thin films with architected columnar morphology": Journal of the Optical Society of America B, 40, 2418 (2023); Sl. No. 5; International
2. A. Maity, S. Bhattacharya, A. Mahato, S. Chaudhuri and M. Pradhan. "A pattern-recognition-based clustering method for non-invasive diagnosis and classification of various gastric conditions": European Journal of Mass Spectrometry, 29, 192 (2023); Sl. No. 9; National

## Outreach program organized / participated

1. Participated and presented an invited talk via Zoom Online at the BRICS Workshop on BioPhotonics-2023, Saratov, Russia, 16-18th May, 2023

## Areas of Research

Experimental Laser Spectroscopy, Applied Optics and Photonics, Chemical and Optical Physics, Physical and Analytical Chemistry

1. **Geometric phase and photonic spin Hall effect in thin films with architected columnar morphology:**

   We have detected spin-dependent splitting of light, the signature of the photonic spin Hall effect (PSHE), via quantum weak measurements on two types of thin films with architected columnar morphology. Specifically, we fabricated columnar thin films comprising parallel tilted nanocolumns and chiral sculptured thin films comprising parallel upright nanohelices by resistively heating zinc selenide (ZnSe) in a low-pressure chamber and collecting the collimated vapor flux of ZnSe on planar substrates with dynamically varying orientation. The architected columnar morphology creates a spin-dependent geometric Pancharatnam–Berry (PB) phase corresponding to the evolution of polarization states on the Poincaré sphere. Morphology-controlled anisotropy and spatial inhomogeneity result in the depolarization and optical rotation of incident plane-polarized light, and intrinsic spin-precession coupling with the propagation vector, contributing to the efficient generation and two-dimensional manipulation of both in-plane and out-of-plane spin splitting and steering the PB phase in the propagation process. The first experimental observations of widely tailorable PSHE and PB phase in thin films with architected columnar morphology may lead to new applications ranging from spin-controlled nanophotonics to optoelectronic devices for quantum information processing and optical communication.

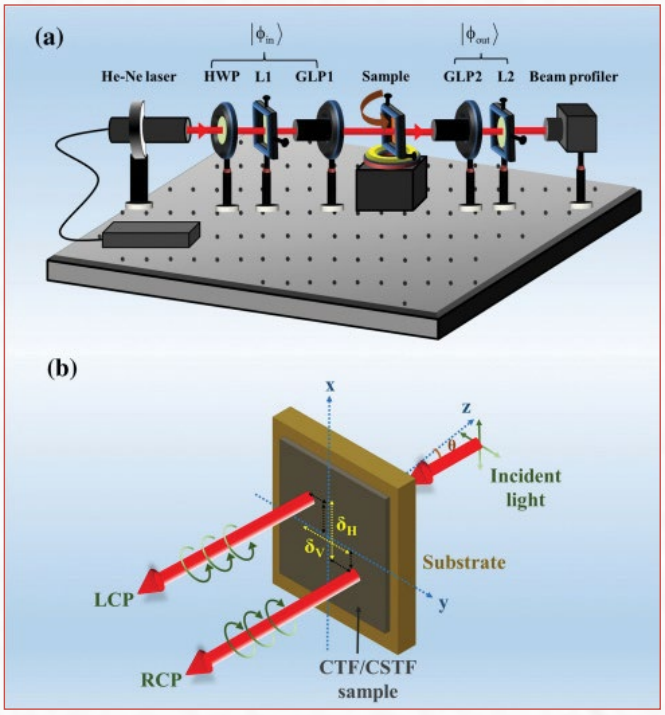



Fig.1: Experimental quantum weak-measurement setup for the measurement of the PSHE of light in the transmission mode. The pre-selection unit consists of a half-wave plate (HWP), plano–convex lens (L1), and a Glan–Thompson linear polarizer (GLP1). The post-selection unit consists of another linear polarizer (GLP2) and a plano–convex lens (L2). The weak value amplification is achieved by the near orthogonal orientation of GLP2 with respect to GLP1. (b) Schematic representation of splitting: incident linearly polarized light undergoes transverse and longitudinal displacement after transmission through the CTF/CSTF.

1. **Anomalous scattering of polystyrene microparticles revealed by evanescent-wave coupled cavity ring-down spectroscopy:**

   Forward scattering is an essential tool for investigating the colloidal suspension of polystyrene microspheres (PSMs). Evanescent wave coupled cavity ringdown spectroscopy (EW-CRDS) shows the anomalous extinction behavior in the limit of PSM particles that is much larger than the wavelength. EW-CRDS is a highly sensitive technique that improves weak absorption signals by enhancing the absorption path length, allowing for probing a range of processes at the solid/liquid interface by assessing the extinction properties. Additionally,

it possesses the ability to sense a minimum absorbance of 1.2 × 10–6. EW-CRDS provides sufficient accuracy to detect correlation effects for PSMs in water at the interfacial region and their influence on forward scattering or extinction. In this work, we discuss the impact of volume fraction on the extinction of scatterers composed of microparticles in aqueous media. The findings of this study will contribute to a deeper understanding of the scattering dynamics in colloidal suspensions, with potential applications in various fields, including biology and metrology.

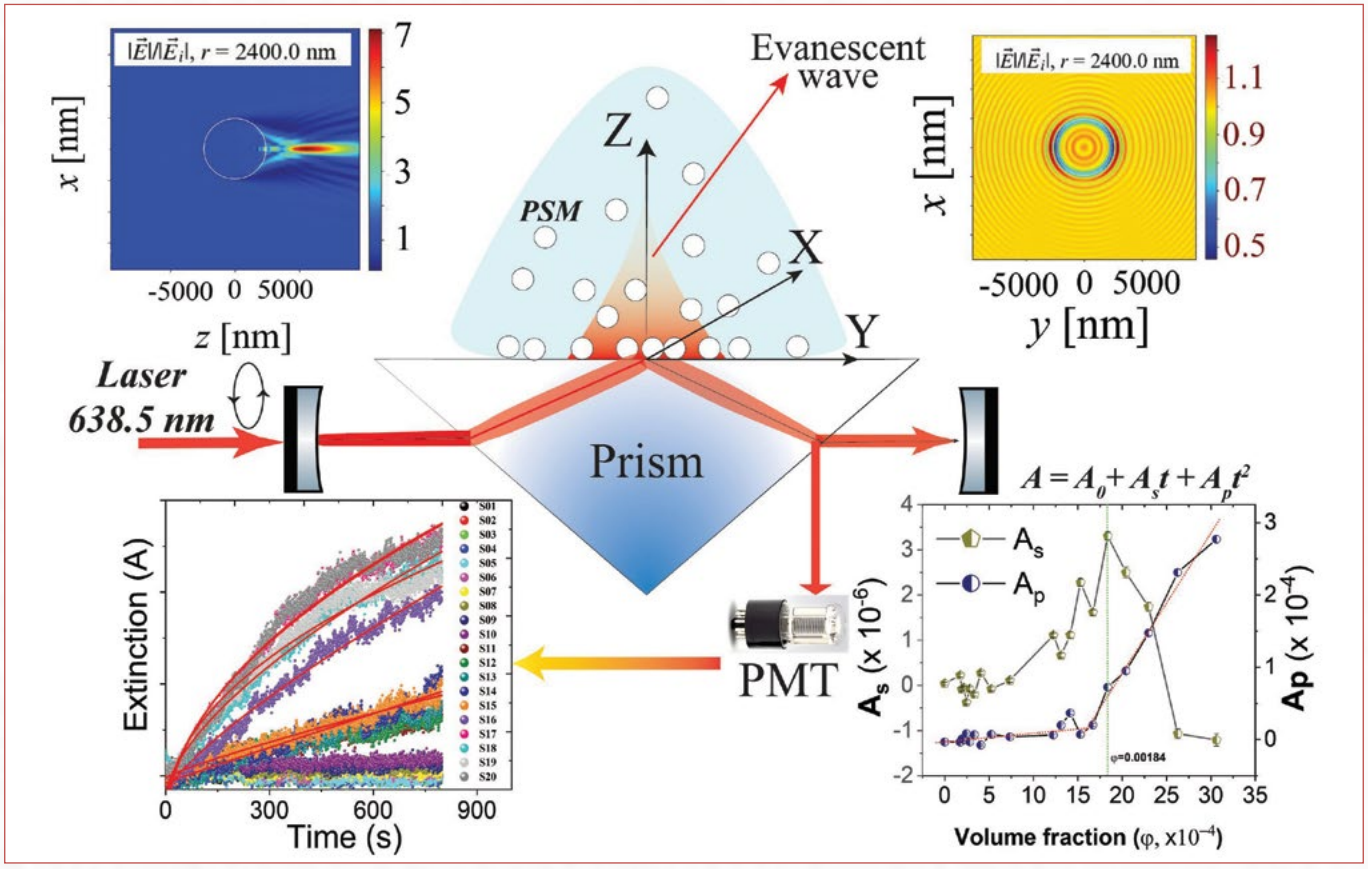



Fig. 2: A pictorial representation of the penetration depth of the evanescent field in this EW-CRDS technique and also change of extinction with time for different samples with varying volume fractions of PSMs.

## Plan of Future Work Including Project

1. Development of a quantum weak measurement technique using single photon light source for studying photonic spin Hall effect and optical beam shifts at the quantum level in various exotic and 2D materials.
2. Explore high-resolution fundamental molecular spectroscopy in various long-chain VOCs using quantum cascade laser coupled cavity ring-down spectroscopy in the mid-IR spectral regions.


## Pradip S Pachfule

Assistant Professor

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Bikash Chandra Mishra; Covalent Organic Frameworks for Energy Storage and Generation; Under progress
2. Bidhan Kumbhakar; Functionalized Covalent Organic Frameworks for Energy Storage and Catalysis; Under progress
3. Avanti Chakraborty; Covalent Organic Frameworks for Photocatalytic Hydrogen Peroxide Generation; Under progress
4. Supriti Dutta; Covalent Organic Frameworks for Organocatalysis; Under progress
5. José Ignacio Hernández García; Tunable Micro-Mesoporous Covalent Organic Frameworks for CO2 Reduction; Under progress; Dr. DAVID DÍAZ DÍAZ (Co-supervisor)
6. Archisman Sinha; SERB-SRG Grant: Olefin-linked Covalent Organic Frameworks (COFs) for Photocatalytic Water Splitting for Hydrogen Generation; Under progress
7. Chowdhury Ismat Nurani; TRC Project: Functionalised Covalent Organic Frameworks for Water Splitting and Energy Storage; Under progress

#### b) Post-Docs

1. Akhtar Alam; Covalent Organic Frameworks for Photocatalysis
2. Upasana Das; Development of a Group of Crystalline Framework-based Magnetic Nanocomposites as Theranostics for Targeting Breast Cancer Stem Cells

#### c) External Project Students / Summer Training

1. Archisman Sinha; Quinone-based Covalent Organic Frameworks (COFs) for Electrochemical Water Splitting

### Teaching

1. Spring semester; CB 641: Surfaces & Interfaces; PhD; 05 students; with Dr. Ali Hossain Khan (Co-teacher)
2. Spring semester; PHY 491: Methods of Experimental Physics; Integrated PhD; 11 students; with Prof. Kalyan Mandal, Dr. Ramkrishna Das and Dr. Nitesh Kumar (Co-teachers)

### Publications

#### a) In journals

1. Shuang Li, Bidhan Kumbhakar, Bikash Mishra, Jérôme Roeser, Nicolas Chaoui, Johannes Schmidt, Arne Thomas, and **Pradip Pachfule**, *Dithiophenedione-Based Covalent Organic Frameworks for Supercapacitive*

*Energy Storage,* ACS Applied Energy Materials, 6, 9256-9263, 2023

2. Rui Yan, Bikash Mishra, Michael Traxler, Jérôme Roeser, Nicolas Chaoui, Bidhan Kumbhakar, Johannes Schmidt, Shuang Li, Arne Thomas, **Pradip Pachfule**, *A Thiazole-linked Covalent Organic Framework for Lithium-Sulphur Batteries,* Angewandte Chemie, 62, e202302276, 2023
3. Shamkumar Deshmukh, Krishna Pawar, Valmiki Koli, and **Pradip Pachfule**, *Emerging Graphitic Carbon Nitride-based Nanobiomaterials for Biological Applications,* ACS Applied Bio Materials, 6, 1339-1367, 2023
4. Bikash Mishra, Akhtar Alam, Bidhan Kumbhakar, David Díaz Díaz, and **Pradip Pachfule**, *Impact of the Crystallinity of Covalent Organic Frameworks on Photocatalytic Hydrogen Evolution,* Crystal Growth & Design, 23, 4701-4719, 2023
5. Kamal Prakash, Bikash Mishra, David Díaz Díaz, C. M. Nagaraja and **Pradip Pachfule**, *Strategic design of covalent organic frameworks (COFs) for photocatalytic hydrogen generation,* Journal of Materials Chemistry A, 11, 14489-14538, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Delivered an invited talk titled 'Porous Materials and Their Applications for Energy Storage' as a resource person at a conference organized at New Arts, Commerce, and Science College, Parner. My presentation focused on the utilization of porous materials for various energy storage applications, contributing to the academic discourse and knowledge dissemination at the event; February 17, 2024; Parner, Maharashtra; 60 minutes
2. Presented an invited talk titled 'Covalent Organic Frameworks for Energy Storage' at the All India Scientific and Technical Official Language Seminar held at the International Advanced Research Centre for Powder Metallurgy and New Materials in Hyderabad, India. My presentation highlighted the applications of covalent organic frameworks in energy storage, contributing to the scientific dialogue and exchange of ideas at the seminar; March 21, 2024 International Advanced Research Centre for Powder Metallurgy and New Materials, Hyderabad, India; 15 minutes

## Administrative duties

1. Member of the Committee named 'Outreach Programmes for the Students of SC/ST Communities under VASP', which was involved in organizing outreach programs at the following locations: 1. The University of Burdwan 2. Singur Vigyan Kendra (Branch of Paschimbanga Vigyan Mancha) 3. Tarakeswar Degree College, Hoogly, West Bengal. These programs aimed to provide support and opportunities for students from SC/ST communities, fostering inclusivity and educational empowerment.
2. Member of the Committee constituted to declare items as obsolete/unserviceable: As a member of the Committee constituted to declare items as obsolete or unserviceable, I was appointed by the Competent Authority to assess and declare certain items as obsolete or unserviceable. This task was undertaken in connection with the ongoing work of Physical Asset Verification conducted by M/S. RSA & Co. The committee's responsibility was to review items identified by users or indenters as no longer functional or useful and to make recommendations accordingly.
3. Member of the shortlisting committee to shortlist the candidates for 01 (one) position of 'Driver': The Competent Authority has appointed me as a member of the shortlisting committee tasked with shortlisting candidates for the position of 'Driver'. This committee is responsible for reviewing applications and selecting suitable candidates to proceed to the next stage of the recruitment process.

## Patents Taken and Process Developed with Details

1. Photosynthesis of hydrogen peroxide from water using hydrazone-based covalent organic frameworks (COFs); Applied

## Awards, Recognitions, if any

1. Top 2% of the world's scientists (October 2023): The Stanford University database provides standardized information on citations, h-index, and a composite indicator (c-score) to better understand and celebrate the contributions of scientists in different fields. The database classifies scientists from around the world into 22 scientific fields and 174 subfields using the standard Science-Metrix classification. The selection criteria are based on being in the top 100,000 scientists by c-score or having a percentile rank of 2% or above in a sub-field (data used from a Scopus updated to the end of the 2022 citation year).

## Membership of Learned Societies

1. Young Associate of Maharashtra Academy of Sciences: Recognized for notable contributions to the field of Chemical Sciences, I was honored with the designation of Young Associate by the Maharashtra Academy of Sciences. This esteemed accolade was conferred by the Academy, a distinguished scientific society founded in 1976 with the explicit objective of advancing science and technology. The selection process for the designation of 'Young Associate' is rigorous, requiring candidates to demonstrate a substantial contribution and publication record in their respective

research area. This recognition underscores the significance of my research endeavors and scholarly achievements within the scientific community.

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. SERB-SRG Grant: Olefin-linked Covalent Organic Frameworks (COFs) for Photocatalytic Water Splitting for Hydrogen Generation; SCIENCE & ENGINEERING RESEARCH BOARD (SERB); 24 Months; PI
2. Tunable Micro-Mesoporous Covalent Organic Frameworks for CO2 Reduction; Spanish Ministry of Science and Innovation; 24 Months; Co-PI

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. Arne Thomas and the Group: Department of Chemistry/ Functional Materials, Technische Universität Berlin, 10623 Berlin, Germany; Sl. No. 1, 2; International
2. Prof. Shuang Li and the Group: College of Polymer Science & Engineering, StateKey Laboratory of Polymer Materials Engineering, Sichuan University, Chengdu 610065, China; Sl. No. 1, 2; International
3. Prof. David Díaz Díaz: Instituto Universitario de Bio-OrgánicaAntonio González y Departamento de Química Orgánica, Universidad de La Laguna, La Laguna 38206 Tenerife, Spain; Sl. No. 4, 5; International
4. Dr. Shamkumar Deshmukh Department of Chemistry, DamaniBhairuratan Fatechand, Dayanand College of Arts andScience, Solapur 413002, India; Sl. No. 3; National
5. Prof. C. M. Nagaraja and the Group: Department of Chemistry, Indian Institute of Technology Ropar, Rupnagar 140001, Punjab, India; Sl. No. 4, 5; National

## Outreach program organized / participated

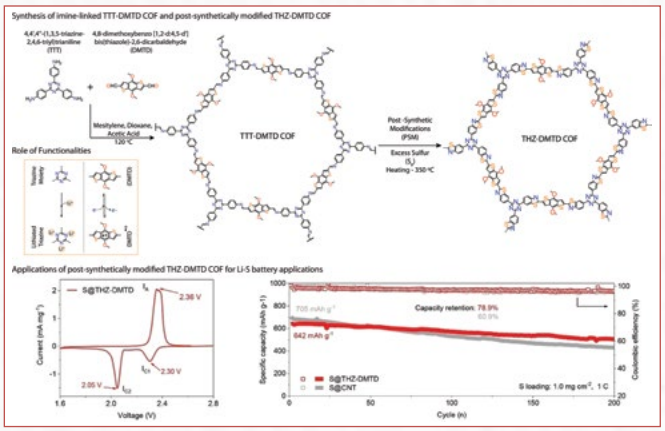
1. Date: 13th March, 2024 (10:00 AM- 11:00 AM) Place: Department of Physics, Gurucharan College, Silchar, Assam. Title of the Talk: The Porous World - With (Nearly) Nothing As a resource person, I delivered a talk at the Topical Research School (TRS) on Recent Trends of Research in Theoretical and Experimental Physics, jointly organized by the Department of Physics at Gurucharan College Silchar and the S. N. Bose National Centre for Basic Sciences Kolkata. The event, held from March 11th to 13th, 2024, on the premises of Gurucharan College, facilitated academic discourse and knowledge exchange among participants in the field of porous materials. My presentation provided valuable insights and contributed to advancing understanding and research in this area.

## Areas of Research

### Materials Chemistry, Porous Materials, Covalent Orgnaic Frameworks (COFs), Photocatalysis, Energy Storage

Lithium-sulfur (Li-S) batteries hold promise as a next-generation power source due to their potential for higher energy density compared to current lithium-ion batteries. Porous materials are commonly employed as cathode materials in Li-S batteries, serving as hosts for sulfur. Covalent Organic Frameworks (COFs) represent a class of crystalline and porous materials offering opportunities for integrating functional groups into their structure. However, COFs often encounter stability issues, limiting their durability under practical conditions of Li-S batteries. To address this challenge and explore COFs for Li-S batteries, we synthesized a crystalline and porous imine-linked triazine-based dimethoxybenzo-dithiophene functionalized COF (TTT-DMTD) incorporating high-density redox sites. Further post-synthetic transformation of the imine linkages yielded a robust thiazole-linked COF (THZ-DMTD) using a sulfur-assisted chemical conversion method while preserving crystallinity.

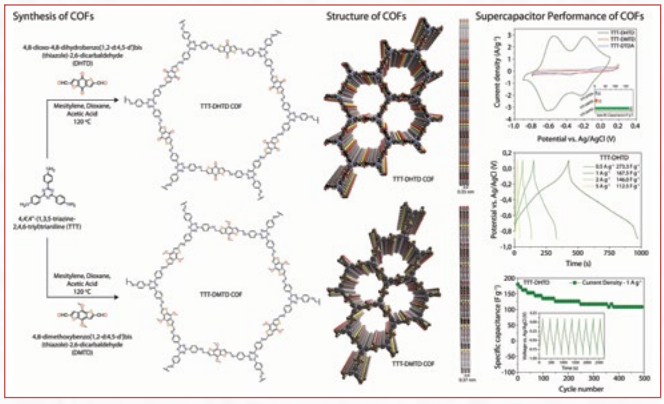
Benefiting from its high crystallinity, porosity, and redox-active moieties, THZ-DMTD exhibited impressive performance as a cathode material in Li-S batteries. It demonstrated a high capacity and long-term stability, retaining 78.9% of its capacity after 200 cycles, with a capacity of 642 mAh/g at 1.0 C. The sulfur-assisted chemical conversion of imine-linked COF proved to be an efficient method for producing robust COFs with superior performance, holding promise for a range of energy storage and other applications.




Supercapacitors are increasingly favored for their rapid charge-discharge capabilities, elevated power densities, and extended operational lifespans. While activated carbon and heteroatom-doped carbonaceous materials are commonly used as electrode materials, they primarily exhibit double-layer capacitance, where the electrostatic charge storage performance is heavily influenced by pore type and size, potentially limiting energy density. In

contrast, redox-active quinone-based organic materials offer a promising alternative with high energy density for energy storage, known for being cost-effective and environmentally friendly. Leveraging these advantages, we synthesized a crystalline COF based on dithiophenedione moieties in its backbone (TTT-DHTD) and assessed its performance as an electrode material for supercapacitors. By comparing it with a dimethoxybenzene-dithiophene-based COF (TTT-DMTD), we observed that the incorporation of redox-active dithiophenedione moieties significantly enhanced capacitance.

Benefitting from its high porosity, well-defined crystalline structure, and redox-active components, the TTT-DHTD COF demonstrated both high energy storage density and long-term durability (273.3 F/g at 0.5 A/g and 163.7 F/g at 10 mV/s). We believe that integrating heterocyclic moieties with redox-active centers holds promise for developing novel COFs suitable for electrocatalysis applications, particularly in batteries and supercapacitors.




In addition to energy storage, our research group has delved into the utilization of covalent organic frameworks (COFs) for photocatalytic water splitting and hydrogen peroxide generation. Presently, we are actively involved in exploring the synthesis and applications of COFs in the realm of lithium-ion batteries and photocatalytic organic transformations. These endeavors reflect our commitment to advancing the multifaceted potential of COFs across diverse fields, aiming to address pressing challenges in energy conversion and organic synthesis.

## Plan of Future Work Including Project

1. Synthesis of covalent organic frameworks for photocatalytic hydrogen peroxide generation: The conversion of solar energy into chemical energy or high-value-added chemicals has attracted considerable research interest due to the global energy crisis. Hydrogen peroxide (H2O2), one of the most valuable chemicals, is widely used as a potent oxidizing agent in several industries, including chemical synthesis, pharmaceuticals, medical disinfection, and environmental treatment. Moreover, H2O2 can be a green fuel that generates electricity in fuel cells with zero carbon emissions. Recently, the sustainable generation of H2O2 using covalent organic framework (COF)-based photocatalysts from water and oxygen has gained significant interest. The findings reveal that rationally designed benzothiophene-based COF amalgamating polar hydrazone linkages might provide desired sites for docking water and oxygen and promote instant water oxidation and oxygen reduction simultaneously to generate H2O2. Considering these factors, we are exploring the construction of COFs with variable imine and hydrazone linkages and to study their profound impact on photocatalytic H2O2 generation. We believe that highly dense hydrazone linkages will endorse photosynthesis of H2O2 via water oxidation and oxygen reduction, resulting in high yields with efficient solar-to-chemical conversion.
2. Synthesis of covalent organic frameworks for photocatalytic organic transformations: In our quest for an efficient and recyclable photocatalyst capable of facilitating the dehydrogenative coupling of alcohols and amines to form amide bonds at room temperature, we are exploring a COF-mediated synthesis approach. Our strategy involves designing COFs with a high density of functional units, particularly dithiophenedione, to effectively trap photogenerated electrons and facilitate hydrogen atom abstraction reactions using solvothermal methods. We believe that the unique properties of COFs, including high crystallinity and surface area, light absorption across the entire visible range, narrow band gap, and favorable valence band position, render them well-suited for efficiently generating excitons necessary for targeted dehydrogenation. This innovative approach holds promise for achieving the desired transformation under mild conditions, offering significant potential for advancing synthetic methodologies in organic chemistry.
3. Design and synthesis of covalent organic frameworks for photocatalytic water splitting: Photocatalytic water splitting for hydrogen generation stands as a crucial endeavor in the pursuit of clean energy. However, the inefficiencies inherent in current materials underscore the pressing need for the development of enhanced photocatalysts. In our pursuit of improved efficiencies, we are focused on synthesizing ordered organic network materials, specifically microporous and hierarchically structured covalent organic frameworks (COFs), tailored for photocatalytic water splitting. We anticipate that these advanced semiconducting materials will exhibit enhanced visible light absorption and effectively address substrate diffusion issues that often hamper water splitting performance. By leveraging the unique properties of COFs, we aim to overcome existing limitations and pave the way for novel applications in the water splitting process. Our efforts represent a significant stride towards realizing more efficient and sustainable methods for hydrogen generation from water.


## Rajib Kumar Mitra

Senior Professor

Chemical and Biological Sciences

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Sumana Pyne; Application of Ultrafast Spectroscopy in Biological Systems; Awarded
2. Ria Saha; Studies on the Effects of Different Crowding agents on Protein FoldingUnfolding Process and its Kinetics as well as Activity; Under progress
3. Aritra Marick; Biomolecular hydration in presence of solutes; Under progress
4. Shah Imtajul Haque; Membrane hydration; Under progress
5. Asesh Bera; Small molecules in biology; Under progress
6. Anushree Sen; Computational Biology; Under progress; Prof. Jaydeb Chakrabarti (Co-supervisor).

#### b) Post-Docs

1. Indrani Bhattacharya; Bimolecular hydration
2. Tanushree Das; Computational Chemistry

### Teaching

1. Autumn semester; PHY 301 (Atomic and Molecular Physics); Integrated PhD; 10 students; with Prof. Anjan Barman (Co-teacher)
2. Autumn semester; CB 527 (Molecular Physics & Spectroscopy); PhD; 6 students; with Prof. Anjan Barman (Co-teacher)

### Publications

#### a) In journals

1. Pratap Kumar Pal, Subhadip Chakraborty, **Rajib Kumar Mitra**, Anjan Barman, *Optimizing the polarization and antireflection characteristics of metallic wire grid structures in the Terahertz frequency range,* Optical Materials, 146, 114553, 2023
2. Partha Pyne, Sumana Pyne, **Rajib Kumar Mitra**, *Sugar Molecules Inhibit Insulin Aggregation: A Decisive Role Being Played by the Protein Solvation Energetics,* The Journal of Physical Chemistry B, 127, 8825-8832, 2023
3. Subhadip Chakraborty, Indrani Bhattacharya, and **Rajib Kumar Mitra**, *Solvation Plays a Key Role in Antioxidant-Mediated Attenuation of Elevated Creatinine Level: An In Vitro Spectroscopic Investigation,* The Journal of Physical Chemistry B, 127, 8576-8585, 2023
4. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Rajib Kumar Mitra** and Samit Kumar Ray, *Superior piezoelectric performance of chemically synthesized transition metal dichalcogenide heterostructures for self-*

*powered flexible piezoelectric nanogenerator,* Nanotechnology, 34, 435401, 2023

5. Subhadip Chakraborty, Partha Pyne, **Rajib Kumar Mitra**, Debasish Das Mahanta, *Hydrogen bond structure and associated dynamics in micro-heterogeneous and in phase separated alcohol-water binary mixtures: A THz spectroscopic investigation,* Journal of Molecular Liquids, 382, 121998, 2023
6. Sumana Pyne, Partha Pynea and **Rajib Kumar Mitra**, *The explicit role of interfacial hydration during polyethylene glycol induced lipid fusion: a THz spectroscopic investigation,* Physical Chemistry Chemical Physics, 25, 31326-31334, 2023
7. Bibhab Bandhu Majumdar, Partha Pyne, **Rajib Kumar Mitra** and Debasish Das Mahanta, *Impact of hydrophobicity on local solvation structures and its connection with the global solubilization thermodynamics of amphiphilic molecules,* Physical Chemistry Chemical Physics, 25, 27161-27169, 2023
8. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Rajib Kumar Mitra** and Samit Kumar Ray, T*MDC ternary alloy–based triboelectric nanogenerators with giant photo-induced enhancement,* Nanoscale, 15, 17398-17408, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk entitled: "Biomolecular aggregation and the associated hydration: spectroscopic investigations" in the Symposium "From single water molecules to bulk solvation: 25 years adventures in laser spectroscopy"; April 14, 2023; Ruhr University, Bochum, Germany; 30 min
2. Invited talk entitled: "Investigating collective vibrational dynamics of water in soft materials using THz spectroscopy"; April 20, 2023; Technische Universität Braunschweig, Germany; 1 hr
3. Invited talk entitled: "Solvation governs biomolecular aggregations: THz spectroscopic investigations"; September 7, 2023; CEBS, Mumbai; 1 hr
4. Invited talk entitled: "Investigating collective vibrational dynamics of water in soft materials using THz spectroscopy"; August 10, 2023; JNU, Delhi; 1 hr
5. Invited talk entitled: "Solvation governs biomolecular aggregations: THz spectroscopic investigations"; September 18, 2023; IIT Delhi; 1 hr
6. Invited talk at UFS-2023 entitled "Solvation dynamics around hydrophobic solutes: an insight from THz Spectroscopy"; November 27, 2023; NPL, Delhi; 30 min

## Administrative duties

1. Dean (Administration and Resource Generation)
2. Associate Nodal Officer (TRC-SNBNCBS)
3. Chairman, SCOLP Committee

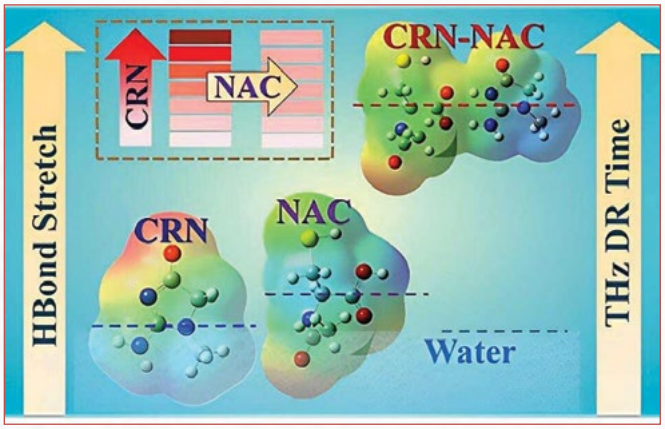
## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Biomolecular condensates: Exploring the associated hydration and energetics using THz spectroscopy; SERB-DST; 2024-2027; PI

## Areas of Research

### Terahertz spectroscopy, protein condensation, thermodynamics, self-aggregated systems

1. Our study reveals that an elevated level of creatinine in body could be removed by the addition of anti-oxidants. Experiments and calculation show that a barrier-less proton transfer from water to creatinine (in presence of antioxidants) is the key mechanism for the elevated water solubility of creatinine.




2. Our study shows that sugar molecules (glucose, sucrose etc.) inhibit Insulin aggregation. Our study also confirms that it is the protein solvation energetic that play a crucial role in the inhibition process. The finding is of pharmacological importance for long-term storage of Ins.
3. We have reported the experimental validation of the fact that PEG-induced membrane fusion is associated with the dehydration of the membrane(s). We explore the explicit hydration behavior at three different lipids (DOPC, POPC and DPPC) membranes with different aliphatic tails as they undergo fusogenic transition in the presence of PEG of average molecular weight of 4000 using THz-FTIR spectroscopy. Dynamic light scattering and electron microscopic measurements confirm the formation of different intermediate steps of the liposomes during the fusion process: bilayer aggregation, destabilization and

finally lipid fusion. We observe that membrane hydration follows a systematic trend with the lipid specificity as the fusion process sets in.

4. We combine THz spectroscopic analysis with MD simulations to investigate the impact of the altered hydrophobicity and polarity of amphiphilic solute molecules on the local solvation configurations. We use two water soluble alcohols: ethanol (EtOH) and its fluorinated counterpart, 2,2,2-trifluoroethanol (TFE), as model solutes. We determine the relative abundance of different hydrogen bonded conformers and to establish a correlation between the spectral signatures (as obtained from THz spectroscopic measurements) and correlate this with the microscopic solute–solvent interactions associated with the local solvation structures (as obtained from MD simulations). We estimate the possible energetic parameters associated with the alcohol solubilization process and found that they receive a contrasting solvation energy share in terms of entropy and enthalpy.

5. We have found a simple yet efficient way to boost the polarization efficiency of metallic wire grid polarizers made of gold by reducing the period of the wire grid structures. The thus fabricated metallic wire grids offer a degree of polarization as high as 94.3 % and an extinction ratio ~22.1 dB over a broad frequency range of 0.2–2.5 THz. Simultaneously, the thus prepared metallic wire grid structures also perform efficiently as anti-reflection coating materials, showcasing their versatility and multifunctionality.

## Plan of Future Work Including Project

1. We aim to experimentally in-vitro realize and establish the concept that biomolecular (protein, membrane etc.) condensation process is associated with a definite modification in the structure and dynamics of the interfacial solvation. We will monitor the explicit change in protein/lipid hydration at the different aggregated state(s) during the condensation process using THz time domain (TTDS) and FIR-FTIR spectroscopic technique(s) combined with other complementary spectroscopy/microscopy techniques and its possible modulation by altering the solvent physical parameter(s) upon the addition of excipient(s). THz spectroscopy probes the low frequency collective vibration modes of water, and therefore is very sensitive to the global network dynamics of water around the different polar and nonpolar moieties of biomolecules. We expect that the different aggregated state(s) would render different solvation imprint(s), which can be traced and detected in real time using THz spectroscopy. We will extend our studies in presence of externally added excipient(s), which is expected to change the physical properties of water, and thus also the condensation dynamics; this study could lead to find a strategy to modulate the aggregate formation process. Finally, we will estimate the energetic parameters (entropy and enthalpy) associated with the condensation process using temperature dependent TTDS and FIR-FTIR measurements following a recently developed concept of THz calorimetry. Our study would result in a fundamental and molecular level apprehension on the otherwise less studied aspect of solvation change during biomolecular condensation. The output of this proposal would render positive impetus for further research on the condensation associated bio-physical phenomenon.


## Ranjit Biswas

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Narayan Maity; Experimental Studies of Metastable and Self-Organised Systems; Under progress
2. Jayanta Mondal; Experimental Studies of Ionic and Neutral Deep Eutectics; Thesis submitted
3. Dhrubajyoti Maji; Computer Simulations of Deep Eutectics; Thesis submitted
4. Amrita Mondal; Experimental Studies of Complex Chemical Systems; Under progress
5. Sudipta Mitra; Computer Simulations of Relaxation Dynamics in Condensed Phases; Under progress
6. Rik N Mukherjee; Computer Simulations of Ionic Deep Eutectic and Other Systems; Under progress
7. Abdul Aziz Mondal; Computer Simulations and Experiemntal Studies of Aggregation and Other Dynamics; Under progress

### b) Post-Docs

1. Jayeta Banerjee; Application of Surface Plasmon Resonance Spectroscopic Technique to Understand Multicomponent Mixtures

### c) External Project Students / Summer Training

1. Rituraj Dubey; Simulation Studies of Complex Systems: Literature Survey & Initial Computation

## Teaching

1. Spring semester; Physical Chemistry: Theory & Experiments; PhD; 3 students

## Publications

### a) In journals

1. Ria Ghosh, Lopamudra Roy, Dipanjan Mukherjee, Sushmita Sarker, Jayanta Mondal, Nivedita Pan, Md. Nur Hasan, Subhajit Ghosh, Arpita Chattopadhyay, Arghya Adhikary, Maitree Bhattacharyya, Asim Kumar Mallick, **Ranjit Biswas**, Ranjan Das, and Samir Kumar Pal, *Structurally Dynamic Monocyte–Liposome Hybrid Vesicles as an Anticancer Drug Delivery Vehicle: A Crucial Correlation of Microscopic Elasticity and Ultrafast Dynamics,* The Journal of Physical Chemistry Letters, 15, 3078-3088, 2024
2. Jayanta Mondal, Dhrubajyoti Maji, **Ranjit Biswas**, *Temperature-dependent dielectric relaxation measurements of (acetamide + K/Na SCN) deep eutectic solvents: Decoding the impact of cation identity via computer simulations,* The Journal of Chemical Physics, 160, 084506, 2024

3. Jayanta Mondal, Narayan Chandra Maity & **Ranjit Biswas**, *Detection of ultrafast solvent dynamics employing a streak camera,* Journal of Chemical Sciences, 135, 84, 2023
4. Shrestha Chowdhury, Pradip Kr. Ghorai, Narayan Chandra Maity, Kajal Kumbhakar, and **Ranjit Biswas**, *Identical Diffusion Distributions and Co-Cluster Formation Dictate Azeotrope Formation: Microscopic Evidences and Experimental Signatures,* The Journal of Physical Chemistry B, 127, 8417-8431, 2023
5. Tamisra Pal, Suman Das, Dhrubajyoti Maji and **Ranjit Biswas**, *Validity of the Onsager–Glarum relationship in a molecular coulomb fluid: investigation via temperature-dependent molecular dynamics simulations of a representative ionic liquid, [BMIM][PF6],* New Journal of Chemistry, 47, 14906-14920, 2023
6. Dipanwita Roy, Narayan Chandra Maity, Sourav Kumar, Anupam Maity, Bhisma N. Ratha, **Ranjit Biswas**, Nakul Chandra Maiti, Atin Kumar Mandal, Anirban Bhunia, *Modulatory role of copper on hIAPP aggregation and toxicity in presence of insulin,* International Journal of Biological Macromolecules, 241, 124470, 2023
7. Dhrubajyoti Maji, **Ranjit Biswas**, *Dielectric relaxation and dielectric decrement in ionic acetamide deep eutectic solvents: Spectral decomposition and comparison with experiments,* The Journal of Chemical Physics, 158, 174503, 2023
8. Dhrubajyoti Maji, Narayan Chandra Maity & **Ranjit Biswas**, *Structure and dynamics of a glucose-based cryoprotectant mixture: a computer simulation study,* Theoretical Chemistry Accounts, 142, 43, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited Keynote Lecture in Chemistry Symposium "Recent Trends in Chemical Science and Technology (RTCST-2024)" at IIT Patna, entitled, "Dielectric Relaxation in Ionic Acetamide Deep Eutectic Solvents: Static and Dynamic Contributions to the Observed Dielectric Decrement."; March 2, 2024; IIT, PATNA; 25 minutes
2. Invited Lecture in an Outreach Program, entitled "Physical Chemistry of a Few Complex Systems: Basic Science Aspects"; January 25, 2024; Chemistry Department, Burdwan University; 30 minutes
3. Two lectures in "Refreshers Course in Emerging Trends in Science and Technology" entitled "Deep eutectics, ionic liquids, binary mixtures: Some basic aspects"; December 13, 2023; Burdwan University; 2x90 minutes
4. Invited lecture in Theoretical Chemistry Conference, entitled, "Liquid Phase of Deep Eutectics: A Novel Interplay Between Enthalpy and Entropy."; December 10, 2023; IIT, Madras; 20 minutes
5. Invited lecture at GITAM Chemistry Research Conference, entitled, "Dielectric decrement in ionic deep eutectic solvents: Understanding the roles of cross correlations via spectral decompositions"; December 7, 2023; GITAM University, Vizag; 25 minutes
6. Invited Talk (online, SMCB) entitled, "Alcohol-Water Binary Azeotropes: Is there a unique dynamical signature?"; November 25, 2023; Online, Statistical Mechanics in Chemistry & Biology (SMCB) Platform; 60 minutes
7. Invited lecture in an Outreach Program conducted by JCSC Editorial Board, entitled "Binary Mixtures, Deep Eutectics and Azeotropes"; November 17, 2023; IIT Roorkee; 40 minutes
8. Invited lecture in an international conference "Structure and Dynamics of Chemical and Biomolecular Systems", entitled, "Alcohol-Water Binary Azeotropes: In search of an exclusive signature"; October 27, 2023; IIT Kanpur; 20 minutes
9. Invited lecture in a one-day seminar "Journey of the Chemists", entitled, "Identical Diffusion Distributions and Co-cluster Formation Dictate Azeotrope Formation: Microscopic Evidences and Experimental Signatures."; September 22, 2023; Kalyani University; 30 minutes
10. Invited lecture (60 minutes), Outreach Program (Vignan Bharati), entitled, "Satyendra Nath Bose: Brilliance Meets Compassion."; August 19, 2023; Sikar, Rajasthan; 60 minutes
11. Invited Lecture in an Outreach Program, entitled "Chemistry: Excitements and Applications."; May 25, 2023; Ranaghat College; 60 minutes

## Administrative duties

1. Chair, APRP Committee

## Awards, Recognitions, if any

1. Elected Member, National Academy of Sciences, Allahabad

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. A Theoretical Approach to Predict Deep Eutectic Formation: Locating the Lowest Melting Point; SERB-MATRICS; 3 years; PI

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Dipanwita Roy, Narayan Chandra Maity, Sourav Kumar, Anupam Maity, Bhisma N. Ratha, Ranjit Biswas, Nakul

Chandra Maiti, Atin Kumar Mandal, Anirban Bhunia, Modulatory role of copper on hIAPP aggregation and toxicity in presence of insulin, International Journal of Biological Macromolecules, 241, 124470(1-11), 2023; SI. No. 6; National

## Outreach program organized / participated

1. Invited Lecture on January 25, 2024 in an Outreach Program at the Chemistry department of Burdwan University entitled, "Physical Chemistry of a Few Complex Systems: Basic Science Aspects".
2. Two lectures (90 minutes each) on December 13, 2023 in "Refreshers Course in Emerging Trends in Science and Technology" at Burdwan University, entitled "Deep eutectics, ionic liquids, binary mixtures: Some basic aspects."
3. Invited lecture on November 17, 2023 in an Outreach Program conducted by JCSC Editorial Board during Nov 16 -17, 2023, at IIT Roorkee, entitled "Binary Mixtures, Deep Eutectics and Azeotropes

## Areas of Research

### Physical Chemistry, Chemical Physics, Biophysical Chemistry; Experiments, Theory & Computer Simulations; Azeotropes, Deep Eutectics, Cryoprotectants, Protein Aggregation & Enzyme Catalysis

What selects azeotropic pairs and governs the azeotropic condition (composition and temperature) is an open and intriguing question. A combined simulation and experimental work was performed by considering ethanol-water mixtures. We found identical distributions of centre-of-mass diffusion coefficients for ethanol and water molecules at the azeotropic condition (95.5wt% ethanol+4.5 wt% water, T_azeo= 351.1K). Cluster analyses indicated that solution at T_azeo with x_water≤ 15 wt% was more microheterogeneous than those with higher water content, although no anomaly in the composition-dependent solution structural properties could be detected. Ethanol-water and ethanol-ethanol interaction energies show pronounced non-ideal composition dependence, but the size of the relative fluctuations in them remained small (~0.5 k_B T). Rare water-water H-bonding, predominant water-ethanol H-bonding and a sizeable population of 'free' water molecules characterized the azeotropic solutions. Steady state spectral study confirmed solution microheterogeneity. Dynamic anisotropy measurements revealed a nonmonotonic composition dependence of solute rotation times with a peak at the azeotropic condition. In summary, equalization of the component translational diffusion coefficients and solution microheterogeneity with regular composition-dependence of the solution structure appeared to characterize the ethanol-water azeotrope (JPC B, 2023 127, 8417 - 8431).

In another work, the impact of successive replacement of K^+ by Na^+ on the megahertz-gigahertz polarization response of 0.25[fKSCN+(1-f)NaSCN]+0.75CH_3 CONH_2 deep eutectic solvents (DESs) was explored via temperature dependent (303≤T/K≤343) dielectric relaxation (DR) measurements and computer simulations. Both DR measurements (0.2≤ $\nu$ /GHz≤50) and simulations revealed multi-Debye relaxations accompanied by a decrease of the solution static dielectric constant ( $\varepsilon$ _s) upon replacement of K^+ by Na^+. Temperature dependent measurements revealed much stronger viscosity decoupling of DR times for Na^+ containing DES than for the corresponding K^+ system. Computer simulations revealed gradual decrease of the average number of H-bonds (⟨n_HB ⟩) per acetamide molecule and increased frustrations in the average orientational order upon replacement of K^+ by Na^+. Both measured and simulated $\varepsilon$ _s values were found to decrease linearly with ⟨n_HB⟩. Decompositions of the simulated DR spectra revealed that the cation-dependent cross interaction (dipole-ion) term contributes negligibly to $\varepsilon$ _s, and appears in the terahertz regime (JCP, 2024, 160, 084506(1-16)).

We investigated the inhibitory effects of tannic acid on amyloid fibrillation of single amino acid tryptophan. Amyloid fibrillation involving specific amino acids is a key factor contributing to the development of various neurodegenerative disorders, which remain being investigated. A promising therapeutic approach for treatment involves the use of small molecules as inhibitors. We presented experimental evidences demonstrating the efficacy of tannic acid (TA) as a potent inhibitor of fibrillation of tryptophan (Trp). We employed a combination of steady-state and time-resolved fluorescence measurements. To visualize the effects of TA on Trp fibrils, we have employed various imaging techniques such as atomic force microscopy, transmission electron microscopy, and field emission scanning electron microscopy. These imaging techniques have vividly captured the TA-induced disruption of long Trp fibrils. Additionally, we have determined the binding constant and calculated changes in the free energy associated with Trp-TA interactions through temperature-dependent spectroscopic measurements (JPPA: Chemistry 2024, 453, 115660(1-8)).

## Plan of Future Work Including Project

i. Understanding Structure & Dynamics of Cryoprotectants via Dielectric Relaxation Measurements, Time-resolved Fluorescence Measurements and Simulations

ii. Exploring the Interaction & Dynamics of Azeotropes via Simulations & Experiments

iii. Prediction of the Lowest Melting Points of Probable Deep Eutectic Mixtures via Theory and Simulations

iv. Understanding Water Dynamics in Aquoeus Solutions of Copolymers

v. Understanding the Enzyme Promiscuity by Probing the Kinetics via Simulations & Experiments



## Samir Kumar Pal

Senior Professor

Chemical and Biological Sciences

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Susmita Mondal; Studies on Biochemical and Molecular aspects of Redox Modulatory Theranostic Nanomaterials in Preclinical Disease Model; Thesis submitted
2. Md Nur Hasan; Optical spectroscopy and Ab-initio Study on Biocompatible Nanohybrid for their Potential Biomedical and Environmental Applications; Awarded
3. Amrita Banerjee; Multi-parameter Detection Using Optical Spectroscopy for Monitoring and Control of Bio-medical Anomalies, Food Adulteration and Environmental pollution; Awarded; Prof. Subhadipta Mukhopadhyay (Co-supervisor)
4. Nivedita Pan; Photophysical Studies on Hybrid nanomaterials for Manifold Applications; Under progress
5. Ria Ghosh; In Vitro and in Vivo Investigations on Self-organized Assemblies for TheirPotential Drug Delivery Activity; Under progress; Prof. Maitree Bhattacharyya (Co-supervisor)
6. Lopamudra Roy; Exploration of Optical Methodologies for the Development of Prototypes in the Real-World Applications; Under progress; Prof. Kallol Bhattacharya (Co-supervisor)
7. Monojit Das; Preclinical Studies on the Mechanism of Redox Modulation and its Therapeutic Applications in Physiological Milieu; Under progress; Prof. Jayanta Kumar Kundu (Co-supervisor)
8. Neha Bhattacharyya; Spectroscopic Studies on Biomaterials and Development of Small Spectroscopy-based Devices for Potential Application in Biomedical Diagnosis and Therapeutic Strategy; Under progress; Prof. Pulak Mondal (Co-supervisor)

### b) External Project Students / Summer Training

1. Debdutta Mukherjee; A Combined Spectroscopic and Theoretical Study on A Nanosensor-Based Prototype for Heavy Metal Detection

## Teaching

1. Spring semester; PHY491; Integrated PhD; 13 students; Prof. Soumen Mondal (co-teacher)

## Publications

### a) In journals

1. Nivedita Pan, Lopamudra Roy, Md. Nur Hasan, Amrita Banerjee, Ria Ghosh, Meshari A. Alsharif, Basim H. Asghar, Rami J. Obaid, Arpita Chattopadhyay, Ranjan Das, Saleh A. Ahmed, **Samir Kumar Pal**, *Unraveling an Ultrafast Electron*

*Transport Mechanism in a Photocatalytic "Micromachine" for Their Potential Light Harvesting Applications,* Micromachines, 14(5), 980, 2023

2. Saleh A Ahmed, **Samir Kumar Pal**, *Spectroscopic studies on a natural biomarker for the identification of origin and quality of tea extracts for the development of a portable and field deployable prototype,* Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 299, 122842, 2023

3. Lopamudra Roy, Amrita Banerjee, Neha Bhattacharyya, Susmita Mondal, Ria Ghosh, Manojit Das, Radha Tamal Goswami, Kallol Bhattacharya, Asim Kumar Mallick, Arpita Chattopadhyay, **Samir Kumar Pal**, *Radiolucency in conventional X-ray imaging leads potential diagnosis of hypoxia in human organ,* Journal of Clinical Images and Medical Case Reports, 4, 2023

4. Sruti Singha Roy, Atmaja Goswami, Dipanjan Mukherjee, Ria Ghosh, **Samir Kumar Pal**, Raja Banerjee, *Alanine-Induced Alteration of Organogelation Properties of Phenylalanine-Based Shortest Peptide Sequence,* ChemistrySelect, 8, e202300542, 2023

5. Amrita Banerjee, Dipanjan Mukherjee, Md. Nur Hasan, Subhadipta Mukhopadhyay, Debjani Karmakar, Ranjan Das, Arpita Chattopadhyay, **Samir Kumar Pal**, *Interaction of Chlorophyll with Artificial Colorants in Restricted Nanoscopic Environment: Key Insights on the Toxicity from Electronic Spectroscopy,* Nanoscience and Nanotechnology: Open Access, 2(1), 1012, 2023

6. Susmita Mondal, Monojit Das, Ria Ghosh, Manali Singh, Aniruddha Adhikari, Soumendra Darbar, Anjan Kumar Das, Siddhartha Sankar Bhattacharya, Debasish Pal, Debasish Bhattacharyya, Ahmed S. A. Ahmed, Asim Kumar Mallick, Munirah M. Al-Rooqi, Ziad Moussa, Saleh A. Ahmed, and **Samir Kumar Pal**, *Chitosan functionalized Mn3O4 nanoparticles counteracts ulcerative colitis in mice through modulation of cellular redox state,* Communications Biology, 6, 647, 2023

7. Lopamudra Roy, Susmita Mondal, Neha Bhattacharyya, Ria Ghosh, Amrita Banerjee, Soumendra Singh, Arpita Chattopadhyay, Saleh A. Ahmed, Rabab S. Jassas, Munirah M. Al-Rooqi, Ziad Moussa, Ismail I. Althagafi, Debasish Bhattacharya, Kallol Bhattacharya, Asim Kumar Mallick & **Samir Kumar Pal**, *A spectroscopy based prototype for the noninvasive detection of diabetes from human saliva using nanohybrids acting as nanozyme, Scientific Reports,* 13, 17306, 2023

8. Debjani Karmakar, Manuel Pereiro, Md. Nur Hasan, Ritadip Bharati, Johan Hellsvik, Anna Delin, **Samir Kumar Pal**, Anders Bergman, Shivalika Sharma, Igor Di Marco, Patrik Thunström, Peter M. Oppeneer, and Olle Eriksson, *Magnetism in AV3Sb5 (A=Cs,Rb,K): Complex landscape of dynamical magnetic textures,* Physical Review B, 108, 174413, 2023

9. Md. Nur Hasan, Ritadip Bharati, Johan Hellsvik, Anna Delin, **Samir Kumar Pal**, Anders Bergman, Shivalika Sharma, Igor Di Marco, Manuel Pereiro, Patrik Thunström, Peter M. Oppeneer, Olle Eriksson, and Debjani Karmakar, *Magnetism in AV3Sb5 (A=Cs, Rb, and K): Origin and Consequences for the Strongly Correlated Phases,* Physical Review Letters, 131, 196702, 2023

10. Lopamudra Roy, Nivedita Pan, Susmita Mondal, Ria Ghosh, Md. Nur Hasan, Neha Bhattacharyya, Soumendra Singh, Kallol Bhattacharyya, Arpita Chattopadhyay and **Samir Kumar Pal**, *Ultrafast spectroscopic studies on the interaction of reactive oxygen species with a probe impregnated in nanoscopic and microscopic matrix formulation,* Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 308, 123671, 2024

11. Gourab Ghosh, Debanjana Singha Roy, Ria Ghosh, Dipanjan Mukherjee, Suman Biswas, Lopamudra Roy, Arpita Chattopadhyay, Ranjan Das, **Samir Kumar Pal**, *Excited-State Dynamics of a Photoacid: A Potential Probe for Recognizing Transition from Lamellar to Nonlamellar Inverted Structures of Liposome based Nanocarriers,* ChemPhysChem, 25, e202300635, 2024

12. Lopamudra Roy, Nivedita Pan, Ria Ghosh, Md. Nur Hasan, Susmita Mondal, Amrita Banerjee, Monojit Das, Oyshi Sen, Kallol Bhattacharya, Arpita Chattopadhyay, **Samir Kumar Pal**, *A Mutagen Acts as a Potent Reducing Agent of Glycated Hemoglobin: a Combined Ultrafast Electron Transfer and Computational Studies,* ChemBioChem, 25, e202300721, 2024

13. Ria Ghosh, Lopamudra Roy, Dipanjan Mukherjee, Sushmita Sarker, Jayanta Mondal, Nivedita Pan, Md. Nur Hasan, Subhajit Ghosh, Arpita Chattopadhyay, Arghya Adhikary, Maitree Bhattacharyya, Asim Kumar Mallick, Ranjit Biswas, Ranjan Das, and **Samir Kumar Pal**, *Structurally Dynamic Monocyte–Liposome Hybrid Vesicles as an Anticancer Drug Delivery Vehicle: A Crucial Correlation of Microscopic Elasticity and Ultrafast Dynamics,* The Journal of Physical Chemistry Letters, 15, 3078-3088, 2024

### b) Other Publications

1. L. Roy, S. Mondal, R. Ghosh, M. Das, M. N. Hasan, A. Banerjee, N. Pan, A. Chattopadhyay, and S. K. Pal "Recent progress in the synthesis of nanozymes and their functionalization ", (Book Chapter) in " Nanozymes - Approachable Bio-applications" Edited by Ravi Mani Tripathi, Ramesh Namdeo Pudake, Peng Huang, Nesrin Horzum, ELSEVIER, ISBN: 9780443137891, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. "Seeing" Invisibles: Cross-disciplinary Research; May 30, 2023; Jagadis Bose National Science Talent Search, Kolkata; 60 minutes
2. Transforming Business through Bio-photonics Technology: Innovations, Challenges and Digital Renovation in Healthcare; November 7, 2023; Institute of Engineering and Management; 60 minutes
3. International Conference on Molecular Matter - Emerging Directions for Sustainability; December 3, 2023; INDIAN INSTITUTE OF TECHNOLOGY MADRAS; 30 minutes
4. Transforming Business through Bio-photonics Technology: Innovations, Challenges and Digital Renovation in Healthcare; February 24, 2024; Panskura Banamali College, Panskura; 60 minutes

## Administrative duties

1. Chairman of Technical cell
2. Chairman of Pest control committee
3. Chairman of Security monitoring committee
4. Member of the internal technical committee

## Patents Taken and Process Developed with Details

1. A portable point-of-care LOPA-Device (Loading of Pathogen Analyzer) for quantitative detection of pathogens; Indian Pat. Appl. (2024), TEMP/E-1/45713/2024-KOL dated 18th May 2024; Granted

## Awards, Recognitions, if any

1. Fellow of the West Bengal Academy of Science & Technology (WAST) 2023
2. Abdul Kalam Technology Innovation National Fellowship 2018 (Indian National Academy of Engineering: INAE) Extension for another two years

## Membership of Learned Societies

1. Indian Association for the Cultivation of Science, Life Member
2. Indian Physical Society
3. Member of Governing Council Indian National Academy of Engineering: INAE
4. Programme Advisory Committee (PAC): 2021-2024 in Electrical, Electronics and Computer Engineering of Science and Engineering Research Board (SERB)
5. Fellow of Indian National Academy of Engineering (FNAE)

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Abdul Kalam Technology Innovation National Fellowship (INAE/121/ AKF); Indian National Academy of Engineering (INAE); 5 years; PI
2. Development of nano sensor and its application through cloud based network for real time irrigation to soil and plant; Indian Council for Agricultural Research (ICAR) and the National Agricultural Science Fund (NASF); 3 years; Co-PI

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Professor Saleh Ahmed, Umm Al-Qura University · Department of Chemistry, Saudi Arabia; Sl. No. 1, 2, 6, 7; International
2. Professor Asim Kumar Mallick, NRS Medical College, Kolkata, 700014, India; Sl. No. 2, 3, 6, 7, 13; National
3. Professor Ranjan Das, Department of Chemistry, West Bengal State University, Kolkata, India; Sl. No. 1, 2, 5, 11, 13; National
4. Dr. Arpita Chattopadhyay, Department of Basic Science and Humanities, Techno International New Town, Kolkata, 700156, India; Sl. No. 1, 2, 3, 5, 7, 10, 11, 12, 13; National
5. Dr. Sudeshna Shyam Choudhury (Bhattacharya) Department: Microbiology & Envs, St.Xavier's College, 30 Park Street, Kolkata 700 016; Sl. No. 2; National
6. Professor Subhananda Chakraborty, India; Sl. No. 1, 2, 5, 11, 13; National
7. Dr. Debjani Karmakar, Bhabha Atomic Research Centre, Trombay, Mumbai, India; Sl. No. 5, 8, 9; National
8. Dr. Siddhartha Sankar Bhattacharya, Department of Zoology, Uluberia College,Uluberia, Howrah-711315, India; Sl. No. 6; National
9. Dr. Debasish Pal, Department of Zoology, Uluberia College,Uluberia, Howrah-711315, India; Sl. No. 6; National
10. Dr. Debasish Bhattacharyya, Department of Gynecology & Obstetrics, Nil Ratan Sircar Medical College & Hospital, Kolkata, 700014 India; Sl. No. 1, 2, 6, 7; National
11. Professor Olle Eriksson, Professor at Department of Physics and Astronomy, Materials Theory, UppsalaUniversity, Sweden; Sl. No. 5, 8, 9; International
12. Dr. Anjan Kumar Das, NRS Medical College, Kolkata, 700014, India; Sl. No. 6; National

## Areas of Research

1. Femtosecond and Picosecond time resolved Laser spectroscopy, Biomolecules, Bio-Nano Interface and Self-organized molecular assembly, Light Harvesting, Dye Sensitized solar cells, Instrumentation, Translational Medicine, Clinical Trial, Nanomedicine, Pre-clinical Studies

## Plan of Future Work Including Project

1. Development of low-cost instruments for the nation.
2. Development of point of care diagnosis.
3. Development of bio-compatible nanohybrids for treating different diseases.
4. Development of low-cost sensors for environmental applications.
5. Basic experimental photophysical studies on bio-mimetic systems.
6. Basic studies on energy harvesting materials.
7. Clinical Trial of Nanomedicine in Human Subject
8. Pre-clinical Studies of Nanomedicines in Animal Model


## Shubhasis Haldar

Associate Professor

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Debojyoti Chaudhuri; Mechanochemical role of Kindlin2 in GBM; Under progress
2. Soham Chakraborty; Understanding the force-directed mechanisms of talin interactions at single-molecule resolution; Thesis submitted; Balaji Chattopadhyay (Co-supervisor)
3. Deep chaudhuri; The mechanical role of molecular and chemical chaperone observed under single-molecule force spectroscopic technique; Under progress; Aryya Ghosh (Co-supervisor)
4. Souradeep Bannerjee; Understanding the chaperone effect in folding-unfolding dynamics of proteins, using magnetic tweezers; Thesis submitted; Shivani Krishna (Co-supervisor)
5. Deboshruti Maiti; Understanding the role of histone chaperone in mechanical regulation of cancer stemness; Under progress

#### b) External Project Students / Summer Training

1. Soumyajit Ghosh; Mechanochemical modulation of Alzheimer's disease by Kindlin2: A transcriptomic analysis
2. Shreyansh Priyadarshi; understanding stemness using machine learning
3. Sayan Biswas; A Deep Learning-Based Mathematical Model for Cell Invasion Study

### Teaching

1. Spring semester; Study of Biomacromolecules; PhD; 4 students; with Suman Chakrabarty (co-teacher)

### Publications

#### a) In journals

1. Ayush Chandrakant Mistry, Debojyoti Chowdhury, Soham Chakraborty, **Shubhasis Haldar**, *Elucidating the novel mechanisms of molecular chaperones by single-molecule technologies,* Trends in Biochemical Sciences, 49, 38-51, 2024
2. Debojyoti Chowdhury, Ayush Mistry, Debashruti Maity, Riti Bhatia, Shreyansh Priyadarshi, Simran Wadan, Soham Chakraborty & **Shubhasis Haldar**, *Pan-cancer analyses suggest kindlin-associated global mechanochemical alterations,* Communications Biology, 7, 372, 2024
3. Deep Chaudhuri, Debojyoti Chowdhury, Soham Chakraborty, Madhu Bhatt, Rudranil Chowdhury, Aakashdeep Dutta, Ayush Mistry and **Shubhasis Haldar**,

*Structurally different chemical chaperones show similar mechanical roles with independent molecular mechanisms,* Nanoscale, 16, 2540-2551, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited lecture in Time-dependent phenomena in soft and active matter (TPSAM-2024) SNBNCBS, March 8-9, 2024; SNBNCBS, Kolkata; 2 days
2. Invited lecture in Interdisciplinary Applications of Magnetic and Optical Tweezers (MTOT2023), IIT Bombay December 19-22, 2023; IIT Bombay, Mumbai; 3 days
3. Invited lecture in Physical Chemistry Symposium – 2023, IIT Kanpur October 29-31, 2023; IIT Kanpur, Kanpur; 3 days
4. Invited lecture in Recent Tandes in chemistry and related disciplins, Burdwan University, January 11, 2024; Invited lecture in Recent Tandes in chemistry and related disciplins, Burdwan University, January 11, 2024; 1 day

## Administrative duties

1. Member of ARPAC brochure committee
2. Initiated and Drafted MOU between SNBNCBS and Ashoka University
3. Act as a judge in poster presentation session in Bose Fest 2024.

## Awards, Recognitions, if any

1. Editorial Advisory Board of Biochemistry (American Chemical Society)
2. Selected as Associate Fellow in Indian National Science Academy (2023)
3. Member of National Committee for International Union of Pure & Applied Biophysics (IUPAB)

## Membership of Learned Societies

1. Associate Fellow in Indian National Science Academy
2. Member of National Committee for International Union of Pure & Applied Biophysics (IUPAB)

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Investigating the mechano-interactome network of talin using novel single molecule fluorescence-force spectroscopy; Department of Biotechnology; 3 years; PI

## Areas of Research

### Biophysics and Biochemistry

Our lab is developing single-molecule technologies to unravel the complexities of biological phenomena. We established India's first covalent magnetic tweezers. Subsequently, our lab introduced real-time microfluidic-magnetic tweezers, a technological marvel that enables the simultaneous quantification of five molecular properties, including unfolding kinetics, refolding kinetics, conformational change, chain flexibility, and $\Delta G$ for folding/unfolding, in a single experiment. Notably, this technology tracks dynamic perturbations in real-time, providing unprecedented insights into molecular behavior.

Utilizing this cutting-edge methodology, our group investigated the mechanical influences of chaperones on cellular energetics and folding pathways. Our pioneering work, published in Communications Biology, introduced the force-clamp assay as a sensitive probe of the folding energy landscape, revealing chaperones' ability to shift equilibrium and reshape cellular energetics. By elucidating the spatially distributed mechanical behavior of chaperones, their research offers profound insights into cellular processes, potentially revolutionizing therapeutic strategies.

## Plan of Future Work Including Project

1. This project investigates the Mechano-Adaptive Roles of Kindlin2/Talin in Cancer Progression. Kindlin 2/Talin, acting as mechanosensitive adapter proteins, facilitate the translation of external mechanical stimuli into cellular responses, crucial for cancer development. Despite their importance, their mechano-adaptive roles in cancer, particularly in stemness, remain unclear. Utilizing GBM cell lines and 3D organoid models, we aim to elucidate how Kindlin2/Talin influence cytoskeletal dynamics and signaling pathways, impacting GBM aggression and Glioblastoma Stem Cell (GSC) dedifferentiation. Employing advanced mechanical assays, we will quantify the mechanical properties of 3D organoids, shedding light on Kindlin2/Talin's influence on cellular mechanics and its regulatory roles in transcription and metabolism. Ultimately, this research aims to enhance our understanding of Kindlin2/Talin's mechanical significance in cancer, providing mechanistic insights into neural development and GBM pathogenesis, potentially revealing novel therapeutic targets for aggressive brain cancers.
2. This proposal will introduces ACSCEND, an innovative machine learning-based digital cytometric approach designed to accurately quantify CSCs and identify tumor

stemness states from bulk RNAseq data obtained from biopsies. Cancer stem cells (CSCs) represent a crucial subset of tumors driving treatment resistance and recurrence, posing significant challenges to conventional therapies. Precise quantification and characterization of CSCs are imperative for enhancing treatment efficacy. ACSCEND leverages machine learning algorithms to capitalize on genetic similarities between normal and cancer stem cells, achieving nearly 99% accuracy in CSC identification. By categorizing tumors into four distinct yet dynamic bulk-tumor potency states, ACSCEND elucidates the developmental cancer-genomic landscape and its implications for tumor heterogeneity. We will apply ACSCEND to patient samples across 21 cancer types, uncovering clinical, transcriptomic, and immunological signatures associated with each bulk-tumor potency state. This comprehensive framework will enhance our understanding of CSC complexities and facilitate tracking patient-specific CSC changes during treatment or follow-up care. ACSCEND promises to revolutionize CSC identification and characterization, offering a scalable, reproducible, and technically robust solution. By providing insights into the dynamic nature of CSCs and their impact on tumor heterogeneity, ACSCEND holds the potential to inform more effective personalized cancer therapies. In summary, ACSCEND represents a significant advancement in cancer research, with the potential to transform treatment strategies by enabling precise targeting of CSCs and personalized therapeutic interventions.

3. This proposal aims to investigate the mechanical chaperone activity of two tunnel-associated chaperones, BiP and ERdj3, in the presence and absence of force, compared to their cytoplasmic homologs DnaK and DnaJ. Polypeptide chains undergo mechanical tension during translocation through cellular tunnels. The interaction between tunnel-associated chaperones and emerging polypeptides under force remains inadequately understood.We will conduct experiments to assess the foldase and holdase activities of BiP/ERdj3 and DnaK/DnaJ under force. Our findings indicate that BiP/ERdj3 exhibit strong foldase activity under force, while DnaK/DnaJ act as holdase. Furthermore, we observe that BiP/ERdj3 revert to holdase in the absence of force, suggesting force-dependent regulation of chaperone behavior.This study reveals that tunnel-associated chaperones play a crucial role in co-translocational protein folding, generating additional mechanical energy during the process. The observed mechanical-chaperone behavior aligns with strain theory, where chaperones with higher intrinsic deformability function as mechanical foldases (BiP, ERdj3), while those with lower deformability act as holdases (DnaK and DnaJ).By elucidating the underlying mechanism of mechanically regulated chaperone activity, this project contributes to our understanding of protein translocation dynamics. The findings provide insights into how mechanical forces influence chaperone function and co-translocational protein folding, offering a novel perspective on cellular protein processing.In summary, this project aims to unravel the intricate interplay between mechanical forces and chaperone activity during protein translocation. By elucidating these mechanisms, we hope to advance our understanding of cellular protein processing and potentially uncover new avenues for therapeutic intervention in protein folding-related disorders.


## Suman Chakrabarty

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Abhinandan Das; Rational design and mechanism of action of inhibitors for Acetylcholinesterase; Under progress
2. Krishnendu Sinha; Computer Simulation Study of Molecular Recognition and Signalling; Under progress
3. Dibyendu Maity; Machine learning in physics: prediction, identification and enhanced sampling; Under progress
4. Sreyan Bhowmick; Computational investigation of allosteric regulation in proteins; Under progress
5. Sutanu Mukhopadhyay; Computational approaches towards drug discovery; Under progress
6. Sayari Bhattacharya; Computational Study of Misfolding and Aggregation in Proteins and Peptides; Under progress

### b) Post-Docs

1. Sk. Samir Ahamed Quantum chemical studies of complex molecules and their solvation behavior
2. Saheb Dutta; QM/MM and classical simulations of enzymes and protein-protein interactions

### c) External Project Students / Summer Training

1. Akash Maity; Computational study of protein-ligand interactions
2. Ashutosh Mahalik; Computational drug discovery to circumvent antibiotic resistance
3. Adway Majumdar; Computational study of inhibitor binding mechanism to Acetylcholinesterase

## Teaching

1. Autumn semester; Computational Methods in Physics; Integrated PhD; 14 students
2. Spring semester; Study of Bio-Macromolecules; PhD; 4 students; with Shubhasis Haldar (Co-teacher)

## Publications

### a) In journals

1. Krishnendu Sinha, Amit Kumawat, Hyunbum Jang, Ruth Nussinov, **Suman Chakrabarty**, *Molecular mechanism of regulation of RhoA GTPase by phosphorylation of RhoGDI,* Biophysical Journal, 123, 57-67, 2024
2. Krishnendu Sinha, Amit Kumawat, **Suman Chakrabarty**, *Elucidating the microscopic origin of observed anti-correlation between the protein-protein and protein-water interaction energies,* Chemical Physics Impact, 8, 100421, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. National Seminar & Discussion Meeting on Simulations in Polymers, Materials and Biomolecules; June 22, 2023; Somaiya Vidyavihar University, Mumbai; 3 days
2. Kaleidoscope: A Discussion Meeting in Chemistry; July 6, 2023; Udaipur; 4 days
3. Structure and Dynamics of Chemical and Biomolecular Systems (SDCBS23); October 2023; IIT Kanpur; 3 days
4. Contemporary Challenges in Chemical Science (C3S); December 6, 2023; IIT Bombay; 3 days
5. JNCASR-CECAM International Conference: MD@60; February 26, 2024; JNCASR, Bengaluru; 4 days
6. Stochastic and Nonlinear dynamics in Chemistry and Biology (SNDCB-2024); January 4, 2024; SNBNCBS Kolkata; 2 days

## Administrative duties

1. Chairman, Library Committee
2. Chairman, Media Cell
3. Member, Seminar & Colloquia Programme (SCOLP)
4. Member, Computer Services Cell Advisory Committee (CSC-AC)
5. Member, Website Design and Maintenance Committee
6. Member, Internal Standing Technical Committee
7. Faculty-in-charge & coordinator: Implementation of supercomputing facility under NSM (National Supercomputing Mission) in collaboration with CDAC, Pune
8. Head of the department, CBS Department

## Awards, Recognitions, if any

1. Editorial Board member of Dialogue: Science, Scientists, and Society published by the Indian Academy of Sciences, Bengaluru

## Membership of Learned Societies

1. Biophysical Society, USA
2. American Chemical Society (ACS), USA
3. Chemical Research Society of India (CRSI), India

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Development of Artificial Neural Network (ANN) based models for rapid prediction of physicochemical properties of drug-like molecules; SERB, India; 3 years; PI

## Conference / Symposia / Schools organized

1. Physical Chemistry Symposium - 2023 (SoPhyC); October 29, 2023; IIT Kanpur; 3 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Ruth Nussinov, National Cancer Institute, USA; Sl. No. 1; International

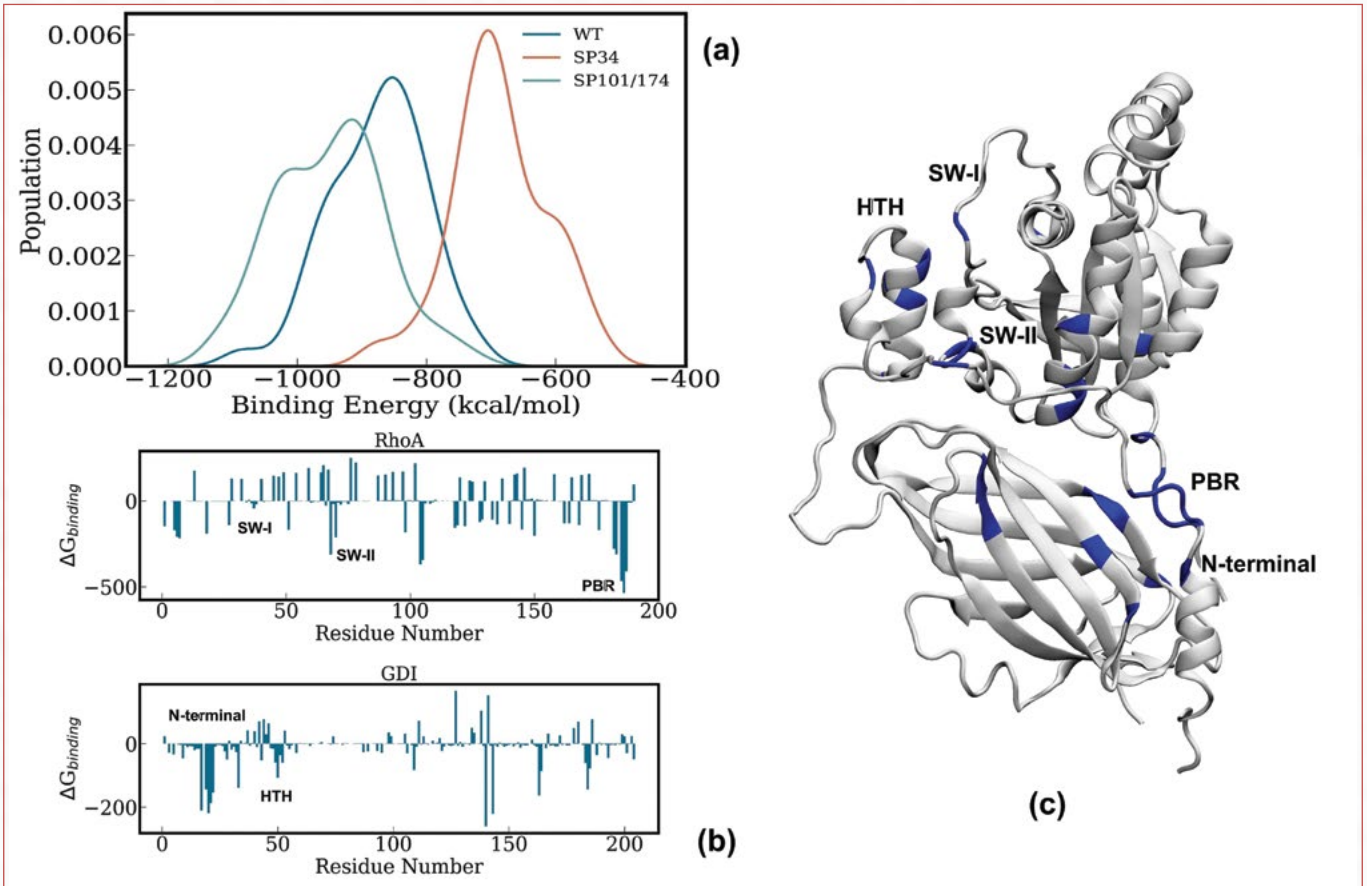
## Areas of Research

### Theoretical and computational physical chemistry and molecular biophysics

The overarching theme of our research is to employ state of the art computational methodologies primarily based on statistical mechanics to solve realistic problems in the interdisciplinary areas of chemistry, physics and biology. Overall, we take an approach of molecular thermodynamics to connect molecular interactions and dynamics to their function and properties.

**A few representative recent success stories are:**

Molecular mechanism of phosphorylation code in regulation of RhoA GTPase by RhoGDI: We have developed an international collaboration with Ruth Nussinov, National Cancer Institute, USA. In this work, we have elucidated the molecular mechanism of the phosphorylation code in the regulation of RhoA GTPases by RhoGDI. RhoGDI can bind and extract several small GTPases like RhoA, Rac1, CDC42 etc. However, to release a specific partner protein some specific amino acids of RhoGDI needs to be phosphorylated. This has been described as the “phosphorylation code”. We have used MD simulations to demonstrated how the correct phosphorylation leads to a long-range allosteric communication to the protein-protein binding interface in terms of rearrangement of hydrogen bonds and salt-bridges. However, the wrong phosphorylation does not alter the binding affinity significantly.




**Identification of allosteric hotspots to modulate protein-protein interactions (PPI):**

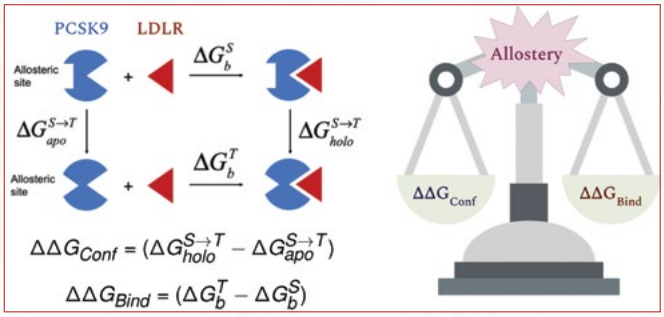
Several protein-protein interactions (PPIs) are lucrative drug targets. However, PPIs are rather difficult targets mostly due to flat featureless surfaces. Another alternative would be to design drug molecules for a distal allosteric pockets, where the inhibitor can remotely modulate the binding affinity of PPIs. In this work, partly sponsored by a pharmaceutical company Sarfez Cure, we have developed a general computational protocol to identify such allosteric hotspots leveraging the bidirectional nature of allostery. As a specific case study, we have taken up the challenging PCSK9-LDLR system, which is a proven drug target to treat Hypercholesterolemia. We have shown that specific conformations at a distal site of PCSK9 correspond to significantly lower binding affinity with LDLR.

## Plan of Future Work Including Project

1. Phase II of the collaborative project with a pharmaceutical company Sarfez Cure is being planned and formulated under the umbrella of TRC project.

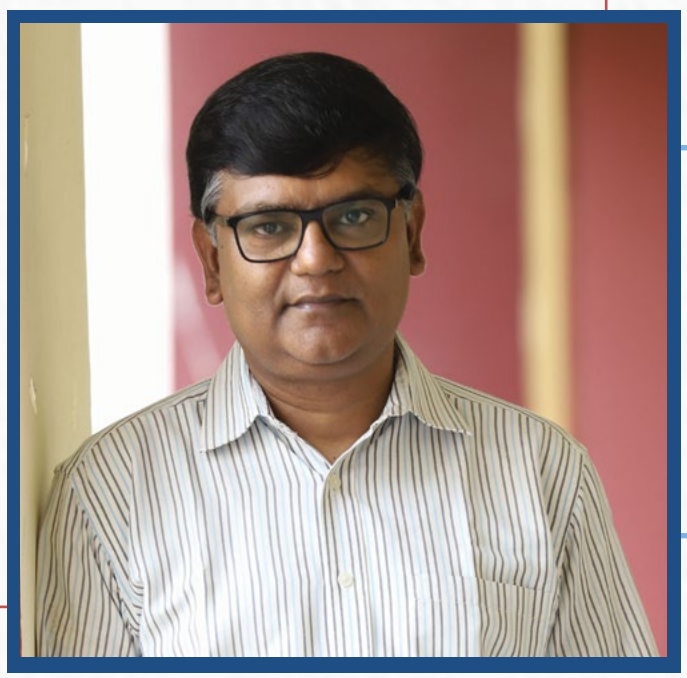
## Any other Relevant Information including social impact of research

1. We are pursuing some projects in collaboration with a pharmaceutical company. The ideas and know-hows generated through these projects will be beneficial to common people in terms of novel treatment strategies.



# Department of

## Condensed Matter and Materials Physics




## Anjan Barman

Senior Professor

Condensed Matter and Materials Physics

abarman@bose.res.in


### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Amrit Kumar Mondal; Ultrafast Spin Dynamics in Continuous and Confined Magnetic Thin Film; Awarded
2. Arundhati Adhikari; Quasistatic and Ultrafast Magnetization Dynamics in Ferromagnetic Nanostructures; Thesis submitted
3. Sudip Majumdar; Spin Wave dynamics in ferromagnetic thin film and nanostructures; Under progress; Prof. Rajib Kumar Mitra, SNBNCBS (Co-supervisor)
4. Pratap Kumar Pal; Spin Wave Dynamics in Ferromagnetic Nanostructures and Heterostructures; Under progress
5. Sreya Pal; Spin Dynamics of Ferromagnetic Thin Films, Heterostructures and Nanostructures; Under progress
6. Soma Dutta; Ultrafast Spin Dynamics in Advanced Magnetic Structures for Applications in Spintronics; Under progress
7. Suchetana Mukhopadhyay; Spintronics in Topological Insulators; Under progress; Prof. Chiranjib Mitra, IISER Kolkata (Co-supervisor)
8. Chandan Kumar; Spin Dynamics in Emerging Magnetic Materials; Under progress
9. Bikram Baghira; Magnetization Dynamics and Spin Waves in Engineered Magnetic Structures; Under progress
10. Suranjana Chakaborty; Spectroscopic Studies of Molecules; Under progress, Dr. Anup Kumar Ghosh, SNBNCBS (Co-supervisor)
11. Sayan Mathur; Spin Wave Dynamics in Advanced Magnetic Textures; Under progress
12. Sayanti Mondal; Ultrafast Spin Dynamics in Low Dimensional Magnetic Systems; Under progress

#### b) Post-Docs

1. Ajit Kumar Sahoo; Spin-Orbit Effects in Spintronics
2. Sumaiya Parveen; Spin Dynamics in Organice/ Ferromagnetic Spinterface

#### c) External Project Students / Summer Training

1. Dimple Sneha Pamarthi; Ultrafast Spin Dynamics in Ferromagnetic Thin Films
2. Adwitiya Das; Magneto-optical Kerr Effect in Ferromagnet/Nonmagnet Heterostructures

## Teaching

1. Autumn semester; PHY501: Atomic and Molecular Physics; Integrated PhD; 11 students; with Prof. Rajib Kumar Mitra
2. Autumn semester; CB 627: Molecular Physics and Spectroscopy; PhD; 8 students; with Prof. Rajib Kumar Mitra
3. Spring semester; PHY292: Project Course I; Integrated PhD; 2 students
4. Autumn semester; PHY304: Project Course II; Integrated PhD; 3 students
5. Spring semester; PHY401: Project Research III; Integrated PhD; 3 students

## Publications

### a) In journals

1. Chandan Kumar, Pratap Kumar Pal, and **Anjan Barman**, *Spin-wave mode reversal and anisotropy in bicomponent magnonic crystals,* Physical Review B, 109, 075407, 2024
2. Suchetana Mukhopadhyay, Pratap Kumar Pal, Subhadip Manna, Chiranjib Mitra, and **Anjan Barman**, *Laser fluence tunable spin transport and ultrafast demagnetization in BiSbTe1.5Se1.5/Co20Fe60B20 bilayers,* Physical Review B, 109, 024437, 2024
3. Soma Dutta, Sajid Husain, Prabhat Kumar, Nanhe Kumar Gupta, Sujeet Chaudhary, Peter Svedlindh and **Anjan Barman**, *Manipulating ultrafast magnetization dynamics of ferromagnets using the odd-even layer dependence of two-dimensional transition metal di-chalcogenides,* Nanoscale, 16, 4105-4113, 2024
4. Sayani Pal, Anuvab Nandi, Sambhu G. Nath, Pratap Kumar Pal, Kanav Sharma, Subhadip Manna, **Anjan Barman**, Chiranjib Mitra, *Enhancement of spin to charge conversion efficiency at the topological surface state by inserting normal metal spacer layer in the topological insulator based heterostructure,* Applied Physics Letters, 124, 112416, 2024
5. Sudip Majumder, Samiran Choudhury, Saswati Barman, Yoshichika Otani and **Anjan Barman**, *Tunable strong magnon-magnon coupling in two-dimensional array of diamond shaped ferromagnetic nanodots,* Physica Scripta, 99, 025935, 2024
6. Pratap Kumar Pal and **Anjan Barman**, *Control of magnon-magnon coupling in Ni80Fe20 nanocross arrays through system dimensions,* Journal of Magnetism and Magnetic Materials, 588, Part B, 171431, 2023
7. Pratap Kumar Pal, Subhadip Chakraborty, Rajib Kumar Mitra, **Anjan Barman**, *Optimizing the polarization and antireflection characteristics of metallic wire grid structures in the Terahertz frequency range,* Optical Materials, 146, 114553, 2023
8. Surya Narayan Panda, Sucheta Mondal, Sudip Majumder, and **Anjan Barman**, *Ultrafast demagnetization and precession in permalloy films with varying thickness,* Physical Review B, 108, 144421, 2023
9. Soma Dutta, Arindam Samanta, Surya Narayan Panda, Saibal Roy, **Anjan Barman**, *Ultrafast demagnetization and Gilbert damping in electrodeposited CoP film,* Journal of Materials Science, 58, 14817-14830, 2023
10. Suchetana Mukhopadhyay, Pratap Kumar Pal, Subhadeep Manna, Chiranjib Mitra & **Anjan Barman**, *All-optical observation of giant spin transparency at the topological insulator BiSbTe1.5Se1.5/Co20Fe60B20 interface,* NPG Asia Materials, 15, 57, 2023
11. Sudip Majumder, J. L. Drobitch, Supriyo Bandyopadhyay & **Anjan Barman**, *Formation of binary magnon polaron in a two-dimensional artificial magneto-elastic crystal,* NPG Asia Materials, 15, 51, 2023
12. Sreya Pal, Pratap Kumar Pal, Raisa Fabiha, Supriyo Bandyopadhyay, **Anjan Barman**, *Acousto-Plasmo-Magnonics: Coupling Spin Waves with Hybridized Phonon-Plasmon Waves in a 2D Artificial Magnonic Crystal Deposited on a Plasmonic Material,* Advanced Functional Materials, 33, 2304127, 2023
13. Chandrima Banerjee & **Anjan Barman**, *Advances in All Optical Spintronic Memory,* Proceedings of the National Academy of Sciences, India Section A: Physical Sciences, 93, 511-516, 2023
14. Mateusz Gołębiewski, Hanna Reshetniak, Uladzislau Makartsou, Maciej Krawczyk, Arjen van den Berg, Sam Ladak, and **Anjan Barman**, *Spin-Wave Spectral Analysis in Crescent-Shaped Ferromagnetic Nanorods,* Physical Review Applied, 19, 064045, 2023
15. Suranjana Chakrabarty, **Anjan Barman**, Anup Ghosh, A disparity in solvatochromism of C–O and S–O vibrational probe: *A study of structurally similar acetone and dimethyl sulfoxide,* Journal of Molecular Liquids, 382, 122005, 2023
16. B. Flebus, S. M. Rezende; D. Grundler; **A. Barman**, *Recent advances in magnonics,* Journal of Applied Physics, 133, 160401, 2023
17. Arundhati Adhikari, Sudip Majumder, YoshiChika Otani, and **Anjan Barman**, *Active Control of Dipole-Exchange Coupled Magnon Modes in Nanoscale Bicomponent Magnonic Crystals,* ACS Applied Nano Materials, 6, 7166-7172, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Nanoscale Hybrid Magnonics for Quantum Technology, Anjan Barman, RPQT-2024; March 14, 2024; School of Physical Sciences, Jawaharlal Nehru University, New Delhi; 30 min
2. Nanoscale Hybrid Magnonics, Anjan Barman, National Physicist's Conclave 2024; February 7, 2024; SRMIST Chennai; 30 min
3. Ultrafast Spin Dynamics and Spin Waves in 2D Material/ Ferromagnet Thin Film Heterostructures, Anjan Barman, 2DMat 2024; January 17, 2024; S. N. Bose National Centre for Basic Sciences; 30 min
4. Nanoscale Hybrid Magnonics, Anjan Barman, Interaction Meeting on Quantum Technology; December 4, 2023; IISER Kolkata; 30 min
5. Nanoscale Hybrid Magnonics, Anjan Barman, IFW-SNB Discussion Meeting; November 27, 2023; S. N. Bose National Centre for Basic Sciences; 30 min
6. Femtosecond Laser Induced Spin Dynamics in Ferromagnetic Thin Films and Synthetic Heterostructures: Towards Ultrahigh Speed Spintronics, Anjan Barman, Ultrafast Science 2023; November 26, 2023; National Physical Laboratory, New Delhi; 45 min
7. Nanoscale Hybrid Magnonics, Anjan Barman, INST-TENS Conference, INST Mohali; November 7, 2023; INST, Mohali; 30 min
8. Nanoscale Hybrid Magnonics, A. Barman, ICQT 2023; July 12, 2023; Moscow; 30 min
9. Nanoscale Hybrid Magnonics, A. Barman, ICETMM2023; July 7, 2023; HBTU Kanpur; 45 min

## Administrative duties

1. Dean Faculty
2. Member of CAC
3. Member of ARPAC
4. Chairman of Works Committee
5. Chairman of Annual Procurement Committee
6. Chairman of Space Committee
7. Member of Faculty Search Committee

## Patents Taken and Process Developed with Details

1. A Micro or nanoscale Magnetic Material for Filtering Microwave or Submillimeter Waveband Signals; 525248; Granted

## Awards, Recognitions, if any

1. Awarded Royal Society Wolfson Visiting Fellowship by the Royal Society, UK in 2023
2. Featured in top 2% most cited scientists' list released by Stanford University in 2023.

## Membership of Learned Societies

1. Member of American Physical Society
2. Fellow of Institute of Physics, UK
3. Life Member of Materials Research Society of India

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Development of strongly spin orbit coupled topological quantum hetero-structures for spintronic application; DST, Nano Mission; 2021-2026; PI
2. Two-dimensional Ferromagnetic and Organic Molecule Spinterfaces as Molecular Spin Qubits for Quantum Technologies and Energy Harvesting Applications; Chanakya, I Hub, IISER Pune; 2023-25; PI

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. Chiranjib Mitra, IISER Kolkata; Sl. No. 2, 4, 10; National
2. Prof. Supriyo Bandyopadhyay, Virginia Commonwealth University, USA; Sl. No. 11, 12; International
3. Prof. Yoshichika Otani, RIKEN and ISSO, University of Tokyo, Japan; Sl. No. 5, 17; International
4. Prof. Peter Svedlindh, Uppsala University; Sl. No. 3; International
5. Dr. Saibal Roy, Tyndall National Institute, Ireland; Sl. No. 9; International
6. Dr. Chandrima Banerjee, IIT Kanpur; Sl. No. 13; National
7. Prof. Maciej Krawczyk, Adam Mickiewicz University, Poland and Dr. Sam Ladak, Cardiff University, UK; Sl. No. 14; International
8. Prof. B. Flebus, Boston College, USA; Prof. S. Rezende, Universidade Federal de Pernambuco, Brazil and Prof. D. Grundler, EPF Lausanne, Switzerland; Sl. No. 16; International

## Areas of Research

### Spintronics, Spin-orbitronics, Magnonics, Ultrafast Spin Dynamics, Quantum and Topological Materials, Thin Films, Heterostructures and Nanostructures

Hybrid Magnonics in Magnetic Nanostructures: We have explored magnons as a quantum platform for on-chip quantum transduction and coherent information transfer. An essential ingredient of hybrid magnonics is the coupling of magnons with other quantum platforms like photons, phonons, magnons, plasmons etc. Here, we have studied both bipartite and tripartite coupling of magnons with other platforms. Furthermore, we have used nanoscale magnets as cavity where well-defined resonant magnon modes can be formed which can couple between themselves (magnon-magnon coupling) or with other platforms like phonons and plasmons. In one work, we have shown strong tripartite magnon-phonon-magnon coupling in a two-dimensional periodic array of magnetostrictive nanomagnets deposited on a piezoelectric substrate, forming a 2D magnetoelastic "crystal"; the coupling occurred between two Kittel-type spin wave (magnon) modes and a (non-Kittel) magnetoelastic spin wave mode caused by a surface acoustic wave (SAW)(phonons). The strongest coupling occurred when the frequencies and wavevectors of the three modes matched, leading to perfect phase matching. We have achieved this condition by carefully engineering the frequency of the SAW, the nanomagnet dimensions and the bias magnetic field that determined the frequencies of the two Kittel-type modes. The strong coupling led to the formation of a new quasi-particle, called a binary magnon-polaron, accompanied by nearly complete (~100%) transfer of energy from the magnetoelastic mode to the two Kittel-type modes. In another work, we have shown coupling between spin waves and hybridized phonon-plasmon waves (tripartite mixing of magnons, phonons and plasmons). Hybridized phonon-plasmon waves naturally form in this composite material and non-linearly couple with spin waves to produce a new breed of waves - acousto-plasmo-spin waves that exhibit a "frequency comb" spanning two octaves. Our findings also reveal the presence of parametric amplification in this system; energy is transferred from the hybridized phonon-plasmon modes to the acousto-plasmo-spin wave modes to amplify the latter. This opens a path to design novel active metamaterials with tailored and enhanced response.

Ultrafast Magnetization Dynamics in Ferromagnet/2D and Topological Material Heterostructures: Ferromagnet/nonmagnet heterostructures offer exotic testbeds for exploring the spin-orbit effects. To this end usage of 2D and topological materials adds novel properties like valley-degree of freedom, topological surface states and spin-momentum locking, giving rise to unusual and superior properties in spin-orbitronics. We have experimentally demonstrated the odd-even layer dependence of WS2 nanolayers by measurements of the ultrafast magnetization dynamics in WS2/Co3FeB thin film heterostructures. The results show the existence of broken symmetry and the dominance of inter- and intraband scattering for odd and even layers of WS2. We have further explored fluence-modulated spin pumping and ultrafast demagnetization in Sub/BiSbTe1.5Se1.5(BSTS)/Co20Fe60B20(CoFeB)/SiO2 heterostructures. The demagnetization time and Gilbert damping are found to be inversely correlated in BSTS/CoFeB due to spin pumping-driven pure spin current transport and interfacial spin accumulations. Furthermore, for BSTS thicknesses far exceeding the spin diffusion length, in the so-called "perfect spin sink" regime, we have obtained an interfacial spin transparency of 0.9, promoting such systems as scintillating candidates for spin-orbitronic devices.

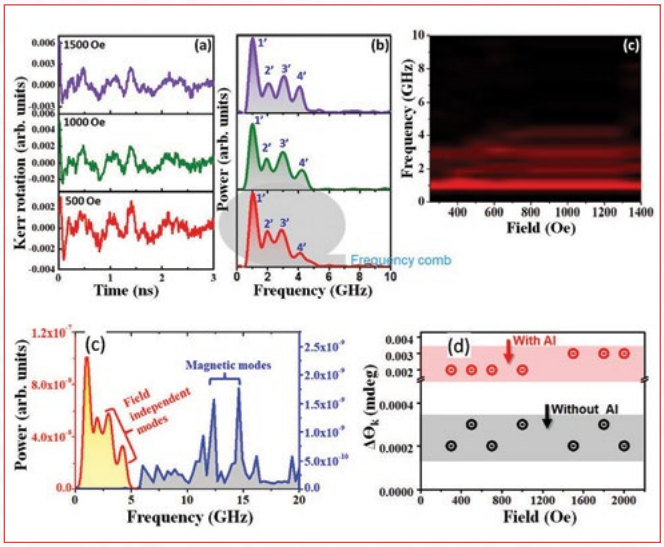



Fig. 1. (a)-(b) Spin wave frequency comb generation due to acousto-plasmo-magnon coupling. (c)-(d) Parametric amplification of spin wave mode due to tri-partite coupling with phonon and plasmon.

## Plan of Future Work Including Project

1. We will study the femtosecond laser-induced ultrafast magnetization dynamics of a [Co/Pt]22 multilayer in presence of different magnetic domain configurations to explore the tunability of the direct transport of spin angular momentum across domain walls. A variety of different magnetic domain configurations will be achieved by applying different magnetic field histories. We will investigate the occurrence of ultrafast demagnetization as well as transient magnetization enhancement (TME) as well as a coexistence of the two states in the system for the development of magnetic spin-texture-driven ultrafast spintronics devices.
2. We will investigate the emergence of spin dynamics in association with phonon dynamics at room temperature in chemically exfoliated two-dimensional (2D) van der Waals (vdW) magnets FexGeTe2 (x=3,4,5) employing time-

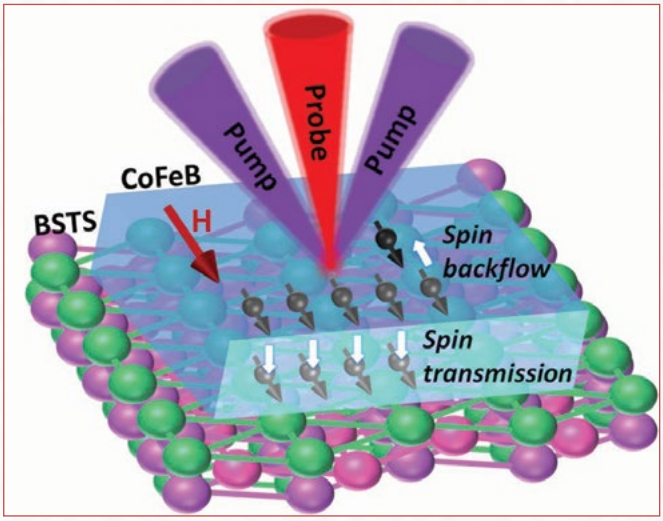



Fig. 2. All-optical measurement of spin pumping and interfacial spin transparency in BSTS/CoFeB heterostructures.

resolved magneto-optical Kerr effect microscope. The high intense femtosecond laser pulse may establish magnetic ordering in the systems at room temperature. Further, we will explore coherent phonon excitation at optical regime which may trigger THz-frequency magnon modes via direct spin-phonon coupling.

3. The family of artificial spin ice (ASI) encompasses a diverse array of metastable microstates, offering insights into both fundamental physics and emerging applications such as reconfigurable magnonic circuits and neuromorphic computing. However, open questions remain on the role of microstate imperfections or angular disorder – particularly in the GHz response of the system. We will measure the GHz frequency spin-wave (SW) field dispersion of ASI along different field axes across various mixed macrospin and vortex microstates. By examining different distinct microstates, we will search for microstate-specific mode frequency shifting, creation, and crossing. This will enable prediction of microstate configurations via SW spectral characterization.

4. The existence of one-dimensional strings of local excitations represents an intriguing aspect of the properties of strongly correlated topological quantum matter. We plan to study the impact of these one-dimensional string phases (1D SPs) on magnetization dynamics in a Santa Fe ice lattice. The possibility of creation of parallel configurational anisotropic doublet or triplet pairs of spin wave (SW) modes due to the SPs will be assessed. These modes may induce the formation of an anti-crossing gap in both reciprocal and non-reciprocal SW dispersion that can be experimentally measured


## Atindra Nath Pal

Associate Professor

Condensed Matter and Materials Physics

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Biswajit Pabi; An investigation of mechanical tunability in single molecular junction; Awarded
2. Shubhrasish Mukherjee; An investigation of electronic and optical properties in 2D semiconductors and their heterostructures; Awarded; Prof. S. K. Ray (Co-supervisor)
3. Shubhadip Moulick; Charge and spin transport in hybrid two dimensional nanodevices; Thesis submitted
4. Rafiqul Alam; An investigation of transport phenomena in topological materials; Under progress
5. Riju Pal; An investigation of magnetic and superconducting layered materials; Under progress
6. Subhankar De; Electronic transport through single molecular junction by tuning metal/molecule interface; Under progress
7. Dayal Das; CVD growth, transport in 2D materials and their hybrid; Under progress
8. Dhritisundar Paramanik; Tranport and shot noise through single molecular junction; Under progress

### b) Post-Docs

1. Sk Obaidulla; CVD growth and hybrid 2D/organic materials
2. Bikash Gajar; Electronic transport in quantum materials and devices, DLTS measurements

### c) External Project Students / Summer Training

1. Gaurab Samanta; Fabrication of large area 2d photodetectors and development of 2D heterostructure
2. Samyabrata Paria; Development of Labview based program for transport measurement
3. Tushar De; Fabrication of 2D hybrid structure
4. Sayanika Bandyopadhyay; Maintaining and providing training: Clean room and equipment
5. Safia Pailan; Maintaining and providing training: Clean room and equipment

## Teaching

1. Autumn semester; PHY 501- Research Methodology; PhD; 38 students; with Prof. Prabhat Mandal (co-teacher)

## Publications

### a) In journals

1. Chumki Nayak, Suvadip Masanta, Sukanya Ghosh, Shubhadip Moulick, **Atindra Nath Pal**, Indrani Bose, and Achintya Singha, *Valley polarization and photocurrent generation in transition metal dichalcogenide alloy MoS2xSe2(1–x),* Physical Review B, 109, 115304, 2024
2. Abhishek Das, Riju Pal, Sakshi Mehta, Kazi Parvez Islam, Abhishake Mondal, **Atindra Nath Pal**, and Debraj Choudhury, *Space-charge driven origin of the reversible pyrocurrent peaks in* $Cu_{1-x}Cd_xCr_2O_4$, Physical Review B, 109, 024104, 2024
3. Rafiqul Alam, Prasun Boyal, Shubhankar Roy, Ratnadwip Singha, Buddhadeb Pal, Riju Pal, Prabhat Mandal, Priya Mahadevan, **Atindra Nath Pal**, *Detection of Nontrivial Topology Driven by Charge Density Wave in a Semi-Dirac Metal,* Avanced Functional Materials, 33, 2306751, 2023
4. Satyabrata Bera, Suman Kalyan Pradhan, Riju Pal, Buddhadeb Pal, Arnab Bera, Sk Kalimuddin, Manjil Das, Deep Singha Roy, Hasan Afzal, **Atindra Nath Pal**, Mintu Mondal, *Enhanced coercivity and emergent spin-cluster-glass state in 2D ferromagnetic material, Fe3GeTe2,* Journal of Magnetism and Magnetic Materials, 583, 171052, 2023
5. A. Rahaman, T. Paramanik, B. Pal, R. Pal, P. Maji, K. Bera, S. Mallik, D. K. Goswami, **A. N. Pal**, and D. Choudhury, *Surface-phase superconductivity in a Mg-deficient V-doped MgTi2O4 spinel,* Physical Review B, 107, 245124, 2023
6. Biswajit Pabi, Štepán Marek, Adwitiya Pal, Puja Kumari, Soumya Jyoti Ray, Arunabha Thakur, Richard Korytár and **Atindra Nath Pal**, *Resonant transport in a highly conducting single molecular junction via metal–metal covalent bond,* Nanoscale, 15, 12995-13008, 2023
7. Aishwaryo Ghosh, Biswajit Pabi, **Atindra Nath Pal** and Tanusri Saha-Dasgupta, *Machine-learning prediction of the formation of atomic gold wires by mechanically controlled break junctions,* Nanoscale, 15, 17045-17054, 2023
8. Shubhrasish Mukherjee, Didhiti Bhattacharya, Samit Kumar Ray, and **Atindra Nath Pal**, *Photoresponse mediated by exciton-plasmon coupling in two-dimensional hybrid phototransistors,* Physical Review Applied, 20, 064010, 2023
9. Biswajit Pabi, Jakub Šebesta, Richard Korytár, Oren Tal, and **Atindra Nath Pal**, *Structural Regulation of Mechanical Gating in Molecular Junctions,* Nano Letters, 23, 3775-3780, 2023

### b) Other Publications

1. Flicker noise in an electrolyte gated large area GrFET, R Alam, S Moulick, AN Pal, AIP Conference Proceedings 3067 (1) (2024)
2. Intrinsic room temperature ferromagnetism in van der Waals Fe5GeTe2 crystal, R Pal, S Bera, B Pal, M Mondal, AN Pal, AIP Conference Proceedings 3067 (1) (2024)
3. G phonon mode splitting in doped bilayer graphene probed by in-situ transport measurement and Raman spectroscopy, S Moulick, S Mukherjee, S Raha, A Singha, AN Pal, AIP Conference Proceedings 3067 (1), (2024)
4. Characterizations of a few layered MoS2 phototransistor using a homebuilt cost-effective measurement setup, S Mukherjee, AN Pal, SK Ray, AIP Conference Proceedings 3067 (1) (2024)

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at ETMQC - 26-29 June, 2023; June 26, 2023; Weizmann Institute, Israel; 4 days
2. 2. Invited talk at ICTN-KLC-2023, IITM, 6-8 July, 2023; July 6, 2023; IITM, Chennai; 3 days
3. Contributary talk at RPGR 23, Bangalore; November 20, 2023; Hotel Lalit, Bangalore; 4 days
4. Invited talk at IWPSD 2023; December 14, 2023; IITM, Chennai; 5 days
5. Invited talk at Frustrated Magnetic system, SNBNCBS; December 27, 2023; SNBNCBS; 2 days
6. Invited talk at 2DMAT 24; January 18, 2024; SNBNCBS; 2 days
7. Invited talk at NPC Conclave, 2024; February 6, 2024; SRM, Chennai; 4 days
8. Invited talk at ICFM 2024; January 9, 2024; IIT KGP; 4 days

## Administrative duties

1. In charge of Ellipsometry system, Helium plant, Oxford system, 3K measurement system and Joint in-charge of clean room
2. Member of Project & Patent Cell, Member of purchase sub committee and several other committees time to time.

## Awards, Recognitions, if any

1. Young Applied Physicist award at the NPC 2024, organized by SRM Chennai

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. DST/NM/TUE/QM-10/2019; DST-Nanomission -ongoing since March, 2023; 5 years (since March 2023); PI
2. CRG/2020/004208 - Project Title - Probing orbital hybridization and structural asymmetry in atomic and molecular nano-contact via inelastic electron spectroscopy and shot noise; SERB-DST; 3 years since 2020; PI

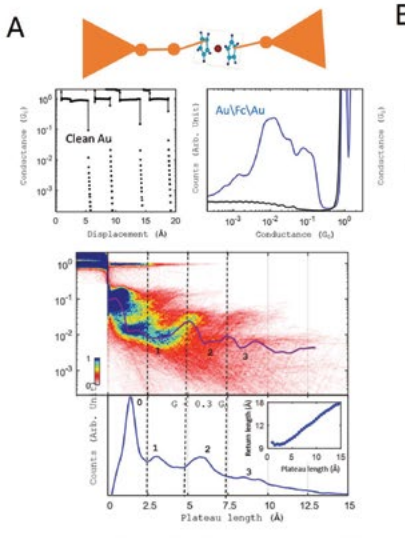
## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prabhat Mandal, SNBNCBS; Sl. No. 3; National
2. Priya Mahadevan, SNBNCBS; Sl. No. 3; National
3. Tanusri Saha-Dasgupta, SNBNCBS; Sl. No. 7; National
4. Debraj Chowdhury, IIT KGP; Sl. No. 5; National
5. S K Ray, IIT KGP; Sl. No. 8; National
6. Mintu Mandal, IACS; Sl. No. 4; National
7. Oren Tal, Weizmann Institute; Sl. No. 9; International
8. Richard Korytar, Charles University Prague; Sl. No. 6, 9; International
9. Tanmoy Das, IISc; Sl. No. 3; National
10. Soumyajyoti Ray, IIT Patna; Sl. No. 6, 9; National
11. Arunabha Thakur, Jadavpur University; Sl. No. 6, 9; National
12. Achintya Singha, Bose Institute; Sl. No. 1; National

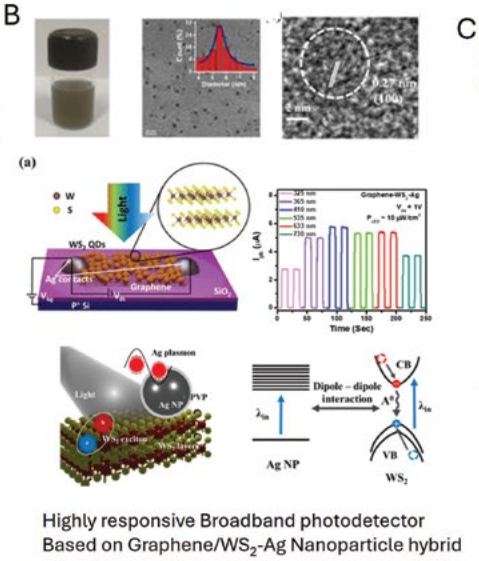
## Areas of Research

### Experimental condensed matter physics

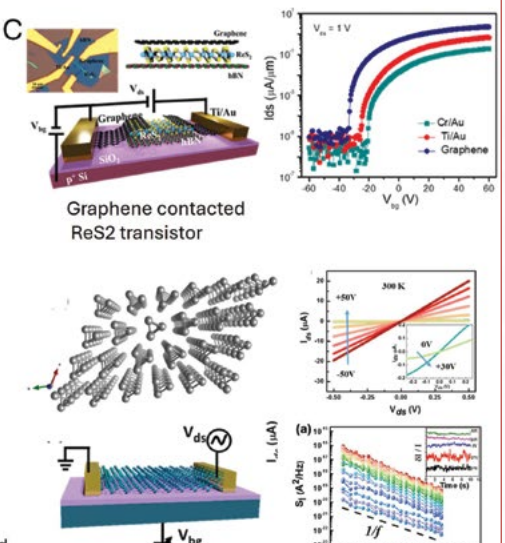
**A. Transport through single molecular junction:** Several new results have been obtained in this direction. (1) We have used machine-learning based technique to predict the formation of atomic gold wires by mechanically controlled break junction (Nanoscale, 2023). (2) We have shown that Ferrocene based molecular junction exhibit resonant transport and high conductance at room temperature (Nanoscale, 2023). (3) Following this we have new results on the formation of molecule assisted 1D atomic chain at 4.2 K with unusual stretching dependence. One PhD student, Mr. Biswajit Pabi, submitted his thesis and defended it as well. At present there are two PhD students working in this direction. They are optimizing the low temperature measurements, shot noise set up and glove box based set up to perform measurements on air-sensitive electrodes like Cu, Pt, Al.




Formation of molecule assisted 1D chain in Au/Ferrocene junction at 4.2 K



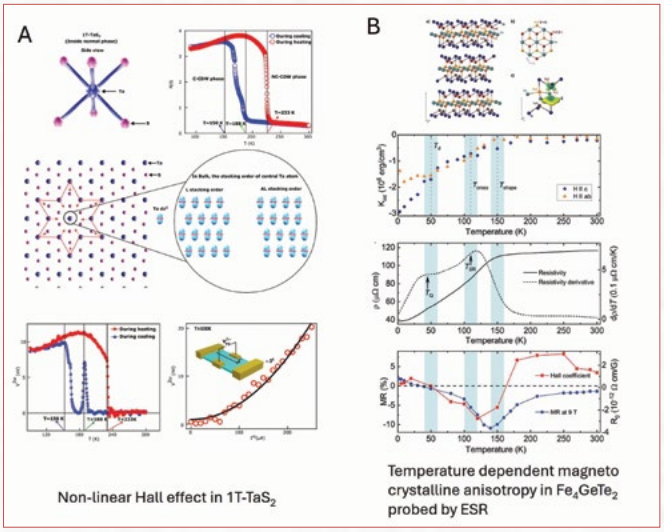

Highly responsive Broadband photodetector Based on Graphene/$WS_2$-Ag Nanoparticle hybrid (Phys. Rev. Applied 20, 064010, 2023 )



**B. Optoelectronics with 2D materials:** After establishing the effect of morphology and alloy engineering on graphene based 2D-0D hybrid photodetectors, our focus was to enhance the optoelectronic performance by tuning the light matter interaction. By incorporating the PVP coated silver nanoparticle on WS2 nanosheets, we have been able to observe tunable exciton-plasmon coupling, further leading to enhance optoelectronic performance (Phys. Rev. Applied, 2023). Mr. Shubhrsish Mukherjee, working on these projects, has submitted his thesis, and defended it as well.

**C. Electronic transport and noise in 2D semiconductors:** In the area of electronic devices, we are focusing on the emerging n-type and p-type 2D semiconductor. (1) After growing 2D Tellurene via hydrothermal method, we have fabricated FETs exhibiting ambipolar behavior. Furthermore, we investigated the temperature dependent transport and low frequency noise characteristics. (2) In another project, we are looking at the transport characteristics of n-type ReS2. We have been able to create barrier free contact on ReS2 by contacting it with graphene, exhibiting superior electronic and optoelectronic behavior. Mr. Shubhradip Moulick working in this area, has submitted his thesis.

**D. Emerging phases in 2D ferromagnet:** Continuing our work on van der Waal ferromagnets, we have published our results in Fe4GeTe2, exhibiting unusual electronic transitions leading to distinct transport behavior (npj 2D Materials and applications, 2024). Following this we unveil the unusual temperature dependent anisotropy via ESR measurement, as a part of collaboration under the SNBNCBS-IFW MOU (ADFM, 2024).




Non-linear Hall effect in 1T-$TaS_2$

Temperature dependent magneto crystalline anisotropy in $Fe_4GeTe_2$ probed by ESR

**E. Correlation and Topology in CDW system:** In this direction we are trying to gain insights into correlation-driven topological transitions via electron transport measurements. (1) First, in LaAgSb2, featuring a square net crystal structure, we observed different behavior in the planar Hall signal, across the CDW transitions and can be explained by the breaking of inversion symmetry, further leading to finite Berry curvature (ADFM, 2023). (2) We are now focusing on another chiral CDW material, 1T-TaS2, which also exhibit finite PHE signal and Non-linear Hall effect (NLHE) appearing only inside the chiral CDW phase. The breakdown of inversion symmetry in the commensurate CDW phase leads to persistent Berry curvature, determined through a developed model Hamiltonian based on electronic band structure.

## Plan of Future Work Including Project

1. Transport through Single molecular junction: We have successfully developed the technique and progressed significantly in this direction. In the coming years we are focusing on the voltage control conformation change in molecular junction, optimization of shot noise measurement and glove box based MCBJ set up to measure metallic electrodes at room temperature other than gold.
2. 2D semiconductor devices: In this direction, we will focus more on anisotropic 2D materials like ReS2, Tellurene. We will also develop the DLTS technique to measure the defect densities along with transport and noise. Also, we will focus on 2D/organic hybrid for possible light-matter interaction.
3. 2D magnet: Our initial measurements show lot of prospects, and we would like to focus on thin layer FGT system to understand the anisotropy and electronic behavior. More materials and new type of devices will be explored.
4. Emergent phases in quantum materials: We will focus more on topological and charge density wave materials for emergent phases with non-trivial tropology. Low temperature phases of 1T-TaS2 will be investigated in more details to clarify the debate on Mott insulating phases.


## Avijit Chowdhury

Assistant Professor

Condensed Matter and Materials Physics

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Nipom Sekhar Das; Organic-Inorganic Layered Nanohybrid Dispersed Ferroelectric Polymer Blend For Nonvolatile Resistive Memory Applications; Thesis submitted; Asim Roy, Department of Physics, NIT Silchar, Assam (Co-supervisor)
2. Suma Das; Development of g-C3N4-based magnetic nanomaterials for photocatalysis applications; Under progress; Ranjith G. Nair, Department of Physics, NIT Silchar, Assam (Co-supervisor)
3. Saikat Mitra; Hallide perovskite for optoelectronic applications; Under progress; Barnali Ghosh (Saha) (Co-supervisor)
4. Swapnamay Paramanik; Solar Photocatalysis for dye degradation and H2 evolution; Under progress
5. Rajesh Jana; 2D materials for optoelectronic synaptic devices; Under progress
6. Mukul Biswas; 2D material based triboelectric nanogenerator; Under progress
7. Rahul Mondal; Self-powered flexible TENG to estimate the pressure distribution inside a prosthetic sockets; Under progress

### b) Post-Docs

1. Ritamay Bhunia (PDRA III); Artificial Optic-Synaptic Organ for Different Colored Long-Time Perception

### c) External Project Students / Summer Training

1. Shareerah Sahid (2023); Hybrid Nanomaterials for memristive device Application
2. Rishiraj Dutta (2023); Two Dimensional Layered Material (gC3N4) for Triboelectric Nanogenerator

## Teaching

1. Spring semester; Electronics & Instrumentation (PHY408); Integrated PhD; 14 students; Kalyan Mandal (Co-teacher)
2. Spring semester; Basic Laboratory II (PHY492); Integrated PhD; 14 students; Kalyan Mandal (Co-teacher)

## Publications

### a) In journals

1. Rajesh Jana, Sagnik Ghosh, Ritamay Bhunia and **Avijit Chowdhury**, *Recent developments in the state-of-the-art optoelectronic synaptic devices based on 2D materials: a review,* Journal of Materials Chemistry C, 12, 5299-5338, 2024

2. Nipom Sekhar Das, Rajesh Jana, Asim Roy & **Avijit Chowdhury**, *Nanohybrid embedded ferroelectric polymer blend for bipolar memristive application,* Applied Physics A, 129, 796, 2023

3. Suma Das, Swapnamoy Pramanik, Ranjith G. Nair, and **Avijit Chowdhury**, *Unlocking the potential of thermally exfoliated ultrathin g-C3N4 nanosheets: abundant active sites for enhanced solar photocatalysis,* New Journal of Chemistry, 47, 12418-12430, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Exfoliated Two-Dimensional Materials for Solar Photocatalysis (2dMAT held at SNBNCBS); January 19, 2024; SNBNCBS; 40 min
2. Neurons are essentially electrical devices (Topical Research School); March 11, 2024; GC College Silchar; 1h

## Administrative duties

1. Member of Theoretical Physics Seminar Circuit, SNBNCBS
2. Faculty In-charge, CKM Laboratory
3. Faculty In-charge, ALD, PLD, RTA

## Membership of Learned Societies

1. Life Member of MRSI
2. Life Member of the Indian Association for the Cultivation of Science

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Development and testing of broadband optoelectronic synaptic devices employing ferroelectric/ photoelectric 2D material hybrid system; DST-SERB; 3 Years (March 09, 2023- to date); PI

## Conference / Symposia / Schools organized

1. Topical Research School on Recent Trends of Research in Theoretical and Experimental Physics; March 11, 2024; Department of Physics, G.C. College, Silchar; 03 days
2. Scientific collaborations with other national / international institutions (based on joint publications)
3. Mr. Sagnik Ghosh, Uppsala University, Sweden; Sl. No. 1; International
4. Prof. Asim Roy, NIT Silchar, Assam, India; Sl. No. 2; National
5. Dr. R G Nair, NIT Silchar, Assam, India; Sl. No. 3; National

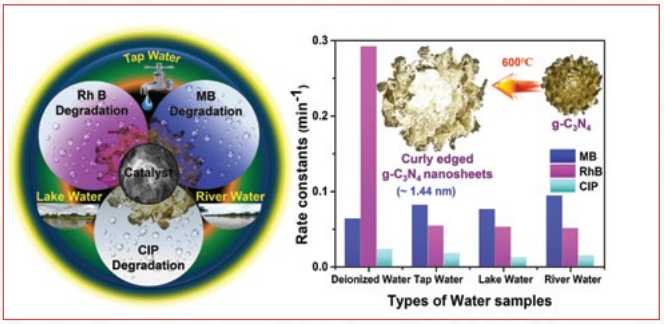
## Outreach program organized / participated

1. C.K. Majumdar Memorial Summer Workshop in Physics 2023, held at SNBNCBS during July 18-28, 2023.

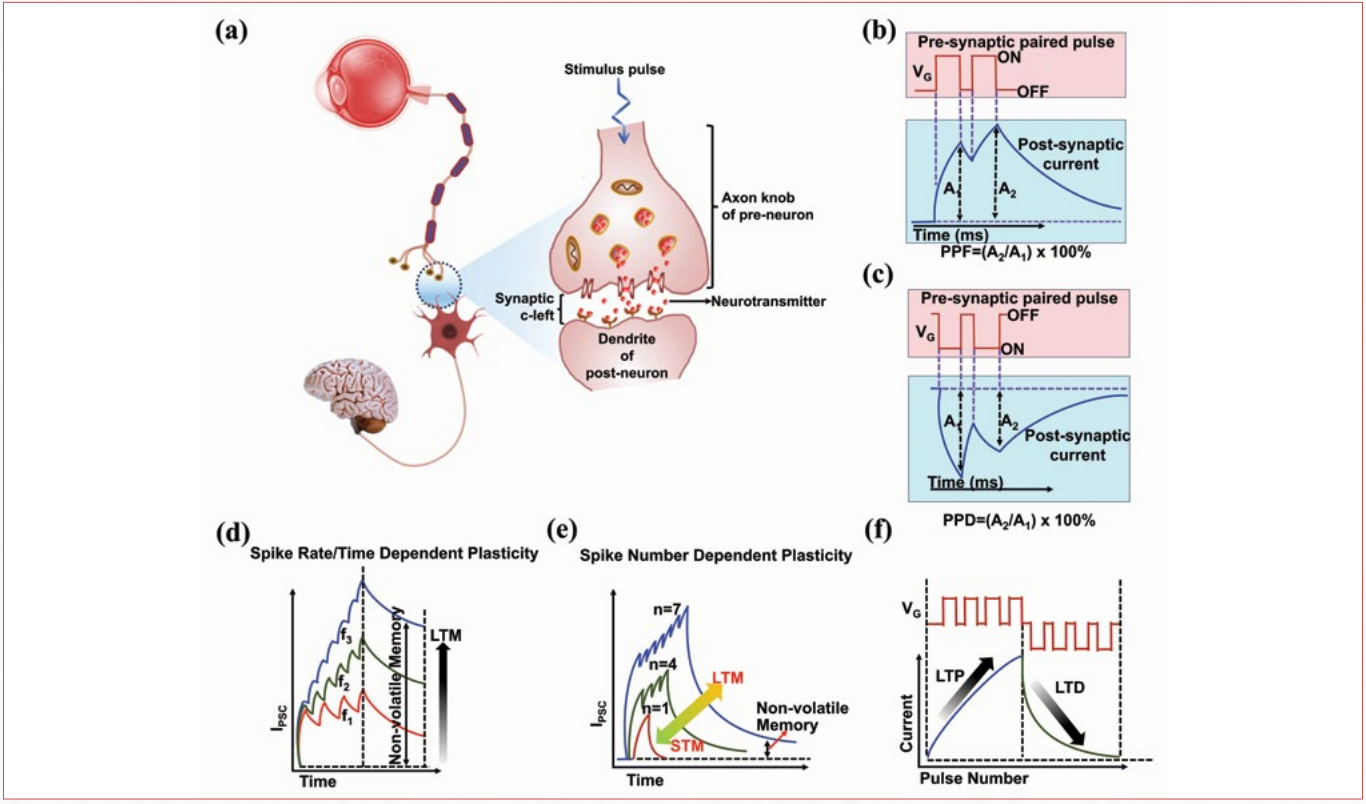
## Areas of Research

### Experimental Condensed Matter Physics and Materials Science

**Work 1:** Tailoring surface properties of the catalysts by introducing various functional groups with superior adsorption properties has been a promising strategy to boost photocatalytic performances. In this study, the thermal exfoliation of graphitic carbon nitride (g-C3N4) was utilized to produce ultrathin nanosheets that exhibit a high specific surface area and abundant active sites. The exfoliated g-C3N4 nanosheets (CN-600) were produced by heating pristine g-C3N4 (CN) in ambient air at 600 ℃ for 2 hours, which exhibits a specific surface area of 171.05 m2/g, and a higher quantity of functional groups (-NH2 and oxygen). The morphological analysis demonstrates exfoliated nanosheets (average thickness ~1.44 nm) with curly edges and fluffy structures. XPS analysis estimates the surface atomic ratio (C/N) as 0.988 and 0.758 for CN and CN-600, respectively, confirming lower structural flaws of the latter. CN-600 demonstrates a noteworthy improvement in its ability to degrade multiple pollutants and antibiotics in diverse aqueous solutions, showcasing its superior photocatalytic activity under solar radiation. CN-600 exhibits a higher rate constant than pristine CN by 3.66, 7.01, and 1.42 times, respectively, in the degradation of methylene blue, rhodamine B, and ciprofloxacin (Figure 1a,b). This enhancement in photocatalytic performance is corroborated by a larger specific surface area of the nanosheets, an abundance of active sites, a higher number of functional groups (-NH2 and oxygen), and a reduced distance of charge transfer between the layers. Overall, the g-C3N4 nanosheets exhibit significant potential as a high-performance photocatalytic material that operates efficiently with visible light, offering a plethora of possible applications in the fields of energy and the environment.



**Work 2:** The synaptic plasticity observed in biological synapses encompasses various timescales crucial for memory, learning, and diverse signal processing with minimal power consumption. Likewise, the synaptic devices, a cutting-edge paradigm in neuromorphic engineering, use external stimuli to replicate biological synaptic functions with utmost energy efficiency, circumventing the constraints imposed by the von Neumann bottleneck. With inherent characteristics like near-atomic thickness, tunable bandgap, defect-mediated states, robust electrical-optical response, high compatibility, and scalability, 2D materials hold significant potential as building blocks for optoelectronic artificial neuromorphic devices. In particular, the distinctive traits of 2D materials facilitate notable improvements in synaptic performances, including learning capability and power efficiency, depending on the materials, device architectures, and external stimulus. This review focuses on state-of-the-art developments in device structures, working principles, material design strategies, and the integration of 2D materials-based optoelectronic synaptic devices. Herein, different biological synaptic functions with time scales are introduced first, followed by the working mechanism of optoelectronic synaptic devices based on 2D materials. Further, the syntheses and exfoliation of 2D materials, including their heterostructures (2D-0D, 2D-1D, 2D-2D) and different device configurations (2 or 3 terminal, integrated devices) are outlined for synaptic applications. The specific applications of 2D materials-based optoelectronic synapses in Boolean functions, visual image memorization, and image processing are emphasized, with subsequent discussions addressing the current challenges and future perspectives in this field (Figures 2a-f).




## Plan of Future Work Including Project

Mesoporous catalysts with a high specific surface area, accessible pore structures, and appropriate band edges are desirable for optimal charge transfer across the interfaces, suppression of electron-hole recombination, and promotion of redox reactions at the active sites. Therefore, we are trying to design mesoporous g-C3N4@ZnFe2O4 magnetic nanocomposites (MNCs) with different pore sizes and pore volumes following various methods. The mesoporous gC3N4@ZnFe2O4 MNCs are expected to improve hydrogen evolution rate and methylene blue (MB) dye degradation via the optimal loading of ZnFe2O4.

In another attempt, an experimental investigation into bipolar switching in a polymer blend, incorporating Ag-decorated g-C3N4, is performed to replicate associative learning processes and explore Morse code applications. The study aims to characterize and comprehend bipolar memory behavior through electrical pulse-dependent measurements. Mechanisms underlying this switching phenomenon and their relevance in mimicking associative learning behaviors found in biological systems are explored.


## Barnali Ghosh (Saha)

Scientist-F

Condensed Matter and Materials Physics

barnali@bose.res.in


## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Avisek Maity; "Synthesis, Characterization, Physical Property Studies & Applications of Perovskite Halide"; Awarded
2. Parushottam Majhi; "Structure And Physical Properties Of Strained Metal Oxide Films"; Awarded; Prof. A.K.Raychaudhuri (Co-supervisor)
3. Snehamoyee Hazra; Investigation on Nanostructured Piezoelectric and Ferroelectric materials"; Awarded
4. Sudipta Chatterjee; Investigation On Transort And Magneto-Transport Properties of Transition Metal Based Oxides And Alloys; Awarded; Prof. Kalyan Mandal (Co-supervisor)
5. Saikat Mitra; Studies of Growth and Physical Properties of Perovskite Halides; Under progress; Dr. Avijit Chowdhury (Co-supervisor)

### b) Post-Docs

1. Mustaque Ali Khan; 2D Materials Based Advanced Photodetectors and Effect of ALD Grown Dielectric Gate Oxide on the Device performance

### c) External Project Students / Summer Training

1. Nibedita Sen; Growth Characterization and Low temperature transport measurements on NdNiO3 Films

## Teaching

1. Spring semester; IPHD Semester-IV, Spring 2023, PHY 401: PROJECT RESEARCH III

## Publications

### a) In journals

1. Avisek Maity, Saikat Mitra, and **Barnali Ghosh**, *Textile Based Lead-Free Halide Perovskite CH3NH3SnI3 Ammonia Gas Sensor Working at Room Temperature,* ACS Applied Electronic Materials, 6, 2677-2682, 2024
2. Sudipta Chatterjee, Saheli Samanta, **Barnali Ghosh**, and Kalyan Mandal, *Half-metallic ferromagnetism and intrinsic anomalous Hall effect in the topological Heusler compound Co2MnGe,* Physical Review B, 108, 205108, 2023
3. Parushottam Majhi, Saikat Mitra, Akriti Singh, **Barnali Ghosh**, V. R. Reddy, Surajit Saha, and A. K. Raychaudhuri, *Phase coexistence and resistance relaxation kinetics in NdNiO3 films below the metal-insulator transition temperature,* Physical Review B, 108, 064103, 2023

4. D. Banerjee, C. C. Dey, Ravi Kumar, Brindaban Modak, Snehamoyee Hazra, Subarna Datta, **Barnali Ghosh**, S. V. Thakare, S. N. Jha and D. Bhattacharyya, *Comprehensive study on the origin of orthorhombic phase stabilization in Gd-doped HfO2 and DFT calculations,* Physical Chemistry Chemical Physics, 25, 21479-21491, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. International Conference for Award Winners in Engineering, Science and Medicine Pondicherry, India, INSO- 2023; 15 & 16-Apr-2023; Pondicherry, India; 2 days
2. International Conference on Recent Trends in Materials Science and Devices (2023) (ICRTMD 2023); 22-23 July, 2023; Organised by Research Plateau Publishers & G.A.V. Degree College, Patauda, Jhajjar, Haryana, India; 2 days
3. The 4th International Workshop in Advanced Materials and Devices - IWAMD 2023, Thai Nguyen, Vietnam; 10-13 August, 2023; Thai Nguyen University of Sciences, Thai Nguyen, Vietnam; 3 days

## Administrative duties

1. Purchase, up-gradation site preparation and installation of common facility equipment s under TRC
2. Scientist - in charge of few Central equipment facilities under TRC
3. Purchase/ upgradation/ Maintenance as In-charge of common facility equipments under Technical Cell
4. Garden and plumbing
5. Various thesis committee
6. Purchase committee

## Patents Taken and Process Developed with Details

1. Flexible Thin Film Transistor using Electric Double layer as gate dielectric and a method of fabricating there of; 438159; Granted on 11/7/2023 file no:201731015268
2. A gas Sensing System for selective detection of nitric oxide (NO) gas at room temperature"; 452697; Granted; File no: 201731038036 (Filled on 26.10.2017)
3. A paper based Ammonia gas selective sensor with electrical readout and a method for Manufacturing the same; 478506; Granted; 201831001993 (Filled on 17.01.2018)
4. Advancement in methodology and system to control isotopic Fractionations in carbon containing gases; Granted; 201731017087 (Filled on 16.05.2017)

## Awards, Recognitions, if any

1. 'Best Paper award' for invited lecture presentation in the ' International Conference on Recent Trends in Materials Science & Devices, 2023, (ICRTMD-2023)
2. OUTSTANDING SCIENTIST AWARD In the International Conference for Award Winners in Engineering, Science and Medicine, held on 15 & 16-Apr-2023, Pondicherry
3. Distinguished Scientist Award ASTRA 2023'under Asia International Science, Technology Research Awards, in Experimental Condensed Matter Physics and Materials Sciences, Nano science and Nanotechnology.
4. ACS Publication Peer Reviewer Certificate of Recognition & Appreciation, 2023

## Membership of Learned Societies

1. Life member Indian Physics Association
2. Life member Indian Association for the Cultivation of Science
3. American Physical Society
4. American Chemical society
5. Editor for the IIP (Iterative International Publishers)

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Understanding of Growth of Vertically aligned Nanowires or nanotubes of binary oxides and Physics of isotopic fractionation of gases by them; SERB-DST; 6/7/2018-5/4/2022; PI
2. Technical Research Centre (TRC), Centre Project, One of the activity leader among others; DST; 01/1/2016- 30/6/2022; PI

## Scientific collaborations with other national / international institutions (based on joint publications)

1. VECC, Kolkata; Sl. No. 4; National
2. CGCRI, Kolkata; Sl. No. 3; National

## Outreach program organized / participated

1. Women's Rights, Laws and Policies in India, IMPRI an immersive Legal Awareness and Certificate Training Course Dates: September 1-3, 2022, Policy learning, Zoom Platform
2. Empowering Women in Sensor Technology, EWST 22" in association with Women in Sensor (WiSe) organized by IEEE Sensors Council Student Branch Chapter II, IIT Indore, 16 December 2022 (hybrid mode)

## Areas of Research

1. Study of Photoresponse and gas sensing property in binary oxide hetero junction systems.
2. Growth and physical property study of perovskite lead halide
3. Synchrotron X-ray and Neutron diffraction study in complex oxides.
4. Paper electronic based device for gas sensing activity of perovskite halides
5. Study on paper electronic based Photo detector of perovskite halides
6. Growth of binary and complex oxide nanowires and thin films by using different techniques like; wet chemistry and pulsed laser deposition methods and atomic layer deposition.
7. Fabrication of single nanowire device of complex oxide systems by using different lithographic techniques and transport measurement on single nanowire.
8. Cross-sectional TEM study in binary and complex oxide nanowires, nanocrystals and thin films
9. Growth of high performance thin film transistors (TFT) and physical property study

**1) Phase coexistence and resistance relaxation kinetics in NdNiO3 films below the metalinsulator transition temperature**

Coexistence of electronically distinct phases below metal-insulator (MI) transition temperature (TMI) in correlated oxides undergoing temperature-driven MI transition has been observed in a number of systems. One of the consequences of the coexisting phases is that the metastable hightemperature metallic phase transforms into the stable insulating phase with a finite relaxation time as the temperature is lowered below TMI. We report an extensive investigation of the phase transformation (referred to as relaxation) using resistivity as a tool where the ramp-dependent hysteresis and isothermal annealing-induced resistance relaxation were studied in films of NdNiO3 grown on three different crystalline substrates (LaAlO3, SrTiO3, and BaTiO3/SrTiO3) down to 10 K, well below the metal-insulator transition temperature. The resistance relaxation experiments were complemented with Raman spectroscopy and high-resolution x-ray diffraction done down to 5 K and reciprocal space mapping (RSM). Isothermal annealing experiment done to temperatures < TMI shows that the average relaxation time ⟨T⟩ decreases on cooling. This can arise from a temperature-dependent barrier to relaxation, where the barrier reduces continuously on cooling down to a temperature, referred to as T*. T* has been interpreted as a likely limit of supercooling so that the relaxation time →0 at this temperature. The resistance relaxation data were linked to x-ray diffraction and Raman spectroscopy data done to temperatures well below TMI, in order to have a structural basis for the coexisting phases and their likely participation in the relaxation process. The experiments (both hysteresis and isothermal annealing) were analyzed by Monte Carlo simulation based on a minimal set of parameters, namely, a temperature T* and an energy scale of transformation E*, which themselves had a temperature dependence. The parameters used in the simulation and other experimentally observed quantities like the width and height of hysteresis were found to be correlated with certain structural parameters, in particular, the residual in-plane strain and the crystallite grain size that determine the size range in these films.

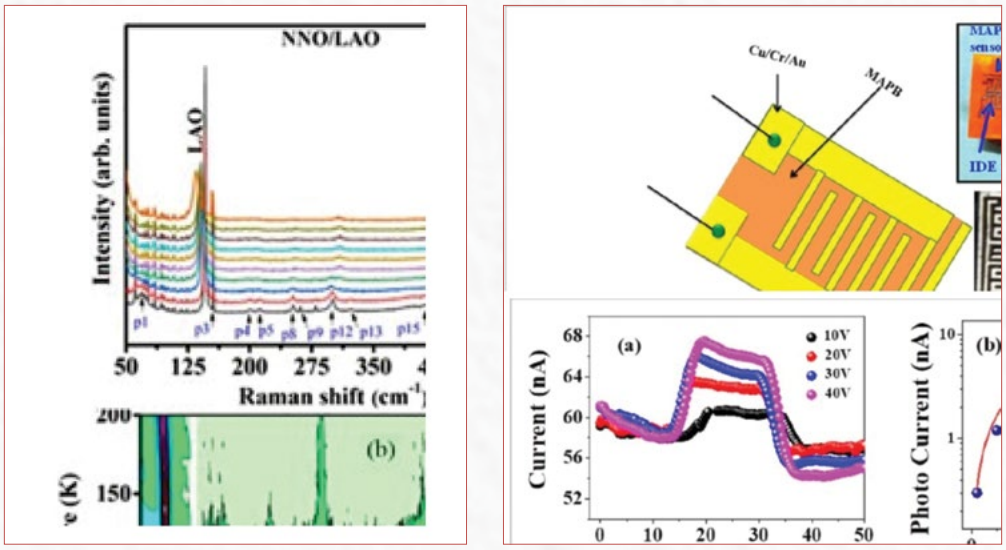



Fig. The Raman spectra for NNO/LAO film at few representative temperatures. (b) A colored contour plot of Raman data showing the evolution of Raman mode with both frequency and temperature.

2) **Low Power Paper Electronics Based Wearable Radiation Detector Using Hybrid Halide Perovskite): A Real Time Monitoring Of Gamma Ray**

In this report we demonstrate that a paper based flexible gamma ray detector can be made using hybrid halide perovskite..The wearable paper based detector is solution processed and works at room temperature. It detects gamma ray by a direct method by change of its resistance on exposure to gamma ray and uses IDE (interdigitated electrodes) for boosting current response. This detector grown on a substrate like a paper with large active area, shows a maximum calibrated sensitivity of 5.26 μC/Gy/cm $^2$ and a reasonable mobility –life time product (μτ) ~2×10^(-5)cm $^2$ /V. The detector can be operated in a wide range of gamma photon energy between 100KeV to 1100 KeV and can detect radiation down to 0.01μCi activity, which is noise limited. The paper detector shows a good shelf life of more than 6 months and a fast response time of a few seconds. The detector has a high degree of sustenance under exposure to high dose of Gamma radiation and was tested for a cumulative dose of minimum 1.6KGy. The detector has low power consumption with can operate down to 1 V DC bias and with a detector current of ~ 1nA. The sensitivity increases with bias and shows saturation beyond 40V bias. Such a low power flexible gamma detector is expected to have application potential in areas like health care and point of use quick radiation detection.

## Plan of Future Work Including Project

Gas Sensors: A development of a visual sensor based on colour change has been done on paper. It could have potential to detect sub ppm capability for real time practical usage. It is extremely useful for Environment protection as well as health care sector. Application areas: Gas industry, Refrigeration industry, Agricultural (fertilizer) industries, Food Beverage and cold storage industries, Medical diagnosis (as marker for renal diseases), chronic kidney diseases (CKD), can be used to check the efficacy of the dialysis.

## Any other Relevant Information including social impact of research

1) Radiation Detector, 2) Hazardas (Ammonia) gas detector, 3) Nanogenerator 1)Radiation Detector: A detector for real time quick monitoring of gamma radiation Novelty of our invention, application areas &social impact: There are several areas like nuclear imaging; cancer therapy; security checking, where needs radiation detector just as a quick tracer of presence of gamma radiation. Conventional techniques are not easy to use. A deviated approach for gamma ray detection not by energy resolution rather via electrical read out method at room temperature using this novel solid state radiation detector as a quick marker of gamma radiation. This Detection technique could be extremely useful in radiation prone areas, in a quick and cost effective way - where fine energy resolution is not a primary concern. Moreover the detector is Highly Radiation Resistant. 2)Gas Sensors: We developed a visual sensor Based on colour change grown on paper. It could have potential to detect sub ppm capability for real time practical usage. It is extremely useful for Environment protection as well as health care sector. Application areas: Refrigeration industry, Agricultural (fertilizer) industries, Food Beverage and cold storage industries, Medical diagnosis (as marker for renal diseases), chronic kidney diseases (CKD), can be used to check the efficacy of the dialysis. 3) Nanogenerator: Generation of power from waste energy: Application 1) Charging of Mobile, Smart watch, Blue tooth devices etc.


## Kalyan Mandal

Senior Professor

Condensed Matter and Materials Physics

kalyan@bose.res.in


### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Swarnali Hait; Multiferroic materials; Thesis submitted
2. Anupam Gorai; Microwave properties of ferrite nanostructures; Thesis submitted
3. Sudipta Chatterjee; Transport And Magneto-Transport Properties of 3d Transition Metal Based Compounds; Thesis submitted; Dr. Barnali Ghosh (Co-supervisor)
4. Saheli Samanta; Magnetocaloric effect; Awarded
5. Soham Saha; Photoelectro-chemical water splitting; Under progress
6. J Sridhar Mohanty; Magnetocaloric effect in alloys of all d metal; Under progress
7. Ishita Jana; Multiferroic materials; Under progress
8. Saurav Sarkar; Magnetic and dielectric properties of transition metal oxides; Under progress

#### b) Post-Docs

1. Mily Kundu; Magnetic phase transitions and critical phenomena

### Teaching

1. Spring semester; Electronics and Instrumentation (PHY 408); Integrated PhD; 14 students; Dr. Abhijit Chaudhuri (Co-teacher)
2. Spring semester; Basic Laboratory (PHY 492); Integrated PhD; 14 students; Dr. Abhijit Chaudhuri (Co-teacher)
3. Spring semester; Methods of Experimental Physics (PHY 592); Integrated PhD; 11 students; Nitesh Kumar, Pradip S Panchule, and Ramkrishna Das (Co-teachers)

### Publications

#### a) In journals

1. Saheli Samanta, Sudipta Chatterjee, Jayee Sinha, and **Kalyan Mandal**, *Giant reversibility of magnetoresponsive properties in all-d-metal Ni-Co-Mn(Cu)-Ti Heusler alloys: Role of phase-fraction-assisted magnetostructural transition,* Physical Review Materials, 7, 084406, 2023
2. Anupam Gorai, Swarnali Hait, Wolfgang Taute, Michael Höft, **Kalyan Mandal**, *Optimization of Magnetic Coating for Improved Electromagnetic Wave Absorption in Bi-Layered Nano-Hollow Spheres, IEEE Transactions on Magnetics,* 59, 2801406, 2023

3. J Sridhar Mohanty, Saheli Samanta, **Kalyan Mandal**, *Effect of heat treatment on coupled magnetostructural transition and magnetocaloric effect of MnNiGe system,* Journal of Magnetism and Magnetic Materials, 578, 170834, 2023
4. Sudipta Chatterjee, Jyotirmay Sau, Saheli Samanta, Barnali Ghosh, Nitesh Kumar, Manoranjan Kumar, and **Kalyan Mandal**, *Nodal-line and triple point fermion induced anomalous Hall effect in the topological Heusler compound Co2CrGa,* Physical Review B, 107, 125138, 2023
5. Swarnali Hait and **Kalyan Mandal**, *Enhancement of Curie temperature of gallium ferrite beyond room temperature by the formation of Ga0.8Fe1.2O3-Y3Fe5O12 composite,* AIP Advances, 13, 025345, 2023
6. Swarnali Hait, Anupam Gorai, **Kalyan Mandal**, *Origin of different microwave absorption in multiferroic Bismuth and Gallium Ferrite,* Materials Letters, 331, 133520, 2023
7. Dipanjan Maity, Debashish Pal, Soham Saha, Pooja Punetha, Debasish Sarkar, Debasis De, Gobinda Gopal Khan, **Kalyan Mandal**, *CeOx as Surface Passivation and Hole Transfer Catalyst Layer Boosting Solar Water Oxidation of ZnFe2O4 Nanorods Photoanode,* Advanced Materials Interfaces, 10, 2201645, 2023
8. Priyanka Saha and **Kalyan Mandal**, *Magnetic field stimulated dielectric, electronic and thermal properties of magnetite nano-hollow spheres based magnetorheological fluids,* Journal of Magnetism and Magnetic Materials, 565, 170237, 2023
9. Swarnali Hait, Ishita Jana and **Kalyan Mandal**, *Simultaneous improvement of leakage, electric, and magneto-dielectric properties due to the reduction in grain size,* Journal of Magnetism and Magnetic Materials, 565, 170239, 2023
10. Soham Saha, Dipanjan Maity, Debashish Pal, Debasish Sarkar, Debasis De, Gobinda Gopal Khan, and **Kalyan Mandal**, S*olar-Driven Water Splitting by a Nanostructured NiFe(OH)x Catalyst Incorporated BiVO4 Photoanode,* ACS Applied Nano Materials, 6, 21385-21394, 2023
11. Sudipta Chatterjee, Saheli Samanta, Barnali Ghosh, and **Kalyan Mandal**, *Half-metallic ferromagnetism and intrinsic anomalous Hall effect in the topological Heusler compound Co2MnGe,* Physical Review B, 108, 205108, 2023
12. Ishita Jana, Swarnali Hait, **Kalyan Mandal**, *Improvement of leakage, magnetic and magnetodielectric properties in cobalt doped gallium ferrite,* Journal of Physics: Condensed Matter, 35, 48, 2023
13. Susanta Ghosh, Achintya Low, Soumya Ghorai, **Kalyan Mandal**, Setti Thirupathaiah, *Tuning of electrical, magnetic, and topological properties of magnetic Weyl semimetal Mn3+xGe by Fe doping,* Journal of Physics: Condensed Matter, 35, 48, 2023
14. Swarnali Hait, Anupam Gorai and **Kalyan Mandal**, *Barium and Yttrium Co-doping in Bismuth Ferrite Nanoparticles to Enhance Microwave Properties,* Physica Scripta, 98, 095940, 2023
15. Swarnali Hait, Anupam Gorai, **Kalyan Mandal**, *Origin of different microwave absorption in multiferroic Bismuth and Gallium Ferrite,* Materials Letters, 331, 133520, 2023

### b) Other Publications

1. A. Gorai and K. Mandal, "Optimization of Magnetic Coating for Improved Electromagnetic Wave Absorption in Bi-layered Nano-hollow Spheres," Proceedings of IEEE International Magnetic Conference - 2023 at Sendai, Japan during 15-19 May, 2023, pp. 1-2.
2. S. Sarkar, P. Saha and K. Mandal, "Correlation between Dielectric and Magnetic properties in MgFe2O4 nano-structures", Proceedings of the International conference MAGMA-2023 at Hyderabad, India during 4-6 December 2023.
3. Soham Saha and Kalyan Mandal, "The One Dimensional p-ZnCo2O4/ n-ZnO Nanoheterojunction Photoanode for Photoelectrochemical Water Splitting", Proceedings of the Annual conference on quantum condensed matter QMAT-2023 at Bhubaneswar, India during 27-30 November 2023.
4. I. Jana, S. Hait and K. Mandal, "Improvement of Leakage, Magnetic and Magnetodielectric Properties in Cobalt doped Gallium Ferrite", Proceedings of the Annual conference on quantum condensed matter QMAT-2023 at Bhubaneswar, India during 27-30 November 2023.

## Talks / Seminars Delivered in reputed conference / institutions

1. "Finite Size Effect on Transition Metal Oxide Nanostructures" at 13$^{th}$ Vidyasagar Satyendra Nath Bose National Workshop on Emerging Fields in Theoretical and Experimental Physics (EFTEP-2024); March 6, 2024; Vidyasagar University, Midnapore 721102; one hour

## Administrative duties

1. Vigilance Officer, SNBNCBS

## Awards, Recognitions, if any

1. "Best Poster Award" in ICMAGMA-2023 organized by the Magnetic Society of India in Hyderabad, during 4-6 December, 2023.
2. "Magnetic leaves and feathers": winner of First Prize of "Magnetism as Art Showcase-2023" in IEEE Intermag-2023 conference held in Sendai, Japan during May 15-19, 2023.
3. "Wiley sponsored Best Presentation in Interdisciplinary Field" award in the International Conference on Sustainable Nanomaterials Integration & Organization for Energy and Environment (iSNIOE2) at the Conference iSNIOE2 held by Shiv Nadar Institute of Eminence, Delhi NCR during 20-23 March 2024.

## Membership of Learned Societies

1. Materials Research Society of India
2. Magnetics Society of India
3. Indian Society for Non-destructive Testing
4. Indian Physical Society
5. Indian Association of Physics Teachers

## Conference / Symposia / Schools organized

1. Young Scientist Colloquium – 2023; December 1, 2023; School of Materials Science and Nanotechnology, Jadavpur University; 01 December 2023

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Dr. Gobinda Gopal Khan, Tripura Central University, Tripura, India on "Electrochemical water splitting"; SI. No. 7, 10; National

## Areas of Research

1. Condensed matter physics, Magnetism and magnetic materials, Nanoscience and technology

## Photo-electrochemical water-splitting:

Energy is essential in modern life and largely sourced from fossil fuels, epleting these non-renewable resources rapidly and contributing to pollution and global warming. Hydrogen fuel from water-splitting offers a promising solution, but it requires significant energy. Our research focuses on creating photoelectrodes cost-effectively. that use sunlight for photoelectrochemical water splitting. This year, we addressed key issues like poor charge separation and transport in metal oxide semiconductors. First, we used a NiFe(OH) x catalyst layer on a BiVO4 (BVO) photoanode, boosting photocurrent density four fold. Second, we combined graphene quantum dots (GQD) with a cobalt phosphate catalyst (Co-Pi) on zinc ferrite nanorods (ZnFe2O4), achieving a 23-fold increase in photocurrent density due to their synergistic effect of band-bending.

## Magnetic Nanostructures:

Metamaterials with negative dielectric permittivity have become a research hotspot due to their potential effectiveness in a variety of electromagnetic applications, including filter and antenna design, innovative capacitance and inductor design, electromagnetic absorber, etc. Our study opens up a world of possibilities for manipulating the morphology of magnesium ferrite, a naturally occurring compound, to induce metamaterial features like negative dielectric permittivity. To the best of our knowledge, this is the first work that promises to obtain metamaterial properties in easily synthesized ferrites just twisting the morphology accordingly.

## Extensive magnetostructural temperature window and giant magnetocaloric effect in B-doped MnNiSi hexagonal system

Coupled first-order magnetic transformations (FOMTs) with narrow widths governed by low external stimuli play a crucial role in magnetic refrigeration for ferromagnetic hexagonal systems. In this work, we report a family of magnetocaloric materials named interstitial boron (B) doped-(MnNiSi)0.67(Fe2Ge)0.33 compounds that are devoid of rare-earth elements. Our results show that varying B concentrations up to 5 at % can tailor the robust FOMTs between the low-temperature ferromagnetic orthorhombic phase and the high-temperature paramagnetic hexagonal phase in a wider temperature regime. We found the samples performed good functional stability from the thermal cycling run. The branch of these B doping materials exhibits robust features of a large magnetocaloric effect (MCE) and temperature-averaged magnetic entropy change (TEC) over an extensive temperature range (~71 K) at a lower magnetic field change of 2T. These several tangible benefits, such as reduced DThys, geometrical compatibility, and robust MCE properties are first reported in the studied hexagonal system. Therefore, our results offer a viable approach to improve the cascading of these materials towards the application of cooling technology.

## Plan of Future Work Including Project

Research on the photo electro-chemical water splitting to produce hydrogen will be continued with earth-abundant, cost-effective materials with low recombination rate, higher mobility and suitable band gap to utilize the higher range of frequency of the solar light. Work on magnetocaloric effect using transition mental based low cost materials will be performed. Effort will be made to find out multiferroic materials with significant magnetoelectric coupling and excellent microwave absorbing materials.


## Manoranjan Kumar

Professor

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Jyotirmoy Sau; Magnetic and transport properties in correlated topological materials: A first-principles study; Under progress
2. Monalisa Chatterjee; Under progress
3. Manodip Routh; Thermal and quantum fluctuations in low dimensional strongly correlated systems; Under progress
4. Sayan Ghosh; Exploring the quantum & thermal fluctuations in frustrated strongly correlated low dimensional systems; under progress
5. Sourabh Saha; Study of exotic phases in multi-band correlated systems; Under progress
6. Anutosh Biswas; Quantum spin liquid in low dimensional system; Under progress; Prof. Tanusri Saha Dasgupta (Co-supervisor)

### b) Post-Docs

1. Sourav Chakraborty; Investigation of magnetic and transport properties within multiorbital Hubbard model

### c) External Project Students / Summer Training

1. Mitali Thorat; Deciphering the factors affecting phagocytosis to develop a minimal model

## Teaching

1. Spring semester; Correlated Electrons and Disorder; PhD; 8 students; Priya Mahadevan (Co-teacher)

## Publications

### a) In journals

1. Monalisa Chatterjee, **Manoranjan Kumar**, and Zoltán G. Soos, *Spin-1/2 string correlations and singlet-triplet gaps of frustrated ladders with ferromagnetic legs and alternate ferromagnetic and antiferromagnetic rungs,* Physical Review B, 109, 094439, 2024
2. Jyotirmoy Sau, Debanand Sa and **Manoranjan Kumar**, *Hydrostatic pressure-induced anomalous hall effect in Co2FeSi semimetal,* Electronic Structure, 6, 015008, 2024
3. Monalisa Chatterjee, **Manoranjan Kumar** and Zoltán G Soos, *Singlet quantum phases of the frustrated spin-1/2 ladder with ferromagnetic (F) exchange in legs and alternating F-AF exchange in rungs,* Physica Scripta, 99, 025973, 2024

4. Shuvankar Gupta, Jyotirmoy Sau, **Manoranjan Kumar**, Chandan Mazumdar, *Spin-gapless semiconducting characteristics and related band topology of quaternary Heusler alloy CoFeMnSn,* Journal of Materials Chemistry C, 12, 706-716, 2024
5. Anjishnu Bose, Manodip Routh, Sreekar Voleti, Sudip Kumar Saha, **Manoranjan Kumar**, Tanusri Saha-Dasgupta, and Arun Paramekanti, *Proximate Dirac spin liquid in the honeycomb lattice J1–J3 XXZ model: Numerical study and application to cobaltates,* Physical Review B, 108, 174422, 2023
6. Jyotirmoy Sau, S. R. Hassan, Nitesh Kumar, **Manoranjan Kumar**, *Topological properties and anomalous transport in van der Waals ferromagnets FenGeTe2: a comparative study,* Physica Scripta, 98, 125916, 2023
7. P. Biswal, S. Guchhait, S. Ghosh, S. N. Sarangi, D. Samal, Diptikanta Swain, **Manoranjan Kumar**, and R. Nath, *Crystal structure and magnetic properties of the spin-12 frustrated two-leg ladder compounds* (C4H14N2)Cu2X6 (X=Cl and Br), Physical Review B, 108, 134420, 2023
8. Sambunath Das, Dayasindhu Dey, Rajamani Raghunathan, Zoltan G. Soos, **Manoranjan Kumar** and S. Ramasesha, *Quantum phase transitions in skewed ladder systems,* Physical Chemistry Chemical Physics, 26, 36-46, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Emerging Materials; July 13, 2023; IISER Pune; 3 days
2. IFW-SNB Meeting; November 27, 2023; SNBNCBS, Kolkata; 3 days
3. The 34th Annual General Meeting of MRSI and 5th Indian Materials conclave; December 12, 2023; IIT BHU, Varanasi; 3 days
4. The Young Investigators Meet on Quantum Condensed Matter Theory; December 14, 2023; IISER Bhopal; 3 days
5. 2dMAT; January 18, 2024; S N Bose Centre Kolkata; 2 days

## Administrative duties

1. Hostel Warden
2. Jest coordinator from S. N. Bose National Centre for Basic Sciences, Kolkata

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature; SERB, DST; 30.12.2020-29.12.2023; PI

## Conference / Symposia / Schools organized

1. Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature; December 26, 2023; S.N. Bose National Centre for Basic Sciences; 2 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Zoltán G. Soos, Princeton University, USA; International
2. Arun Paramekanti, University of Toronto, USA; International
3. Hosho Katsura,University of Tokyo,Tokyo, Japan; International
4. Satoshi Nishimoto,Institute for Theoretical Solid State Physics,IFW Dresden, Germany; International
5. Jeroen van den Brink, Institute for Theoretical Solid State Physics,IFW Dresden, Germany; International
6. Rajiv R.P. Singh, University of California, Davis, USA; International
7. Nitesh Kumar, S.N. Bose National Centre for Basic Sciences, Kolkata, India; National
8. SM Yusuf, Bhabha Atomic Research Centre, India; National
9. Anup Kumar Bera, Bhabha Atomic Research Centre, India; National
10. Tanusri Saha Dasgupta, S.N. Bose National Centre for Basic Sciences, Kolkata, India; National
11. Debanand Sa, Banaras Hindu University, India; National
12. Chandan Mazumdar, Saha Institute of Nuclear Physics, Kolkata, India; National
13. S R Hasan, Institute of Mathematical Science, Chennai, India; National
14. Ramesh Nath, Indian Institute of Science Education and Research, Thiruvannthapuram, India; National
15. Deepshikha Jaiswal, Indian Institute of Science Education and Research, Thiruvannthapuram, India; National

## Areas of Research

### Theoretical Condensed Matter Physics

In last one year, our group have worked various types of the problems: in the first problem we studied the frustrated ladder with alternate ferromagnetic(F) exchange $-J_F$ and AF exchange $J_A$ to first neighbors and F exchange $-J_L$ to second neighbors is studied by exact diagonalization (ED) and density matrix renormalization group (DMRG) calculations in systems of 2N spins-1/2 with periodic boundary conditions. The ground state is a singlet (S = 0) and the singlet-triplet gap $E_m$ is finite for the exchanges considered. Spin-1/2 string correlation functions $g_1(N)$ and $g_2(N)$ are defined for an even number N of consecutive spins

in systems with two spins per unit cell; the ladder has string order $g_2(\infty) > 0$ and $g_1(\infty) = 0$. The minimum $N^*$ of $g_2(N)$ is related to the range of ground-state spin correlations. Convergence to $g_2(\infty)$ is from below, and $g_1(N)$ decreases exponentially for $N \geq N^*$. Singlet valence bond (VB) diagrams account for the size dependencies. The frustrated ladder at special values of $J_F$, $J_L$ and $J_A$ reduces to well-known models such as the spin-1 Heisenberg antiferromagnet and the $J_1 - J_2$ model, among others. Numerical analysis of ladders matches previous results for spin-1 gaps or string correlation functions and extends them to spin-1/2 systems. The nondegenerate singlet ground state of ladder is a bond-order wave, a Kekul´e VB diagrams at $J_L = J_F /2 \leq J_A$, that is reversed on interchanging $-J_F$ and $J_A$. Inversion symmetry is spontaneously broken in the dimer phase of the $J_1 - J_2$ model where the Kekul´e diagrams are the doubly degenerate ground states at $J_2/J_1 = 1/2$. We have also studied and modelled the magnetic properties of the copper halides $(C_4 H_{14} N_2) Cu_2 X_6$ (X=Cl,Br).

In the second type of problem we studied the effect of topology on the electronic properties of real materials: we study the topological properties of the electronic band structure of a half-metallic ferromagnet $Co_2FeSi$ employing the ab-initio density functional theory method and show that it is a strongly correlated material. The experimentally observed magnetic properties can be explained in terms of the Slater–Pauling (SP) rule and our calculations are consistent with it. We also investigate the band topology of $Co_2FeSi$ and find that there are three topological nodal lines at 380 meV above Fermi Energy (E). The degeneracy of these nodal lines is perturbed upon introducing spin–orbit coupling with magnetization along [001] direction. However, some points still preserve degeneracy and are identified as Weyl points, each associated with a specific Chern number. At the ambient pressure, the AHC properties of this material have only extrinsic contribution which is consistent with the experimental results. To make the AHC intrinsic, we tune the position of the nodal line close to the Fermi energy by applying the hydrostatic pressure up to 26 GPa. We also discuss crystal symmetries and their relation with nodal lines and Weyl points. The quaternary Heusler alloy CoFeMnSn and CoCrGa are another materials which are shown to be topological in nature and theoretical work corroborated with experimental observation.

## Plan of Future Work Including Project

Our group has been working on the many-body effect in materials and also on the modelling of magnetic properties of materials. We study the different types of quantum model systems and construct the quantum phase diagram. Recently, our group is interested in the quantum phase in the multi-orbital Hubbard model in the chain and ladder geometry and also see the effect of spin-orbit coupling in these systems. We are also interested in is the quantum phase in the Kagome stripe chain (KSC), which may host the quantum spin liquid (QSL) and will study this model system to understand the quantum fluctuations and also construct the quantum phase diagram of this model system. We are also interested in study of the frustrated spin-1/2 Kitaev-Heisenberg spin-1/2 model with Dzyaloshinskii-Moriya interaction (DMI) on on a honeycomb lattice. We will explore the behavior of the quantum spin liquid in such a complex situation. It is predicted that the DMI can transform the non-chiral Kitaev gapless QSL into a chiral one. In fact, this novel and unusual quantum phase can be detected using the thermal Hall conductivity. Given the abundance of experimental data on Kitaev materials, the study of the Kitaev-Heisenberg model with DMI is crucial. Our overall goal is to understand the complete quantum phase diagram (QPD) in the Kitaev, Heisenberg and DM exchange parameter space.


## Nitesh Kumar

Assistant Professor

Condensed Matter and Materials Physics

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Banik Rai; Anomalous transport of quasi-two dimensional ferromagnets; Under progress
2. Anyesh Saraswati; Single crystal growth and transport of noncentrosymmetric antiferromagnetic Weyl semimetals; Under progress
3. Modhumita Sariket; Electrical transport of quantum materials under pressure; Under progress
4. Kakan Deb; Magnetic anisotropy study by torque magnetometry; Under progress

#### b) Post-Docs

1. Mahima Singh; Single crystal growth and transport of SmMn2Ge2, a layered ferromagnet
2. Chandan Patra; Single crystal growth and transport of LaMnSb2 and related systems
3. Tusita Sau; Synthesis of novel double perovskites (under Indo-Russian project with Prof. Saha-Dasgupta as PI)

#### c) External Project Students / Summer Training

1. Suchetana Manna; Hydrogen evolution by topological semimetals as catalysts

### Teaching

1. Autumn semester; PHY 503, PHY 603 Condensed Matter Physics; Integrated PhD; 21 students; with Dr. T. Setti (Co-teacher)
2. Spring semester; PHY 592, Methods of Experimental Physics; Integrated PhD; 11 students; with Kalyan Mandal, Ramkrishna Das, and Pradip S Pachfule (Co-teachers)

### Publications

#### a) In journals

1. Subhajit Roychowdhury, Mengyu Yao, Kartik Samanta, Seokjin Bae, Dong Chen, Sailong Ju, Arjun Raghavan, **Nitesh Kumar**, Procopios Constantinou, Satya N. Guin, Nicholas Clark Plumb, Marisa Romanelli, Horst Borrmann, Maia G. Vergniory, Vladimir N. Strocov, Vidya Madhavan, Chandra Shekhar, Claudia Felser, *Anomalous Hall Conductivity and Nernst Effect of the Ideal Weyl Semimetallic Ferromagnet EuCd2As2,* Advanced Science, 10, 2207121, 2023
2. Jyotirmoy Sau, S. R. Hassan, **Nitesh Kumar,** Manoranjan Kumar, *Topological properties and anomalous transport in van der Waals ferromagnets FenGeTe2: a comparative study,* Physica Scripta, 98, 125916, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited Talk: 67th DAE Solid State Physics Symposium (DAE-SSPS) 2023; December 22, 2023; GITAM, Visakhapatnam; 5 days
2. Invited Talk: Recent Advances in Solid State Chemistry and Physics, JNCASR; June 23, 2023; JNCASR, Bangalore; 1 day
3. Invited Talk: 2dMAT: A Discussion Meeting on 2D Materials; January 18, 2024; SNBNCBS, Kolkata; 2 days

## Administrative duties

1. Member of Conferences, Workshops and Extension Programme
2. Member of Media Cell Committee
3. Member of Hindi Cell
4. Member of Creche Management Committee

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Core Research Grant: From three-dimensional to two-dimensional quantum anomalous Hall effect in ferromagnetic topological quantum materials; SERB, DST; 3 years; PI
2. Max Planck-India Partner Group: Novel quantum states in quasi-one-dimensional materials; Max Planck Society; 5 years; PI
3. Indo-Russian Project: Search for Novel Magnetic and Topological Materials; DST; 3 years; Co-PI

## Conference / Symposia / Schools organized

1. Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature; December 26, 2023; SNBNCBS; 2 Days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. S. R. Hassan, Institute of Mathematical Sciences, Chennai; Sl. No. 2; National
2. Claudia Felser, Max Planck Institute for Chemical Physics of Solids, Dresden, Germany; Sl. No. 1; International

## Outreach program organized / participated

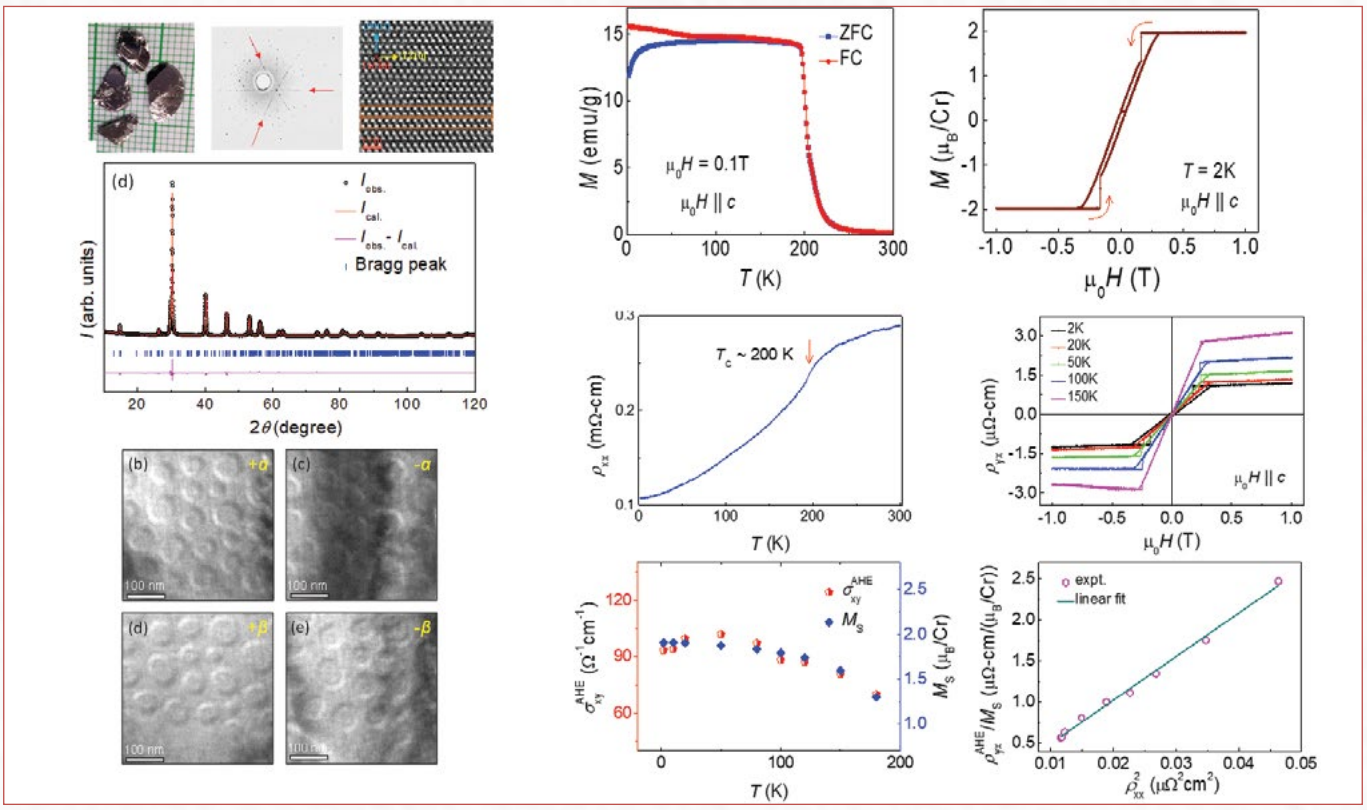
1. Participated as the as a Resource Person for the Topical Research School (TRS) on Recent Trends of Research in Theoretical and Experimental Physics jointly organized by the Department of Physics, Gurucharan College Silchar and S. N. Bose National Centre for Basic Sciences Kolkata from 11th to 13th March, 2024 in the premises of Gurucharan College, Silchar, Assam.

## Areas of Research

### Single crystal growth and magneto-transport properties of quantum materials

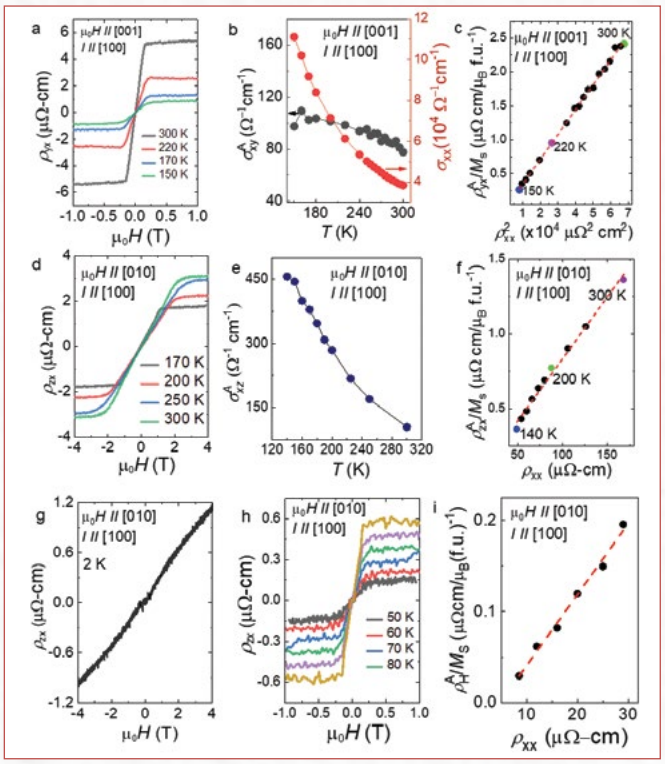
Trigonal Cr5Te8, a self-intercalated van der Waals ferromagnet with an out-of-plane magnetic anisotropy, has long been known to crystallise in a centrosymmetric structure. Through detailed structural analysis together with second harmonic generation experiments, we show that the compound actually adopts a non-centrosymmetric structure. A large anomalous Hall conductivity of 102 Ω-1cm-1 at low temperature stems from intrinsic origin, which is larger than any previously reported values in the bulk Cr-Te system. In addition, we observe a hump-like feature in the field-dependent Hall resistivity data, resembling a typical topological Hall effect signal. We show that this feature is highly tunable and is not related to the topological Hall effect. We also observe Néel-type skyrmions in trigonal Cr5Te8 by Lorentz transmission electron microscopy, which is consistent with the non-centrosymmetric structure of the compound. However, we do not see the obvious signature of skyrmions in our magneto-transport studies. We provide a plausible explanation for this discrepancy.

The intrinsic anomalous Hall conductivity (AHC) in a ferromagnetic metal is completely determined by its band structure. Since the spin orientation direction is an important band structure tuning parameter, it is highly desirable to study the anomalous Hall effect in a system with multiple spin reorientation transitions. We study a layered tetragonal room temperature ferromagnet SmMn2Ge2, which gives us the opportunity to measure magneto-transport properties where the long c-axis and the short a-axis can both be magnetically easy axes depending on the temperature range we choose. We show a moderately large fully intrinsic AHC up to room temperature when the crystal is magnetized along the c-axis. Interestingly, the AHC can be tuned to completely extrinsic with extremely large values when the crystal is magnetized along the a-axis, regardless of whether the a-axis is magnetically easy or hard axis. First principles calculations show that nodal line states originate from Mn-d orbitals just below the Fermi energy (EF) in the electronic band structure when the spins are oriented along the c-axis. Intrinsic AHC originates from the Berry curvature effect of the gapped nodal lines in the presence of spin-orbit coupling. AHC almost disappears when the spins are aligned along the a-axis because the nodal line states shift above EF and become unoccupied states. Since the AHC can be changed from fully extrinsic to intrinsic even at 300 K, SmMn2Ge2 becomes a potential candidate for room temperature spintronics applications.




## Plan of Future Work Including Project

1. We are exploring various magnetic quantum materials. We are forming collaborations and also establishing our capability for conducting neutron scattering measurements. We will particularly focus on kagome spin ice systems which capable of exhibiting many emergent properties. For this we already picked prospective materials and starting to make single crystals.
2. We will undertake high pressure electrical transport measurements of quantum materials which show tricritical points in their phase diagram. In these magnetic systems we will study anomalous Hall effect under high pressure. We will also focus on such systems which show large transport anomaly at temperatures above magnetic phase transitions such as EuCd2P2 understand this feature as a function of hydrostatic pressure.
3. With IFW Dresden, Germany we will work on the magnetic skyrmionic systems with Lorentz TEM with a visit of an SRF to IFW late this year.
4. We will measure magnetic anisotropy of several systems with torque magnetometry. We will also explore Fermiology of semimetals using torque magnetometry.




## Prabhat Mandal

Emeritus Professor

Condensed Matter and Materials Physics

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### Teaching

1. Autumn semester; PHY 501- Research Methodology; PhD; 38 students; with Atindra Nath Pal (co-teacher)

### Publications

#### a) In journals

1. Rafiqul Alam, Prasun Boyal, Shubhankar Roy, Ratnadwip Singha, Buddhadeb Pal, Riju Pal, **Prabhat Mandal**, Priya Mahadevan, Atindra Nath Pal, *Detection of Nontrivial Topology Driven by Charge Density Wave in a Semi-Dirac Metal,* Avanced Functional Materials, 33, 2306751, 2023
2. Abhishek Das, Dheeraj Ranaut, Pratap Pal, Riju Pal, Shubhadip Moulick, Moumita Das, Dinesh Topwal, **Prabhat Mandal**, Atindra Nath Pal, K. Mukherjee, and Debraj Choudhury, *Tuning of magnetic frustration and emergence of a magnetostructural transition in Mn1–xCdxCr2O4,* Physical Review B, 108, 064426, 2023
3. Shubhankar Roy, Ratnadwip Singha, Rafiqul Alam and **Prabhat Mandal**, *Anisotropic transport properties and high-mobility of charge carriers of antiferromagnetic GdAgSb2,* Journal of Physics: Condensed Matter, 35, 425701, 2023

### Scientific collaborations with other national / international institutions (based on joint publications)

1. Academic Collaboration with Dr. D. Choudhury; IIT KGP; Sl. No. 2; National
2. Academic Collaboration with Dr. S. Roy, Vidyasagar College, Kolkata; Sl. No. 1; National

### Areas of Research

1. Single crystals of several Dirac/Weyl semimetals and van der Waals systems have been grown to investigate their structural, magnetic and electrical properties. We have observed several interesting quantum phenomena due to the presence of nontrivial magnetic texture in real space and electronic band structure.
2. We observe that the electrical resistivity ($\rho_{xx}$) of SrZnGe single crystal exhibits linear T dependence at high temperature and $T^2$ dependence below 40 K, consistent with the Fermi liquid behavior. The crossover in field dependence of magnetoresistance (MR) at a critical field $B_c$ is explained based on the quantum limit of Dirac Fermions and the specific topology of the Fermi surface of the compound. The linear B dependence of MR at low temperatures has been explained using Abrikosov's theory. The observed Hall resistivity data establish SrZnGe as a multiband system with contributions from both the electrons and holes.

3. The magnetic and transport properties of single-crystalline $GdAgSb_2$ antiferromagnet have studied in details. The electronic resistivity shows metallic behavior along with large, anisotropic, and non-saturating MR. At 2 K and 9 T, MR reaches as high as $\sim 1.8\times10^3$%. The anisotropic MR along with additional features for applied magnetic field along some specific crystallographic directions reveal the quasi-two-dimensional nature of the Fermi surface of $GdAgSb_2$. Hall resistivity confirms the presence of both electrons and holes. The large transverse MR in $GdAgSb_2$ has been ascribed to high carrier mobilities ($\sim 1.2\times10^4\,cm^2V^{-1}s^{-1}$) and nearly-compensated electron and hole-density ($\sim 10^{19}\,cm^{-3}$). We also observe the de Haas–van Alphen oscillations below 7 K and the robust planar Hall effect up to high temperatures. Observed results confirm the nontrivial nature of the electronic band structure of $GdAgSb_2$.
4. The resistivity measurements on freshly cleaved single crystals of van der Waals system, $YTe_3$, were done using the standard four-probe technique. The large value of residual resistivity ratio (RRR), $\rho_{xx}(300\ K)/\rho_{xx}(2K)\sim 32$, implies that the single crystals of $YTe_3$ are of high quality. Though $\rho_{xx}$ decreases rapidly with decreasing temperature, the nature of $\rho_{xx}(T)$ curve is very sensitive to temperature region. At low temperature below 15 K, $\rho_{xx}$ can be fitted with a $T^n$. In most metallic systems, n is very close to 2, which implies the presence of pure electronic scattering in conduction mechanism. But in the present case, we find $n \approx 3$, which is not unusual for topological materials. $\rho_{xx}(T)$ near 300 K shows the gradual decrease of the slopes with increasing temperature, which may be due to approaching towards charge density wave transition temperature. The value of TMR reaches to ~ 600% at 2 K and 9 T. From Hall resistivity, we observed both mobility ($\sim 3x10^3\ cm^2V^{-1}s^{-1}$) and density ($\sim 2x10^{20}\ cm^{-3}$) of electron and hole are almost same.


## Priya Mahadevan

Senior Professor

Condensed Matter and Materials Physics

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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Debayan Mondal; Properties of hybrid perovskites; Thesis submitted
2. Prasun Boyal; Electronic structure of 2d materials; Under progress
3. Krishnendu Patra; Electronic structure of thin fillms of transition metal oxides; Under progress
4. Shivam Mishra; Electronic structure of semiconductor nanoplatelets; Under progress
5. Shinjini Paul; Electronic structure of transition metal oxides; Under progress
6. Sanuja Khuntia; Properties of hybrid perovskites; Under progress
7. Shivam Jani; Properties of hybrid perovskites; Under progress
8. Madhurita Das; Electronic structure of 2d materials; Under progress
9. Maitreyee Barman; Electronic structure of 2d materials; Under progress
10. Sumanti Patra; Electronic structure of 2d materials; Awarded
11. Joydeep ChatterjeeElectronic structure of layered materials; Awarded

### b) Post-Docs

1. Gargee Bhattacharya; Electronic structure of 2d materials
2. Paramita Banerjee; Catalysis
3. N. Bijoy; Electronic structure of 2d materials

### c) External Project Students / Summer Training

1. Sattwik Bhadra; Electronic structure of rippled graphene

## Teaching

1. Spring semester; PHY 622: Correlated Electrons and Disorder; PhD; 8 students; with Manoranjan Kumar (co-teacher)

## Publications

### a) In journals

1. Rafiqul Alam, Prasun Boyal, Shubhankar Roy, Ratnadwip Singha, Buddhadeb Pal, Riju Pal, Prabhat Mandal, **Priya Mahadevan**, Atindra Nath Pal, *Detection of Nontrivial Topology Driven by Charge Density Wave in a Semi-Dirac Metal,* Avanced Functional Materials, 33, 2306751, 2023

2. Arnab Mandal, Sanuja Kumar Khuntia, Debayan Mondal, **Priya Mahadevan** and Sayan Bhattacharyya, *Spin Texture Sensitive Photodetection by Dion–Jacobson Tin Halide Perovskites,* Journal of the American Chemical Society, 145, 24990-25002, 2023

3. S Patra, M Das and **P Mahadevan**, *The role of stacking on the electronic structure of MoSe2 at small twist angles,* Journal of Physics: Materials, 7, 014001, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Colloquium at UGC-CSR; May 19, 2023; UGC-CSR Indore; 1 hour
2. Invited talk at Virtual symposium on Energy Materials; June 1, 2023; TCG-CREST; 30 min
3. Invited talk at 2D TMS; June 26, 2023; Churchill College, Cambridge, UK; 30 min
4. CRSI-ACS Lecture at CRSI meet; July 5, 2023; NIT Rourkela; 15 min
5. Invited talk at Namma Psi-K; July 26, 2023; JNCASR; 30 min
6. Invited talk at CCMP- 2023; August 8, 2023; Liyang, China; 30 min
7. Invited talk at RPGR – 2023; November 22, 2023; Bengaluru; 30 min
8. Invited talk at QMAT – 2023; November 21, 2023; NISER, Bhubaneshwar; 30 min
9. Invited talk at MRSI – 2023; December 13, 2023; BHU, Varanasi; 30 min
10. Invited talk at ICFM – 2023; January 10, 2024; IIT KGP; 30 min
11. Administrative duties
12. Head of CMMP Department till February 2024; Various evaluation committees in the centre; Various review committees of DST, SERB.

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Twistronics with transition metal dichalcogenides; SERB; 5 years; PI
2. Electronic structure of free standing films of transition metal oxides; SERB; 3 years; PI

## Conference / Symposia / Schools organized

1. Discussion meeting on 2d materials; January 18, 2024; S.N. Bose National Centre for Basic Sciences; 1.5 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. With Sayan Bhattacharya (IISER Kolkata); Electronic structure of 2d materials; National

## Areas of Research

### Electronic, structural and magnetic properties of materials

Systems in which one finds charge ordering are usually insulating. LaAgSb2 is unusual in that it remains metallic, despite undergoing two charge density wave transitions, one at 211 K which is associated with an incommensurate wave involving 40 unit cells along the lattice vector a, and the other along the c direction at 186 K. Initially the CDW transition taking place at 186 K is incommensurate. However, with a lowering of temperature, a commensurate order involving 6 unit cells sets in. The nature and origin of the CDW are still debated. While fermi surface measurements have revealed a nesting vector close to the calculated one, suggesting fermi surface nesting, a lot of experimental observations exist against a nesting driven CDW scenario. These observations are consistent with the growing understanding that while one may have regions of the Fermi surface parallel to each other, usually other effects take over and the direction of the CDW modulation has little or no connection with the nesting vector. We have recently examined the commensurate CDW transition taking place within density functional theory based calculations. The Coulomb interactions between electrons on atoms belonging to different layers leads to the sliding of successive layers. This leads to the unusual presence of a chiral CDW in these systems, which is also metallic because of a weak coupling between the layers. This weak coupling places this system in the regime of easily exfoliable materials, and helps us explain the low energy phonon modes seen in experiments as arising from a shear mode and a compressive mode. The transition into a chiral structure is associated with the breaking of inversion of symmetry that also leads to a planar Hall effect, which is explained by the Berry curvature associated with the Dirac crossings at the Fermi level. This appeared in Advanced Functional Materials.

In another paper that appeared in Journal of Physics Materials we have examined the role of stacking on the electronic structure of twisted bilayers of MoSe2. Considering the untwisted limit

to correspond to the stackings AA and AB, we and examine the changes induced in the electronic structure by considering small angles of rotation of 3.48 from both these stackings. In both cases we largely recover the low energy electronic structure of the untwisted limit. We additionally find flat bands emerging above the dispersing bands. Surprisingly, while the rotation from the AA end leads to one flat band above the highest occupied band at Γ, one finds two flat bands emerging for small rotations from the AB end. Examining the real space localisation of the flat bands allows us to discuss the origin of the flat bands in terms of quantum well states and qualitatively understand the dependence of the number of flat bands found on the twist angle.

## Plan of Future Work Including Project

1. We will be examining ultrathin films of various transition metal oxides and examine their electronic structure at the ultrathin limit and explore how their properties evolve with thickness.
2. We will be exploring the electronic structure as a function of strain in few layers of transition metal oxides and examine how they evolve.
3. The electronic structure at small twist angles of twisted bilayers of transition metal dichalcogenides will be examined


## Saquib Shamim

Assistant Professor

Condensed Matter and Materials Physics

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Subhajit Mondal; Electrical transport in topological materials; Under progress
2. Najrul Islam; Strongly correlated phases in transition metal dichalcogenides; Under progress

#### b) Post-Docs

1. Dibyashree Chakraborti; Topological phases in TMDCs
2. Amrit Kumar Mondal

#### c) External Project Students / Summer Training

1. Punam Barman; Device Fabrication and Characterization of Grain Boundary in CVD Grown Polycrystalline Monolayer WSe2 and Twisted Bilayer Graphene
2. Suman Halder; Low-frequency noise in topological materials
3. Shreetama Pradhan; Low-frequency noise in topological materials
4. Aditya Kumar Ghosh; Operation and maintenance of ALD and RTA systems

### Teaching

1. Spring semester; Mesoscopic Physics (Code - PHY 528); Integrated PhD; 4 students
2. Spring semester; Mesoscopic Physics (Code - PHY 628); PhD; 9 students

### Publications

#### a) In journals

1. Bent Weber, Michael S Fuhrer, Xian-Lei Sheng, Shengyuan A Yang, Ronny Thomale, **Saquib Shamim**, Laurens W Molenkamp, David Cobden, Dmytro Pesin, Harold J W Zandvliet, Pantelis Bampoulis, Ralph Claessen, Fabian R Menges, Johannes Gooth, Claudia Felser, Chandra Shekhar, Anton Tadich, Mengting Zhao, Mark T Edmonds, Junxiang Jia, Maciej Bieniek, Jukka I Väyrynen, Dimitrie Culcer, Bhaskaran Muralidharan and Muhammad Nadeem, *2024 roadmap on 2D topological insulators,* Journal of Physics: Materials, 7, 022501, 2024
2. Christopher Fuchs, **Saquib Shamim**, Pragya Shekhar, Lena Fürst, Johannes Kleinlein, Jukka I. Väyrynen, Hartmut Buhmann, and Laurens W. Molenkamp, *Kondo interaction of quantum spin Hall edge channels with charge puddles,* Physical Review B, 108, 205302, 2023

3. C. Fuchs, M. Hofer, L. Fürst, **S. Shamim**, T. Kießling, H. Buhmann, L. W. Molenkamp, *Fast low bias pulsed DC transport measurements for the investigation of low temperature transport effects in semiconductor devices,* Journal of Applied Physics, 134, 175702, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Departmental Seminar at IISc, Bangalore; May 18, 2023; Departmental Seminar at IISc, Bangalore; 2 days
2. Invited talk at STATPHYS KOLKATA XII; December 18, 2023; SNBNCBS, Kolkata; 5 days
3. Invited talk at International Conference on Functional Materials, IIT Kharagpur; January 10, 2024; Invited talk at International Conference on Functional Materials, IIT Kharagpur; 2 days
4. Invited talk at Materials Science Symposium, IACS Kolkata; March 1, 2024; IACS, Kolkata; 1 day

## Administrative duties

1. Member of SCOLP and Departmental seminar coordinator
2. Member of Placement and Alumni Cell
3. Member of the committee for the annual magazine of S. N. Bose
4. Member of the Brochure Committee
5. Member of the Departmental Syllabus Committee

## Awards, Recognitions, if any

1. Inducted into the Early Career Advisory Board of the journal Physical Review B

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. CRG/2023/002082: Quantum spin Hall insulators: Investigation of electrical and thermal properties; SERB; 36 months; PI

## Conference / Symposia / Schools organized

1. IMPACT 2023 - The Alumni Day; December 28, 2023; SNBNCBS, Kolkata; 1 day
2. 2dMat: A Discussion Meeting on 2D Materials; January 18, 2024; SNBNCBS, Kolkata; 2 days
3. BoseStat@100: International Conference on Photonics, Quantum Information, and Quantum Communication; January 29, 2024; Biswa Bangla Convention Centre, Kolkata; 5 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. Laurens Molenkamp, Experimental Physik III, University of Wuerzburg, Germany; Sl. No. 1,2,3; International
2. Prof. Bent Weber, Nayang Technological University, Singapore; Sl. No. 1; International
3. Prof. Jukka I. Vayrynen; Sl. No. 2; International

## Outreach program organized / participated

1. Member of the organizing Committee for the Public Outreach program celebrating BoseStat@100 on February 3rd, 2024
2. Two numbers of lectures given at the C. K. Majumder Memorial Lectures for B.Sc and M.Sc. students of various colleges on 24.07.2023 and 25.07.2023

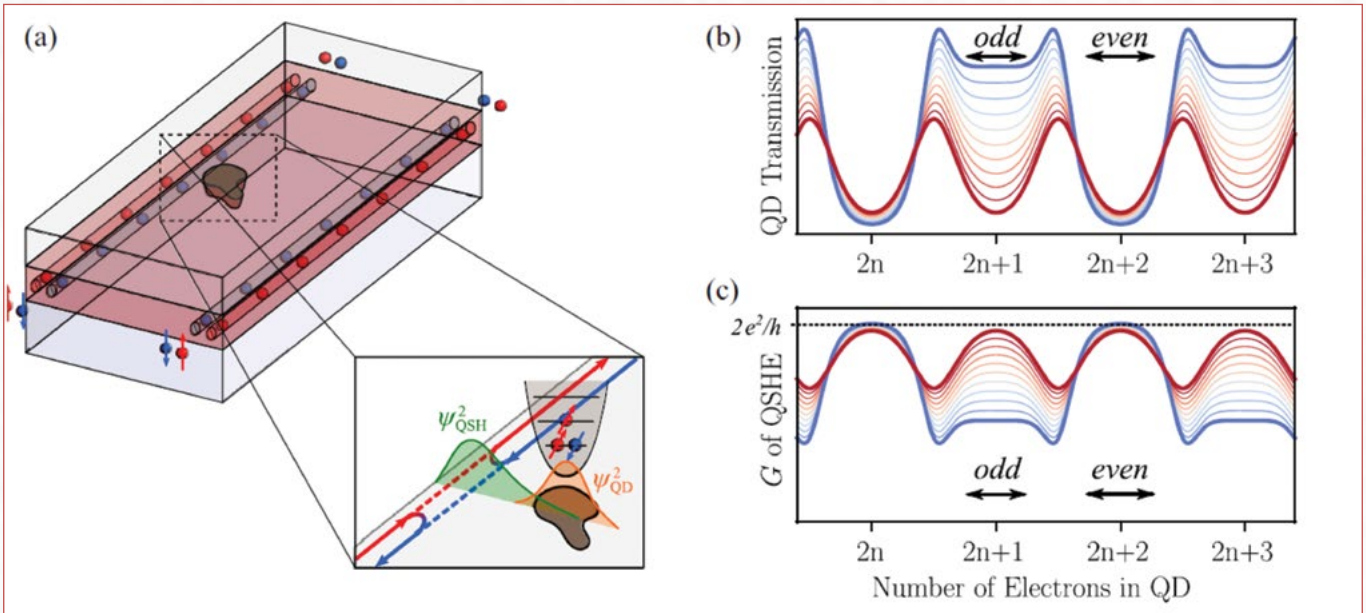
## Areas of Research

### Experimental Condensed Matter Physics, 2D materials, quantum spin Hall effect, topological physics, noise spectroscopy in low-dimensional systems

1. Kondo interaction of quantum spin Hall edge channels with charge puddles

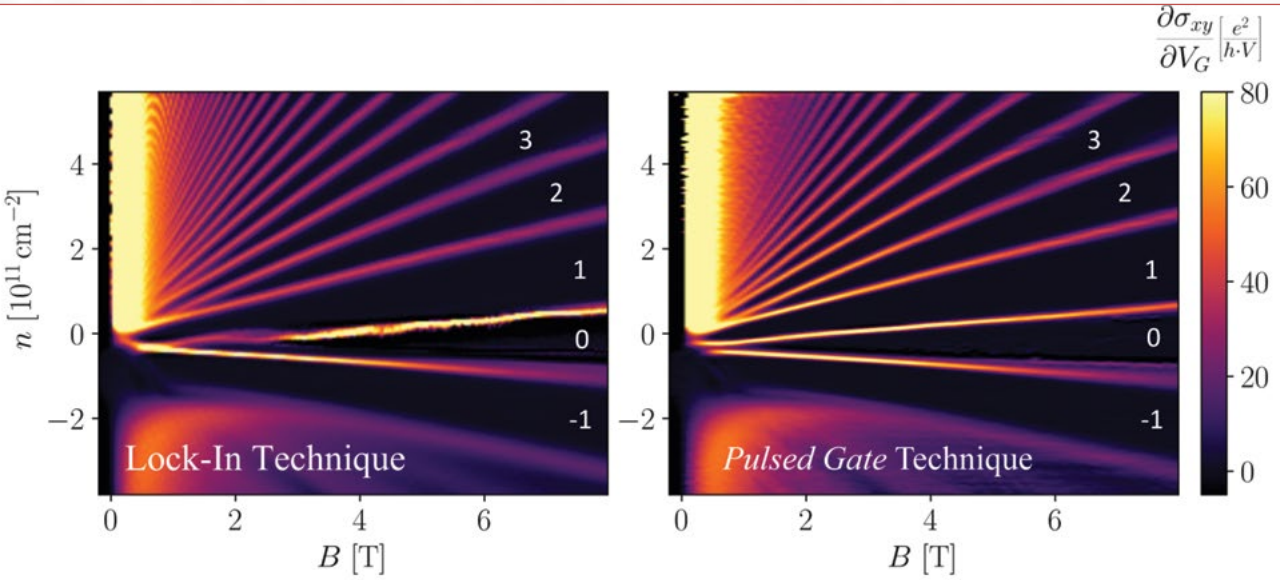
   The quantum spin Hall effect has been unambiguously demonstrated in different material systems. quantum spin Hall edge channels are protected against single-particle elastic backscattering, under time-reversal symmetry. However, reproducible fluctuations shape the quantization plateau when the chemical potential is tuned through the bulk gap. This has been observed in all realizations of the quantum spin Hall effect, including the first report in 2007. We have examined these fluctuations in the quantized conductance in micron-sized devices fabricated from HgTe quantum wells with an inverted band structure. By performing extensive and systematic gate- and temperature (from 20 mK to 2 K)-dependent measurements, we have shown that small charged islands (formed due to an inhomogeneous potential landscape in narrow-gap semiconductor) have a Kondo-type interaction with quantum spin Hall edge channels which results in the observed reproducible fluctuations in conductance. More than 15 years after the initial discovery of the quantum spin Hall effect, our results have finally provided insight into the underlying mechanisms of scattering in quantum spin Hall edge channels.

2. Fast low bias pulsed DC transport measurements for the investigation of low-temperature transport effects in semiconductor devices




*(a) A schematic of the interaction between the helical edge channels and the Kondo quantum dot in the vicinity of the edge channels. (b) Conductance of a Kondo-correlated quantum dot as a function of occupation number, where red and blue indicate high and low temperatures (c) Corresponding quantum spin Hall conductance due to the interaction between helical edge channels and a Kondo quantum dot.*

We have designed a setup for rapid, low-bias (less than 1mV) DC transport measurements with microsecond-level time resolution suitable for high-ohmic resistant (near the Klitzing constant) semiconducting samples. The circuit employed, instrumentation and the digital processing of the data have been optimized to achieve the desired low-noise level and resolution. The technique can be applied to various semiconducting materials and devices. To showcase the efficacy of our technique, we conduct experiments measuring transitions between quantum Hall plateaus in HgTe quantum wells, successfully resolving plateaus with durations as short as 100 microseconds." We have measured the Landau-level fan diagram using our fast pulsed DC technique and compared it with the fan diagram obtained using conventional lock-in techniques. The fast DC technique has much better magnetic field resolution and takes about one and a half hours to complete, which is more than 10 times faster compared to the steady-state approach.




*Landau-level fan diagram obtained using conventional lock-in techniques (left) and pulsed gated technique (right)*

## Plan of Future Work Including Project

1. Novel phases in van der Waals heterostructures of TMDCs: We will investigate the topological phases in 1T' phase of transition metal dichalcogenides (TMDCs). We will employ electrical transport measurements at low temperatures and high magnetic fields to explore topological physics in these materials. The devices fabricated from monolayer TMDCs will be used for investigating quantum spin Hall phases, while the multilayer devices will be used to investigate higher-order topology and Weyl physics.


## Sujoy Kumar Ghosh

DST INSPIRE Faculty

Condensed Matter and Materials Physics


### Guidance of Students/Post-Docs/Scientists

#### a) External Project Students / Summer Training

1. Gautam Kumar (Summer Training); Bio-Mechanical Energy Harvester for Self-Powered Electronics Development

### Publications

#### a) In journals

1. Biswajit Mahanty, **Sujoy Kumar Ghosh**, Gajula Prasad, Arunkumar Shanmugasundaram, Dong-Weon Lee, *Giant Energy Harvesting via Maxwell Displacement Current Enhancement Using Metal Sheet Interspaced Hetero-Layer Structured Piezo-Composite Nanofiber Device,* Advanced Functional Materials, 34, 2307723, 2024
2. Biswajit Mohanty, **Sujoy Kumar Ghosh**, Dong-Weon Lee, *High-performance polyaniline-coated electrospun P(VDF-TrFE)/BaTiO3 nanofiber-based flexible piezoelectric nanogenerator,* Materials Today Nano, 24, 100421, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. DST (SERB) Sponsored National Conference on Materials and Devices (NCMD); 28/12/23 and 29/12/23; Department of Physics, (Faculty of Engineering) Teerthanker Mahaveer University; 2 days

### Scientific collaborations with other national / international institutions (based on joint publications)

1. Scientific collaboration with Dr. Biswajit Mahanty, Postdoc at Chonnam National University, South Korea; Sl. No. 1, 2; International

### Areas of Research

#### Self-powered Flexible Electronics

Triboelectric nanogenerator (TENG) is an energy harvesting device which can convert the mechanical vibrations/external pressures into electrical energy output. This kind of device is very useful for the development of self-powered pressure sensors, wearable and implantable bio- medical devices, soft robotic appliances, acoustic transducer, and internet-of-things (IOTs). Considering the operational mechanism of TENG, it depends on contact electrification and electrostatic induction between two dissimilar materials. There are two main factors affecting the output performance of TENG, the differences of electronegativity between the two materials and the effective frictional contact area between the two materials. To date there are several approaches have been offered for developing high performance TENGs which included mainly the structural approaches and materials approaches. The structural approaches included self-assembly of micro-/nano-pattern surfaces, nanowire fabrications, microsponge structure development for effectively increasing large surface area and multilayer structure, rotator construction

and textile based device architecture for effectively increasing contact area which are cumulatively improved the friction of contact surfaces. On the other hand, materials based approaches included surface functionalization, employing high k-dielectric material and artificial control of ferroelectric polarization to control the electronegativity, surface charge density and dielectric permittivity/constant. However, there are still significant limitations for developing structure modified TENGs and materials control TENGs. For example, high performing structure modified

TENGs are limited by their complex fabrication process, limited application for wearable devices due to their bulky structure. In addition, it is very difficult to achieve simultaneously both flexibility and high output performance because, organic materials based TENGs are flexible but low performing but in-organic materials TENGs are not flexible but demonstrated high performances. In this context, organic-inorganic ferroelectric/ piezoelectric composite based TENGs are effective approach but still limited due to aggregation of fillers, ineffective stress transfer to the inorganic nanoparticles, high loss appear with high k-dielectric materials which restricted the improvement of piezoelectricity of the composites. There are several efforts has been observed for developing TENGs by incorporating in-organic materials such as, Barium titanate ($BaTiO_3$ /BTO), Lead zirconate titanate (PZT), Lead(II) titanate ($PbTiO_3$), Zinc oxide (ZnO), Zinc sulfide (ZnS), Gallium nitride (GaN), Cadmium sulfide (CdS), Indium nitride (InN) into the organic ferroelectric polymers, such as, PVDF, PVDF-HFP and PVDF-TrFE. Still the improvement of piezoelectricity of composite was restricted which control the polarization, surface charge density and eventually energy harvesting performance of the TENGs. In this work, we have prepared a micro-hemisphere structured PVDF-TrFE/BTO nanocomposite based thin film (Figure 1a) which shows very high piezoelectricity with the longitudinal piezoelectric co-efficient, $d_{33}$ of –88 pC/N. This thin film was further used for TENG device fabrication with a interlocked device architecture where micro-hemisphere structured PVDF-TrFE/BTO nanocomposite was used as tribo-positive material and micro-hemisphere structured polydimethylsiloxane (PDMS) thin film was used as tribo-negative material (Figure 1b). The device generated open-circuit voltage output of 108 V, short-circuit current of 607 nA, power output of 1.74 W/m2 under the external pressure of 10 kPa (force of 3.2 N). The pressure sensitivity of the device was 10.3 V/kPa and force sensitivity was 31.9 V/N.

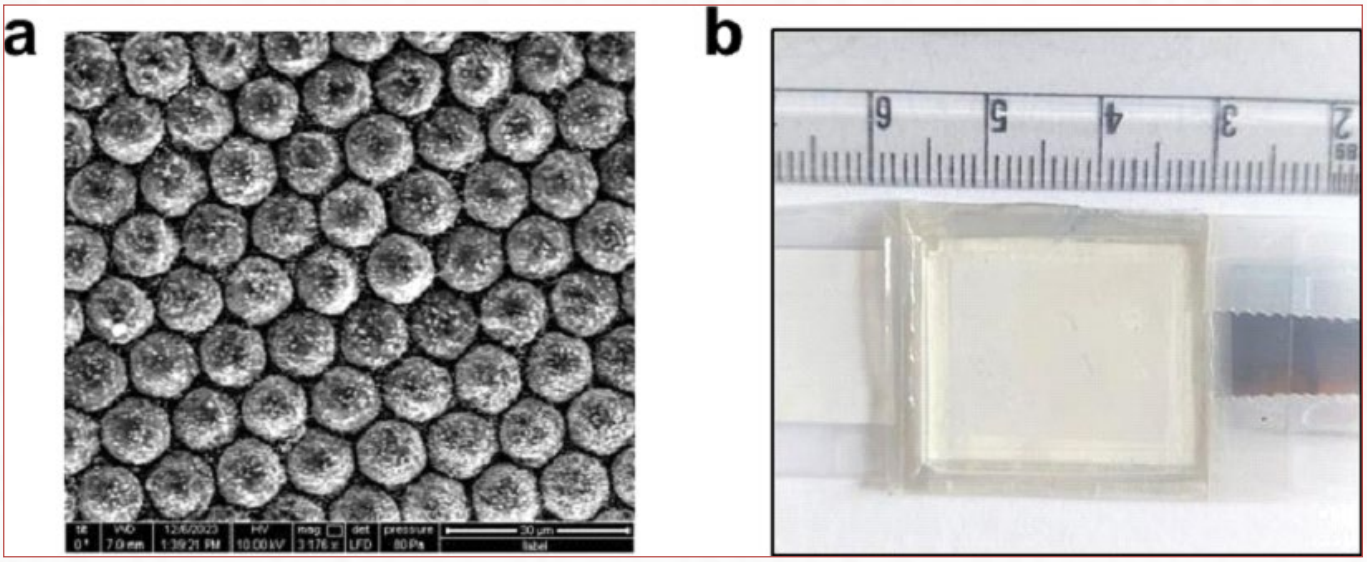



Figure 1. (a) The SEM image of the prepared PVDF-TrFE/BTO film and (b) the fabricated TENG with the film


## Tanusri Saha Dasgupta

Director & Senior Professor
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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Shiladitya Karmakar; Computational Study of Technologically Indigenous Materials; Awarded
2. Samir Rom; First-principles study of magnetic compounds; Under progress
3. Koushik Pradhan; Electronic structure of Oxides; Under progress
4. Manoj Gupta; Correlated Electrons; Under progress
5. Rajdeep Biswas; Spin-Orbit coupling driven physics; Under progress
6. Arnab Paul; Model Hamiltonian study of materials; Under progress
7. Sweta Ghosh; Topolgical Materials; Under progress
8. Rima Ghosh; 2D materials; Under progress; Arijit Haldar, SNBNCBS (Co-supervisor)
9. Prosanta Sarkar; Mixed compounds; Under progress; Goutam Dev Mukherjee, IISER K (Co-supervisor)
10. Avik Sasmal; Large scale simulation of Confined materials; Under progress; Jaydeb Chakraborty, SNBNCBS (Co-supervisor)
11. Anutosh Biswas; Quantum spin systems; Under progress; Manoranjan Kumar, SNBNCBS (Co-supervisor)

#### b) Post-Docs

1. Arun Maurya; Superconductivity
2. Dipayan Sen; Van der Waals materials

#### c) External Project Students / Summer Training

1. Sidhartha Chatterjee; 2D magnetism
2. Sarbajit Mazumdar; High Tc superconductors

### Publications

#### a) In journals


1. Shiladitya Karmakar, Soumendu Datta and **Tanusri Saha-Dasgupta**, *First principles predictions of structural, electronic and topological properties of two-dimensional Janus Ti2N2XI (X = Br, Cl) structures,* Physical Chemistry Chemical Physics, 26, 10557-10567, 2024
2. Victor da Cruz Pinha Barbosa, Shreya Das, **Tanusri Saha-Dasgupta**, and Patrick M. Woodward, *The Magnetism of Nonstoichiometric Sr2Cr1+xRe1–xO6 (0 < x < 0.5) Double Perovskites,* Inorganic Chemistry, 62, 21353-21363, 2023

3. Manoj Gupta, Basudeb Mondal, Subhro Bhattacharjee, and **Tanusri Saha-Dasgupta**, *Ab initio insights on the fermiology of d1 transition metals on the honeycomb lattice: Hierarchy of hopping pathways and spin-orbit coupling,* Physical Review Research, 5, 043219, 2023
4. Anjishnu Bose, Manodip Routh, Sreekar Voleti, Sudip Kumar Saha, Manoranjan Kumar, **Tanusri Saha-Dasgupta**, and Arun Paramekanti, *Proximate Dirac spin liquid in the honeycomb lattice J1–J3 XXZ model: Numerical study and application to cobaltates,* Physical Review B, 108, 174422, 2023
5. Aabhaas Vineet Mallik, Adhip Agarwala, and **Tanusri Saha-Dasgupta**, *Correlation-driven nontrivial phases in single-bilayer kagome intermetallics,* Physical Review B, 108, 205125, 2023
6. Olga S. Volkova, Peter S. Berdonosov, Irina K. Shamova, Badiur Rahaman, Asif Iqbal, **Tanusri Saha-Dasgupta**, Alexander N. Vasiliev, *Thermal and magnetic properties of Cu4O(SeO3)3 composed by ferrimagnetic O2Cu6 units of edge-sharing OCu4 tetrahedra,* Journal of Alloys and Compounds, 956, 170346, 2023
7. Sreekar Voleti, Koushik Pradhan, Subhro Bhattacharjee, **Tanusri Saha-Dasgupta** & Arun Paramekanti, *Probing octupolar hidden order via Janus impurities,* npj Quantum Materials, 8, 42, 2023
8. Arnab Bera, Samir Rom, Suman Kalyan Pradhan, Satyabrata Bera, Sk Kalimuddin, **Tanusri Saha-Dasgupta**, and Mintu Mondal, *Centrosymmetric-noncentrosymmetric structural phase transition in the quasi-one-dimensional compound (TaSe4)3I,* Physical Review B, 108, 035112, 2023
9. Dipayan Sen and **Tanusri Saha-Dasgupta**, *Pressure-tuned valence transition, insulator-metal transition in van der Waals antiferromagnet CrPS3,* Physical Review Materials, 7, 064008, 2023
10. Koushik Pradhan, Prabuddha Sanyal, and **Tanusri Saha-Dasgupta**, *Robust half-metallicity and topological properties in square-net potassium manganese chalcogenides,* Physical Review B, 107, 155115, 2023

### b) Other Publications

1. Swastika Chatterjee, Rabindranath Mondal, Chirantan Pramanik, Prosenjit Ghosh, Tanusri Saha-Dasgupta Influence of Fe on the distribution and isotopic fractionation of Li in olivine: A first-principles study Meeting of EGU (European Geoscience Union) EGU24, Issue EGU24-18016
2. T Saha-Dasgupta Robust half-metallicity and topological properties in square-net potassium manganese chalcogenides Bulletin of the American Physical Society (2024)

## Talks / Seminars Delivered in reputed conference / institutions

1. Foundation day seminar; February 29, 2024; IISER Tirupati; 1 hour
2. Public lecture in Women Empowerment: Career Opportunities in Science; March 15, 2024; IIT Indore; 1 hour
3. International Conference on Sustainable Nanomaterials Integration & Organization for Energy and Environment (iSNIOE2-2024); March 21, 2024; Shiv Nadar University; 1 hour
4. Indo-Russian Meet; January 3, 2024; IIT Goa; 40 mins
5. International Winter School 2023 and Recent Advances in Materials; December 8, 2023; JNCASR; 35 mins
6. Annual General Meeting of the Department of Geology; October 13, 2023; Presidency University; 1 hour
7. Indo-Israel 2023; July 10, 2023; Weizmann Institute; 35 mins
8. Wednesday colloquium; May 31, 2023; TIFR; 1 hour
9. 14th APCTP-IACS-ACADEMY-JNCASR Joint Activity on Novel Phases in Oxide Materials and Low Dimensional Systems; November 30, 2023; Orange County, Coorg; 40 mins
10. 10. 5th International Conference on "Physics for Sustainable Development & Technology (5th ICPSDT-2023); September 7, 2023; Chittagong University of Engineering and Technology (CUET); 1 hour

## Administrative duties

1. Director

## Awards, Recognitions, if any

1. Interview featured in Communication physics [Communications Physics volume 7, Article number: 71 (2024)]

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. JCBose Fellowship; SERB; Until 2025; PI
2. DST-RSF project on Magnetic and Topological Materials; Until 2025; PI

## Conference / Symposia / Schools organized

1. 1st conference of BoseStat@100: Centenary of Bose Statistics; January 29, 2024; Vishwa Banga Convention Center; 5 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Arun Paramekanti, Collaboration through Vajra scheme; Sl. No. 4, 7; International
2. P. Sanyal, long term collaboration, former post-doc; Sl. No. 10; National
3. P Woodward, collaboration with experiment; Sl. No. 2; International
4. S. Bhattacharjee, Collaboration with adjunct faculty; Sl. No. 3; National
5. A. Agarwala; Sl. No. 5; National
6. Manoranjan Kumar, intra-department collaboration; Sl. No. 4, 7; National
7. A. Vasiliev, Indo-Russian collaboration; Sl. No. 6; International
8. Mintu Mandal, collaboration with experimentalist; Sl. No. 8; National

## Outreach program organized / participated

1. Guest in DD Bangla program Bigyan Prasange on 13th March
2. Lecture on Quantum Materials at Ramkrishna Mission Institute of Culture Golpark, on 7th November
3. Arun Paramekanti, Collaboration through Vajra scheme

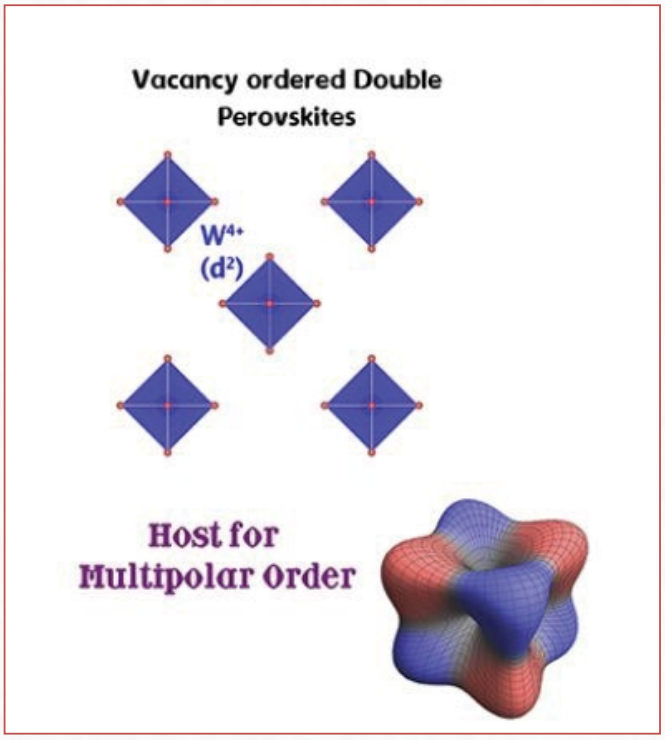
## Areas of Research

Computational Materials Physics; Electronic Structure; Spin systems; Machine learning approach to materials informatics

## Multipolar magnetism in $5d^2$ vacancy-ordered halide double perovskites

Vacancy-ordered halide double perovskites hosting 4d/5d transition metals have emerged as a distinct platform for investigating unconventional magnetism arising out of the interplay of strong atomic spin-orbit coupling (SOC) and Coulomb interactions. Using first principles and exact diagonalization calculations, this work establishes transition metal based vacancy-ordered halide double perovskites as new candidates for *octupolar* magnetism. In contrast to dipolar refrigerator magnets, multipolar magnets possess more than just a north pole and a south pole. This work uncovers a non-Kramers doublet ground state in these materials, explain the strong temperature-dependent effective magnetic moment, highlight the breakdown of the classic Kotani plot, and predict hidden octupolar order which may be tested in future experiments.

Koushik Pradhan, Arun Paramekanti, and Tanusri Saha-Dasgupta, Multipolar magnetism in 5d2 vacancy-ordered halide double perovskites, Physical Review B, 109, 184416, 2024

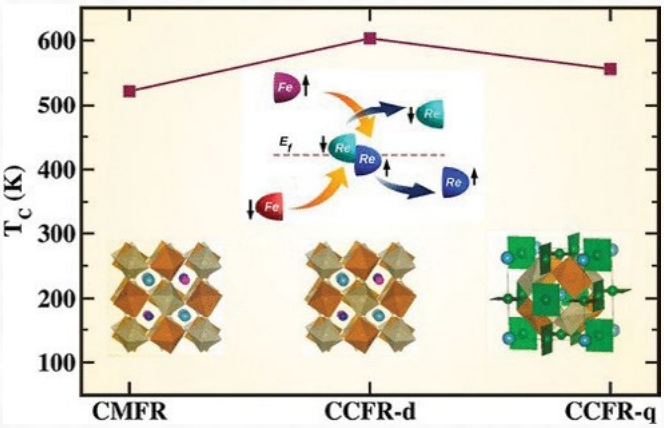



## Magnetism in Cation-Ordered Multicomponent Oxide Perovskites

Cation ordering of A and B sites in ABO3 perovskite-derived multicomponent structures can give rise to fascinating properties. Following this, in recent times, high-pressure synthesis of double double perovskites and quadruple perovskites have been reported, incorporating transition metal ions at the A site along with alkali metal/alkaline earth or rare earth A cations. This is expected to further improve the magnetic properties of B-site-ordered double perovskites. In this study, we consider three Fe–Re-based multicomponent compounds: $CaCuFeReO_6$, $CaMnFeReO_6$, and $CaCu_3Fe_2Re_2O_{12}$. While the first two compounds belong to the class of double double perovskite with 1:1 cation ordering at the A site, the third compound belongs to the class of quadruple perovskite with 1:3 cation-ordered A sites. Despite the chemical diversity as well as structural diversity of the magnetic A site in the three compounds, their high-temperature magnetic behavior is found to be similar, posing a puzzle. In our computational study, we unravel the underlying mechanism of magnetism,

thus demystifying the situation. We also provide a theoretical description of the observed magneto-resistive behavior of $CaCuFeReO_6$ and $CaCu_3Fe_2Re_2O_{12}$

Koushik Pradhan, Prabuddha Sanyal, and Tanusri Saha-Dasgupta, Magnetism in Cation-Ordered Multicomponent Oxide Perovskites, Chemistry of Materials, 36, 3829-3836, 2024




## Plan of Future Work Including Project

1. Inhomogeneities in 2D materials. - Machine learning applications. - Vacancy ordered systems. - Topological properties of intermetallics


## Thirupathaiah Setti

Associate Professor

Condensed Matter and Materials Physics

setti@bose.res.in


## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Susmita Changdar; Topological semimetals; Thesis submitted
2. Achintya Low; Experimental Condensed Matter Physics, Topological Quantum Materials; Under progress
3. Sayan Rauth; Topological Superconductors; Under progress; Prof. Prosenjit Singha Deo (Co-supervisor)
4. Shubham Purwar; 2D Magnetic Systems; Under progress
5. Susanta Ghosh; Experimental Condensed Matter Physics, Topological Quantum Materials; Under progress; Prof. Kalyan Mondal (Co-supervisor)
6. Soumya Ghorai; Oxide Double Perovskites; Under progress
7. Anupam Barik; Topological Quantum Materials; Under progress

### b) Post-Docs

1. Tushar Kanti Bhowmik; Investigation of High Tc superconductors and strongly corelated materials

### c) External Project Students / Summer Training

1. Swastika Chakraborty; Experimental investigation of magnetic topological semimetals
2. Anubhab Rudra; Experimental investigation of topological materials

## Teaching

1. Autumn semester; PHY 503: Condensed Matter Physics; Integrated PhD; 11 students; with Dr. Nitesh Kumar (Co-teacher)
2. Spring semester; PHY402: Electromagnetic Theory; Integrated PhD; 11 students

## Publications

### a) In journals

1. Shubham Purwar, Achintya Low, Anumita Bose, Awadhesh Narayan, and **S. Thirupathaiah**, *Investigation of the anomalous and topological Hall effects in layered monoclinic ferromagnet Cr2.76Te4,* Physical Review Materials, 7, 094204, 2023

2. Achintya Low, Susanta Ghosh, Soumya Ghorai, and **Setti Thirupathaiah**, *Effect of electron-phonon scattering on the anomalous Hall conductivity of Fe3Sn:* A kagome ferromagnetic metal, Physical Review B, 108, 094404, 2023
3. Susmita Changdar, Susanta Ghosh, Anumita Bose, Indrani Kar, Achintya Low, Patrick Le Fèvre, François Bertran, Awadhesh Narayan and **Setti Thirupathaiah**, *Weak electronic correlations observed in magnetic Weyl Semimetal Mn3Ge,* Journal of Physics: Condensed Matter, 36, 125502, 2024
4. Susanta Ghosh, Achintya Low, Susmita Changdar; Shubham Purwar, **Setti Thirupathaiah**, *Unusual multiple magnetic transitions and anomalous Hall effect observed in antiferromagnetic Weyl semimetal, Mn2.94Ge (Ge-rich),* Journal of Physics: Condensed Matter, 36, 215705, 2024
5. Susanta Ghosh, Achintya Low, Soumya Ghorai, Kalyan Mandal, **Setti Thirupathaiah**, *Tuning of electrical, magnetic, and topological properties of magnetic Weyl semimetal Mn3+xGe by Fe doping,* Journal of Physics: Condensed Matter, 35, 48, 2023
6. Indrani Kar, Susanta Ghosh, Shuvankar Gupta, Sudip Chakraborty, **S. Thirupathaiah**, *Comparative study of Kondo effect in Vanadium dichalcogenides VX2 (X=Se & Te),* Physica B: Condensed Matter, 674, 415532, 2024
7. Susmita Changdar, Susanta Ghosh, Kritika Vijay, Indrani Kar, Sayan Routh, P.K. Maheshwari, Soumya Ghorai, Soma Banik, **S. Thirupathaiah**, *Nonmagnetic Sn doping effect on the electronic and magnetic properties of antiferromagnetic topological insulator MnBi2Te4,* Physica B: Condensed Matter, 657, 414799, 2023
8. Indrani Kar, Sayan Routh, Soumya Ghorai, Shubham Purwar, **Setti Thirupathaiah**, *Observation of weak Kondo effect and angle dependent magnetoresistance in layered antiferromagnetic V5S8 single crystal,* Solid State Communications, 369, 115209, 2023

### b) Independent publications of student/s

1. Sayan Routh, Indrani Kar, Achintya Low, Susanta Ghosh, Tushar Kanti Bhowmik, *Magnetoresistance behavior across the critical region in ferrimagnet FeCr2Te4 single crystal,* Physics Letters A, 486, 129101, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Colloquium Seminar: Tuning of Electrical, Magnetic and Topological Properties in Kagome Antiferromagnetic Semimetals; December 21, 2023; NPL, Delhi; 1 day
2. Colloquium Seminar: Electronic, Magnetic, and Topological Properties of Correlated Topological Kagome Antiferromagnets; August 3, 2023; SRM University, Amaravati; 1 day
3. Colloquium Seminar: Electronic, Magnetic, and Topological Properties of Correlated Topological Kagome Antiferromagnets; August 30, 2023; IISER Kolkata; 1 day
4. Invited Talk: Electronic, Magnetic, and Topological Properties of Correlated Topological Kagome Antiferromagnets; July 5, 2023; UGC-DAE Indore; 1 day
5. Invited Talk: Topological Properties and Electronic Structure Studies of Kagome Antiferromagnets; November 13, 2023; IOP Bhuwaneswar; 15$^{th}$-17$^{th}$ November, 2023
6. Invited Talk: Tuning of Electrical, Magnetic and Topological Properties in Kagome Antiferromagnetic Semimetals; December 13, 2023; MRSI-AGM, Varanasi; 12$^{th}$-15$^{th}$ December, 2023
7. Electronic Properties of Some Topological Systems; November 25, 2023; SNBNCBS; 25$^{th}$-29$^{th}$ November 2024

## Administrative duties

1. Acted as member and chairperson of several committees

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Investigation of Magnetotransport, Magnetic, and Electronic Band Structure in Transition-metal Monosilicides (MSi; M=Fe, Cr, Co, Mn, and Rh) under Time Reversal Symmetry Breaking; DST-SERB-CRG; Approved (3 years); PI
2. Indo-Russian Project; DST-RSF; 2022-2025; Co-PI

## Conference / Symposia / Schools organized

1. National conference on electronic structure (NCES); November 15, 2023; IOP Bhubhaneswar; 15$^{th}$-17$^{th}$ November, 2023
2. IFW-SNB Discussion Meeting on "Novel Magnetic and Topological Quantum Materials"; November 25, 2023; SNBNCBS; 25$^{th}$-29$^{th}$ November 2023
3. A discussion meeting on "Novel Quantum Materials: Magnetism and Topology"; January 2, 2024; IIT Goa; 2$^{nd}$-5$^{th}$ January 2024
4. Exploring Quantum and Thermal Fluctuations in Frustrated Magnets at Low Temperature; December 26, 2023; SNBNCBS; 26$^{th}$-27$^{th}$ December 2023

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Awadesh Narayan (IISc Bangalore), Sudip Chakraborty (SINP Kolkata), Soma Banik (RRCAT, Indore); Sl. No. 1, 3, 6, 7; National
2. Patrick Le Fevre, François Bertran (Soleil Synchrotron Centre, France); Sl. No. 3; International

## Areas of Research

### Single crystal growth and characterization of novel magnetic and topological quantum materials

Our research work aims at synthesis of high-quality single crystals and studying their electrical, magnetic and electronic band structure of various topological quantum materials, novel and 2D magnetic systems. In the below we list a few important and representative studies carried out by our group during the last one year.

1. Effect of Electron-Phonon Scattering on the Anomalous Hall Conductivity of Fe3Sn: A Kagome Ferromagnetic Metal

In this work, we report on magnetic and magnetotransport studies of the kagome ferromagnetic metal Fe3Sn. Our studies reveal a large anomalous Hall conductivity σzx in this system, mainly contributed by temperature-independent intrinsic Hall conductivity (σxy=485±60Scm−1) and temperature-dependent extrinsic Hall conductivity due to skew scattering. Although the value is large and almost equivalent to the intrinsic Hall conductivity at low temperatures, it drastically decreases with increasing temperature, under the influence of electron-phonon scattering. The presence of electron-phonon scattering in this system is also confirmed by the linear dependence of the longitudinal electrical resistivity at higher temperatures [ρ(T)∝T]. We further find that Fe3Sn is a soft ferromagnet with an easy axis of magnetization lying in the ab plane of the crystal with a magnetocrystalline anisotropy energy density as large as 1.02×106Jm−3. Below is the representative image describing the effect of electron-phonon scattering on the anomalous Hall conductivity.

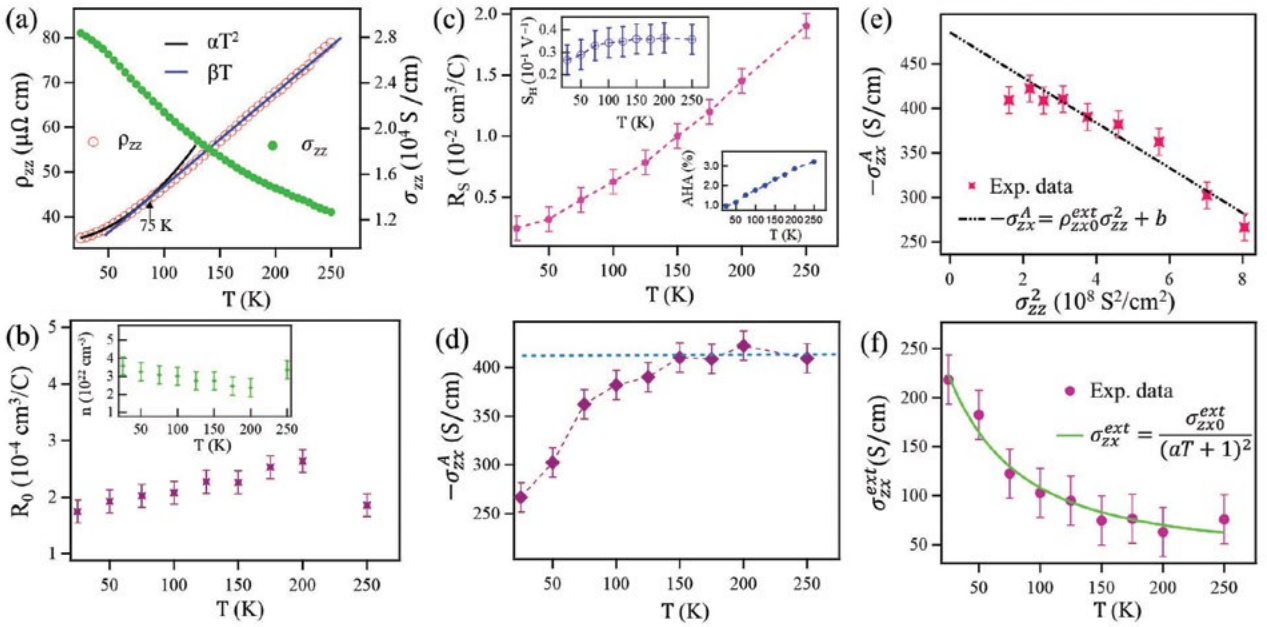



**Figure 1:** (a) Longitudinal electrical resistivity ($\rho_{zz}$) and electrical conductivity ($\sigma_{zz}$) plotted as a function of temperature. (b) and (c) Normal Hall coefficient ($R_0$) and Anomalous Hall coefficient ($R_S$) plotted as a function of temperature, respectively. Charge carrier density ($n$) is shown in the inset of (b). Top inset in (c) shows anomalous Hall scale factor ($S_H$) and bottom inset in (c) shows anomalous Hall angle percentage (AHA%). (d) Anomalous Hall conductivity ($-\sigma^A_{zx}$) as a function of temperature. (e) $-\sigma^A_{zx}$ *vs.* $\sigma^2_{zz}$ plot. The dashed line in (e) is a linear fitting using the relation $-\sigma^A_{zx} = \rho^{ext}_{zx0}\sigma^2_{zz} + b$. (f) Extrinsic anomalous Hall conductivity $\sigma^{ext}_{zx}$ plotted as a function of temperature. The solid green curve in (f) is a fit with the equation $\sigma^{ext}_{zx} = \frac{\sigma^{ext}_{zx0}}{(aT+1)^2}$.

2. Investigation of the Anomalous and Topological Hall Effects in Layered Monoclinic Ferromagnet Cr2.76Te4

   In this work, we studied the electrical transport, Hall effect, and magnetic properties of monoclinic layered ferromagnet Cr2.76Te4. Our studies demonstrate Cr2.76Te4 to be a soft ferromagnet with strong magnetocrystalline anisotropy. Below 50 K, the system shows an antiferromagnetic type transition. Interestingly, between 50 and 150 K, we observe fluctuating magnetic moments between in-plane and out-of-plane orientations, leading to noncoplanar spin structure. On the other hand, the electrical resistivity data suggest it to be metallic throughout the measured temperature range, except a kink at around 50 K due to antiferromagnetic ordering. The Rhodes-Wohlfarth ratio 1.89(>1) calculated from our magnetic studies confirms that Cr2.76Te4 is an itinerant ferromagnet. Large anomalous Hall effect has been observed due to the skew scattering of impurities and the topological Hall effect has been observed due to noncoplanar spin structure in the presence of strong magnetocrystalline anisotropy. We examined the mechanism of anomalous Hall effect by employing the first-principles calculations. Below is the representative image describing the correlation between magnetocrystalline anisotropy and topological Hall effects in Cr2.76Te4.

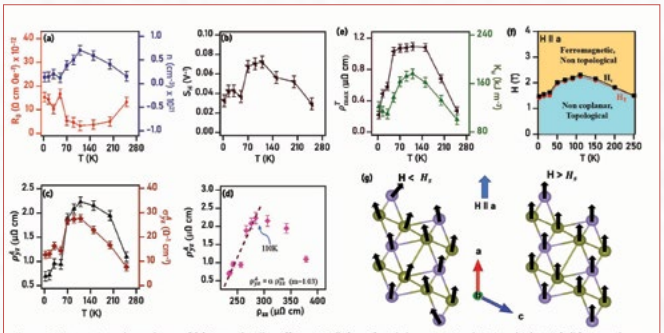



**Figure 2:** Temperature dependence of (a) Normal Hall coefficient R0 (left axis) and charge carrier density n (right axis). (b) Anomalous Hall scaling coefficient SH plotted as a function of temperature. (c) Anomalous Hall resistivity ($\rho^A_{yz}$) and Hall conductivity ($\sigma^A_{xy}$). (d) Plot of $\rho^A_{yz}$ vs. $\rho_{xx}$. Dashed line in (d) is linear fitting with equation shown on the figure. (e) Maximum value of $\rho^T_{max}$ and magnetocrystalline anisotropy ($K_u$) plotted as a function of temperature. (f) Saturation magnetic field ($H_s$) and magnetic field ($H_T$) above which the topological Hall effect disappears for H ∥ a. (g) Schematic representation of Cr spin configuration for H <$H_s$ (left) and H >$H_s$.

1. Weak Electronic Correlations Observed in Magnetic Weyl Semimetal Mn3Ge

   In this work, using angle-resolved photoemission spectroscopy (ARPES) and density functional theory (DFT) calculations, we systematically studied the electronic band structure of Mn3Ge in the vicinity of the Fermi level. We observe several bands crossing the Fermi level, confirming the metallic nature of the studied system. We further observe several flat bands along various high symmetry directions, consistent with the DFT calculations. The calculated partial density of states suggests a dominant Mn 3d orbital contribution to the total valence band DOS. With the help of orbital-resolved band structure calculations, we qualitatively identify the orbital information of the experimentally obtained band dispersions. Out-of-plane electronic band dispersions are explored by measuring the ARPES data at various photon energies. Importantly, our study suggests relatively weaker electronic correlations in Mn3Ge compared to Mn3Sn. Below is the representative image describing the electronic band structure of Mn3Ge.

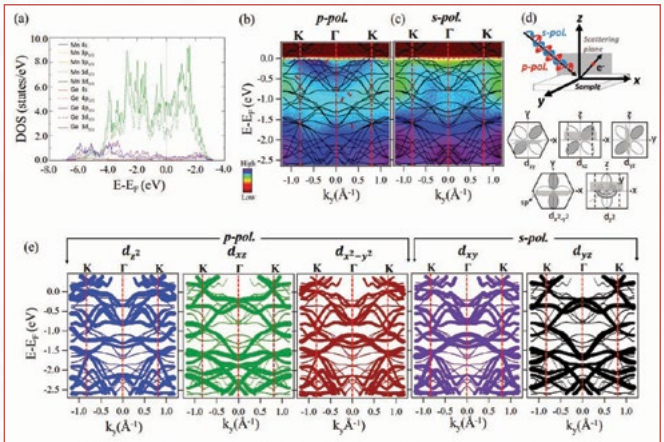


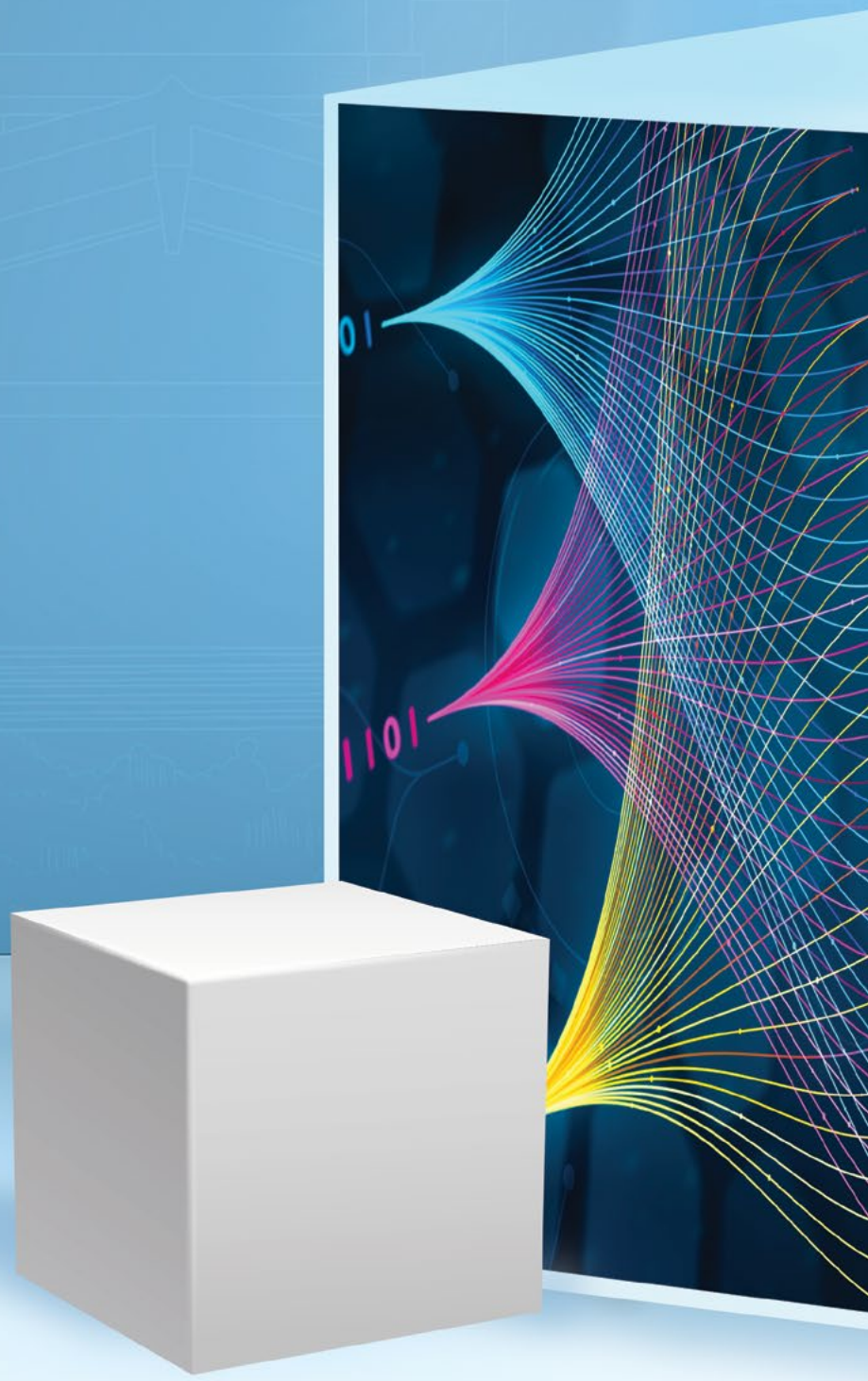

**Figure 3:** (a) Partial density of states (PDOS) of $Mn_3Ge$. ARPES spectra along the $\Gamma - K$ direction measured with (b) $p-$polarized and (c) $s-$polarized lights overlapped with the DFT band structure (with SOC). Arrows in panel (b) show the $(E, k)$ location of various flat bands. The top panel in (d) shows schematic ARPES measuring geometry with $p-$ and $s-$polarized lights defined with respect to the scattering plane (sp). The bottom panel in (d) shows various Mn $3d$ orbitals projected onto the hexagonal Brillouin zone and oriented w.r.t. the scattering plane. In this measuring geometry, the $p-$polarized light has the even parity and the $s-$polarized light has the odd parity. Similarly, w.r.t. to sp the orbital characters $d_{xz}$, $d_{x^2-y^2}$, and $d_{z^2}$ have the even parity, while $d_{xy}$ and $d_{yz}$ have the odd parity. (e) Orbital-resolved DFT band structure (without SOC) calculated for Mn $3d$ orbitals, $d_{z^2}$, $d_{xz}$, $d_{x^2-y^2}$, $d_{xy}$, and $d_{yz}$.

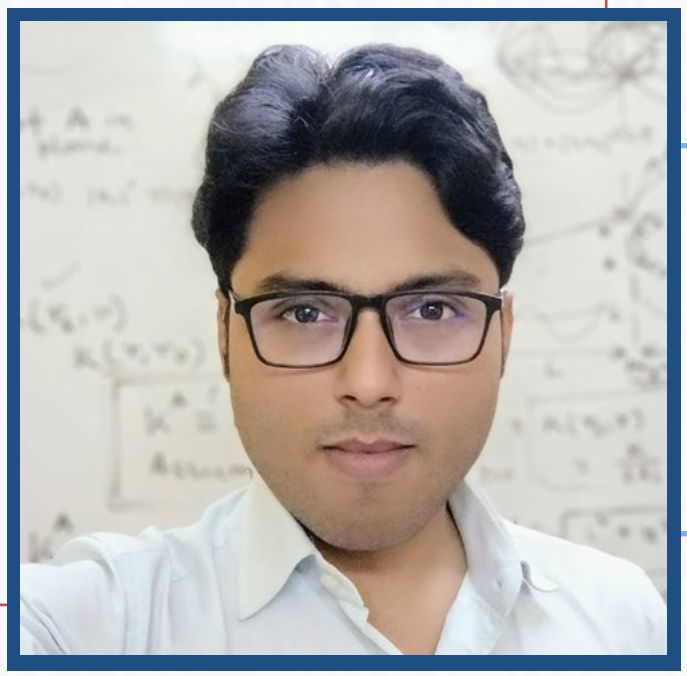
## Plan of Future Work Including Project

1. Growing high-quality single crystals of Dirac and Weyl semimetals, Transition metal dichalcogenides (TMDC), Quantum spin liquids (QSL), and Two-dimensional (2D) magnetic materials using the solid-state reaction route of molten-growth, flux-growth, and chemical vapor transport (CVT) techniques. As grown samples will be extensively studied for their electrical, magnetic properties and electronic band structure to understand the underlying physics of these exotic materials.

# Department of

## Physics of Complex Systems






## Arijit Haldar

Assistant Professor

Physics of Complex Systems

arijit.haldar@bose.res.in


## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Anish Chaudhuri; Gauge theories and topological phases in CMP; Under progress
2. Arnab Paul; Interplay of charge, spin and orbital in oxides; Under progress; Tanusri Saha-Dasgupta (Co-supervisor)
3. Rima Ghosh; Twisted Bilayer systems; Under progress; Tanusri Saha-Dasgupta (Co-supervisor)

### b) Post-Docs

1. Asmita Kumari; Quantum foundations and Information, Sequential measurement, Quantum channel
2. Shantanu Mukherjee; Field theory of superconductors and topological materials
3. Shiladitya Karmakar; Computation Based Understanding and Prediction of Technologically Important Indigenous Materials

### c) External Project Students / Summer Training

1. Sinchan Ghosh; Topological Quantum Computation
2. Sumit Yadav; Application of path integrals in statistical physics and in instantons
3. Rakesh Ghosh; Basic introduction to Machine Learning

### Teaching

1. Spring semester; Spring semester; Quantum Mechanics 2 (PHY 406); Integrated PhD; 11 students
2. Spring semester; Spring semester; Quantum Mechanics 2 (PHY 406); Integrated PhD; 14 students
3. Spring semester; Project Research (PHY 494) of IPhD. Students; Integrated PhD; 2 students
4. Autumn semester; Project Research (PHY 691); PhD; 1 student

## Publications

### a) In journals

1. **Arijit Haldar**, Omid Tavakol, Han Ma, and Thomas Scaffidi, *Hidden Critical Points in the Two-Dimensional O(n>2) Model: Exact Numerical Study of a Complex Conformal Field Theory,* Physical Review Letters, 131, 131601, 2023
2. Surajit Bera, **Arijit Haldar**, and Sumilan Banerjee, *Dynamical mean-field theory for Rényi entanglement entropy and mutual information in the Hubbard model,* Physical Review B, 109, 035156, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Presented an invited talk in the "Frontiers in Physics" conference (as part of a MoU between Ashoka University and SNBNCBS); April 1, 2024; Ashoka University; 2 days
2. Presented an invited talk in RTCMPQM 2024 organized by Indian Association for the Cultivation of Science (IACS), Kolkata; February 15, 2024; IACS Kolkata; 2 days
3. Presented an invited talk in the IFW-SNB joint meeting (as part of a MoU between IFW-Dresden and SNBNCBS); November 27, 2023; SNBNCBS Kolkata; 2 days
4. Delivered two lectures at the C.K. Majumdar memorial workshop; July 24, 2023; SNBNCBS Kolkata; 2 days

## Administrative duties

1. Active member of the CSC Working Group Committee.
2. Active member of the Website Committee: Spearheaded and implemented the prompt redesign of the centre's official website to make it up to date with the requirements.
3. Active member of the Email migration Committee: Spearheaded and proactively aided the migration of centre's email facilities to Google workspace.
4. Active member of the ARPAC 2023-2024 report committee: This committee was tasked with the creation of a comprehensive academic report for the centre which was presented to the members of ARPAC for evaluation.
5. Active member of the Bhagirathi Guesthouse Committee: Surveyed, prepared a report, and meticulously supervised the renovation of the guesthouse infrastructure for the 1st Bose Statistics Centenary conference and in general.
6. 6. Sports Coordinator for the centre: Supervised the setup for the centre's gym facilites at Radhachura Hostel. Supervising the ongoing process of installing new equipment in the gym based on feedback.
7. Judge for the Bose Fest 2024 Poster session. BOSE-FEST is a multi day event showcasing the research work of all students and faculty from the centre.
8. Nominated presenter for ARPAC: Presented the research activities of several faculty members of DPCS at ARPAC 2023-2024.
9. Active member of the Bhagirathi Rooftop Cafeteria Committee: The committee has been formed to oversee the setup of a cafeteria in the 1st floor premises of Bhagirathi Guesthouse.
10. Organizer for conducting "Outreach Programmes for the students of SC/ST communities under VASP".
11. Interview panel member for the IPhD admissions 2023, and PhD admissions 2023 as well as IISER-SNBNCBS Joint PhD 2023 admission interviews.
12. Member of the PDRA selection committee.

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Harnessing the Interplay of Quantum Entanglement, Topology, and Strong Correlations in Condensed Matter Systems for Near-term Quantum Applications and Beyond; SERB DST India; 2 years; PI

## Conference / Symposia / Schools organized

1. International Conference on Photonics, Quantum Information, and Quantum Communication PQIQC (1st conference of BoseStat@100); January 29, 2024; SNBNCBS, Biswa Bangla Convention Centre, Kolkata; 5 days
2. Public Outreach Celebrating BoseStat@100 (Special Lecture by Prof. Charles H. Bennett); February 3, 2024; Science City, Kolkata; 1 day

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. Sumilan Banerjee, IISc; Sl. No. 2; National
2. Prof. Thomas Scaffidi, UC Irvine, USA; Sl. No. 1; International

## Outreach program organized / participated

1. Organized a one day outreach program at Sir Rajendra Nath Mukherjee Govt. Polytechnique College, Basirhat, North 24 Pargana, West Bengal. This program was also organized to celebrate the India International Science Festival (IISF-2023) on 21st December 2023. Additionally, presented a lecture along with demonstrations of principles in quantum mechanics at the event.
2. Organized a one day outreach program at the Dept. of Physics, Sidho-Kanho-Birsha University, Purulia on March 18, 2024
3. Organized a one day Science Outreach Program "Horizon 2023" at Department of Chemistry & Physics, Ranaghat College on 26 May 2023. Also presented a lecture along with a demonstration of fundamental principles of quantum mechanics at the event.
4. Organized a one day Science Outreach outreach program at Tarakeswar Degree College, Hoogly, West Bengal on 25th August 2023. Also presented a lecture along with a demonstration of the principles of quantum mechanics at the event.

5. Organized a one day Science Outreach outreach program at the Department of Chemistry, the University of Burdwan, Burdwan, West Bengal on 25 January 2024, and presented a lecture on the principles of quantum mechanics.

## Areas of Research

**Theoretical condensed matter physics. Sub-fields: quantum many-body theory, physics of disordered systems, quantum entanglement, transport, and topological phases.**

I am a theoretical condensed matter physicist by training with a background in topics such as quantum many-body theory, phase transitions, quantum non-equilibrium phenomena, and topological phases. My current research area of interest involves exploring the interplay of quantum entanglement, topology, and strong correlations in condensed matter systems. I joined the SNBNCBS team on 5$^{th}$ September 2022. Recently, we have published original ideas covering various facets of condensed-matter physics and critical phenomena. In particular, we have provided the first proof of a microscopic Complex Conformal Field Theoretic (CFT) model that was long sought after by the physics community. Conformal Field Theory (CFT) is widely regarded to be our best understanding of critical phenomena such as those often encountered in phase-transitions. Our finding significantly advances CFT research and has been published in Physical Review Letters. In another work, we have demonstrated the algorithmic application of our recently-discovered interpretation of quantum entanglement in many-electron systems. Our interpretation, which is based on ideas from quantum field theory and extracts entanglement entropy by applying kicks to electrons, was successfully integrated with the Dynamical Mean Field Theory approach in the form of an algorithm that allows us to compute entanglement in realistic models for materials such as the Hubbard model. Our findings were published as an article in Physical Review B.

## Plan of Future Work Including Project

1. Understanding the role of magnons and other novel-quasiparticles in quantum spin systems and related platforms.
2. (a) Understanding quantum-entanglement and strong correlations at the fundamental level and exploring possible applications in the form of quantum devices. (b) Developing analytical and computational methods to characterize quantum properties, such as entanglement, in condensed matter systems with strong electron-electron interactions.
3. Exploring the role of topology in quantum systems and its interplay with strong interactions in various condensed matter systems.
4. Study of strongly correlated electrons in layered materials in the presence of Moire patterns.
5. Study of emergent Gauge theories in lattice systems.

## Any other Relevant Information including social impact of research

1. Our lecture on the quantum eraser experiment at Basirhat Govt. Polytechnic College was attended by many students and teachers and covered in local news https://www.youtube.com/watch?v=yRpyyrMRUuo https://www.facebook.com/share/v/bugeokyJzEoH3JgR/?mibextid=KMUjF5
2. Reviewer for Physical Review Letters.
3. Reviewer for Physical Review B
4. Reviewer for the journal Pramana.
5. Co-anchored the "Public Outreach Celebrating BoseStat@100" event, featuring special guest lecture by Prof. C.H. Bennett, at Science City. The event was covered by several news outlets and articles. https://www.telegraphindia.com/science-tech/a-true-scientist-appreciates-being-proven-wrong-interview-of-professor-charles-henry-bennett/cid/2006046


## Jaydeb Chakrabarti

Senior Professor

Physics of Complex Systems

jaydeb@bose.res.in


## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Suravi Pal; Soft matter physics; Thesis submitted
2. Anirban Pal; Biomolecular systems; Under progress
3. Kanika Kole; Biomolecular systems; Under progress
4. Avik Sasmal; Soft matter physics; Under progress; Prof. Tanusri Saha Dasgupta (Co-supervisor)
5. Anusree Sen; Biomolecular systems; Under progress
6. Sabuj Mandal; Soft matter physics; Under progress

### b) Post-Docs

1. Aayatti Mallick; Biomolecular systems
2. Arijit Mandal; Soft matter physics
3. Soumi Das; Biomolecular systems

## Teaching

1. Autumn semester; PHY530; Integrated PhD; 09 students

## Publications

### a) In journals


1. Aayatti Mallick Gupta, SasthiCharan Mandal, Sukhendu Mandal, **Jaydeb Chakrabarti**, *Immune escape facilitation by mutations of epitope residues in RdRp of SARS-CoV-2,* Journal of Biomolecular Structure and Dynamics, 41, 3542-3552, 2023
2. Aayatti Mallick Gupta, **Jaydeb Chakrabarti**, *Effect on the conformations of the spike protein of SARS-CoV-2 due to mutation,* Biotechnology and Applied Biochemistry, 70, 979-991, 2023
3. Rahul Karmakar, **J. Chakrabarti**, *Hot crystals of thermo-responsive particles with temperature dependent diameter in the presence of a temperature gradient,* The Journal of Chemical Physics, 159, 034904, 2023
4. Abhik Ghosh Moulick and **Jaydeb Chakrabarti**, *Fluctuation-Dominated Ligand Binding in Molten Globule Protein,* Journal of Chemical Information and Modeling, 63, 5583-5591, 2023
5. Kanika Kole, Aayatti Mallick Gupta, **Jaydeb Chakrabarti**, *Conformational stability and order of Hoogsteen base pair induced by protein binding,* Biophysical Chemistry, 301, 107079, 2023
6. Arpan Narayan Roy, Aayatti Mallick Gupta, Deboshmita Banerjee, **Jaydeb Chakrabarti**, Pongali B. Raghavendra, *Unraveling DPP4 Receptor Interactions with SARS-CoV-2 Variants and MERS-CoV: Insights into Pulmonary Disorders via Immunoinformatics and Molecular Dynamics,* Viruses, 15(10), 2056, 2023

7. Sasthi Charan Mandal and **Jaydeb Chakrabarti**, *In-silico studies on hydration in EcoRI-cognate DNA complex,* Biophysical Chemistry, 303, 107121, 2023
8. Rahul Karmakar, **J. Chakrabarti**, *Transport of particles through RO membrane in steady state condition,* ChemistrySelect, 9, e202304343, 2024

## Talks / Seminars Delivered in reputed conference / institutions

1. Statphys 28; August 7, 2023; Tokyo University
2. ICMM-2023; December 16, 2023; IIT-Chennai
3. ICM-24; January 12, 2024; MGU-Kottayam
4. NBI-24; February 16, 2024; JNU, NewDelhi

## Administrative duties

1. Acted as Chairman of the faculty search committee of S N Bose National Cenre for Basic Sciences

## Membership of Learned Societies

1. Indian Biophysical Society

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. TRC; DST; Co-PI

## Conference / Symposia / Schools organized

2. TPSAM-2024; March 8, 2024; S N B N C B S, Kolkata

## Areas of Research

1. Statistical mechanics of soft matter and bio-molecular systems

## Fluctuation-Dominated Ligand Binding in Molten Globule Protein

A molten globule (MG) state is an intermediate state of protein observed during the unfolding of the native structure. In MG states, milk protein α-lactalbumin (aLA) binds to oleic acid (OLA). This MG–aLA–OLA complex, popularly known as XAMLET, performs cytotoxic activities against cancer cell lines. However, the microscopic understanding of ligand recognition ability in the MG state of the protein has not yet been explored. Motivated by this, we explore the binding of bovine aLA with OLA using all-atom molecular dynamics (MD) simulations. We find the binding mode between MG–aLA and OLA using the conformational thermodynamics method. We also estimate the binding free energy using the umbrella sampling (US) method for both the MG state and the neutral state. We find that the binding free energy obtained from US is comparable with earlier experimental results. We characterize the dihedral fluctuations as the ligand is liberated from the active site of the protein using steered MD. The low energy fluctuations occur near the ligand binding site, which eventually transfer toward the Ca2+-binding site as the ligand is taken away from the protein.
DOI: doi.org/10.1021/acs.jcim.3c00642

## Hot crystals of thermo-responsive particles with temperature dependent diameter in presence of a temperature gradient

Structure formation in non-equilibrium steady state conditions is poorly understood. Non-equilibrium steady state can be achieved in a system by maintaining temperature gradient. A class of cross-linked micro-gel particles, poly-N-isopropylacrylamide (PNIPAM), are reported to increase in size due to adsorption of water as temperature decreases. Here we study thermo-responsive particles with temper- ature sensitive diameter in presence of temperature gradient, using Molecular Dynamics simulations with the Langevin thermostat. We find long-ranged structural order using bond order parameters in both cold and hot region of the system beyond a certain diameter ratio of the cold and hot particles. This is due to increase in packing and pressure in both regions. Our observations might be useful in understanding ordered structures in extreme conditions of non-equilibrium steady state.

## Plan of Future Work Including Project

1. Working on conformational fluctuations in a nano-bio conjugate. Paricular focus is on the conformational stabilization in an IDP in presence of ZnO nanoparticles
2. Modeling sensitivity of protein-protein effective interaction in different solvent conditions.
3. Coarse grained studies on protein conformation
4. Freezing of colloids in presence of impurities

## Any other Relevant Information including social impact of research

1. Acting as a member of the Departmental phd committee in physics department of the Presidency University


## Manik Banik

Associate Professor
Physics of Complex Systems
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## Guidance of Students/Post-Docs/Scientists

### a) Ph.D. Students

1. Ananya Chakraborty; Study of Information Processing Protocols and Exploring Quantum Advantages in Communication Tasks; Under progress
2. Sahil Gopalkrishna Naik; A comprehensive Study On Composite Physical Systems And Their Application In Information Protocols; Under progress
3. Ram Krishna Patra; Study of quantum resources to devise advanced communication protocols; Under progress
4. Snehasish Roy Chowdhury; Quantum Information Theory and Quantum Thermodynamics; Under progress; Prof. Guruprasad Kar, Indian Statistical Institute, Kolkata (Co-supervisor)
5. Samrat Sen; A study on various discrimination tasks and their implications in quantum information processing; Under progress

### b) Post-Docs

1. Mir Alimuddin; Quantum Information theory, Quantum Communication, Quantum Thermodynamics, Quantum Foundations
2. Pratik Ghosal; Quantum Information theory, Quantum Communication, Causality in Quantum World

## Teaching

1. Autumn semester; PHY 405 Quantum Mechanics I; Integrated PhD; 17 students; with Sanku Paul (co-teacher)

## Publications

### a) In journals

1. Jitendra Joshi, Mir Alimuddin, T. S. Mahesh, and **Manik Banik**, *Experimental verification of many-body entanglement using thermodynamic quantities,* Physical Review A, 109, L020403, 2024
2. Mir Alimuddin, Ananya Chakraborty, Govind Lal Sidhardh, Ram Krishna Patra, Samrat Sen, Snehasish Roy Chowdhury, Sahil Gopalkrishna Naik, and **Manik Banik**, A*dvantage of Hardy's nonlocal correlation in reverse zero-error channel coding,* Physical Review A, 108, 052430, 2023
3. Zhonghua Ma, Markus Rambach, Kaumudibikash Goswami, Some Sankar Bhattacharya, **Manik Banik**, and Jacquiline Romero, *Randomness-Free Test of Nonclassicality: A Proof of Concept,* Physical Review Letters, 131, 130201, 2023

4. Sahil Gopalkrishna Naik, Govind Lal Sidhardh, Samrat Sen, Arup Roy, Ashutosh Rai, and **Manik Banik**, *Distilling Nonlocality in Quantum Correlations,* Physical Review Letters, 130, 220201, 2023

## Talks / Seminars Delivered in reputed conference / institutions

1. Invited Talk at SPECTRUM 2024, International Students' Conference on Current Advancements in Science & Technology; January 20, 2024; University of Engineering and Management; 60 mins
2. Invited Talk at the meeting on Quantum Information Processing and Applications (QIPA); December 6, 2023; Harish-Chandra Research Institute; 45 mins

## Administrative duties

1. Committee for Theoretical Physics Seminar Circuit (TPSC); Coordinator & Convener; from 19/09/2022
2. Committee for conducting outreach programmes for the students of SC/ST communities under VASP; Convener, from 06/12/2022
3. Media Cell of the Centre; Member, from 23/12/2022
4. Seminar & Colloquia Programme (SCOLP) Sub-Committee under EVLP; Member, from 30/03/2023
5. Computer Services Cell Advisory Committee (CSC-AC); Member; 24/08/2023
6. Placement & Alumni Cell; Member; from 13/07/2023
7. Committee for the planning of the Centenary observation of Bose Statistics; Member; from 16/12/2022

## Conference / Symposia / Schools organized

1. International Conferences on Photonics, Quantum Information, and Quantum Communication; January 29, 2024; Biswa Bangla Convention Centre; 5 days
2. C. K. Majumdar Memorial Summer Workshop in Physics 2023; July 18, 2023; S. N. Bose Centre; 10 days

## Scientific collaborations with other national / international institutions (based on joint publications)

1. Prof. T. S. Mahesh, IISER Pune; Phys. Rev. A 109, L020403 (2024); National
2. Dr. Jacquiline Romero, University of Queensland; Phys. Rev. Lett. 131, 130201 (2023); International
3. Dr. Arup Roy, A.B.N. Seal College; Phys. Rev. Lett. 130, 220201 (2023); National
4. Dr. Ashutosh Rai, KAIST, South Korea; Phys. Rev. Lett. 130, 220201 (2023); International

## Outreach program organized / participated

1. Name: A one-day Science outreach program Venue: Sidho-Kanho-Birsha University, Purulia, WB Date: March 20, 2024 Role: Speaker
2. Name: A one-day Science outreach program, IISF 2023 Venue: Sir R. N. Mukherjee Govt. Polytechnique, Basirhat, WB Date: December 21, 2023 Role: Speaker
3. Name: A one-day outreach program on "Wonders of science: Explore and Learn" Venue: Tarakeswar Degree College, Purulia, WB Date: August 25, 2023 Role: Speaker
4. Name: A One Day Science Outreach Program "Horizon-23 Where Young Minds Tryst With Science" Venue: Seminar Hall, Ranaghat College, WB Date: May 26, 2023 Role: Speaker

## Areas of Research

### Quantum Information Theory, Quantum Communication, Quantum Technology, Quantum Foundations (Reconstruction Programme), Causality in Quantum World

The current research endeavors of our team can be classified into the following three primary categories.

a) Study of nonclassical correlations in multipartite quantum systems: Correlations are paramount in scientific investigations serving as a linchpin for advancing our comprehension of the natural worl. This significance is particularly pronounced in the analysis of quantum systems comprised of multiple components. Quantum correlations, such as entanglement and steering, have puzzled scientists since the inception of quantum theory. J.S. Bell's groundbreaking work leveraged quantum entanglement to unveil the concept of quantum nonlocality. Beyond their foundational significance, these nonclassical correlations serve a spectrum of practical applications. More recently, another form of correlation termed quantum discord has emerged, encapsulating non-classicality even in the absence of entanglement. One of our core research goals is exploring these nonclassical correlations, with a focus on their identification, quantification, and classification.

b) Devising enhanced means of communication utilizing quantum resources: Shannon's pioneering work in 1948 laid the groundwork for the elementary model of communication, addressing the reliable transmission of information between distant servers. The Quantum Shannon theory, an extension of this classical model, seeks to innovate information transmission techniques by leveraging the unique properties of quantum systems. An exemplary demonstration of this is the quantum superdense coding protocol, which efficiently

utilizes quantum entanglement to transmit two classical bits of information by encoding them onto a qubit, a two-label quantum system. Despite the quantum advantages, certain limitations exist. Holevo's theorem, for instance, establishes a ceiling on the capacity of a quantum system to match its classical counterpart in the absence of entanglement between sender and receiver. Recently, Frenkel and Weiner expanded on this theorem, illustrating that even with only pre-shared classical correlations (without entanglement), any input/output correlation achievable with an n-level quantum system can also be replicated using an n-state classical system. One of our current research goals is to establish advantages of elementary quantum systems in network communication wherein there are potentials to bypass the restriction imposed by Holevo- Frenkel-Weiner results. We are also exploring the possibilities of quantum advantages in zero-error information theory, a relatively less explored area of research.

c) Principle based derivation of the mathematical structure of quantum theory: Figuring out the physical rationale behind natural selection of quantum theory is one of the most acclaimed quests in quantum foundational research. This pursuit has inspired several axiomatic initiatives to derive a mathematical formulation of the theory by identifying the general structure of state and effect space of individual systems as well as specifying their composition rules. This generic framework can allow several consistent composition rules for a multipartite system even when state and effect cones of individual subsystems are assumed to be quantum. One of our present research focuses is explore information principles to bring physical rationale toward structural derivation of multipartite quantum systems.


## Prosenjit Singha Deo

Professor

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Sayan Routh; Condensed matter physics; Under progress; Thirupathaiah Setti (Co-supervisor)
2. K. Meena; Mesoscopic physics, quantum mechanics, transport and thermodynamic phenomenon; Under progress

### Publications

a) Other Publications

1. Prosenjit Singha Deo, Mesoscopic Route to Time Travel, Singapore: Springer Verlag, 2022 (ISBN: 978-9811644672)

### Administrative duties

1. Library committee member

### Areas of Research

Mesoscopic physics, quantum mechanics, transport and thermodynamic phenomenon

We have been exploring multiple ways of finding signatures of time travel through experiments in mesoscopic physics and quite a few possibilities has been established. Time travel is possible with present day technologies.


## Punyabrata Pradhan

Professor

Physics of Complex Systems

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Anirban Mukherjee; Studies of hydrodynamics and fluctuations in sandpiles; Thesis submitted
2. Tanmoy Chakraborty; Studies of fluctuations and transport in active matter systems; Under progress
3. Animesh Hazra; Studies of dynamic properties of mass transport processes; Under progress
4. Deepshikha Das; Transport in many-particle systems with time-dependent drive; Under progress; Sakuntala Chatterjee (Co-supervisor)
5. Rupayan Saha; Time-dependent properties of interacting self-propelled particles; Under progress

### Teaching

1. Spring semester; Statistical Mechanics PHY 404; Integrated PhD; 14 students

### Publications

#### a) In journals

1. Deepsikha Das, **Punyabrata Pradhan**, Sakuntala Chatterjee, *Optimum transport in systems with time-dependent drive and short-ranged interactions,* Physical Review E, 108, 034107, 2023
2. Tanmoy Chakraborty and **Punyabrata Pradhan**, *Time-dependent properties of run-and-tumble particles: Density relaxation,* Physical Review E, 109, 024124, 2024

### Talks / Seminars Delivered in reputed conference / institutions

1. Time-dependent properties of run-and-tumble particles; February 10, 2024; Institute of Physics, Bhubaneswar; 30 minutes

### Administrative duties

1. HOD, PCS
2. Chairperson of Newsletter committee
3. Chairperson of the computer service cell working group
4. Media cell member
5. Interview / admission committees, and various other committees

### Conference / Symposia / Schools organized

1. Time-dependent phenomena in soft and active matter (TPSAM2024); March 8, 2024; Punyabrata Pradhan, SNBNCBS; 2 days

## Areas of Research

Hydrodynamic characterization of conserved-mass transport processes, fluctuation relations in and large-deviation properties, single-file transport through confined geometry in the presence of a time-dependent drive

I have been working in the broad area of nonequilibrium statistical physics, including problems relevant to biology. The central theme of my current research involves characterization of systems driven far from equilibrium through studies of large-scale (hydrodynamic) characterization of various non-equilibrium mass transport processes (such as mass chipping and aggregation models, self-propelled particles, and sandpiles, etc.), fluctuation relations in and large-deviation properties of these systems, steady-state thermodynamics of driven systems in terms of intensive thermodynamic variables like equilibrium chemical potential, and single-file transport through confined geometry in the presence of an external drive (time-independent as well as time-dependent), etc.

We considered a one-dimensional lattice gas model of hardcore particles with nearest-neighbor interaction in presence of a time-periodic external potential. We investigate how attractive or repulsive interaction affects particle transport and determine the conditions for optimum transport, i.e., the conditions for which the maximum dc particle current is achieved in the system. We find that the attractive interaction in fact hinders the transport, while the repulsive interaction generally enhances it. The net dc current is a result of the competition between the current induced by the periodic external drive and the diffusive current present in the system. When the diffusive current is negligible, particle transport in the limit of low particle density is optimized for the strongest possible repulsion. But when the particle density is large, very strong repulsion makes particle movement difficult in an overcrowded environment and, in that case, the optimal transport is obtained for somewhat weaker repulsive interaction. When the diffusive current is significantly large, the particle transport is still facilitated by repulsive interaction, but the conditions for optimality change. Our numerical simulations show that the optimal transport occurs at the strongest repulsive interaction for large particle density and at a weaker repulsion for small particle density.

We characterized collective diffusion of hardcore run-and-tumble particles (RTPs) by explicitly calculating the bulk-diffusion coefficient $D(\rho, \gamma)$ for arbitrary density $\rho$ and tumbling rate $\gamma$, in systems on a d-dimensional periodic lattice. We study two minimal models of RTPs: Model I is the standard version of hardcore RTPs introduced in [Phys. Rev. E 89, 012706 (2014)], whereas model II is a long-ranged lattice gas (LLG) with hardcore exclusion, an analytically tractable variant of model I. We calculate the bulk-diffusion coefficient analytically for model II and numerically for model I through an efficient Monte Carlo algorithm; notably, both models have qualitatively similar features. In the strong-persistence limit, the fascinating interplay between persistence and interaction is quantified in terms of two length scales: (i) persistence length and (ii) a "mean free path," being a measure of the average empty stretch or gap size in the hopping direction. We find that the bulk-diffusion coefficient varies as a power law in a wide range of density. As a result, the density relaxation is governed by a nonlinear diffusion equation with anomalous spatiotemporal scaling.

## Plan of Future Work Including Project

1. Characterization of long-range correlations (e.g., in mass and current fluctuations) in driven diffusive systems.
2. Dynamic characterization of hyperuniform state of matter in the presence of center-of-mass conservation.
3. Fluctuation properties of interacting self-propelled particles in the presence of hard walls and disordered potentials.
4. Characterization of current fluctuation in the long-ranged lattice gases exhibiting condensation transition.


## Sakuntala Chatterjee

Professor

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Shobhan Dev Mandal; Bacterial Chemotaxis in noisy environment; Thesis submitted
2. Deepsikha Das; Periodically driven nonequilibrium systems; Under progress; Punyabrata Pradhan (Co-supervisor)
3. Chandradip Khamrai; Coupled driven systems; Under progress
4. Ramesh Pramanik; Bacterial chemotaxis in time-verying environment; Under progress
5. Ajay Sharma; Study of Blazars in high energy regime; Under progress; Debanjan Ghosh (Central University of Kashmir) (Co-supervisor)
6. Debojit Sen; Coupled dynamics of lipid and integrin molecules; Under progress
7. Pallabi Roy; Stochastic response in biological systems; Under progress; Gautam Gangopadhyay (Co-supervisor)

#### b) Post-Docs

1. Ramu Kumar Yadav; Intracellular Copper Transport, Chemotactic response in time-varying environment

### Publications

#### a) In journals

1. Deepsikha Das, Punyabrata Pradhan, **Sakuntala Chatterjee**, *Optimum transport in systems with time-dependent drive and short-ranged interactions,* Physical Review E, 108, 034107, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. Taught a course on "Bacterial Chemotaxis" in Bangalore School of Statistical Physics 2023; September 11, 2023; RRI Bangalore
2. Presented a seminar on "Chemotaxis in a noisy environment"; September 18, 2023; JNCASR Bangalore
3. Presented an online seminar on "Noise in bacterial chemotaxis"; May 23, 2023; Edinburgh University (online)
4. Presented a seminar on "Bacterial chemotaxis in time-varying environment" in the conference "Time dependent phenomenon in soft and active matter systems"; March 8, 2024; SNBNCBS, Kolkata

### Administrative duties

1. Served in many internal committees of the center

## Awards, Recognitions, if any

1. Invited to join Editorial Board of the Journal of Biosciences
2. Co-editor of Euro Physics Letters (EPL) journal

## Membership of Learned Societies

1. Invited member of European Physical Society

## Conference / Symposia / Schools organized

1. Organized StatPhys Kolkata XII; December 18, 2023; SNBNCBS, Kolkata; 5 days

## Outreach program organized / participated

1. Organized a visit of school children (girls) from east Midnapore district to SNBNCBS on 22nd September 2023. During this visit, the children visited few labs and heard from few woman researchers about their journey. This event was organized under Vigyan Jyoti Scheme.

## Areas of Research

1. Nonequilibrium Statistical Physics, Biological Systems

## Effect of relative timescale on a system of particles sliding on a fluctuating energy landscape

We consider a system of hardcore particles advected by a fluctuating potential energy landscape, whose dynamics is in turn affected by the particles. Earlier studies have shown that as a result of two-way coupling between the landscape and the particles, the system shows an interesting phase diagram as the coupling parameters are varied. The phase diagram consists of various different kinds of ordered phases and a disordered phase. We introduce a relative timescale between the particle and landscape dynamics, and study its effect on the steady state properties. We find there exists a critical value of the relative time-scale when all configurations of the system are equally likely in the steady state. We prove this result exactly in a discrete lattice system and obtain an exact expression for the critical value in terms of the coupling parameters of the system. We independently calculate the critical time-scale from a coarse-grained level description of the system using linear hydrodynamics, and show it exactly matches with our discrete model result. (With Chandradip Khamrai)

## Plan of Future Work Including Project

1. Study of dynamics of coupled driven systems 2. Study of cellular response in time-varying environment


## Sanku Paul

DST INSPIRE Faculty

Physics of Complex Systems


### Teaching

1. Autumn semester; PHY 405 Quantum Mechanics I; Integrated PhD; 17 students; with Manik Banik (co-teacher)

### Publications

#### a) In journals

1. **Sanku Paul**, J. Bharathi Kannan, and M. S. Santhanam, *Interaction-induced directed transport in quantum chaotic subsystems,* Physical Review E, 108, 044208, 2023

### Talks / Seminars Delivered in reputed conference / institutions

1. Attended a conference on Data Dynamics Summit 2024; 14/03/2024 – 15/03/2024; IISER Pune
2. Gave a talk on "Hidden quantum criticality and entanglement in quench dynamics"; 19/03/2024; IISER Pune; 1 hour talk

### Areas of Research

#### Quantum and classical chaos, Non-equilibrium physics, Quantum critical phenomena

i. Superlinear entanglement production in N-interacting quantum chaotic system:

Entanglement captures the degree of inseparability between quantum-mechanical states and serves as a crucial resource in the development of quantum technologies, identification of phases and phase transitions. In an ergodic phase, entanglement characterized by von-Neumann entropy, SvN, displays linear growth with time before saturating. In contrast, in a non-ergodic many-body localized phase, SvN grows logarithmically with time. Faster than

linear rate of generating entanglement, e.g., superlinear growth, will be useful in many practical settings. Faster entanglement generation has been observed in a non-Hermitian PTsymmetric system. In contrast, we show a super-linear entanglement production in a Hermitian quantum many-body system, specifically, N-interacting kicked rotors. This work has been done in collaboration with Prof. M.S. Santhanam and Bharathi Kannan at IISER Pune (arXiv:2405.06622).

ii. Detecting classical and quantum localization using Krylov complexity: In recent years, probing many-body quantum chaos and scrambling have been topics of huge interest. Several quantities, for instance, level spacing ratio, out-of-time ordered correlator, spectral form factor have been formulated to detect many-body quantum chaos. In our work, we focus on a recently formulated quantity, the Krylov complexity. We address the question of applicabity of Krylov complexity in probing different types of localization, namely, the classically induced localization, quantum dynamical localization/exponential localization, power-law localization, and localization due to anti-resonance. Our work reveals that

Krylov complexity display unique signatures in distict types of localization. This work has been done in collaboration with Prof. M.S. Santhanam, Bharathi Kannan, Dr. Harshini Tekur, Dr. P. G. Sreeram at IISER Pune. The manuscript is under reparation.

iii. Hidden quantum criticality in quench dynamics: Entanglement exhibits universal behavior near the ground state of a critical point, where the thermodynamic entropy is vanishing. Conversely, a quantum quench results in build-up of entropy, thereby negating the expectation of critical behavior in a long-time stationary state. In our work, we demonstrate that during a critical-to-critical quench, a genuine quantum critical behavior emerges in the long-time stationary state in an integrable spin chain. This critical behavior is manifested in higher-order correlations and remains invisible to local observables. This work has been done in collaboration with Prof. Mohammad Maghrebi at MSU, USA and Dr. Paraj Titum at Johns Hopkins University, USA. This work is in communication with PRL (arXiv:2202.04654). We extended this work to long-range Kitaev chain. This work is done in collaboration with Dr. Shashi Srivastava and Akash Mitra at VECC, Kolkata. The manuscript is under preparation.

iv. Non-equilibrium phenomenon in non-linear kicked rotor: Universality of fluctuations is a remarkable phenomenon in physics. An examples is the Kardar-Parisi-Zhang (KPZ) physics that descibes a universal framework in non-equilibrium processes. While initially associated with classical systems, recent numerical and experimental investigations have revealed KPZ physics in quantum systems. We are investing the signatures of KPZ physics in the dynamics of an adaibatic non-linear kicked rotor. This work is an ongoing and is in collaboration with Prof. Gabriel Lemarie, Prof. Maxime Richard, Prof. Christian Miniatura, and Dr. Mu Sen at NUS, Singapore.

## Plan of Future Work Including Project

The plan for my future work includes finishing the existing projects, and starting new projects. I would also like to teach a course this year and hire one/two project students. The new projects includes:

### Research works:

a) **Prethermalization in aperiodically driven integrable and near-integrable spin chains:** In recent years, the study of non-equilibrium physics has attracted huge attention, motivated largely by the desire to create interesting phenomena and states of matter with properties be yond those achievable in equilibrium. In this pursuit, we would like to investigate an aperiodically driven critical-to-critical quench in integrable and near-integrable spin chains. The objective of this work is to explore the possibility of achieving prethermalization and the role of the soft mode, an important ingredient at criticality in integrable spin chain. And also investigate the fate of prethermalization in the presence of integrability breaking term. For this work, I am collaborating with Dr. Arijit Haldar, and Dr. Aslam Parvej at Universität Hamburg, Germany.

b) **Investigate the Kardar-Parisi-Zhang (KPZ) physics in aperiodically kicking the kicked rotor system:** Recently, KPZ physics and prethermalization in quantum system has moved to the forefront of research. In this regard, we like to investigate the possibilty of the emergence of KPZ physics at the prethermal regime in an aperiodic kicked rotor. The aperiodic kicking may include Fibonacci sequence and Thue-Morse sequence. To complete this project, I would like to hire a project student from my Inspire Faculty Grant.

## Any other Relevant Information including social impact of research

I am guiding two M.Sc. Students at SNBNCBS in their semester research project: i) Sumit Yadav, ii) Dibyendu Dhar


## Urna Basu

AssociateProfessor

Physics of Complex Systems

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### Guidance of Students/Post-Docs/Scientists

#### a) Ph.D. Students

1. Ritwick Sarkar; Activity driven transport; Under progress
2. Debraj Dutta; Dynamics of inertial active particles; Under progress

#### b) External Project Students / Summer Training

1. Anandu Vinod; Lattice Models for Particle Transport
2. Dipyendu Dhar; Instroduction to zero-range process
3. Sourav Mondal; Modelling diffusion via Langevin equations

### Teaching

1. Autumn semester; CB 635; PhD; 3 students
2. Autumn semester; PHY 509; Integrated PhD; 1 student
3. Spring semester; PHY 502; Integrated PhD; 1 student

### Publications

#### a) In journals

1. Ion Santra, Durgesh Ajgaonkar and **Urna Basu**, *The dichotomous acceleration process in one dimension: position fluctuations,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 083201, 2023
2. Santanu Das and **Urna Basu**, *Chirality reversing active Brownian motion in two dimensions,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 063205, 2023
3. Seemant Mishra and **Urna Basu**, *Symmetric exclusion process under stochastic power-law resetting,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 053202, 2023

#### b) Other Publications

1. Urna Basu, Sanjib Sabhapandit, Ion Santra, Target search by active particles, arXiv:2311.17854 (Invited chapter in an upcoming book 'The Target Problem' to be published by Springer-Nature)
2. Shashank Prakash, Urna Basu, Sanjib Sabhapandit, Tagged particle behavior in a harmonic chain of direction reversing active Brownian particles, arXiv:2402.11964

### Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at the conference "Physics of life: Active and living matter (PoL24)" organized by IOP, Bhubaneshwar and IISER Mohali; February 8, 2024; Toshali sands, Puri; 3 days
2. Invited talk at the international conference "Frontiers in Statistical Physics" organized by RRI, India; December 4, 2023; RRI, Bengaluru; 5 days

3. Invited talk at Soft Matter Young Investigators Meet hosted by IIT Kanpur; June 14, 2023; Ashokas Tiger Trail Resort, Uttarakhand; 4 days
4. Invited talk at the ICTP program "Signatures of Nonequilibrium Fluctuations in Life"; May 15, 2023; ICTP, Italy; 5 days
5. Invited talk at the "Meeting On Statistical Physics and Complex Systems (SPCS 2023)" organized by IIT Kharagpur; June 5, 2023; IIT Kharagpur; 3 days
6. Invited talk at the meeting "Time-dependent phenomena in soft and active matter (TPSAM2024)"; March 8, 2024; SNBNCBS; 2 days

## Administrative duties

1. Member of Faculty Search Committee
2. Member of Complaints committee
3. Member of Computer Services Cell -- Working Group
4. Member of SCOLP
5. Member of CWEP
6. Member of Media Cell
7. Warden (joint) of the hostel
8. Member of internal TPSC committee
9. Member of admission committee
10. Member of the Syllabus Modification Committee
11. Member of organizing committee of BoseStat@100
12. Member of the brochure committee for ARPAC
13. Member of tender committee regarding 'Retrofitting of the existing Street Light poles' at the institute
14. Member of tender committee regarding AMC of water purifiers at the institute
15. Member of tender committee for repair works at Krishnachura Hostel

## Extramural Projects (DST, CSIR, DAE, UNDP, etc.)

1. Ramanujan Grant; SERB; 5 years; PI
2. MATRICS; SERB; 3 years; PI

## Conference / Symposia / Schools organized

1. StatPhys Kolkata XII; December 18, 2023; SNBNCBS; 5 days
2. Stochastic and Nonlinear Dynamics in Chemistry and Biology; January 4, 2024; SNBNCBS; 2 days

## Scientific collaborations with other national / international institutions

1. Sanjib Sabhapandit, Raman Research Institute, India; National

## Outreach program organized / participated

1. Presented a lecture at the CK Majumder Memorial Workshop for Master and Bachelor students, July 2023
2. Instructor at Vigyan Pratibha Teachers' Workshop at IISER Kolkata, November 2023
3. Co-organized public lecture by Charles Bennett (part of BoseStat@100 celebrations) at Science City Auditorium, February 2024

## Areas of Research

### Statistical Physics

Active particle dynamics: Active particles are self-propelled agents which consume energy from environment and convert it into directed motion. One of my main research interests is to study and characterize the properties of single active particles, using simple, analytically tractable models. In a very recent work we have analytically characterized the behaviour of a chirality reversing active Brownian particle, which models a class of active motion observed in nature. In another ongoing work we study the stationary behaviour of an inertial active particle in a harmonic trap. We show that the position and velocity distribution shows very different shapes depending on the relative strengths activity, damping, and inertia.

Activity driven transport: The transport properties of an extended system driven by active reservoirs is an issue of paramount importance, which remains virtually unexplored. In a set of previous works, we have studied energy transport through chain of harmonic oscillators driven by active reservoirs, which exert correlated forces on the boundary oscillators. Recently, we have introduced a microscopic model for an active reservoir. We characterize the dynamics of a probe particle connected to such an `active Rubin bath'---a linear chain of overdamped run-and-tumble particles. We derive exact analytical expressions for the effective noise and dissipation kernels, acting on the probe, and show that the active nature of the bath leads to a modified fluctuation-dissipation relation. We also study the properties of an activity-driven system, modeled by a chain of harmonic oscillators connected to two such active reservoirs at the two ends. We show that the system reaches a nonequilibrium stationary state (NESS), remarkably different from that generated due to a thermal gradient. We characterize this NESS by computing the kinetic temperature profile, spatial and temporal velocity correlations of the oscillators, and the average energy current

flowing through the system. It turns out that, the activity drive leads to the emergence of two characteristic length scales, proportional to the activities of the reservoirs. Strong signatures of activity are also manifest in the anomalous short-time decay of the velocity autocorrelations. Finally, we find that the energy current shows a non-monotonic dependence on the activity drive and reversal in direction, corroborating previous findings.

## Plan of Future Work Including Project

1. Presently, with one of my PhD students, I am actively pursuing the study of transport properties of extended systems driven by active reservoirs. We apply the nonequilibrium response formalism to quantitatively obtain the energy current flowing through a system generated by an active drive. The generic nature of the formalism makes it applicable to systems with nonlinear interactions as well as disorders, which are hard to treat analytically otherwise. I am also working on various projects which continue to explore the behaviour of active particles. In particular, I am exploring the behaviour of interacting active particle systems.

# Adjunct Faculty

## Indranil Sarkar

Adjunct faculty

### Lectures given at SNBNCBS

a) Pedagogical Lecture series on X-Ray methods for Nanomaterials study

b) Pedagogical Lecture series on X-Ray methods for Magnetic and electronic structure study

### Research interest

Thin film and heterostructure growth of quantum and spintronic materials. Electronic and magnetic structure-property relationship.

### Research works done

My group has been working towards developing intrinsic understanding of how to control and tune interfacial physical and electronic structure of ferromagnet/non-magnetic metal for achieving low magnetic damping and high spin-mixing conductance. We have demonstrated successful growth of high quality interface of iron alloy based ferromagnet/heavy metal heterostructure. Using spin resolved electronic structure studies we have established electronic and physical structure correlation in CoFeB/non-magnet spin torque structure vis-a-vis spin transfer property.

## Partha Guha

Adjunct faculty

### Research interest

1. Geometrical Mechanics and Mathematical Physics
2. Generalized Entropy and Information Geometry

### Journal Publications using SNBNCBS affiliation

1. Supriyo Dutta and Partha Guha, A system of billiard and its application to information-theoretic entropy, Advances in Theoretical and Mathematical Physics, 26(8), 2599-2610, 2024
2. José F. Cariñena, Partha Guha, and Manuel F. Rañada, Painlevé equations, integrable systems and the stabilizer set of Virasoro orbit, Reviews in Mathematical Physics, 35(7), 2330004, 2023

### Other Publication using SNBNCBS affiliation

1. A Primer on Noncommutative Classical Dynamics on Velocity Phase Space and Souriau Formalism, José F. Cariñena, Héctor Figueroa and Partha Guha, Chapter 13, 533-568, In: Algebras without borders- Classical and Constructive Nonassociative Algebraic Structures: Foundations and Applications, Editors: Mahouton Norbert Hounkonnou, Melanija Mitrović, Mujahid Abbas, Madad Khan, Publisher: Springer, 2023.

# Facilities

# Library

## About Library

Library of the Centre is the hub of learning and research activities. Since inception of the Centre in 1986, library has been playing an important role in providing information and various academic services to its users. The library also provides service to outside students, researchers and professionals working throughout the country and abroad in all possible ways.

## Resources

The Library has a good and useful collection of documents. Presently library possesses more than 17231 books and 8000 bound volume journals. The Library subscribes many useful journals published by reputed publishers mostly in electronic version. In addition, being a member of National Knowledge Resource Consortium (NKRC), library gets access to a wide range of online journals. The library is also equipped with databases like Web of Science, SciFinder Scholar, Mathscinet, ICSD (Inorganic Crystal Structure Database) etc. Library has a Fiction Section with popular books on English, Hindi and Bengali literature. It includes novels, short stories, biographies, dramas, and books on general interests aiming to satisfy all type of readers. Library has a good collection of audio-visual materials. In the magazine and newspaper reading section, 25 popular magazines and 13 daily newspapers in different languages have been subscribed regularly. The library is enriched with a valuable archive of S N Bose. This archive includes some personal belongings of S N Bose and some of his personal book collections. Digital version of the archive is available in the website.

## Library Hours

The Library is open from morning 9.00 AM to 12.00 at night. During examination Library is open for whole night. Saturday 9.00 AM to 8.00 PM. However, circulation counter is open from 9:00 AM to 5:30 PM. Library is closed on Sundays and national holidays.

## Library Users

On an average 50 users visit the library per day. Online journals and databases are accessible within the campus through campus LAN and outside the campus through VPAN. Therefore users may use those online resources from their convenient places.

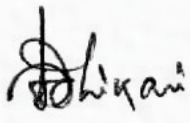
## Services

1. Reading Facility: Library provides reading facility to its members as well as outside visitors. All the books including reference collections are classified and open-accessed.
2. Document Lending Service: Each member is entitled to issue 6 books and 2 bound volumes of journals at a time.

3. Reference Service: Reference service is provided via e-mail, telephone or personal interaction with the help of different reference tools like encyclopedias, directories, dictionaries, yearbooks, web of science, annual report etc.
4. OPAC: Library offers Online Public Access Catalogue (OPAC) which allows user to browse library collection by author, title, subject, classification number, etc. through web OPAC.
5. E-resources and Internet Facility: Library is well equipped with sufficient number of computers with internet connectivity through cable LAN and wireless networking facility for laptop users. Library is having access to plenty of electronic journals, databases, archives and consortium resources. Users are having full access to the subscribed e-resources.
6. Reprographic Services: Library has printer cum copier, good colour printer, photocopy machine and poster printer for providing extensive reprographic service.
7. Audio-visual Room: Library has a separate Audio-visual Room for showing multimedia presentations, video lectures, documentaries etc. The room is equipped with projector, screen, white board and sitting arrangements. The room is used as a discussion room for teachers and students.
8. Bibliometric Services: Library helps to prepare various bibliometric reports specially usage statistics, citation analysis, h-index, Impact factor of Journals etc. as per users' requirements.
9. Library Resource Sharing Activities: The library shares its resources with all important academic/research institutions in India. As a member of National Knowledge Resource Consortium (NKRC), the library keeps close contacts with libraries under DST and CSIR. SNB library has institutional membership in the British Council Library (BCL), Kolkata and American Library Kolkata.
10. Library is for Leisure: Library has a separate section for Bengali, Hindi, and English literature, fiction, classic literature, novel, history, and books on general interest.
11. Map Section: Library created a map section containing 5 large wall fixed maps. i.e. map of World, India, West Bengal, North 24 Parganas and Salt Lake City.
12. Documentation Service: Library has been compiling the Annual Report in Hindi and English versions, Diary, and Calendar of the Centre and coordinating the process of printing. Printing and designing of different documents of the Centre like poster, conference brochure etc.
13. New arrival Section: Library has a section where newly processed books are displayed for users in every month. Same list is uploaded in the website in every month and e-mail intimation is given to all library members.
14. Research publication status and citation received: Every month Library has been preparing pictorial research publication status of the Centre and citation received by those publications. The report also includes h-index, citation received per year etc. It is being uploaded in the website on regular basis.
15. Institutional Repository: Library has an institutional digital repository with search engine facility. It is enriched with pre-published version of the published research papers of the S.N. Bose Centre. Library has also developed the S.N. Bose Archive containing photographs and scanned documents related to S. N. Bose. The archive is linked to the Centre's website. Library has repository of Ph.D. thesis of the Centre.
16. S N Bose Archive and Museum: Library has been maintaining the S N Bose Archive and Museum, where documents and articles related to S N Bose has been preserved. Library staff guides the visitors to explore the museum.

## Resources and Services Added in the F.Y. 2023-24

1. Approximately 200 new books and some new journals have been added in the library collection during the above mentioned financial year.
2. Library has developed an institutional digital repository for PhD thesis.
3. In the Financial Year 2023-24, the Fiction Section has been enriched by procuring 12 books of classic literature, novel, short story, biography and books of general interests.
4. 8 Hindi books are added in the Library collection the mentioned financial year.



**Saumen Adhikari**
Librarian – cum – Information Officer

# Engineering Section

## A. Civil Work

1. Construction of Shed over Compactor: Construction of a shed for housing the waste compactor done using tubular trusses and pre-coated GI sheet for roofing. An RCC ramp has also been constructed for ease approachability of the hook-loader for lifting the compactor along with an approach road of paver blocks over cement concrete base.
2. The West Side entry gate of the Centre has been renovated with a digital display and sunshine structure to portray an aesthetic look at a-glance. The gate ceiling has be constructed keeping higher elevation for easy entry of tall fleets and to ensure visibility of display board from far distance.
3. Relocation of Existing Wash Room at Ground Floor of Basundhara Building for housing the C-DAC Supercomputing facilities at Ground Floor, Basundhara Building, SNBNCBS
4. Replacing of Damaged Roof Sheet, False Ceiling and Painting Works carried out at Furnace Lab-3, 4 and Security Change Room near Clean Room, SNBNCBS

Compactor Shed over the Compactor Ramp

Newly renovated Main Gate

## B. Electrical

1. Dedicated earthing system was installed at various laboratories to protect the sophisticated research equipments/instruments and also for the proper electrical installation.
2. Electrical installation work for Basundhara Building.
3. Various procurement of electrical items through GeM portal and upkeep the inventory/electrical store.
4. Installation of LED lighting systems replacing the conventional lighting system including streetlights.
5. New street lights, bollard lights and area lightning of the Centre were installed that brighten up the Centre.
6. Industrial grade ducted AC were installed at various places of the centre in order to replace the old and defunct ACs.

## C. Estate

1. Maintenance and developing of landscaping and horticulture to upkeep the aesthetic look of the campus
2. Maintaining "Zero Plastic Green Campus" by preventing the usages of plastic carry bags of less than 75 micron.
3. Monthly observance of Swachhata 2.0 campaign at the Centre premises.
4. Installation of trilingual name plates on the office room doors on all floors of the Main Building of the Centre.
5. Tree trimming in association with Bidhannagar Municipal Corporation for over grown Trees in the Centre.

**Mithilesh Kumar Pande**
Campus Engineer cum Estate Officer

# Computer Services Cell

**Dr. Sanjoy Choudhury**

Scientist – E

The nature of work has two distinct regions:

1. **Administrative nature:** Handling Central Computational facilities under Computer Services Cell as Scientist I/C of the Cell.
2. **Academic nature:** Research Activities individual and along with Collaborative research.

**a) Academic Work - General research areas and problems worked on:**

**Areas of Research: IoT, Machine Learning, Edge/Fog Computing, Smart Cities**

Brief research work: The key objectives of this research on edge/fog computing and renewable energy optimization are as follows:

1. Feasibility of Deploying Edge/Fog Computing Sites in Diverse Geographical Locations Key Factors:
   - » Infrastructure Availability
   - » Connectivity
   - » Environmental Conditions
2. Develop Energy Harvesting Mechanisms for Edge/Fog Computing Key Factors:
   - » Renewable Energy Sources: Assess the availability and reliability of renewable energy sources such as solar, wind, and hydroelectric power in different locations.
   - » Energy Storage Solutions: Effective storage solutions are necessary to ensure a steady power supply, especially for intermittent renewable sources.
3. Design and Implement Intelligent Resource Allocation Algorithms Key Factors:
   - » Energy Efficiency: Developing algorithms that optimize resource allocation based on energy availability and demand is critical.
   - » Scalability: Ensure that the algorithms can scale with the number of edge/fog nodes and the complexity of tasks.
4. Evaluate the Economic Viability of the Pay-As-You-Go Model Key Factors:
   - » Cost Analysis: Detailed cost analysis considering initial deployment, maintenance, and operational costs.
   - » Revenue Models: Explore different revenue models, including subscription-based and usage- based pricing.
5. Analyze the Environmental Impact of Edge/Fog Computing and Renewable Energy Integration Key Factors:
   - » Carbon Emissions: Measure the reduction in carbon emissions due to the use of renewable energy.
   - » Energy Consumption: Assess overall energy consumption and identify areas for further efficiency improvements.
6. Address Security and Privacy Concerns in Edge/Fog Computing Environments Key Factors:
   - » Data Security: Implement robust encryption and data protection mechanisms.
   - » Privacy: Develop privacy-preserving techniques to safeguard user data.

By addressing these objectives, my research can significantly contribute to the practical implementation and optimization of computing environment, ensuring efficient resource utilization, cost-effective service delivery, and sustainable computing solutions globally.

## Publications:

1. Sanjoy Choudhury, Buddhadeb Pradhan, Sharmila Anand John Francis, Diptendu Sinha Roy, An energy efficient fog level resource management scheme for software defined cities, Sustainable Energy Technologies and Assessments, 57, 13289, 2023
2. Sanjoy Choudhury, Ashish Kumar Luhach, Joel J. P. C. Rodrigues, Mohammed AL-Numay, Uttam Ghosh, Diptendu Sinha Roy, A Residual Resource Fitness-Based Genetic Algorithm for a Fog-Level Virtual Machine Placement for Green Smart City Services, Sustainability, 15(11), 8918, 2023

The Computer Centre at S.N. Bose National Centre for Basic Sciences (SNBNCBS) serves as a central facility designed to support the academic departments and various sections of the institute. Its mission is to establish and maintain a robust computing environment that fosters academic excellence.


## Central Computational Resources (2023-24):

S.N. Bose National Centre for Basic Sciences, Computing Facility for its academic research & administrative pursuit:

**As part of India's ambitious National Super Computing Mission, SNBNCBS hosts an 838 TF Supercomputer dedicated to academic and research purposes.**

This High-Performance Computing (HPC) facility is ranked among the top 50 supercomputers in India, featuring the CRAY XE6 and CRAY XC50 clusters with a theoretical performance of 222.40 TF. These resources cater to the extensive computational needs of the Centre.

### Strengths

- Proficiency in Development & Implementation of New Technology
- Database Management
- Designing & development of Window/Linux based software's in house.

### Activities

- In house software development Database Management Networking Solutions & Services
- Infrastructure Procurement, Installation & Maintenance
- Information Security Solutions Storage Solutions
- Web Services
- User Support Services Training
- Academic & Research

### Software's in use (Developed In House)

- Personnel Information System
- Back Office Automation for Accounts Department (Includes Billing, Salary, Pension, GPF, NPS, Income Tax, E-Payment etc.)
- Back Office Automation for Purchase, Main Store
- ERP - Personal Information Software, Web based Personal Information
- Gateway Protection & Data Security Email Service under Institute Domain
- Web Portals - E-learning.
- Web Sites - Internet, Intranet
- Biometric Attendance Processing System and Time Keeping
- Online Admission Form Submission
- Online staff/student leave entry, approval and duty roster.
- Online MIS Dashboard Library Management
- Gate Pass Management
- Project Portal-for monitoring institute projects Student Payment Gateway
- File Tracking System
- Software for Academic Section for Monthly Progress report submission
- Video Conferencing and Virtual Class

### Room Tools

- Institute General Software's Antivirus Endpoint Protection Mathematica
- Mathlab MS 365
- ChenDraw
- Overleaf

### Facilities

**Summary of central/project computational facilities**

| Machine Name HPC (Parallel/ Serial) | Processor Core | Storage | User |
|---|---|---|---|
| Photon | 84 | - | 55 |
| Phonon | 84 | - | 27 |
| UNANST | 480 | 12 TB | 25 |
| UNANST | 96 | 12 TB | 30 |
| Polaron | 416 | 64 TB | 35 |
| New HPC | 1312 | 80 TB | 15 |
| NEW GPU | 6 Nodes | - | 5 |
| Hybrid System (CPU+GHP) | 24 CPU Cores + 14336 GPU cores | 4 TB | 08 |
| ATHENA | 320 | - | 12 |
| TRC CRAY | 960 | 120 TB | 30 |

State-of-the-Art Data Centre with 1000 Mbps leased line internet connection and NKN Connectivity including 100 Mbps BSNL Connectivity.

Wi-Fi enabled campus with 400 nodes.

- SNBNCBS has become a part of Eduroam, a global Wi-Fi roaming programme across academic campuses, through ERNET, India.
- Web Servers - 4
- Institute Email Server - 1 Application/Management/Terminal Servers - 14 Network Security Equipment's - 2
- Routers and Switches - 89
- Wireless Controller - 1, Access Points - 50 Laser Printers - 128
- Deskjet Printers - 38 Document Scanners - 7 PC - 383
- Surveillance Camera - 55 NVR - 2
- Computer Lab with 20 PCs
- Common browsing facility in Library with 20 PCs

## Services

**User Support Services - A true convergence of services, satisfying entire need of Organization.**

- Maintenance of software and hardware
- Support for research activities Web site updates
- Monitoring and management of servers, switches, intrusion detection systems, firewalls. Patch management, upgrades
- Security assessments, security audits Responding to emergencies.

**Best Practices Followed for Services**

- User focus & service
- Hardware and software vendor independence Decrease in cost of ownership as much as possible
- Hardware units of best performance, flexibility and scalability
- Security and Resilience
- Centralized and efficient service call management
- Application Availability
- Decrease in associated electricity consumption Physical space constraints, server, storage tiring Flexibility and scalability of all systems.


sanjoy choudhury

**Sanjoy Choudhury**
In-charge, Computer Services Cell

# Project and Patent Cell

The Project and Patent Cell acts as the record keeping Cell of the Projects and Patents of the Centre. It keeps tracks of the project proposals submitted for extramural funding, the sanctioned projects, the patent proposals filed and the patents granted to the Centre. It also coordinates with the Committee(s) constituted by the Authority for evaluating proposals to be filed for grant of patent and also takes care of the administrative matters during the filing of patents under the instruction of the inventor(s).

The members of the Project and Patent Cell during the year 2023-24:

Prof. Amitabha Lahiri – Convener

Prof. Gautam Gangopadhyay – Member

Prof. Soumen Mondal - Member

Dr. Atindra Nath Pal - Member

Deputy Registrar (Administration) – Member

Deputy Registrar (Finance) - Member

Dealing Assistant, Office of Dean (Faculty) – Member

Office Assistant, Academic Section - Member

Mr. Achyut Saha, PA to Director will render Secretarial Assistance to the Project & Patent Cell.

The following table summarizes the details of the externally funded projects in the Centre, for the last five years:

| Year | No. of Projects | Amount Received (Rs.) |
|---|---|---|
| 2019-2020 | 27 | 4,15,59,908=00 |
| 2020-2021 | 30 | 2,21,97,328=00 |
| 2021-2022 | 34 | 3,22,95,557=00 |
| 2022-2023 | 40 | 3,55,46,511=00 |
| 2023-2024 | 33 | 2,49,73,471=00 |

Apart from this, the Centre has also received the TRC project during January 2016.

## S. N. Bose National Centre for Basic Sciences

### Projects during 2023-24

| Project Title | PI / Co – PI | Funding Agency | Duration of the Project | Total Sanctioned | Remarks |
|---|---|---|---|---|---|
| DST/ASM/17-18/201 – "Quantum Information Technologies with Photonic Devices" | Prof. Archan S. Majumdar | DST DST/ICPS/QuST/ Theme-1/2019 (Proposal-18) | 24-04-2019 to 23-04-2022 Extended till 31-03-2024 | 17,00,000/- (Capital) 97,14,000/- (General) | |
| INAE/SKP/18-19/219 – "Large Scale Validation / Field Trial of an Indigenous Non-Invasive Non-Contact Robust Portable Hand-held device for Accurate Measurement of Bilirubin Level, Haemoglobin Concentration and Oxygen Saturation in Neonatal Subject" - Abdul Kalam Technology Innovation National Fellowship | Prof. S.K. Pal | INAE INAE/121/AKF | 01-08-2018 to 31-07-2021 Extended for 2 Years from 01-08-2021 to 31-07-2023 | 57,00,000/- (For the first three years) + 19,00,000/- + 19,00,000/- | |
| ICAR/SKP/18-19/230 – "Development of nano sensor and its application through cloud based network for real time irrigation to soil and plant" | Prof. S.K. Pal (Co-PI from SNBNCBS) Lead Centre: ICAR–IISS Other Co Centre: ICAR-CIAE | ICAR (NASF) NASF/NRM-8031/ 2020-21/214 dated 31-05-2021 | 01-06-2021 to 31-05-2024 | 41,00,000/- (Non Recurring) 59,04,278/- (Recurring Cost) For SNBNCBS | |

| Project Title | PI / Co – PI | Funding Agency | Duration of the Project | Total Sanctioned | Remarks |
|---|---|---|---|---|---|
| DST/AB/19-20/246 – "Development of strongly spin orbit coupled topological quantum heterostructures for spintronic applications" | Prof. Anjan Barman | DST DST/NM/TUE/QM-3/ 2019-1G-SNB | 21-10-2021 to 20-10-2026 | 1,28,43,000/- | |
| DST/TSD-AP/19-20/249 – "Consortium for Collective and Engineered Phenomena in Topology Concept" | Investigators from SNBNCBS: Dr. Atindra Nath Pal | (DST) DST/NM/TUE/QM-10/ 2019 (C)/2 (Nano Mission) | 28-03-2023 to 27-03-2028 | 97,92,549/- | |
| PM/SERB/19-20/250 – "Twistronics with Transition Metal Dichalcogenides" | Prof. Priya Mahadevan | SERB IPA/2020/000021 | 30-03-2020 to 29-03-2025 | 2,17,60,250/- | |
| SERB/MK/19-20/253 – "Exploring Quantum and Thermal Fluctuations in Frustrated Magnets at Low Temperature" | Dr. Manoranjan Kumar | SERB CRG/2020/000754 | 30-12-2020 to 29-12-2023 | 58,68,145/- | |
| SERB(DST)/ANP/19-20/255 – "Probing orbital hybridization and structural asymmetry in atomic and molecular nano-contact via inelastic electron spectroscopy and shot noise" | Dr. Atindra Nath Pal | SERB CRG/2020/004208 | 17-02-2021 to 16-05-2024 | 36,12,421/- | |
| SERB/TSD/20-21/260 – "J.C. Bose Fellowship"\ | Prof. Tanusri Saha Dasgupta | SERB JCB/2020/000004 Dairy No. SERB/F/3797/ 2020-2021 | 12-10-2020 to 11-10-2025 | 95,00,000/- | |
| SERB/NK/20-21/264 – "From three-dimensional to two-dimensional quantum anomalous Hall effect in ferromagnetic topological quantum materials" | Dr. Nitesh Kumar | SERB CRG/2021/ 002747 | 10-3-2022 to 09-3-2025 | 27,26,791/- | |
| DST/ASM/20-21/265 – "Quantum Heat Engines" (QuEST Project Q-79) | Prof. Archan S. Majumdar (Co PI) PI – Dr. Sibasish Ghosh, IMSc, Chennai | DST DST/ICPS/QuST/ Theme-1/2019 (Proposal-13) | 22-04-2021 to 31-03-2024 | 12,17,000/- (1st Year) 8,07,000/- (2nd Year) 8,66,000/- (3rd Year) | |
| SERB/SC/20-21/266 – "Development of Artificial Neural Network (ANN) based models for rapid prediction of physicochemical properties of drug-like molecules" | Dr. Suman Chakrabarty | SERB MTR/2021/000859 | 24-02-2022 to 23-02-2025 | 6,60,000/- | |
| RSF-DST/TSD/21-22/268 – "Search for Novel Magnetic and Topological Materials" | Prof. Tanusri Saha-Dasgupta | DST DST/INT/RUS/ RSF/P-53/2021 (G) | 20-01-2023 to 19-01-2026 | 82,52,170/- | |

| Project Title | PI / Co – PI | Funding Agency | Duration of the Project | Total Sanctioned | Remarks |
|---|---|---|---|---|---|
| "Ab Initio search for topological Mott insulators" | Prof. Priya Mahadevan | DST DST/INT/SWD/VR/P-08/2019 | 12-01-2021 to 11-01-2024 | 30,30,600/- | |
| "Electronic structure of free standing films of transition metal oxides". | Prof. Priya Mahadevan | SERB SPF/2021/000066 | 24-03-2021 to 23-03-2024 | Amount received 12,70,000/- + 7,23,000/- + 11,00,000/- | |
| Max Planck/NK/21-22/275 - "Novel quantum states in quasi-one-dimensional materials" | Dr. Nitesh Kumar | Max Planck | 01-09-2022 to 31-08-2027 | Euro 1,00,000 | |
| UGC-DAE CSR/TS/21-22/276 – "Spectroscopic Investigation of Correlated Magnetic Topological Semimetals" | Dr. T. Setti | UGC-DAE CSR CRS/2021-22/01/373 | 06-04-2022 to 05-04-2023 | 45,000/- | |
| DBT/MM/21-22/277 – "Exploring the water-oxidation mechanism and proton coupled electron transfer reactions in Photosystem II: an approach towards clean fuel" Ramalingaswamy Re-entry Fellowship | Dr. Manoj Mandal | DBT BT / RLF / Re-entry / 41 / 2020 | 15-07-2021 to 14-07-2026 | 1,13,60,000/- | Resigned on 07.02. 2024 |
| SERB/AHK/21-22/278 – "Doped 2D Nanocrystals for Photonic Applications (Ramanujan Fellowship) | Dr. Ali Hossain Khan | SERB RJF/2020/000091 | 01-11-2021 to 31-03-2026 | Credited Till Date: 11,62,598/- + 19,14,000/- +23,70,000/- | |
| DAE(RRF)/RB/21-22/279 – "Gauge and Gravitational Symmetries in Nonrelativistic Theories: Formalism & Applications" – DAE Raja Ramanna Fellowship | Prof. Rabin Banerjee | DAE (RRF) 1003/6/2021/RRF/R&D-II/10348 Dated 2-9-2021 | 03-05-2021 to 02-05-2024 | 13,50,000/- (1st Release) 7,56,280/- (2nd Release) 12,07,442/- (3rd Release) 13,44,558/- (4th Release) 7,23,438/- (5th Release) | |
| SERB/PSP/21-22/281 – "Olefin-linked Covalent Organic Frameworks (COFs) for Photocatalytic Water Splitting for Hydrogen Generation" | Dr. Pradip Shashikant Pachfule | SERB SRG/2022/000217 Dated 9-9-2022 | 27-09-2022 to 26-09-2024 | 32,35,560/- | |
| Ramanujan Fellowship | Dr. Urna Basu | SERB SB/S2/RJN-077/2018 | 15-10-2022 to 31-10-2023 | 7,88,440/- | (At SNBNCBS) |
| SERB/AHK/22-23/283 – "Heavy-Metal-Free Photonic Colloidal 2D Nanocystals" | Dr. Ali Hossain Khan | SERB CRG/2022/006225 | 08-02-2023 to 07-02-2026 | 42,26,428/- | |

| Project Title | PI / Co – PI | Funding Agency | Duration of the Project | Total Sanctioned | Remarks |
|---|---|---|---|---|---|
| SERB/AC/22-23/284 – "Development and testing of broadband optoelectronic synaptic devices employing ferroelectric / photoelectric 2D material hybrid system" | Dr. Avijit Chowdhury | (SERB) CRG/2022/001145 | 09-03-2023 to 08-03-2026 | 22,08,600/- | |
| IHQTF/MB/22-23/290 – "Devising practically implementable enhanced means of communication with the aid of quantum resources – Chanakya Post Doctoral Fellowship under mentorship of Dr. Manik Banik" | Dr. Manik Banik | I-Hub Quantum Technology Foundation (IHQTF) I-HUB/PDF/2021-22/008 | 13-06-2022 to 31-03-2025 (At SNBNCBS) | Amount Received till date: 11,10,653/- +1,38,896/- +9,38,028/- | Chanakya Post-Doctoral Research Fellow: Dr. Mir Alimuddin Resigned on 28-06-2024 |
| SERB(NPDF)/UD/22-23/291 – "Development of a group of Crystalline Framework – based Magnetic Nanocomposites as Theranostics for Targetting Breast Cancer Stem Cells" | Dr. Upasana Das | SERB (NPDF) PDF/2022/000322 | 26-12-2022 to 25-12-2024 | 22,36,800/- | Resigned on 25.12.2023 |
| SERB(NPDF)/IB/22-23-293 – "Exploring Hydration Hydration Dynamics of Protein Aggregation and Its Connection with Liquid-Liquid Phase Separation Triggered by Modulation in Local Environmental Parameters Employing Terahertz Spectroscopy and Complementary Experimental Techniques" | Dr. Indrani Bhattacharya | SERB (NPDF) PDF/2022/000540 | 28-12-2022 to 27-12-2024 | 22,36,800/- | |
| SERB(NPDF)/GB/22-23/294 – "Proximity induced spin-orbit coupling and magnetism on graphene from magnetic topological quantum matter (MTQM)" | Dr. Gargee Bhattacharyya | SERB (NPDF) PDF/2022/002839 | 06-01-2023 to 05-01-2025 | 22,36,800/- | |
| SERB/AH/22-23/295 – "Harnessing the Interplay of Quantum Entanglement, Topology, and Strong Correlations in Condensed Matter Systems for Near-term Quantum Applications and Beyond" | Dr. Arijit Haldar | SERB (SRG) SRG/2023/000118 | 22-12-2023 to 21-12-2025 | 19,33,200/- | |
| SERB/RKM/22-23/298 – "Biomolecular condensates: Exploring the associated hydration and energetics using THz spectroscopy" | Prof. Rajib Kumar Mitra | SERB CRG/2023/001034 | Sanction Date: 23-02-2024 3 Years | 44,49,597/- | |

| Project Title | PI / Co – PI | Funding Agency | Duration of the Project | Total Sanctioned | Remarks |
|---|---|---|---|---|---|
| SERB/UB/22-23/301 – "Activity driven transport in low dimensional systems" | Dr. Urna Basu | SERB MTR/2023/000392 | Sanction Date: 23-01-2024 3 Years | 6,60,000/- | |
| SERB/RB/22-23/302 – "A Theoretical Approach to Predict Deep Eutectic Formation: Locating the Lowest Melting Point" | Prof. Ranjit Biswas | SERB MTR/2023/000336 | Sanction Date: 30-01-2024 3 Years | 6,60,000/- | |
| IHQTF/AB/23-24/304 – "Two-dimensional ferromagnetic and organic molecule spinterfaces as molecular spin qubits for quantum technologies and energy harvesting applications – Chanakya Post Doctoral Fellowship under mentorship of Dr. Anjan Barman" | Prof. Anjan Barman | I-Hub Quantum Technology Foundation (IHQTF) I-HUB/PDF/2022-23/001 | 17-08-2023 to 16-08-2024 | 12,60,000/- | Chanakya Post-Doctoral Research Fellow: Dr. Sumaiya Parveen Resigned on 28-06-2024 |

*** Apart from this, the Centre has also received the TRC project during January 2016.

## Postdocs & Scientists under Projects; DST INSPIRE Faculty & Others (2023-24)

| Sl. | Name | Designation | Project Name | P. I. of Project | Joined on | Appt. upto |
|---|---|---|---|---|---|---|
| 1 | Dr. Dipayan Sen | Research Associate – III, CMMP | J.C. Bose Award (Fellowship) | Prof. Tanusri Saha-Dasgupta | 01.11.2022 | 31.03.2024 |
| 2 | Dr. Indrani Bhattacharyya | National Post-Doctoral Fellow | Exploring Hydration Dynamics of Protein Aggregation and Its Connection with Liquid-Liquid Phase Separation Triggered by Modulation in Local Environmental Parameters Employing Terahertz Spectroscopy and Complementary Experimental Techniques | Self [Prof. Rajib K Mitra, Mentor] | 28.12.2022 | 27.12.2024 |
| 3 | Dr. Gargee Bhattacharyya | National Post-Doctoral Fellow | Proximity induced spin-orbit coupling and magnetism on graphene from magnetic topological quantum matter (MTQM) | Self [Prof. Priya Mahadevan, Mentor] | 06.01.2023 | 05.01.2025 |
| 4 | Dr. Mir Alimuddin | Chanakya PDF | Devising Practically implementable enhanced means of communication with the aid of quantum resources | Dr. Manik Banik, Mentor | 13.06.2022 | 31.03.2025 Resigned on 28-06-2024 |
| 5 | Dr. Soumendu Datta | Research Associate – III, CMMP | J.C. Bose Award (Fellowship) | Prof. Tanusri Saha-Dasgupta | 25.08.2021 | 24.08.2023 |
| 6 | Dr. Sourav Chakraborty | Research Associate – I, CMMP | Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature | Dr. Manoranjan Kumar | 05.12.2022 | 30.11.2023 |

| Sl. | Name | Designation | Project Name | P. I. of Project | Joined on | Appt. upto |
|---|---|---|---|---|---|---|
| 7 | Dr. Sumaiya Parveen | Chanakya PDF | Two-dimensional Ferromagnetic and Organic Molecule Spinterfaces as Molecular Spin Qubits for Quantum Technologies and Energy Harvesting Applications | Prof. Anjan Barman | 17.11.2023 | 16.11.2025 Resigned on 28-06-2024 |
| 8 | Dr. Tusita Sau | Research Associate – I | Search for Novel Magnetic and Topological Materials | Prof. Tanusri Saha-Dasgupta | 03.04.2023 | 02.04.2024 |
| 9 | Dr. Upasana Das | National Post-Doctoral Fellow | Development of a Group of Crystalline Framework-based Magnetic Nanocomposites as Theranostics for Targeting Breast Cancer Stem Cells | Self [Dr. P.S. Pachfule, Mentor] | 26.12.2022 | Resigned on 25.12.2023 |

| Sl. | Name | Designation | Project Name | P. I. of Project | Joined on | Appt. upto |
|---|---|---|---|---|---|---|
| 1 | Dr. Anup Ghosh | DST INSPIRE Faculty | Ultrafast 2D-IR spectroscopy on the structural dynamics of DNA/G Quadruplex | Self | 01.01.2019 | 31.12.2023 [Resigned on 13.03.2024] |
| 2 | Dr. Dipanwita Majumdar | DST INSPIRE Faculty | Optical and Electronic Properties of Metal Nanoparticles Decorated Transition Metal Dichalcogenides and Their Applications | Self | 03.01.2019 | 16.04.2022 [no cost extension up to 16.04.2023] |
| 3 | Prof. Rabin Banerjee | Raja Ramanna Fellow | Gauge and Gravitational Symmetries in Nonrelativistic Theories : Formalism and Applications | Self | 03.05.2021 | 02.05.2024 |
| 4 | Dr. Manoj Mandal | Ramalingaswami Re-entry Fellow | Exploring the water oxidation mechanism and proton coupled electron transfer reactions in photosystem II : an approach towards clean fuel | Self | 15.07.2021 | 14.07.2026 [Resigned on 07.02.2024] |
| 5 | Dr. Ali Hossain Khan | Ramanujan Fellow (Transferred from INST, Mohali) | Doped 2D Nanocrystals for Photonic Applications | Self | 01.11.2021 | 31.03.2026 |
| 6 | Dr. Suman Chowdhury | DST INSPIRE Faculty | Exploration of Thermochromism in 2D transition-metal oxides | Self | 10.10.2022 | Resigned w.e.f 08.06.2023 |
| 7 | Dr. Sujoy Kr. Ghosh | DST INSPIRE Faculty | Self-powered bio-resorbable Implantable device | Self | 09.03.2023 | 08.03.2028 [Resigned on 12.01.2024] |
| 8 | Dr. Sanku Paul | DST INSPIRE Faculty | Hidden quantum criticality and its application in data hiding | Self | 22.05.2023 | 21.05.2028 |
| 9 | Dr. Rajeswari Roy Chowdhury | DST INSPIRE Faculty (Transferred from IISER | Spectroscopy and imaging down to sub-nanometer length scales on topological systems and their heterostructure devices | Self | 28.06.2023 | Resigned w.e.f 10.02.2024 |

LIST OF STUDENTS UNDER PROJECT F.Y. 2023-2024

| Sl | Name of The Student | Current Designation | Project Instructor | Dept. | Name of The Project | Joined on | Appointment Tenure | No. of Students | Duration of the Project | Appointed Upto | Resigned on |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sinchan Snigdha Rej | Project JRF | Manoranjan Kumar | CMMP | Exploring Quantum and Thermal Fluctuations in Frustated Magnets at Low Temperature | 03.04.2023 | Till the end of the project | | 29.12.2023 | 29.12.2023 | 30.06.2023 |
| 2 | Sweta Ghosh | Project JRF | Tanusri Saha Dasgupta | CMMP | Search for Novel Magnetic and Topological Materials | 08.11.2023 | Till the end of the project | | 19.01.2026 | Till the end of the project | |
| | | | **DEPT. TOTAL** | | | | | | | | |
| 1 | Ria Ghosh | Project SRF | Samir Kumar Pal | CBS | Development of nano sensor and its application through cloud based network for real time irrigation to soil and plant | 14.01.2022 | Till the end of the project | 31.05.2024 | 31.05.2024 | 31.05.2024 | |
| 2 | Avanti Chakraborty | Project Assistant | Ali Hossain Khan | CBS | Doped 2D Nanocrystals for Photonic Applications | 25.04.2022 | 1 Year from the date of joining + 3 Months extension | 31.03.2026 | 24.07.2023 | 24.07.2023 | |
| 3 | Niravra Chakraborty | Project Assistant | Manoj Mandal | CBS | Exploring the water-oxidation mechanism and proton coupled electron transfer reactions in photosystem II: an approach towards clean fuel | 13.01.2023 | 1 Year from the date of joining | 14.07.2026 | 12.01.2024 | 26.12.2023 | |
| 4 | Bikram Das | Project JRF | Ali Hossain Khan | CBS | Doped 2D Nanocrystals for Photonic Applications | 12.06.2023 | 1 Year form the date of joining | 31.03.2026 | 11.06.2024 | | |
| 5 | Sourik Dutta | Project JRF | Ali Hossain Khan | CBS | Doped 2D Nanocrystals for Photonic Applications | 13.06.2023 | 1 Year form the date of joining | 31.03.2026 | 12.06.2024 | | |
| 6 | Archisman Sinha | Project JRF | Pradip S Pachfule | CBS | Olefin-linked Covalent Organic Frameworks (COFs) for Photocatalytic Water Splitting for Hydrogen Generation | 22.09.2023 | 21.09.2024 | 26.09.2024 | 21.09.2024 | Resignation Date: 20.07.2024 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | **DEPT. TOTAL** | | | | | | |
| 1 | Arun Kumar Das | Project JRF | Archan S Majumdar | APHEP | Applications of Quantum Information | 16.10.2019 | 30.09.2023 | 31.03.2024 | 30.09.2023 |
| 2 | Subhankar Bera | Project JRF | Archan S Majumdar | APHEP | Applications of Quantum Information | 03.10.2019 | 30.09.2023 | 31.03.2024 | 30.09.2023 |
| 3 | Arnab Mukherjee | Project JRF | Archan S Majumdar | APHEP | Quantum Heat Engines | 12.11.2021 | 31.12.2023 | 31.03.2024 | 31.12.2023 |

**Patents Granted / Applied (2023-24)**

**Patents Granted:**

(1) Patent No.: 428911

Application No.: 201631002214

Date of Filing: 21/01/2016

**Date of Grant: 13/04/2023**

A SYSTEM AND KIT FOR NON-INVASIVE DETECTION OF PEPTIC ULCER DISEASE, NON-ULCEROUS DYSPEPSIA AND HELICOBACTER PYLORI INFECTION

(2) Patent No.: 431879

Application No.: 201731042502

Date of Filing: 27/11/2017

**Date of Grant: 16/05/2023**

A SYSTEM FOR MONITORING HEMODIALYSIS EFFICACY OF A SUBJECT

(3) Patent No.: 432954

Application No.: 201631003758

Date of Filing: 03/02/2016

**Date of Grant: 26/05/2023**

SYSTEM AND KIT FOR MONITORING BLOOD GLUCOSE PROFILE BASED ON BREATH ANALYSIS

(4) Patent No.: 438159

Application No.: 201731015268

Date of Filing: 29/04/2017

**Date of Grant: 11/07/2023**

FLEXIBLE THIN FILM TRANSISTOR USING ELECTRIC DOUBLE LAYER AS GATE DIELECTRIC AND A METHOD OF FABRICATING THEREOF

(5) Patent No.: 449904

Application No.: 201931026410

Date of Filing: 02/07/2019

**Date of Grant: 06/09/2023**

A SPARK SPECTROMETRY BASED POINT OF CARE PORTABLE DEVICE FOR SIMULTANEOUS DETECTION OF NA+, LI+ AND K+ CONCENTRATION IN BODY FLUID

(6) Patent No.: 452697

Application No.: 201731038036

Date of Filing: 26/10/2017

**Date of Grant: 19/09/2023**

A GAS-SENSING SYSTEM FOR SELECTIVE DETECTION OF (NITRIC OXIDE) NO GAS AND A METHOD FOR FABRICATING THE SAME

(7) Patent No.: 476777

Application No.: 201931028219

Date of Filing: 13/07/2019

**Date of Grant: 05/12/2023**

A SPECTROSCOPY BASED FLUORIDE SENSOR FOR DRINKING WATER

(8) Patent No.: 478506

Application No.: 201831001993

Date of Filing: 17/01/2018

**Date of Grant: 07/12/2023**

A PAPER BASED AMMONIA GAS SELECTIVE SENSOR WITH ELECTRICAL READ OUT AND A METHOD FOR MANUFACTURING THE SAME

(9) Patent No.: 488610

Application No.: 201731029434

Date of Filing: 19/08/2017

**Date of Grant: 26/12/2023**

DNA-BASED FIBER OPTIC SENSOR FOR DIRECT IN-VIVO MEASUREMENT OF OXIDATIVE STRESS

(10) Patent No.: 506019

Application No.: 201831029718

Date of Filing: 07/08/2018

**Date of Grant: 01/02/2024**

A NON INVASIVE SCREENING SYSTEM FOR NEONATAL HYPERBILIRUBINEMIA

(11) Patent No.: 507919

Application No.: 201731017087

Date of Filing: 16/05/2017

**Date of Grant: 07/02/2024**

ADVANCEMENT IN METHODOLOGY AND SYSTEM TO CONTROL ISOTOPIC FRACTIONATIONS IN CARBON CONTAINING GASES

(12) Patent No.: 509256

Application No.: 201931028306

Date of Filing: 15/07/2019

**Date of Grant: 09/02/2024**

A SPECTROSCOPY-BASED OPTICAL DEVICE FOR ESTIMATION OF MILK QUALITY

(13) Patent No.: 529689

Application No.: 202031038152

Date of Filing: 04/09/2020

**Date of Grant: 21/03/2024**

A NANOCEUTICAL FABRIC FOR SOURCE CONTROL TO PREVENT COVID-19 SPREAD INCLUDING THROUGH EXPELLED RESPIRATORY DROPLETS

Amitabha Lahiri

**Amitabha Lahiri**
Convenor, Project & Patent Cell

# Technical Research Centre (TRC)

The Technical Research Centre (TRC), funded by Department of Science & Technology, Ministry of Science & Technology, Government of India at S. N. Bose National Centre for Basic Sciences has been launched on 1st January 2016. The aim is to establish an innovation cum translational research centre within the S. N. Bose National Centre that would build harness able science and technology platforms by leveraging on its existing core strength in materials science and spectroscopic techniques. The extension phase of TRC (Phase-II) has started formally since January 2021 though the budget funding for Phase-II was sanctioned on February 2023 from the DST.

## Major Target Areas in the Extended Phase (Phase II):

» Computational Materials Sciences: Computation Modelling for Technologically Important Indigenous New Materials and New Functionalities; etc.

» Nano-fabrication for Quantum Technology & Nanodevices: Innovation in Technology development - Nano-fabrication for Quantum Technology & Nanodevices; Development of ensors and opto-electronic devices using ultra-thin layered materials; Prototyping thin film devices using functional oxide patterned films; etc.

» Bio-medical Instrumentation: Spectroscopic and Optical techniques -Triboelectric Nanogenerators for Biomedical and Health Care Applications; An optical emission spectroscopy-based sensor for minimally-invasive detection of essential electrolytes in human body, like sodium, lithium and potassium (NaLiK); Modulation of THz-FIR radiation using patterned materials and its application to authenticate pharmaceutics; etc.

» Food Adulteration and Environmental Mitigation: Prototype development of Optical/NIR spectroscopic instrumentation for applications - A spectroscopy-based fluoride sensor in drinking water (FeFlu); Adulteration in Milk using spectroscopic techniques (Mil-Q-Way); etc.

## Project Investigators (TRC Phase II):

Prof. Soumen Mondal (Nodal Officer); Prof. Rajib K. Mitra (Assocated Nodal Officer);Prof. Tanusri Saha Dasgupta; Prof. Anjan Barman Prof. Samir K. Pal; Prof. Jaydeb Chakrabarti; Dr. Atindra Nath Pal; Dr. Suman Chakrabarty; Dr. Avijit Chowdhur; Dr. Nitesh Kumar, Dr. Pradip S Pachfule; Dr. Saquib Shamim; Dr. Shubhasis Haldar and Dr. Ali Hossain Khan.

## Manpower details (phase II):

» Number of Scientists (C & D): 8

» Number of Project Students: 13

» Number of Project Assistants: 6

» Number of Project Officers: 01

## A few Research Activities undertaken under TRC (Phase II):

1. Computation Modelling for Technologically Important Indigenous New Materials and New Functionalities.
2. New Semiconductor Materials with Unique Optoelectronic Properties.
3. New COF material for H2O2 generation.
4. Development of GHz to THz Frequency Nanoscale Ferroic and Multiferroic Structures and Devices for Wave-Based Computation, Communication and Extreme Sub-Wavelength Antenna Application.
5. Molecular dynamics simulations of polymer nanocomposites.
6. Modulation of THz-FIR radiation using patterned materials and its application to authenticate pharmaceutics.
7. Design and building of low-cost Sun photometer to measure Aerosol Optical Depth and its effect on environment.
8. Adulteration in Milk using spectroscopic techniques (Mil-Q-Way).
9. Pathogen Detection in dairy Product.
10. Towards flexible optoelectronic sensor and wearable self-powered health-monitoring devices.
11. Antimicrobial resistance (AMR): Novel inhibitors for beta-lactamase.
12. Low-noise devices for applications in quantum circuits.
13. The only high-throughput CSC quantifier and identifier.
14. Design and development of a self-powered flexible triboelectric nanogenerator for real-time monitoring of internal pressure distribution inside a prosthetic socket.
15. Functional covalent organic frameworks (COFs) for water splitting and energy storage.
16. Testing of topological semimetals for catalytic activity.

## A Few Highlighted Research Outputs :

» Number of Research Publications: 60

» Number of Ph.D. produced : 08

» Number of Patent Filed/Granted : 13

## A few prototypes developed under TRC ready for Transfer of Technology :

» Ammonia Gas Sensor and A Method for Manufacturing the Same (Ammo-Watch)

» A Spark Spectrometry based point of care portable device for simultaneous detection of Na+, Li+ and K+ concentration in body fluid (NaliK).

» A Spectroscopy-based Optical Device for estimation of milk quality (Mil-Q-Way) -

» A Spectroscopy Based Fluoride Sensor for Drinking Water (Feflu)

» A Chromogenic Nanocomposite-based Optical Device CapNanoScope for detection and quantification of CO2 (CapNanoScope)

» Piezo-electric nanowires for energy harvesting and sensitive motion (PIEZOcell) - Technology and prototype is ready to be transfer to Indian start-up/Companies.


## Knowledge Based Services at TRC:

The TRC offers knowledge based services in a number of highly sophisticated instrumentation, ranging from several spectroscopic to microscopic instruments. For more information, please visit our web site : http://newweb.bose.res.in/departments/TRC

Soumen Mondal

**Soumen Mondal**
Nodal Officer
Technical Research Centre

# Technical Cell

Technical cell was established in the year of 2008 to maintain the central experimental facilities of SNBNCBS which can be availed by any researcher from our Centre as well as from other institutions / laboratories. The details of the available experimental facilities and the terms and conditions for using the s e facilities are mentioned in the website : https://newweb.bose.res.in/facilities/TechnicalCell/. The activities of Technical Cell during April 2023 - March 2024 are reported in the following sections:

## I. Equipments available under technical cell

| Sl. No. | Name of the equipment |
|---|---|
| 1. | Transmission electron Microscope (TEM) with other attachments |
| 2. | Thermo Gravimetry/Differential Thermal Analyzer (TG-DTA) |
| 3. | Dynamic Light Scattering (DLS) |
| 4. | Clean Room |
| 5. | E-beam evaporator |
| 6. | ICP-RIE |
| 7. | Dual beam FIB/SEM |
| 8. | Wire Bonder |
| 9. | Mask aligner |
| 10. | 3K Resistivity Measurement Setup |
| 11. | Field Emission Scanning Electron Microscopy (FESEF) Quanta FEG 250 |
| 12. | X-ray Diffraction |
| 13. | UV Visible Spectrometer (UV-VIS) (2600) |
| 14. | UV Visible Spectrometer (UV-VIS) (2450) |
| 15. | Circular Dichroism (CD) |
| 16. | Chemical Lab |
| 17. | Ellipsometer |
| 18. | Viscometer |
| 19. | Densitymeter |
| 20. | X-ray Diffractometer (XRD) (PANalytical X-PERT PRO |
| 21. | Pulsed Laser Deposition (PLD) Unit |
| 22. | Helium Leak Detector |
| 23. | Liquid Nitrogen and Gases for Laboratory Use |
| 24. | Fluorescence spectrometer (Fluorolog) |
| 25. | Spevtrofluorometer (Fluoromax) |
| 26. | Fourier Transform Infrared Spectrometer (FTIR) |
| 27. | Mechanical workshop, Sputtering Unit, Millipore Water |
| 28. | Vibrating Sample Magnetometer (VSM) |
| 29. | Differential Scanning Calorimeter (DSC) |
| 30 | Atomic Force Microscope (AFM) |

## II. Support to research activities:

Around 81 students and several post-doctoral fellows of the Centre avail the above-mentioned experimental facilities extensively for their Ph.D. thesis work. 10 students completed their M.Sc. / M.Tech. project work; 19 students completed their summer projects performing extensive work using the equipment under the Technical Cell. About 86 external users used the Technical Cell facilities for their research work.

## III. Support to the teaching activities of SNBNCBS

Students of the Centre's IPhD programme use the Technical Cell facilities and perform some of the experiments like Xray diffraction, UV – VIS spectroscopy, Differential Scanning Calorimetry as a part of their Advanced Experimental course (PHY 391). Also they did their project works as a part of their IPhD curriculum.

## IV. Major maintenance and up-gradation:

1. Millipore water purifier :- To make the system operational replace the below spare parts.
   a. Progard 25 Alone(long)
   b. Cent. Front Panel Display
   c. Jack Female Connector

## V. Utilization of some of the major equipment

| Item | Usage (Time In Hours) | Up Time% | Down Time % | No. of External Users |
|---|---|---|---|---|
| PLD | 0 | 0% | 100% | NIL |
| FESEM | 1000 | 95% | 5% | 19 |
| XPERT PRO | 900 | 90% | 10% | NIL |
| MINI XRD | 300 | 90% | 10% | NIL |
| TG/DTA | 450 | 95% | 5% | 14 |
| AFM | 392 | 65% | 45% | NIL |
| VSM | 0 | 0% | 100% | NIL |
| DSC | 300 | 55% | 45% | 1 |
| HRTEM | 1040 | 75% | 35% | 15 |

## VI. Revenue Generation

Some revenue was generated from the external users for using the facilities of Technical Cell.

**Rajib Kumar Mitra**
In-charge, Technical Cell

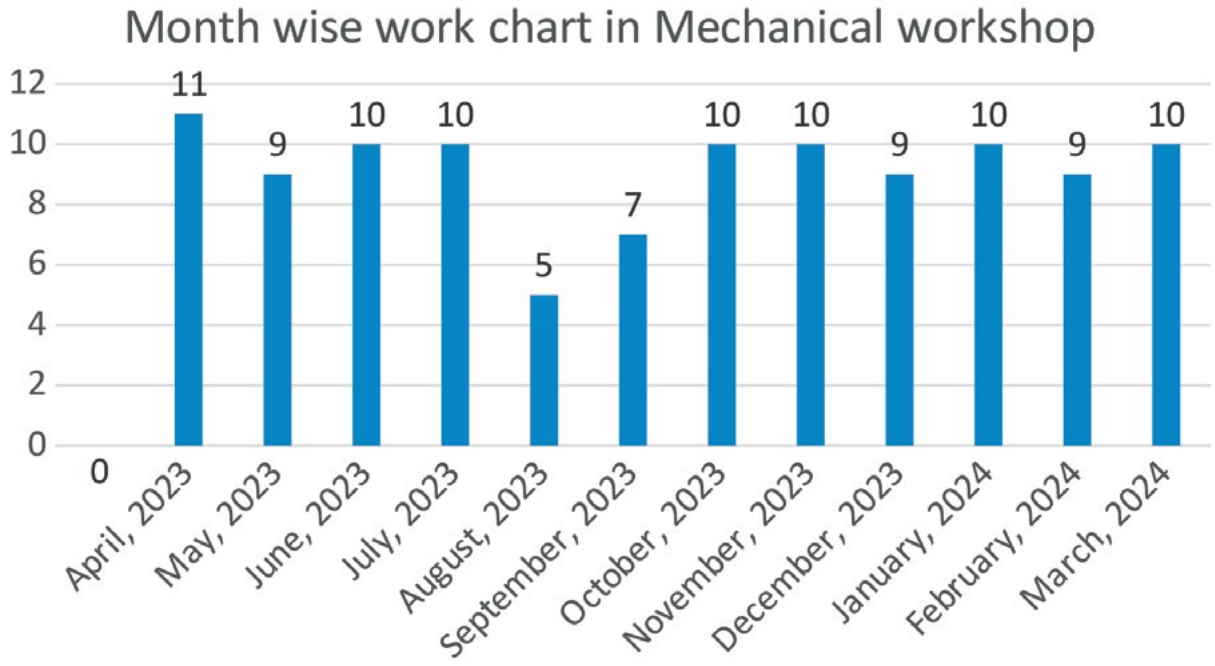
# Mechanical Workshop

Mechanical workshop at the center is an important part, particularly to the experimental faculties. Throughout the year mechanical workshop functioned and catered to the demands of different departments and to the outside. It is handled by a mechanic in all days of the week and the users are required to enter their demands of major jobs in a log book for record, along with at least a rough sketch each. Total number of jobs finished: mechanical workshop – 110. Month wise breakups are given below: (2023 – 2024). Three major equipment were procured during this time: CNC Milling Machine, All Gear Lathe Machine and Welding Machine from Center's TRC project. Also, whole workshop has moved to the old AC plant in the main building premises. With these new facilities will definitely help to make more sophisticated research equipment in future.

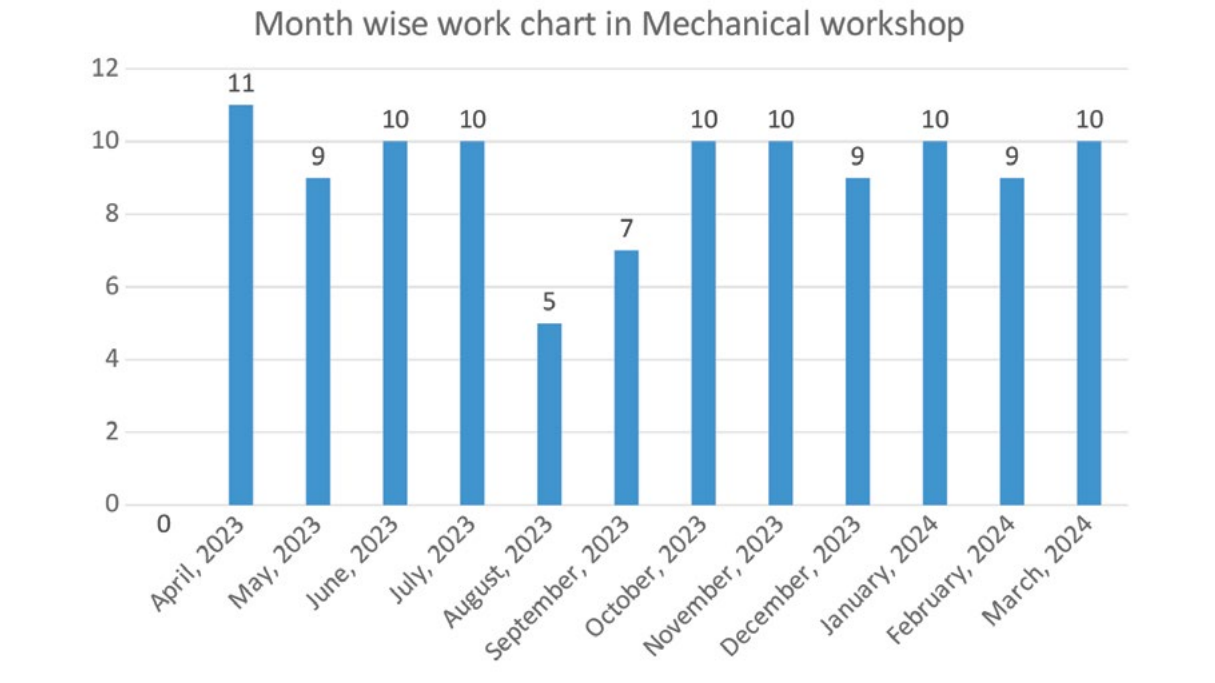

All Gear Lathe Machine


CNC Milling Machine

WELDING MACHINE




TOTAL JOB DONE ON 23 APRIL 2023 TO 24 MARCH 2024: 110 nos



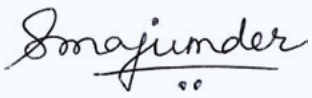

Atindra Nath Pal

**Dr. Atindra Nath Pal**
In charge of the Mechanical Workshop

# Guest House

## BHAGIRATHI – THE GUEST HOUSE

The Centre has its own upfront modern guest house named 'Bhagirathi' located within the premises. It houses five (5) fully air conditioned suites and three (3) fully air conditioned transit rooms each having attached bath and kitchenette. The kitchenettes are equipped with refrigerators, microwave-ovens & toasters. There are also eight (8) double-bedded rooms and forty six (46) single bedded rooms. All the double and single bedded rooms are air-conditioned and are fully furnished and have attached baths. All rooms are provided with basic amenities like hot and normal water, intercom telephone, television with DTH connection, electric kettle etc. The Guest House is Wi-Fi enabled and a state-of-the-art display unit is installed in the Guest House Front Desk displaying various information about the Guest House. These guests' rooms spread across the ground floor, first floor and second floor of the Bhagirathi building. Presently, the third floor of the building comprising of twenty-two (22) single bedded rooms and four (4) double bedded rooms are being used as hostel rooms for accommodating Centre's students. There is a seminar room within the guest house for hosting small conferences, meetings etc with separate dining facility. The Guest House also hosts the Medical Cell where doctor consultations are available for Centre's staff and students. The Centre's modern cafeteria with a state-of-art kitchen is housed in the guest house building. Apart from serving regular meals to the staff members of the Centre and to the visitors, the cafeteria also serves as a venue for hosting lunches, dinners and high-tea on special occasions. The terrace, above the Dining Hall has been designed to set up a Rooftop Cafeteria to serve snacks & beverages, to be operational soon. Apart from accommodating Centre's guests and visitors, the Centre extends its guest house facilities to various government departments, organizations, research laboratories, universities etc based on availability of guest house rooms. The guest house extends efficient service and warm hospitality to the guests availing the services.



**Shohini Majumder**
Registrar

Staff members, Engineering Section

Members of Technical Research Centre

# List of Publications

## 2023-2024


Differential Forms on Singular Varieties
Borrelli
Coleman
Preliminary
Edition
DIFFERENTIAL EQUATION
DISCRETE CHAOS
Second Edition
WITH APPLICATIONS IN
SCIENCE AND ENGINEERING
Carvalho · Langa · Robinson
Attractors for infinite-dimensional
non-autonomous dynamical systen
Applied and Computational Measurable Dynamics
Erik M. Bollt
Michèle Audin, Ana Cannas da Silva
and Eugene Lerman
Geometry of Differential Forms
Exterior Analysis
Erdoğan S. Şuhubi
Differential Geometry

# List of Publications 2023-2024

## Department of Astrophysics and High Energy Physics

1. **Ajay Sharma**, Sushanth Reddy Kamaram, Raj Prince, Rukaiya Khatoon and Debanjan Bose, *Probing the disc–jet coupling in S4 0954+65, PKS 0903–57, and 4C +01.02 with γ-rays*, Monthly Notices of the Royal Astronomical Society, 527, 2672-2686, 2024
2. Riya Barick, Indrajit Ghose, and **Amitabha Lahiri**, *Neutrino Oscillations Induced by Chiral Torsion,* Letters in High Energy Physics, 2023, 362, 2023
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76. Susmita Changdar, Susanta Ghosh, Kritika Vijay, Indrani Kar, Sayan Routh, P.K. Maheshwari, Soumya Ghorai, Soma Banik, **S. Thirupathaiah**, *Nonmagnetic Sn doping effect on the electronic and magnetic properties of antiferromagnetic topological insulator MnBi2Te4,* Physica B: Condensed Matter, 657, 414799, 2023

77. Satyabrata Bera, **Sudipta Chatterjee**, Subhadip Pradhan, Suman Kalyan Pradhan, Sk Kalimuddin, Arnab Bera, Ashis K. Nandy, and Mintu Mondal, *Anomalous Hall effect induced by Berry curvature in the topological nodal-line van der Waals ferromagnet Fe4GeTe2,* Physical Review B, 108, 115122, 2023

78. Biswajit Mahanty, **Sujoy Kumar Ghosh**, Gajula Prasad, Arunkumar Shanmugasundaram, Dong-Weon Lee, *Giant Energy Harvesting via Maxwell Displacement Current Enhancement Using Metal Sheet Interspaced Hetero-Layer Structured Piezo-Composite Nanofiber Device,* Advanced Functional Materials, 34, 2307723, 2024

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84. Aabhaas Vineet Mallik, Adhip Agarwala, and **Tanusri Saha-Dasgupta**, *Correlation-driven nontrivial phases in single-bilayer kagome intermetallics,* Physical Review B, 108, 205125, 2023

85. Sreekar Voleti, Koushik Pradhan, Subhro Bhattacharjee, **Tanusri Saha-Dasgupta** & Arun Paramekanti, *Probing octupolar hidden order via Janus impurities,* npj Quantum Materials, 8, 42, 2023

86. Dipayan Sen and **Tanusri Saha-Dasgupta**, *Pressure-tuned valence transition, insulator-metal transition in van der Waals antiferromagnet CrPS3,* Physical Review Materials, 7, 064008, 2023

87. Olga S. Volkova, Peter S. Berdonosov, Irina K. Shamova, Badiur Rahaman, Asif Iqbal, **Tanusri Saha-Dasgupta**, Alexander N. Vasiliev, *Thermal and magnetic properties of Cu4O(SeO3)3 composed by ferrimagnetic O2Cu6 units of edge-sharing OCu4 tetrahedra,* Journal of Alloys and Compounds, 956, 170346, 2023

88. Koushik Pradhan, Prabuddha Sanyal, and Tanusri Saha-Dasgupta, *Robust half-metallicity and topological properties in square-net potassium manganese chalcogenides,* Physical Review B, 107, 155115, 2023

89. Shiladitya Karmakar, Soumendu Datta and **Tanusri Saha-Dasgupta**, *First principles predictions of structural, electronic and topological properties of two-dimensional Janus Ti2N2XI (X = Br, Cl) structures,* Physical Chemistry Chemical Physics, 26, 10557-10567, 2024

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91. Arnab Bera, Samir Rom, Suman Kalyan Pradhan, Satyabrata Bera, Sk Kalimuddin, **Tanusri Saha-Dasgupta**, and Mintu Mondal, *Centrosymmetric-noncentrosymmetric structural phase transition in the quasi-one-dimensional compound (TaSe4)3I,* Physical Review B, 108, 035112, 2023

92. Md. Sariful Sheikh, **Tushar Kanti Bhowmik**, **Alo Dutta**, Sujoy Saha, Chhatra R. Joshi, and T. P. Sinha, Triclinic BiFeO3: *A room-temperature multiferroic phase with enhanced magnetism and resistivity,* Physical Review B, 108, 104427, 2023

## Department of Physics of Complex Systems

1. **Arijit Haldar**, Omid Tavakol, Han Ma, and Thomas Scaffidi, *Hidden Critical Points in the Two-Dimensional O(n>2) Model: Exact Numerical Study of a Complex Conformal Field Theory,* Physical Review Letters, 131, 131601, 2023

2. Surajit Bera, **Arijit Haldar**, and Sumilan Banerjee, *Dynamical mean-field theory for Rényi entanglement entropy and mutual information in the Hubbard model,* Physical Review B, 109, 035156, 2024

3. Sasthi Charan Mandal and **Jaydeb Chakrabarti**, *In-silico studies on hydration in EcoRI-cognate DNA complex,* Biophysical Chemistry, 303, 107121, 2023

4. Arpan Narayan Roy, Aayatti Mallick Gupta, Deboshmita Banerjee, **Jaydeb Chakrabarti**, Pongali B. Raghavendra, *Unraveling DPP4 Receptor Interactions with SARS-CoV-2 Variants and MERS-CoV: Insights into Pulmonary Disorders via Immunoinformatics and Molecular Dynamics,* Viruses, 15(10), 2056, 2023

5. Abhik Ghosh Moulick and **Jaydeb Chakrabarti**, *Fluctuation-Dominated Ligand Binding in Molten Globule Protein,* Journal of Chemical Information and Modeling, 63, 5583-5591, 2023

6. Rahul Karmakar, **J. Chakrabarti**, *Hot crystals of thermo-responsive particles with temperature dependent diameter in the presence of a temperature gradient,* The Journal of Chemical Physics, 159, 034904, 2023

7. Rahul Karmakar, **J. Chakrabarti**, *Transport of particles through RO membrane in steady state condition,* ChemistrySelect, 9, e202304343, 2024

8. Aayatti Mallick Gupta, SasthiCharan Mandal, Sukhendu Mandal, **Jaydeb Chakrabarti**, *Immune escape facilitation by mutations of epitope residues in RdRp of SARS-CoV-2,* Journal of Biomolecular Structure and Dynamics, 41, 3542-3552, 2023

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10. Kanika Kole, Aayatti Mallick Gupta, **Jaydeb Chakrabarti**, *Conformational stability and order of Hoogsteen base pair induced by protein binding,* Biophysical Chemistry, 301, 107079, 2023

11. Sahil Gopalkrishna Naik, Govind Lal Sidhardh, Samrat Sen, Arup Roy, Ashutosh Rai, and **Manik Banik**, *Distilling Nonlocality in Quantum Correlations,* Physical Review Letters, 130, 220201, 2023

12. Jitendra Joshi, Mir Alimuddin, T. S. Mahesh, and **Manik Banik**, *Experimental verification of many-body entanglement using thermodynamic quantities,* Physical Review A, 109, L020403, 2024

13. Mir Alimuddin, Ananya Chakraborty, Govind Lal Sidhardh, Ram Krishna Patra, Samrat Sen, Snehasish Roy Chowdhury, Sahil Gopalkrishna Naik, and **Manik Banik**, *Advantage of Hardy's nonlocal correlation in reverse zero-error channel coding,* Physical Review A, 108, 052430, 2023

14. Zhonghua Ma, Markus Rambach, Kaumudibikash Goswami, Some Sankar Bhattacharya, **Manik Banik**, and Jacquiline Romero, *Randomness-Free Test of Nonclassicality: A Proof of Concept,* Physical Review Letters, 131, 130201, 2023

15. **Manu Mathur** and **Atul Rathor**, *Disorder operators and magnetic vortices in SU(N) lattice gauge theory,* Physical Review D, 108, 114507, 2023

16. **Manu Mathur** and Atul Rathor, *Exact duality and local dynamics in SU(N) lattice gauge theory,* Physical Review D, 107, 074504, 2023

17. Xue Yang, Yan-Han Yang, **Mir Alimuddin**, Raffaele Salvia, Shao-Ming Fei, Li-Ming Zhao, Stefan Nimmrichter, and Ming-Xing Luo, Battery *Capacity of Energy-Storing Quantum Systems,* Physical Review Letters, 131, 030402, 2023

18. Kanchan Meena, **P. Singha Deo**, *Time reversed states in barrier tunnelling,* Physica E: Low-dimensional Systems and Nanostructures, 149, 115680, 2023

19. Tanmoy Chakraborty and **Punyabrata Pradhan**, *Time-dependent properties of run-and-tumble particles: Density relaxation,* Physical Review E, 109, 024124, 2024

20. Deepsikha Das, **Punyabrata Pradhan**, **Sakuntala Chatterjee**, *Optimum transport in systems with time-dependent drive and short-ranged interactions,* Physical Review E, 108, 034107, 2023

21. **Sanku Paul**, J. Bharathi Kannan, and M. S. Santhanam, *Interaction-induced directed transport in quantum chaotic subsystems,* Physical Review E, 108, 044208, 2023

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23. Ion Santra, Durgesh Ajgaonkar and **Urna Basu**, *The dichotomous acceleration process in one dimension: position fluctuations,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 083201, 2023

24. Santanu Das and **Urna Basu**, *Chirality reversing active Brownian motion in two dimensions,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 063205, 2023

25. Seemant Mishra and **Urna Basu**, *Symmetric exclusion process under stochastic power-law resetting,* Journal of Statistical Mechanics: Theory and Experiment, 2023, 053202, 2023

### Inter-Departmental Publications

1. Jayarshi Bhattacharya, **Gautam Gangopadhyay** and **Sunandan Gangopadhyay**, *Entropic force for quantum particles,* Physica Scripta, 98, 085305, 2023

2. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Rajib Kumar Mitra** and **Samit Kumar Ray**, *Superior piezoelectric performance of chemically synthesized transition metal dichalcogenide heterostructures for self-powered flexible piezoelectric nanogenerator,* Nanotechnology, 34, 435401, 2023

3. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Rajib Kumar Mitra** and **Samit Kumar Ray**, *TMDC ternary alloy–based triboelectric nanogenerators with giant photo-induced enhancement,* Nanoscale, 15, 17398-17408, 2023

4. **Sanjoy Choudhury**, Ashish Kumar Luhach, Joel J. P. C. Rodrigues, Mohammed AL-Numay, Uttam Ghosh, Diptendu Sinha Roy, *A Residual Resource Fitness-Based Genetic Algorithm for a Fog-Level Virtual Machine Placement for Green Smart City Services,* Sustainability, 15(11), 8918, 2023

5. **Sanjoy Choudhury**, Buddhadeb Pradhan, Sharmila Anand John Francis, Diptendu Sinha Roy, *An energy efficient fog level resource management scheme for software defined cities,* Sustainable Energy Technologies and Assessments, 57, 13289, 2023

6. Tathagata Gupta, Subhendu B. Ghosh, Ardra A V, Anandamay Das Bhowmik, **Sutapa Saha**, Tamal Guha, Ramij Rahaman, and **Amit Mukherjee**, *Hierarchical activation of quantum nonlocality: Stronger than local indistinguishability,* Physical Review A, 107, 052418, 2023

7. Pratap Kumar Pal, Subhadip Chakraborty, **Rajib Kumar Mitra**, **Anjan Barman**, *Optimizing the polarization and antireflection characteristics of metallic wire grid structures in the Terahertz frequency range,* Optical Materials, 146, 114553, 2023

### Adjunct Faculty

1. Monika Bhakar, Mona Garg, Pooja Bhardwaj, Nikhlesh Singh Mehta, **Goutam Sheet**, *Laser-induced structural modulation and superconductivity in SrTiO3,* Applied Physics Letters, 123, 052601, 2023

2. Supriyo Dutta and **Partha Guha**, *A system of billiard and its application to information-theoretic entropy,* Advances in Theoretical and Mathematical Physics, 26(8), 2599-2610, 2024

3. José F. Cariñena, **Partha Guha**, and Manuel F. Rañada, *Painlevé equations, integrable systems and the stabilizer set of Virasoro orbit,* Reviews in Mathematical Physics, 35(7), 2330004, 2023

**Total number of Journal Publications: 249**

## Other Publications

### Department of Astrophysics and High Energy Physics

1. GR Habtie and R Das, "Optical Photometry and Spectroscopy of Nova Sco 2024 (V1723 Sco)", The Astronomer's Telegram, 16454

2. Dutta, Broja G.; Mondal, Soumen, -"Origin of Soft/Hard X-ray Time Lags in Black Hole Transients and Bare-Type AGN", 42nd meeting of the Astronomical Society of India (ASI), held 31 January-04 February 2024, in Bengaluru, India. Hosted jointly by Indian Institute of Science (IISc), Indian Space Research Organisation (ISRO) and Jawaharlal Nehru Planetarium (JNP). Online at https://www.astron-soc.in/asi2024, id.043

3. Samrat Roy and Tapas Baug, "Probing the Rocket Effect: A Study of Massive Stars and Bright Rimmed Clouds", 42nd meeting of the Astronomical Society of India (ASI), P164, 01/2024

## Department of Chemical and Biological Sciences

1. L. Roy, S. Mondal, R. Ghosh, M. Das, M. N. Hasan, A. Banerjee, N. Pan, A. Chattopadhyay, and S. K. Pal "Recent progress in the synthesis of nanozymes and their functionalization ", (Book Chapter) in " Nanozymes - Approachable Bio-applications" Edited by Ravi Mani Tripathi, Ramesh Namdeo Pudake, Peng Huang, Nesrin Horzum, ELSEVIER, ISBN: 9780443137891, 2024

## Department of Condensed Matter and Materials Physics

1. Flicker noise in an electrolyte gated large area GrFET, R Alam, S Moulick, AN Pal, AIP Conference Proceedings 3067 (1) (2024)
2. Intrinsic room temperature ferromagnetism in van der Waals Fe5GeTe2 crystal, R Pal, S Bera, B Pal, M Mondal, AN Pal, AIP Conference Proceedings 3067 (1) (2024)
3. G phonon mode splitting in doped bilayer graphene probed by in-situ transport measurement and Raman spectroscopy, S Moulick, S Mukherjee, S Raha, A Singha, AN Pal, AIP Conference Proceedings 3067 (1), (2024)
4. Characterizations of a few layered MoS2 phototransistor using a homebuilt cost-effective measurement setup, S Mukherjee, AN Pal, SK Ray, AIP Conference Proceedings 3067 (1) (2024)
5. A. Gorai and K. Mandal, "Optimization of Magnetic Coating for Improved Electromagnetic Wave Absorption in Bi-layered Nano-hollow Spheres," Proceedings of IEEE International Magnetic Conference - 2023 at Sendai, Japan during 15-19 May, 2023, pp. 1-2.
6. S. Sarkar, P. Saha and K. Mandal, "Correlation between Dielectric and Magnetic properties in MgFe2O4 nano-structures", Proceedings of the International conference MAGMA-2023 at Hyderabad, India during 4-6 December 2023.
7. Soham Saha and Kalyan Mandal, "The One Dimensional p-ZnCo2O4/ n-ZnO Nanoheterojunction Photoanode for Photoelectrochemical Water Splitting", Proceedings of the Annual conference on quantum condensed matter QMAT-2023 at Bhubaneswar, India during 27-30 November 2023.
8. I. Jana, S. Hait and K. Mandal, "Improvement of Leakage, Magnetic and Magnetodielectric Properties in Cobalt doped Gallium Ferrite", Proceedings of the Annual conference on quantum condensed matter QMAT-2023 at Bhubaneswar, India during 27-30 November 2023.
9. Swastika Chatterjee, Rabindranath Mondal, Chirantan Pramanik, Prosenjit Ghosh, Tanusri Saha-Dasgupta Influence of Fe on the distribution and isotopic fractionation of Li in olivine: A first-principles study Meeting of EGU (European Geoscience Union) EGU24, Issue EGU24-18016
10. T Saha-Dasgupta Robust half-metallicity and topological properties in square-net potassium manganese chalcogenides Bulletin of the American Physical Society (2024)
11. S Voleti, K Pradhan, S Bhattacharjee, T Saha-Dasgupta, A Paramekanti Probing octupolar hidden order via Janus impurities npj Quantum Materials 8, 42 (2023)

## Department of Physics of Complex Systems

1. Urna Basu, Sanjib Sabhapandit, Ion Santra, Target search by active particles, arXiv:2311.17854 (Invited chapter in an upcoming book 'The Target Problem' to be published by Springer-Nature)
2. Shashank Prakash, Urna Basu, Sanjib Sabhapandit, Tagged particle behavior in a harmonic chain of direction reversing active Brownian particles, arXiv:2402.11964

**Total number of Other Publications: 17**

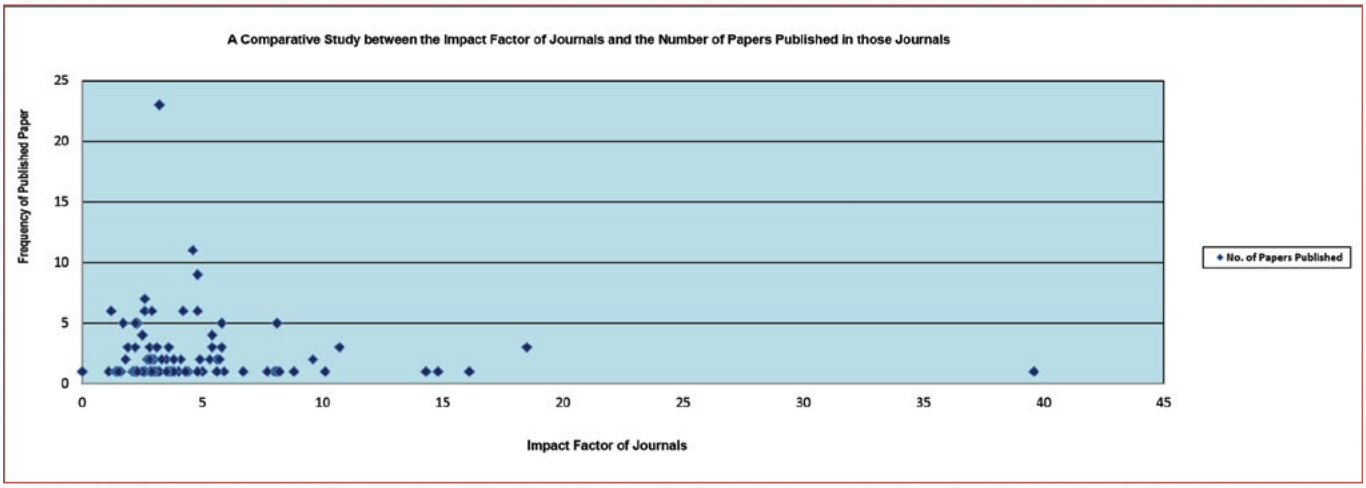
# Impact Factor for Publications in the Financial Year 2023-24

| Sl No. | Name of Journal | Journal Impact Factor | No. of Papers Published | Total of Impact Factor in the Journal |
|---|---|---|---|---|
| 1 | ACS Applied Bio Materials | 4.6 | 1 | 4.6 |
| 2 | ACS Applied Electronic Materials | 4.4 | 2 | 8.8 |
| 3 | ACS Applied Energy Materials | 5.9 | 1 | 5.9 |
| 4 | ACS Applied Nano Materials | 5.4 | 3 | 16.2 |
| 5 | ACS Omega | 4 | 1 | 4 |
| 6 | Advanced Functional Materials | 18.5 | 3 | 55.5 |
| 7 | Advanced Quantum Technologies | 4.4 | 1 | 4.4 |
| 8 | Advanced Science | 14.3 | 1 | 14.3 |
| 9 | Advances in Space Research | 2.8 | 1 | 2.8 |
| 10 | Advances in Theoretical and Mathematical Physics | 2.1 | 1 | 2.1 |
| 11 | Angewandte Chemie | 16.1 | 1 | 16.1 |
| 12 | Analyst | 3.6 | 1 | 3.6 |
| 13 | Analytical Chemistry | 6.7 | 1 | 6.7 |
| 14 | Annals of Physics | 3 | 2 | 6 |
| 15 | Applied Physics A | 2.6 | 1 | 2.6 |
| 16 | Applied Physics Letters | 3.5 | 2 | 7 |
| 17 | Astronomy & Astrophysics | 5.4 | 4 | 21.6 |
| 18 | Astrophysical Journal | 4.8 | 6 | 28.8 |
| 19 | Astrophysical Journal Letters | 8.8 | 1 | 8.8 |
| 20 | Biophysical Chemistry | 3.3 | 2 | 6.6 |
| 21 | Biophysical Journal | 3.2 | 1 | 3.2 |
| 22 | Biotechnology and Applied Biochemistry | 3.2 | 1 | 3.2 |
| 23 | Chemical Physics Impact | 3.8 | 1 | 3.8 |
| 24 | Chemical Science | 8 | 1 | 8 |
| 25 | ChemistrySelect | 1.9 | 3 | 5.7 |
| 26 | ChemBioChem | 2.6 | 1 | 2.6 |
| 27 | ChemPhysChem | 2.3 | 1 | 2.3 |
| 28 | Classical and Quantum Gravity | 3.6 | 1 | 3.6 |
| 29 | Communications Biology | 5.6 | 2 | 11.2 |
| 30 | Crystal Growth & Design | 3.2 | 1 | 3.2 |
| 31 | Electronic Structure | 2.9 | 1 | 2.9 |
| 32 | European Journal of Mass Spectrometry | 1.1 | 1 | 1.1 |
| 33 | European Physical Journal C | 4.2 | 6 | 25.2 |
| 34 | European Physical Journal Plus | 2.8 | 1 | 2.8 |
| 35 | Infrared Physics & Technology | 3.1 | 1 | 3.1 |
| 36 | IEEE Transactions on Magnetics | 2.1 | 1 | 2.1 |

| Sl No. | Name of Journal | Journal Impact Factor | No. of Papers Published | Total of Impact Factor in the Journal |
|---|---|---|---|---|
| 37 | Inorganic Chemistry | 4.3 | 1 | 4.3 |
| 38 | International Journal of Biological Macromolecules | 7.7 | 1 | 7.7 |
| 39 | International Journal of Hydrogen Energy | 8.1 | 1 | 8.1 |
| 40 | International Journal of Modern Physics A | 1.4 | 1 | 1.4 |
| 41 | International Journal of Modern Physics B | 2.6 | 1 | 2.6 |
| 42 | Journal of Alloys and Compounds | 5.8 | 3 | 17.4 |
| 43 | Journal of Applied Physics | 2.7 | 2 | 5.4 |
| 44 | Journal of Astrophysics and Astronomy | 1.2 | 6 | 7.2 |
| 45 | Journal of Biomolecular Structure and Dynamics | 3.2 | 1 | 3.2 |
| 46 | Journal of Chemical Information and Modeling | 5.9 | 1 | 5.9 |
| 47 | Journal of Chemical Physics | 3.6 | 3 | 10.8 |
| 48 | Journal of Chemical Sciences | 1.7 | 5 | 8.5 |
| 49 | Journal of Chemical Thermodynamics | 2.2 | 1 | 2.2 |
| 50 | Journal of Clinical Images and Medical Case Reports | 2.6 | 1 | 2.6 |
| 51 | Journal of Cosmology and Astroparticle Physics | 5.3 | 2 | 10.6 |
| 52 | Journal of Electronic Materials | 2.2 | 1 | 2.2 |
| 53 | Journal of High Energy Physics | 5 | 1 | 5 |
| 54 | Journal of Magnetism and Magnetic Materials | 2.5 | 4 | 10 |
| 55 | Journal of Materials Chemistry A | 10.7 | 3 | 32.1 |
| 56 | Journal of Materials Chemistry C | 5.7 | 2 | 11.4 |
| 57 | Journal of Materials Science | 4 | 1 | 4 |
| 58 | Journal of Molecular Liquids | 5.3 | 2 | 10.6 |
| 59 | Journal of Molecular Spectroscopy | 1.4 | 1 | 1.4 |
| 60 | Journal of Optics | 1.6 | 1 | 1.6 |
| 61 | Journal of the American Chemical Society | 14.8 | 1 | 14.8 |
| 62 | Journal of the Optical Society of America B | 1.8 | 2 | 3.6 |
| 63 | Journal of Photochemistry and Photobiology A: Chemistry | 4.1 | 2 | 8.2 |
| 64 | Journal of Physical Chemistry B | 2.8 | 3 | 8.4 |
| 65 | Journal of Physical Chemistry Letters | 4.8 | 1 | 4.8 |
| 66 | Journal of Physics: Condensed Matter | 2.3 | 5 | 11.5 |
| 67 | Journal of Physics: Materials | 4.9 | 2 | 9.8 |
| 68 | Journal of Statistical Mechanics: Theory and Experiment | 2.2 | 3 | 6.6 |
| 69 | Langmuir | 3.7 | 1 | 3.7 |
| 70 | Laser Physics Letters | 1.4 | 1 | 1.4 |
| 71 | Letters in High Energy Physics | 0 | 1 | 0 |
| 72 | Materials Chemistry and Physics | 4.3 | 1 | 4.3 |
| 73 | Materials Today Nano | 8.2 | 1 | 8.2 |
| 74 | Micromachines | 3 | 1 | 3 |

| Sl No. | Name of Journal | Journal Impact Factor | No. of Papers Published | Total of Impact Factor in the Journal |
|---|---|---|---|---|
| 75 | Molecular Physics | 1.6 | 1 | 1.6 |
| 76 | Monthly Notices of the Royal Astronomical Society | 4.8 | 9 | 43.2 |
| 77 | Monthly Notices of the Royal Astronomical Society: Letters | 4.8 | 1 | 4.8 |
| 78 | Nano Letters | 10.1 | 1 | 10.1 |
| 79 | Nanoscale | 5.8 | 5 | 29 |
| 80 | Nanoscience and Nanotechnology: Open Access | 1.4 | 1 | 1.4 |
| 81 | Nanotechnology | 2.9 | 2 | 5.8 |
| 82 | Nature Nanotechnology | 39.6 | 1 | 39.6 |
| 83 | New Journal of Chemistry | 2.8 | 2 | 5.6 |
| 84 | NPG Asia Materials | 9.6 | 2 | 19.2 |
| 85 | npj Quantum Materials | 5.6 | 1 | 5.6 |
| 86 | Nuclear Physics B | 2.5 | 1 | 2.5 |
| 87 | Optical Materials | 3.8 | 1 | 3.8 |
| 88 | Physica B: Condensed Matter | 2.8 | 2 | 5.6 |
| 89 | Physica E | 2.9 | 1 | 2.9 |
| 90 | Physica Scripta | 2.6 | 6 | 15.6 |
| 91 | Physica Status Solidi B: Basic Solid State Physics | 1.5 | 1 | 1.5 |
| 92 | Physical Chemistry Chemical Physics | 2.9 | 6 | 17.4 |
| 93 | Physical Review A | 2.6 | 7 | 18.2 |
| 94 | Physical Review Applied | 3.8 | 2 | 7.6 |
| 95 | Physical Review B | 3.2 | 23 | 73.6 |
| 96 | Physical Review D | 4.6 | 11 | 50.6 |
| 97 | Physical Review E | 2.2 | 5 | 11 |
| 98 | Physical Review Letters | 8.1 | 5 | 40.5 |
| 99 | Physical Review Materials | 3.1 | 3 | 9.3 |
| 100 | Physical Review Research | 3.5 | 1 | 3.5 |
| 101 | Physics Letters A | 2.3 | 1 | 2.3 |
| 102 | Physics Letters B | 4.3 | 1 | 4.3 |
| 103 | Proceedings of the National Academy of Sciences, India Section A: Physical Sciences | 1 | 1 | 1 |
| 104 | Quantum Information Processing | 2.2 | 1 | 2.2 |
| 105 | Reviews in Mathematical Physics | 1.4 | 1 | 1.4 |
| 106 | Scientific Reports (Nature Publishing Group) | 3.8 | 1 | 3.8 |
| 107 | Semiconductor Science and Technology | 1.9 | 1 | 1.9 |
| 108 | Solid State Communications | 2.1 | 1 | 2.1 |
| 109 | Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy | 4.3 | 3 | 12.9 |
| 110 | Sustainability | 3.3 | 1 | 3.3 |

| Sl No. | Name of Journal | Journal Impact Factor | No. of Papers Published | Total of Impact Factor in the Journal |
|---|---|---|---|---|
| 111 | Sustainable Energy Technologies and Assessments | 7.1 | 1 | 7.1 |
| 112 | Theoretical Chemistry Accounts | 1.7 | 1 | 1.7 |
| 113 | Thin Solid Films | 2 | 1 | 2 |
| 114 | Trends in Biochemical Sciences | 11.6 | 1 | 11.6 |
| 115 | Viruses | 3.8 | 1 | 3.8 |
| | **TOTAL** | **524.7** | **249** | **1065.8** |



# Accounts

# Satyendra Nath Bose National Centre for Basic Sciences

# Block JD, Sector-III, Salt Lake, Kolkata – 700 106

## BUDGET SUMMARY 2023-2024

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2023-2024.

(Figure in Lakhs)

| | Actuals 2022-2023 | Budget Estimate 2023-2024 | Revised Estimate 2023-2024 |
|---|---|---|---|
| Plan | 4175.96 | 5124.74 | 5158.57* |

* Sanctioned by DST Plan Rs.5019.00 lakh released as under:

| Sl no. | Sanction Letter No. | Dated | Amount (Rs. in lakh) |
|---|---|---|---|
| 1 | AI/SNB/SAL/003/2023/1 | 06.04.2023 | 422.00 |
| 2 | AI/SNB/SAL/003/2023/2 | 26.06.2023 | 291.00 |
| 3 | AI/SNB/SAL/003/2023/3 | 26.09.2023 | 470.00 |
| 4 | AI/SNB/SAL/003/2023/4 | 01.01.2024 | 440.00 |
| 5 | AI/SNB/GEN/003/2023/1 | 06.04.2023 | 524.00 |
| 6 | AI/SNB/GEN/003/2023/2 | 26.06.2023 | 516.00 |
| 7 | AI/SNB/GEN/003/2023/3 | 26.09.2023 | 470.00 |
| 8 | AI/SNB/GEN//003/2023/4 | 01.01.2024 | 850.00 |
| 9 | AI/SNB/CAP/003/2023/1 | 06.04.2023 | 166.00 |
| 10 | AI/SNB/CAP/003/2023/2 | 26.06.2023 | 300.00 |
| 11 | AI/SNB/CAP/003/2023/3 | 26.09.2023 | 70.00 |
| 12 | AI/SNB/CAP/003/2023/4 | 11.12.2023 | 500.00 |
| **TOTAL (PLAN)** | | | **Rs. 5019.00** |

# INDEPENDENT AUDITOR'S REPORT

**To the Governing Body of Satyendra Nath Bose National Centre for Basic Sciences**

We have audited the accompanying financial statements of Satyendra Bose National Centre for Basic Sciences ("the Centre"), which comprise the balance sheet as at March 31, 2024, and the Income and Expenditure Account, Receipts and Payments Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion, the accompanying financial statements of the entity are prepared, in all material respects, in accordance with the rules of the Centre and the Society.

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the Code of Ethics issued by ICAI and we have fulfilled our other ethical responsibilities in accordance with the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

**Emphasis of matter**

We draw attention to the matters stated in the following note numbers to the financial statements. Our opinion is not modified in respect of these matters.

a) Retirement Benefits: Gratuity Liability & Leave Salary Liability- Note no 8.1 & 8.2

b) Un Adjusted Traveling Advance-:Amartya Sarkar- Rs.63,000/- outstanding since 2012-13

c) Liability for T.D.S. default as per 26AS statement – Rs.96,259/-

**Responsibilities of Management and Those Charged with Governance for the Financial Statements**

The management of the Centre is responsible for the preparation of the financial statements in accordance with the rules of the Centre and for such internal control as the management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the entity's financial reporting process.

**Auditor's Responsibilities for the Audit of the Financial Statements**

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by GB.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty

# INDEPENDENT AUDITOR'S REPORT (Contd...)

exists related to events or conditions that may cast significant doubt on the entity's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the entity to cease to continue as a going concern.

- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

Materiality is the magnitude of misstatements in the financial statements that, individually or in aggregate, makes it probable that the economic decisions of a reasonably knowledgeable user of the financial statements may be influenced. We consider quantitative materiality and qualitative factors in (i) planning the scope of our audit work and in evaluating the results of our work; and (ii) to evaluate the effect of any identified misstatements in the financial statements

We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, related safeguards

For **Mookherjee Biswas & Pathak,**
Chartered Accountants
FRN: 301138E

**(S P Mukherjee)**
Partner
Membership No. -010807
UDIN: 24010807BKEADA2557

Place: Kolkata
Date: 05.09.2024

# Satyendra Nath Bose National Centre for Basic Sciences

## Balance Sheet as at 31st March 2024

(Amount in ₹)

| Particulars | Schedule | Current Year | Previous Year |
|---|---|---|---|
| **FUNDS AND LIABILITIES** | | | |
| Capital / Corpus Fund | 1 | 1446695954.93 | 1348893098.36 |
| Reserves and Surplus | 2 | - | - |
| Earmarked/Endowment Funds | 3 | 283897133.79 | 296187801.93 |
| Secured Loans and Borrowings | 4 | - | - |
| Unsecured Loans and Borrowings | 5 | - | - |
| Deferred Credit Liabilities | 6 | - | - |
| Current Liabilities and Provisions | 7 | 36096214.22 | 48792269.22 |
| **TOTAL** | | **1766689302.94** | **1693873169.51** |
| **ASSETS** | | | |
| Fixed Assets | 8 | 698192577.26 | 653407453.97 |
| Investments-From Earmarked/Endowment Funds | 9 | 204957371.00 | 192121693.00 |
| Investments - Others | 10 | 432314479.00 | 479577646.00 |
| Current Assets, Loans, Advances Etc. | 11 | 431224875.68 | 368766376.54 |
| Miscellaneous Expenditure | | | |
| (to the extent not written off or adjusted) | | | |
| **TOTAL** | | **1766689302.94** | **1693873169.51** |

**As Per our report of even date**
**For Mookherjee Biswas & Pathak**
Chartered Accountants
FRN: 301138E

**Date:** 05.09.2024
Place: Kolkata

**(S P MUKHERJEE)**
Partner
Membership no: 010807

# Satyendra Nath Bose National Centre for Basic Sciences

## Income and Expenditure Account for 31st March 2024

(Amount in ₹)

| Particulars | Schedule | Current Year | Previous Year |
|---|---|---|---|
| **INCOME** | | | |
| Income from Services | 12 | 9692814.00 | 11265542.15 |
| Grants/Subsidies | 13 | 398299846.00 | 305423171.00 |
| Fees/Subscriptions (Student Admission & Semester Fees) | 14 | 1545300.00 | 1545501.00 |
| Income from Investments (Income on Investment) | 15 | - | - |
| from earmarked/endowment Funds transferred to Funds) | | - | - |
| Income from Technology Transfer & Contract Project | 16 | - | - |
| Interest Earned on Term Deposits (including in on HBA) | 17 | 27823459.00 | 24581336.00 |
| Other Income | 18 | 1435080.38 | 1074686.00 |
| Increase/(decrease) in stock of finished goods and works-in-progress | 19 | - | - |
| **TOTAL (A)** | | **438796499.38** | **343890236.15** |
| **EXPENDITURE** | | | |
| Establishment Expenses | 20 | 159685687.00 | 165404561.00 |
| Other Administrative Expenses etc. | 21 | 223607928.12 | 206901765.27 |
| Expenditure on Grants, Subsidies etc. | 22 | - | - |
| **TOTAL (B)** | | **383293615.12** | **372306326.27** |
| **Balance being excess of Income over Expenditure(A-B)** | | 55502884.26 | -28416090.12 |
| Prior period adjustments (Credit) | | 53096.12 | 271564.28 |
| Transfer to/from Capital Fund | | | |
| **Balance Being Surplus/(Deficit) Carried to Corpus/Capital Fund** | | **55555980.38** | **-28144525.84** |

**As Per our report of even date**
**For Mookherjee Biswas & Pathak**
Chartered Accountants
FRN: 301138E

**Date:** 05.09.2024
Place: Kolkata

**(S P MUKHERJEE)**
Partner
Membership no: 010807

# Satyendra Nath Bose National Centre for Basic Sciences

## Receipts and Payments Accounts for the year ended 31st March 2024

Amount (Rs.)

| RECEIPTS | Current Year | Previous Year | PAYMENTS | Current Year | Previous Year |
|---|---|---|---|---|---|
| **I. Opening Balances** | | | I. Expenses : | | |
| a) Cash in hand | 4934.00 | 17877.00 | a) Establishment Expenses | 243678714.00 | 207101769.00 |
| b) Bank Balances : | | | b) Administrative Expenses | 102352205.00 | 95282270.08 |
| I. In current accounts (Schd 11A) | 33929134.53 | 114243200.96 | c) Maintenance | 71118030.96 | 53185227.00 |
| ii. In deposit accounts | | | II. Payments made against funds for various Projects | | |
| Schedule - 10 | 479577646.00 | 596732724.00 | | | |
| Schedule - 11A | 0.00 | 1192809.00 | | | |
| iii. Savings accounts (Schd 11A) | 64387626.00 | 49935060.20 | III. Investments and deposits made | | |
| iv. Remittance-in-Transit | | | a) Out of Earmarked/ Endowment | 0.00 | 0.00 |
| **II. Grants Received** | | | b) CPWD Deposit and NBCC Deposit | | |
| a) From Government of India | | | c) Bank Gurantee & LC A/C | 46705855.00 | |
| - For the year | 593864623.00 | 447874865.00 | d) Out of Own Fund | 87966655.00 | 258620290.00 |
| - For the previous year | | | | | |
| b) From State Government | | | IV. Expenditure on Fixed Assets & Capital Work-in-Progress | | |
| c) From Other sources (details) | | | a) Purchase of Fixed Assets | 159114325.00 | 189400272.00 |
| (Grants for capital & revenue exp.To be shown separately) | | | b) Expenditure on Capital Work-in-Progress | | |
| | | | V. Refund of Interest | | |
| III. Interest Received | | | a) To the Government of India | | |
| a) On Bank deposits | 2605024.00 | 5531552.00 | b) To the State Government | | |
| | | | c) To other providers of funds | | |
| IV. Other Income | 12964391.88 | 12730092.00 | VI. Finance Charges (Interest) | | |
| V. Amount Borrowed | | | VII. Other Payments | 69808471.29 | 136031669.43 |
| VI. Any other receipts | 3086938.27 | 7847732.88 | VIII. Closing Balances | | |

# Satyendra Nath Bose National Centre for Basic Sciences

## Receipts and Payments Accounts for the year ended 31st March 2024

Amount (Rs.)

| RECEIPTS | Current Year | Previous Year | PAYMENTS | Current Year | Previous Year |
|---|---|---|---|---|---|
| | | | a) Cash in hand | 0.00 | 4934.00 |
| VII. Amount transferred from Current Account/ Savings Account to Deposit Account. | 112216034.00 | 278892693.00 | b) Bank Balances : | | |
| | | | I. In current accounts (Schd 11A) | 27770569.94 | 33929134.53 |
| | | | ii. In deposit accounts | | |
| VIII. Amount transferred from Deposit Account | 69885653.00 | 2522232.00 | Schedule - 10 | 432314479.00 | 479577646.00 |
| to Savings Account & Currect Account. | | | Schedule - 11A | 71512546.00 | 0.00 |
| | | | iii. Savings accounts (Schd.11A) | 60180153.49 | 64387626.00 |
| | | | iv. Remittance-in-Transit | | |
| | **1372522004.68** | **1517520838.04** | | **1372522004.68** | **1517520838.04** |

Date:05.09.2024
Place: Kolkata

Per our report of even date
For **Mookherjee Biswas & Pathak**
**Chartered Accountants**
FRN: 301138E

**(S P MUKHERJEE)**
Partner
Membership no: 010807

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 1 - Capital Fund:

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| **Balance as at the beginning of the year** | 1348893098.36 | | 1339278916.58 | |
| Add : Contributions towards Corpus/Capital Fund | 102759663.00 | | 72999342.00 | |
| Less:Depreciation for the year | 63197153.34 | | 35240634.38 | |
| Add- Adjustment during the year | 2684366.53 | | - | |
| Add : Surplus / Deficit during the year | 55555980.38 | | -28144525.84 | |
| | | 1446695954.93 | | 1348893098.36 |
| **BALANCE AS AT THE YEAR - END** | | **1446695954.93** | | **1348893098.36** |

## Schedule 2 - Reserves and Surplus:

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| **1. Capital Reserve:** | | | | |
| As per last Account | | | | |
| Addition during the year | | | | |
| Less: Deductions during the year | | | | |
| 2. Revaluation Reserve: | | | | |
| As per last Account | | | | |
| Addition during the year | | | | |
| Less: Deductions during the year | | | | |
| 3. Special Reserves: | | | | |
| As per last Account | | | | |
| Addition during the year | | | | |
| Less: Deductions during the year | | | | |
| 4. General Reserve: | | | | |
| As per last Account | | | | |
| Add : Surplus during the year | | | | |
| **TOTAL** | | | | |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 3 - Earmarked/ Endowment Funds

(Amount in ₹)

| | FUND-WISE BREAK UP | | | | | TOTAL | |
|---|---|---|---|---|---|---|---|
| | Technical Research Centre | Project Fund | Retirement Benefits Fund | Staff Medical Fund | Corpus Fund | Current Year | Prev. Year |
| **a) Opening balance of the funds** | 1040861.85 | 129276288.58 | 129327016.00 | 11372532.00 | 25171103.50 | 296187801.93 | 294625792.61 |
| **b) Additions to the Funds** | | | | | | | |
| I) Donations/grants/ Contributions | 51973123.00 | 41572329.00 | 88728.00 | 1462570.00 | 734856.00 | 95831606.00 | 89108018.50 |
| ii) Income from investments made on account of funds | 135441.00 | 3585362.00 | 5601812.00 | 610946.00 | 884325.00 | 10817886.00 | 13498057.00 |
| iii) Other addition-provision during the year | | | | | | | |
| **TOTAL (a + b)** | **53149425.85** | **174433979.58** | **135017556.00** | **13446048.00** | **26790284.50** | **402837293.93** | **397231868.11** |
| **c) Utilisation/Expenditure towards objectives of funds** | | | | | | | |
| I) Capital Expenditure | | | | | | | |
| Fixed Assets | | | | | | | |
| Others | 31064998.00 | 18710757.76 | | | | 49775755.76 | 9099772.00 |
| Total | | | | | | | |
| ii) Revenue Expenditure | | | | | | | |
| Salaries, Stipend and | 7806437.00 | 29011252.00 | | | | 36817689.00 | 29712497.00 |
| allowances etc. | | | | | | | |
| Rent | | | | | | | |
| Other Administrative | 11317186.54 | 9917328.84 | | | | 21234515.38 | |
| expenses | | | | | | | |
| Other Payments | 0.00 | 0.00 | 8457062.00 | 610946.00 | 1308848.00 | 10376856.00 | 16692664.18 |
| iii) Adjustment | | | | | | | |
| Interest Refunded to DST | 618238.00 | 117106.00 | | | | 735344.00 | 3465142.00 |
| Unspent balance refunded to DST | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 42073991.00 |
| **TOTAL (c)** | **50806859.54** | **57756444.60** | **8457062.00** | **610946.00** | **1308848.00** | **118940160.14** | **101044066.18** |
| | **2342566.31** | **116677534.98** | **126560494.00** | **12835102.00** | **25481436.50** | **283897133.79** | **296187801.93** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 4 - Secured Loans and Borrowings:

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| 1. Central Government | | | | |
| 2. State Government (Specify) | | | | |
| 3. Financial institutions | | | | |
| a) Term Loans | | | | |
| b) Interest accrued and due | | | | |
| 4. Banks: | | | | |
| a) Term Loans | | | | |
| Interest accrued and due | | | | |
| b) Other Loans (Specify) | | | | |
| Interest accrued and due | | | | |
| 5. Other Institutions and Agencies | | | | |
| 6. Debentures and Bonds | | | | |
| 7. Others (Specify) | | | | |
| **TOTAL** | **Nil** | **Nil** | **Nil** | **Nil** |

## Schedule 5 - Unsecured Loans and Borrowings

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| 1. Central Government | | | | |
| 2. State Government (Specify) | | | | |
| 3. Financial Institutions | | | | |
| 4. Banks: | | | | |
| a) Term Loans | | | | |
| b) Other Loans (Specify) | | | | |
| 5. Other Institutions and Agencies | | | | |
| 6. Debentures and Bonds | | | | |
| 7. Fixed Deposits | | | | |
| 8. Others (Specify) | | | | |
| **TOTAL** | **Nil** | **Nil** | **Nil** | **Nil** |

## Schedule 6 - Deferred Credit Liabiilties:

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| a) Acceptances secured by hypothecation of capital equipment and other assets | | | | |
| b) Others | | | | |
| **TOTAL** | **Nil** | **Nil** | **Nil** | **Nil** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 7 - Current Liabilities and Provisions

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| **A. CURRENT LIABILITIES** | | | | |
| 1. Acceptances | | | | |
| 2. Sundry Creditors: | | | | |
| a) For Capital expenditure | 30000.00 | | | 4979152.00 |
| b) Others - Revenue expenditure (including TRC & Project) | 59000.00 | | | 9055454.00 |
| 3. Othert Liabilities | 3032575.88 | | | 7955462.88 |
| 4. Deposit from Contractors (including Project & TRC) | 11388273.50 | | | 10644816.50 |
| 5. Deposit from Students | 2384500.00 | | | 2229500.00 |
| 6. Deposit from Contractual Employees | 1445207.00 | | | 1601023.00 |
| 7. Provident Fund Account (Payable) | 4043941.80 | | | 1554375.80 |
| 8. Project Overhead Fund | 7456720.53 | | | 7783807.53 |
| 9. Other liabilities | 3267318.00 | | | 0.00 |
| 10. Employees Welfare Fund | 129429.00 | | | 129429.00 |
| 11. EVLP Overhead Fund | 2859248.51 | | | 2859248.51 |
| **TOTAL (A)** | **36096214.22** | | | **48792269.22** |
| **B. PROVISIONS** | | | | |
| 1. For Taxation | | | | |
| 2. Gratuity | | | | |
| 3. Superannuation/Pension | | | | |
| 4. Accumulated Leave Encashment | | | | |
| 5. Trade Warranties/Claims | | | | |
| 6. Others - Adhoc Bonus | 0.00 | | | 0.00 |
| **TOTAL (B)** | **0.00** | | | **0.00** |
| **TOTAL (A + B)** | **36096214.22** | | | **48792269.22** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 8 - Fixed Assets

(Amount in ₹)

| | FUND-WISE BREAK UP | | | | | | | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Cost/valuation As at begin. of the year | Additions during the year | Adjustment during the year | Cost/valuation at the year-end | As at the beginning of the year | Additions during the year | Adjustment during the year | Total up to the Year-end | Current Year-end | Previous Year-end |
| **A. FIXED ASSETS:** | | | | | | | | | | |
| **1. LAND:** | | | | | | | | | | |
| a) Freehold | | | | | | | | | | |
| b) Leasehold | 10950654.60 | 0.00 | | 10950654.60 | 0.00 | 0.00 | | 0.00 | 10950654.60 | 10950654.60 |
| **2. BUILDINGS:** | | | | | | | | | | |
| a) On Leasehold Land | 455056229.86 | 4828835.00 | 391420.00 | 459493644.86 | 87958705.10 | 7247740.52 | 75397.39 | 95131048.23 | 364362596.63 | 367097524.76 |
| b) On Freehold Land | | | | | | | | | | |
| c) Ownership Flats/Premises | | | | | | | | | | |
| d) Superstructures on Land not belonging to the entity | | | | | | | | | | |
| 3. Plant Machienry & Equipment | 675607532.45 | 76504156.00 | 17167210.18 | 734944478.27 | 481498109.31 | 40622343.85 | 16129235.59 | 505991217.57 | 228953260.70 | 193660861.18 |
| 4. Vehicles | 1042199.00 | 0.00 | 321013.00 | 721186.00 | 716835.92 | 85640.84 | 321011 | 481465.76 | 239720.24 | 325363.08 |
| 5. Furniture, Fixtures | 51070926.22 | 1126784.00 | 8107655.51 | 44090054.71 | 38803724.48 | 1415791.05 | 7345828.45 | 32873687.08 | 11216367.63 | 12238801.15 |
| 6. Office Equipment | 6875010.29 | 55999.00 | 1360573.21 | 5570436.08 | 5873358.21 | 180031.17 | 1352094.02 | 4701295.36 | 869140.72 | 997757.59 |
| 7. Computer & Lan Installation | 145951110.19 | 24603874.00 | 42577549.99 | 127977434.20 | 82103379.02 | 12721908.11 | 42400012.89 | 52425274.24 | 75552159.96 | 63596483.83 |
| 8. Electric Installations | 11699040.00 | 1139996.00 | 52469.00 | 12786567.00 | 10216643.50 | 923697.80 | 5383.92 | 11145725.22 | 1640841.78 | 1482396.50 |
| 9. Library Books | 281633858.11 | 0.00 | 281633858.11 | 0.00 | 69586478.05 | 0 | 69586478.05 | 0.00 | 0.00 | 0.00 |
| 10. Tubewells & W.Supply | - | | | | | | | 0.00 | 0.00 | - |
| 11. Other Fixed Assets | 84225.55 | 0.00 | 74225.55 | 10000.00 | 80014.27 | 0 | 70514.27 | 9500.00 | 500.00 | 4211.28 |
| **Total of Current Year** | **1639970786.27** | **108259644.00** | **351685974.55** | **1396544455.72** | **776837247.86** | **63197153.34** | **137285955.58** | **702759213.46** | **693785242.26** | **650354053.97** |
| **Previous Year** | **1445319480.52** | **194651305.75** | **31,98,46,255.51** | **1320124530.76** | **741596613.48** | **35240634.38** | **10,70,66,771.07** | **669770476.79** | **650354053.97** | **703722867.04** |
| **B. Capital Work in Progress** | **3053400.00** | **1353935.00** | | **4407335.00** | - | - | - | **0.00** | **4407335.00** | **3053400.00** |
| **TOTAL (A + B)** | **1643024186.27** | **109613579.00** | **351685974.55** | **1400951790.72** | **776837247.86** | **63197153.34** | **137285955.58** | **702759213.46** | **698192577.26** | **653407453.97** |

Note: 1. Library books transferred to Other Non current Assets - Rs.22,05,24,360.06 in schedule-11 (Previous year figure -Rs.21,20,47,380.06)

2. Assets held for Diposal transferred to Non Current Assets - Rs.6,22,356.20 in schedule -11 (Previous year - Rs.7,32,104.38), see note in 11B

3. Previous year figure reguouped/ re arranged where ever necessery.

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 9 - Investments from Earmarked/Endowment Funds

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1. In Government Securities | | |
| 2. Other approved Securities | | |
| 3. Shares | | |
| 4. Debentures and Bonds | | |
| 5. Subsidiaries and Joint Ventures | | |
| 6. Project Fund Investment | 68690866.00 | 66247478.00 |
| 7. Retirement Benefit Fund Investment | 113393971.00 | 104094692.00 |
| 8. Staff Medical Fund Investment | 8140719.00 | 7047708.00 |
| 9. Corpus Fund Investment (Project Overhead) | 14731815.00 | 14731815.00 |
| 10. TRC Fund Investment | 0.00 | 0.00 |
| **TOTAL** | **204957371.00** | **192121693.00** |

## Schedule 10 - Investments - Others

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1. In Government Securities | | |
| 2. Other approved Securities | | |
| 3. Shares | | |
| 4. Debentures and Bonds | | |
| 5. Subsidiaries and Joint Ventures | | |
| 6. Others - Fixed Deposit with Indian Overseas Bank (including Project Overhead Investment) | 280658745.00 | 323480333.00 |
| Fixed Deposit with Union Bank of India | 151655734.00 | 156097313.00 |
| **TOTAL** | **432314479.00** | **479577646.00** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 11 - Current Assets, Loans, Advances Etc.

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| **A. CURRENT LIABILITIES** | | | | |
| 1. Inventories: | | | | |
| a) Stores and Spares | | 145787.91 | | 32868.57 |
| 2) Cash balances in hand | | 0.00 | | 4934.00 |
| 3) Bank Balances: | | | | |
| a) With Scheduled Banks: | | | | |
| **On Current Accoutns:** | | | | |
| Indian Overseas Bank (CA-089302000000220) | 19917835.16 | | 21669307.18 | |
| Indian Overseas Bank (CA-089302000000273) | 1430700.95 | | 3479505.55 | |
| Union Bank of India (CA-460901010034252) | 6422033.83 | | 6824170.95 | |
| | | | 12184.00 | |
| Reserve Bank of India(TSA) | | 27770569.94 | 24776.00 | 32009943.68 |
| **On Deposit Accounts for LC&BG:** | | | | |
| Indian Overseas Bank (CA-089302000000220) | 70078526.00 | | **24806691.00** | |
| Indian Overseas Bank (SB-089301000018598 TRC) | 1434020.00 | | | |
| Indian Overseas Bank (CA-089302000000273 PROJECT) | | 71512546.00 | | 24806691.00 |
| **On Savings Accounts:** | | | | |
| Indian Overseas Bank(SB-089301000010662 UNAST) | 3770610.60 | | 3770610.60 | |
| Indian Overseas Bank(SB-089301000012029 SYNC.) | 840319.96 | | 840319.96 | |
| Indian Overseas Bank(SB-089301000011479 NANO TECH) | 595777.66 | | 595777.66 | |
| Union Bank of India (SB-460901110050013) | 8046874.97 | | 8046874.97 | |
| Axis Bank (SB-775010100024408) | 426984.00 | | 426984.00 | |
| Axis Bank (SB-775010100017860) | 309906.00 | | 1906.00 | |
| BOM(1817) | 4722041.00 | | 4722041.00 | |
| BOM(3237) | 24071569.00 | | 24071569.00 | |
| Indian Overseas Bank-(SB-089302000019902) | 6946413.80 | | 20509911.80 | |
| Union Bank of India(SB-460902010097273 TRC) | 70138.80 | | 68242.80 | |
| Indian Overseas Bank (SB- 089301000018598 TRC) | 3886107.09 | | 1850948.05 | |
| HDFC Bank (SB-6771192) | 6480856.61 | | 1401631.01 | |
| HDFC Bank (GEM)(373218248) | 12554.00 | 60180153.49 | | 66306816.85 |
| 5. Remittance - in - Transit | | | | |
| 6. Post Office-Savings Accounts | | | | |
| **TOTAL (A)** | | **159609057.34** | | **123161254.10** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 11 - Current Assets, Loans, Advances Etc. (Contd.)

(Amount in ₹)

| Particulars | Current Year | | Previous Year | |
|---|---|---|---|---|
| **B. LOANS, ADVACNES AND OTHER ASSETS** | | | | |
| 1. Loans: | | | | |
| a) Staff including HBA, Vehicle &PC Advance (includes Project A/c) | | 251598.00 | | 155000.00 |
| 2. Advances and other amounts recoverable in cash or in kind or for value to be received: | | | | |
| a) On Capital Account - CPWD Deposit Account | 438840.00 | | 438840.00 | |
| b) GST payment | 0.00 | | 0.00 | |
| c) Others | 373359.00 | | 377073.00 | |
| d) Contractors & Suppliers | 17762941.00 | 18575140.00 | 323347.00 | 1139260.00 |
| 3. Income Accrued: | | | | |
| a) On Investments from Earmarked/Endowment Funds(Including Project & TRC) | 18111709.00 | | 20958302.00 | |
| b) On investmetns - Others | 11316471.00 | | 8436645.00 | |
| c) Income tax (TDS) Refundable | | 29428180.00 | | 29394947.00 |
| 4. Sundry Debtors - National Research Development Corporation & Tecnology Hub(ISI) | | 2125566.00 | | 2030313.00 |
| 5. Security Deposit (including Project) | | **88618.00** | | **106118.00** |
| 6. Non Current Assets (Library books) | | 220524360.06 | | 212047380.06 |
| 7. Other Non current Assets (Assets held for disposal)* | | 622356.28 | | 732104.38 |
| **TOTAL (B)** | | **271615818.34** | | **245605122.44** |
| **TOTAL (A + B)** | | **431224875.68** | | **368766376.54** |

| | |
|---|---|
| * Opening Balance | Rs.7,32104.38 |
| Less- Assets sold during the year | Rs.1,09748.10 |

Loss of Rs.18741.10 adjusted with capital fund shown in schedule-1

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Balance Sheet as at 31.03.2024

## Schedule 12 - Income from Sales/Services

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1) Income from Sales | | |
| a) Sale of Finished Goods | | |
| b) Sale of Raw Material | | |
| c) Sale of Scraps | 0.00 | 484250.00 |
| 2) Income from Services | | |
| a) Guest House Rent | 1553100.00 | 1948300.00 |
| b) Hostel Charges (Recovery of HRA) | 4690790.00 | 5670237.00 |
| c) Equipment Utilisation Fees | 521000.00 | 449000.00 |
| d) Hostel Maintenance Fees | 1394452.00 | 1937455.00 |
| e) Project Overhead | 293942.00 | 431939.40 |
| f) Income from BSNL | 123570.00 | 141107.00 |
| g) course fees | 12000.00 | 0.00 |
| h) Dining Hall Rent | 0.00 | 0.00 |
| i) Recovery of Water Charges | 0.00 | 0.00 |
| j) Conference Registration Fee | 1103960.00 | 202000.00 |
| k) Sale of assets | 0.00 | 1253.75 |
| **TOTAL** | **9692814.00** | **11265542.15** |

## Schedule 13 - Grants/Subsidies (Irrevocable Grants & Subsidies Received)

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1) Central Government | 398299846.00 | 305423171.00 |
| 2) State Government(s) | | |
| 3) Government Agencies | | |
| 4) Institutions/Welfare Bodies | | |
| 5) International Organsations | | |
| 6) Others | | |
| | | |
| **TOTAL** | **398299846.00** | **305423171.00** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Income & Expenditure for the Year Ended 31.03.2024

## SCHEDULE 14 - FEES/SUBSCRIPTIONS

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1) Student Admission Fee | | |
| 2) Annual Fees/Subscriptions | 111550.00 | 132501.00 |
| 3) Student Semester Fee | | |
| 4) Consultancy Fees | 1433750.00 | 1413000.00 |
| 5) Others | | |
| **TOTAL** | **1545300.00** | **1545501.00** |

Note: Accounting Policies towards each item are to be disclosed

## SCHEDULE 15 - INCOME FROM INVESTMENTS

(Income on Invest. From Earmarked/Endowment Funds transferred to Funds)

(Amount in ₹)

| Particulars | Investment from Earmarked Fund | | Investment - Others | |
|---|---|---|---|---|
| | Current Year | Previous Year | Current Year | Previous Year |
| 1) Interest | | | | |
| a) On Govt. Securities | 0.00 | 0.00 | 0.00 | 0.00 |
| b) Other Bonds/Debentures | | | | |
| 2) Dividends: | | | | |
| a) On Shares | | | | |
| b) On Mutual Fund Securities | | | | |
| 3) Rents | | | | |
| 4) Others | | | | |
| a) Interest on Fixed Deposits with Banks | 0.00 | 0.00 | | |
| b) Interest on SB Accounts | 0.00 | 0.00 | | |
| **TOTAL** | **0.00** | **0.00** | | |
| **TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS** | | | | |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Income & Expenditure for the Year Ended 31.03.2024

## SCHEDULE 16 - INCOME FROM TECHNOLOGY TRANSFER & CONTRACT PROJECT

(Amount in ₹)

| Particulars | Current Year | Previous Year |
|---|---|---|
| 1. Income from Technology Transfer | | - |
| 2. Income from Contract Project | | |
| 3. Others | | |
| **TOTAL** | **0.00** | **0.00** |

## SCHEDULE 17 - INTEREST EARNED

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| 1) On Term Deposits: | | |
| a) With Scheduled Banks | 27721981.00 | 24066810.00 |
| b) With Institutions | | |
| c) Others | | |
| 2) On Savings Accounts: | | |
| a) With Scheduled Banks | 101478.00 | 498902.00 |
| b) Post Office Savings Accounts | | |
| c) Others | | |
| 3) On Loans: | | |
| a) Employees/Staff (Interest on HBA etc.) | 0.00 | 15624.00 |
| b) Others | | |
| 4) Interest on Debtors and Other Receivables | | |
| **TOTAL** | **27823459.00** | **24581336.00** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Income & Expenditure for the Year Ended 31.03.2024

## SCHEDULE 18 - OTHER INCOME

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| 1) Profit on Sale/disposal of Assets: | | |
| a) Owned assets | | |
| b) Assets acquired out of grants, or received free of cost | | |
| 2) Export Incentives realized | | |
| 3) Fees for Miscellaneous Services | | |
| 4) Miscellaneous Income | 1435080.38 | 1074686.00 |
| **TOTAL** | **1435080.38** | **1074686.00** |

## SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| a) Closing stock | | |
| Finished Goods | | |
| Work-in-progress | | |
| b) Less: Opening Stock | | |
| Finished Goods | | |
| Work-in-progress | | |
| **NET INCREASE/(DECREASE) [a-b]** | **Nil** | **Nil** |

## SCHEDULE 20 - ESTABLISHMENT EXPENSES

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| a) Salaries and Wages | 139479059.00 | 126933421.00 |
| b) Other Allowances and Bonus | 0.00 | 0.00 |
| c) Employer's Contribution to Provident Fund | 3144559.00 | 3152185.00 |
| d) Contribution to Retirement Benefits Fund | - | 16724007.00 |
| e) Staff Welfare Expenses (Medical) | 3936972.00 | 3669973.00 |
| f) Employer's Contribution to NPS | 9233663.00 | 12002345.00 |
| g) Others (LTC, Leave Encashment on LTC, Re-imbursement of Tuition Fees etc.) | 3891434.00 | 2922630.00 |
| **TOTAL** | **159685687.00** | **165404561.00** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Income & Expenditure for the Year Ended 31.03.2024

## SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| a) Extended Visitors Programme.(Including Seminars & Workshops) | 38555191.00 | 21635553.30 |
| b) Meeting Expenses | 1998604.00 | 1212737.00 |
| c) Library General Expenses | 281325.00 | 74011.00 |
| d) Electricity and Power | 34445571.00 | 34917178.00 |
| e) Laboratory Expenses | 10619564.00 | 12689570.00 |
| f) Insurance | 35813.00 | 36707.00 |
| g) Repairs and Maintenance | 62962165.66 | 66728055.00 |
| h) TPSC Programme | 200000.00 | 614000.00 |
| i) Parliamentary Committee Meeting Exps | 0.00 | 0.00 |
| j) Vehicles Hire Charges | 1762447.00 | 1705009.00 |
| k) Postage, Telephone and Communication Charges | 546762.00 | 985775.00 |
| l) Printing and Stationary | 1214290.00 | 1793414.00 |
| m) Travelling and Conveyance Expenses | 3288733.00 | 2443845.00 |
| n) Contingency to Faculty | 0.00 | 0.00 |
| o) Auditors' Remuneration | 59000.00 | 59000.00 |
| p) Bank Charges | 363989.61 | 211797.45 |
| q) Professional Charges (Legal Charges) | 101480.00 | 20793.00 |
| r) Staff Training & Welfare | 860046.00 | 514136.00 |
| s) Patent & Trademark | 106256.00 | 48,451.00 |
| t) Integrated Ph.D. | 2618125.00 | 2724857.00 |
| u) Hindi Programme | 113781.00 | 157206.00 |
| v) Advertisement and Publicity | 286883.00 | 246641.00 |
| w) Others | 2218878.85 | 2120552.52 |
| x) Municipal Tax | 141388.00 | 141388.00 |
| y) Contract Services | 19143440.00 | 18606757.00 |
| z) Stipend (Post BSc. & Post MSc.) | 41684195.00 | 37214332.00 |
| **TOTAL** | **223607928.12** | **206901765.27** |

# Satyendra Nath Bose National Centre for Basic Sciences

## Schedules Forming Part of Income & Expenditure for the Year Ended 31.03.2024

## SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| a) Grants given to Institutions/Organisations | | |
| b) Subsidies given to Institutions/Organisations | | |
| **TOTAL** | **Nil** | **Nil** |

## SCHEDULE 23 - INTEREST

(Amount in ₹)

| | Current Year | Previous Year |
|---|---|---|
| a) On Fixed Loans | | |
| b) On Other Loans (including Bank Charges) | | |
| c) others | | |
| **TOTAL** | **Nil** | **Nil** |

## 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. Interest on interest bearing loans/advances granted to the staff and Guest House Rent are accounted on cash basis. Interest on Fixed deposit on lien against LC/BG is accounted on Cash basis. W.e.f 13.06.2022, all Government Grant (core fund) are recognized and utilized on actual realization/payment basis.

**2. INVENTORY VALUATION**

2.1 Stores and Spares are valued at cost.

**3. INVESTMENTS**

3.1 Investments are valued at cost.

**4. FIXED ASSETS**

4.1 Fixed assets are stated at cost of acquisition inclusive of inward freight, duties and taxes and incidental and direct expenses related to acquisition, as well as customs duty & clearing charges on imported equipment are also capitalized.

4.2 Fixed Assets received by way of non-monetary grants (other than towards the Capital Fund), are capitalized at value stated / agreed by corresponding credit to Capital Fund. Incomplete work is shown as Capital-Work- in Progress to be capitalized on completion.

**5. Non-Current Assets**

5.1 Library Books shown under Fixed assets up to FY 2022-23, transferred to Non current

Assets in Financial year 2023-24,shown under schedule-11

5.2 No depreciation/ amortization is provided on Assets held for disposal. Short/Excess over written down value(W.D.V) on disposal of such assets is provided in the year of sale.

**6. DEPRECIATION**

6.1 Depreciation on capitalization has been charged on the value determined / estimated at the time of take over and as and when on further items were added subsequently to Assets

6.2 Depreciation is provided on straight-line method as per rates specified in the Companies Act, 2013.

6.3 In respect of additions to / deletion from fixed assets during the year, depreciation is considered on pro-rata basis. Depreciation is provided from the date of acquisition of the assets.

6.4 Depreciation arising on Fixed Assets is deducted from Fixed Assets and also from Capital Fund out of which Fixed Assets are created and not passed through the Income and Expenditure Account and directly debited to Capital Fund..

6.5 Depreciation on part of Office Building funded by TRC Fund is not provided but depreciation on part of the building funded by Centre Fund is provided

**7. FOREIGN CURRENCY TRANSACTIONS**

7.1 Transactions denominated in foreign currency are accounted at the exchange rate prevailing at the date of transaction.

**8. RETIREMENT BENEFITS**

8.1 Gratuity Liability as on 31.03.2024 = Rs. 6,92,66,637/- Provision already made = Rs. 6,11,48,812/-

8.2 Leave salary Liability as on 31.03.2024 = Rs.7,16,01,131/- Provision already made = Rs. 6,54,11,682/-

8.3 Investment under above accounts are invested separately in fixed deposit accounts with nationalized bank

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR-III, SALT LAKE, KOLKATA-700 106

# SCHEDULE 25 - CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

**1. CONTINGENT LIABILITIES**

1.1 Claims against the Centre not acknowledged as debts – Rs. Nil (Previous year Rs. Nil).

1.2 In respect of

Bank guarantees given by/on behalf of the Centre – Rs.1,05,00,000.00 against 100% margin money by way of fixed deposit (Previous year Rs.1,05,00,000.00). Interest earned on such deposit is accounted on cash basis.

Letters of Credit opened by Bank on behalf of the Centre and Project- Rs.5,87,86,857/- (Previous year Rs.1,81,06,372.00) against 100% margin money. Interest earned on such deposit is accounted on cash basis.

Bills discounted with banks – Rs. Nil (Previous year Rs. Nil).

1.3 Disputed demands in respect of:

Income-tax Rs. Nil (Previous year Rs. Nil)

GST Rs. Nil (Previous year Rs. Nil)

1.4 In respect of claims from parties for non-execution of orders, but contested by the Centre – Rs.Nil (Previous year Rs.Nil).

**NOTES ON ACCOUNTS**

2.1.1 Capital Commitments: Estimated value of contracts remaining to be executed on capital account and not provided for Rs. 36,00,000/- (Previous year Rs. Nil).

2.2.1 Physical verification of fixed assets was entrusted to an out side agency, who has submitted this report in the year 2023-24. Adjustments given in the accounts based on the Physical Verification Reports in this FY 2023-24.

2.2.2 Capital work-in-progress as on 1st April, 2023 was Rs.30,53,400.00 addition during the year is Rs.13,53,935/-,totaling to Rs.44,07,335,.00 an amount of Rs.0.00 has been capitalized, leaving balance of Rs.44,07,335.00 which has been carried forward.

2.2.3 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.

Unadjusted Travelling advances:-

| Name | Amount | Remarks |
|---|---|---|
| Amrtya Sarkar | Rs. 63000.00 / | Unadjusted since 2012-13 |

2.2.4 Taxation

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

2.2.5 Foreign Currency Transactions

i) Value of Imports Calculated on C.I.F basis :

| Name | Current Year | Previous Year |
|---|---|---|
| - Capital Goods | Rs. /- 57,53,385.80 | Rs. 2,21,25,361/- |
| - Consumables | Rs. /- 12,11,656/- | Rs. 53,11,119/- |

ii) Expenditure in foreign currency:

a) Travel: Nil

b) Remittances and Interest payment to Financial Institutions/Banks in Foreign Currency : Nil

c) Other expenditure: Nil

- Commission on Sales
- Legal and Professional Expenses
- Miscellaneous Expenses.
- Bank Charges

iii) Earnings:

Value of Exports on FOB basis: Nil

2.2.6 Corresponding figures for the previous year have been re-grouped/re-arranged, wherever necessary.

2.2.7 The Centre had incurred during 2022-23, Rs.286.33 lakh under following budget head out of its own source, which is yet to be disbursed by DST:

| Budget head | Amount |
|---|---|
| SALARY | Rs. 79.06 lakhs |
| GENERAL | Rs. 207.27 lakh |

Kolkata

Dated: 05.09.2024

# Para-Wise Replies to the Audit Observations

| SL | Audit Observation | Para-wise replies |
|---|---|---|
| 1 | Retirement Benefits: Gratuity Liability & Leave Salary Liability- Note no 8.1 & 8.2 of schedule- 24 | Gratuity Liability as on 31.03.2024 = Rs. 6,92,66,637/-<br>Provision already made = Rs.6,11,48,812/-<br>Leave salary Liability as on 31.03.2024 = Rs.7,16,01,131/-<br>Provision already made = Rs.6,54,11,682/- |
| 2 | Un Adjusted Traveling Advance-: note no 2.2.3 of schedule-25<br>Amartya Sarkar- Rs.63,000/- outstanding since 2012-13 | Shri Amartya Sarkar was a Phd Student. He was given a Travel Advance of Rs. 63000/-. He left the Centre without taking the clearance from the Centre. As a result his Travel Advance could not be adjusted. Shri Amartya Sarkar could not be communicated owing non-availability of his present address. |
| 3 | Liability for T.D.S. default as per 26AS statement – Rs.96,259/- | The observation is noted for future compliance and necessary rectification measures have been taken |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