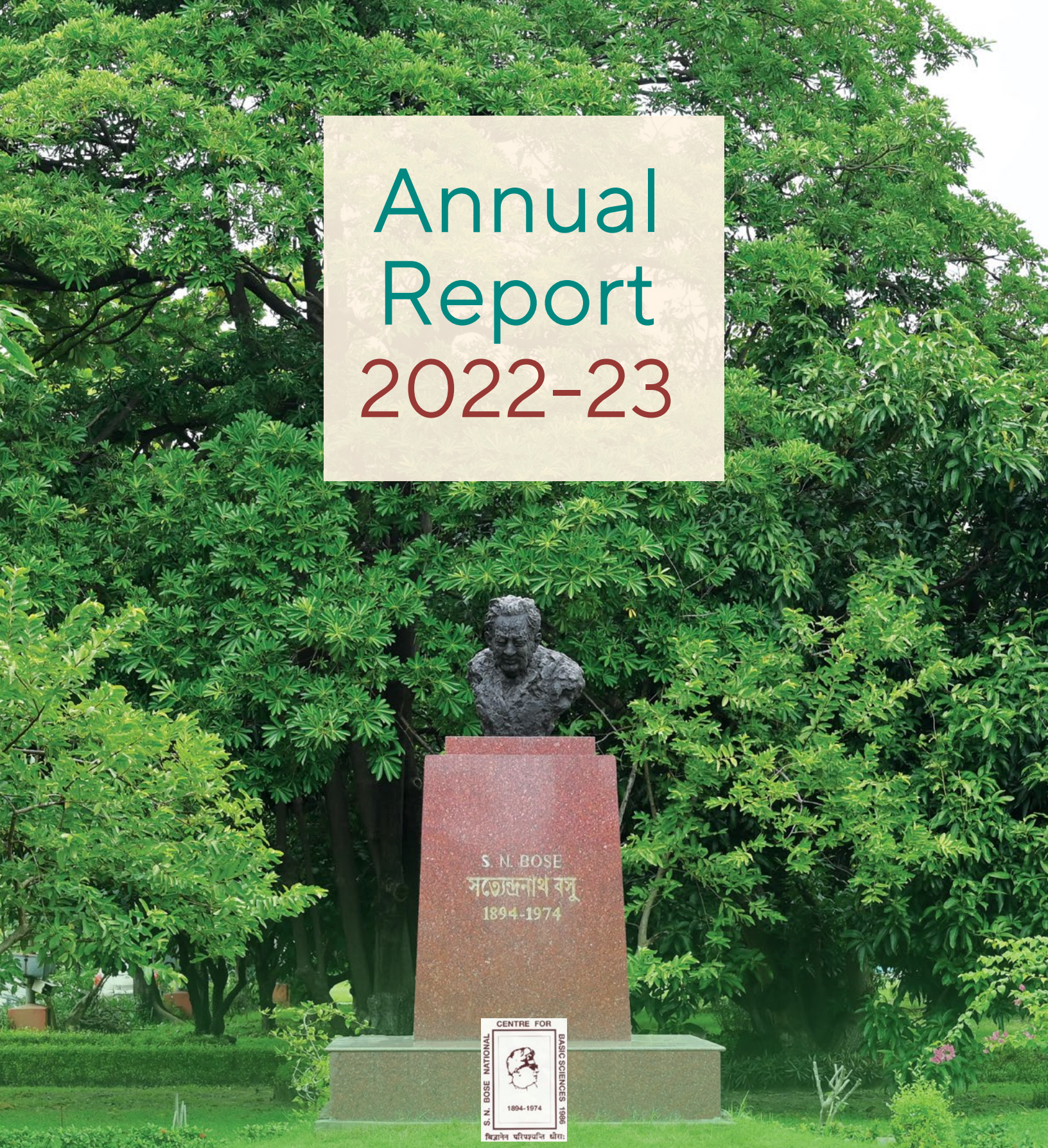
Annual Report 2022-23

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

Satyendra Nath Bose National Centre for Basic Sciences

Annual Report 2022-23



Satyendra Nath Bose National Centre for Basic Sciences

Annual Report 2022-2023

Satyendra Nath Bose National Centre for Basic Sciences

Publisher

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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 13th 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 7th time the Annual Report is translated and typed in Hindi within the Centre. The Office Assistant (Hindi), Ajay Kumar Shaw 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

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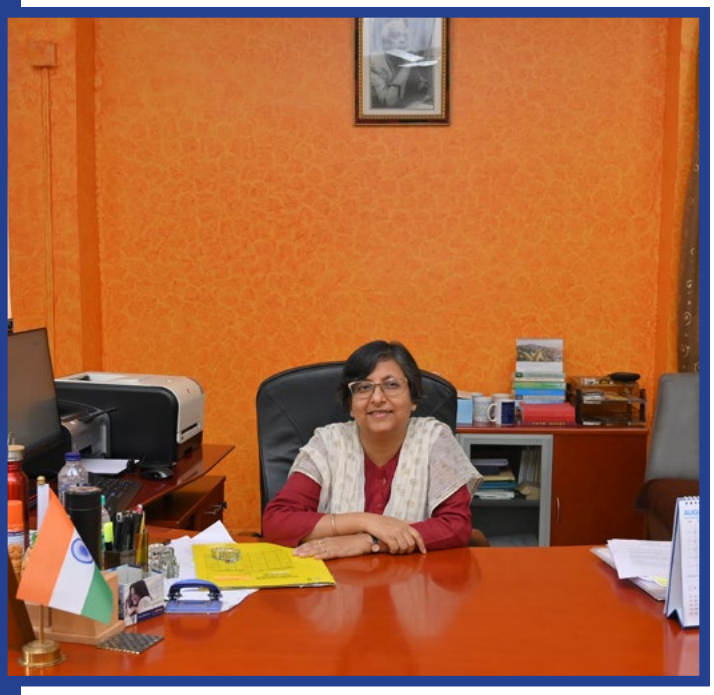


Message from the Director

It gives me immense pleasure to present the Annual report of the Satyendra Nath Bose National Centre for Basic Sciences for the year 2022-2023, the year that has seen the success of India's conquest of the Moon. While celebrating the great technological advancement of Chandrayan-3, I am happy to announce that the translational activity of the Centre has resumed with new activities catalyzed within the extension phase of TRC. I am hopeful that useful technologies will be developed within this ambit.

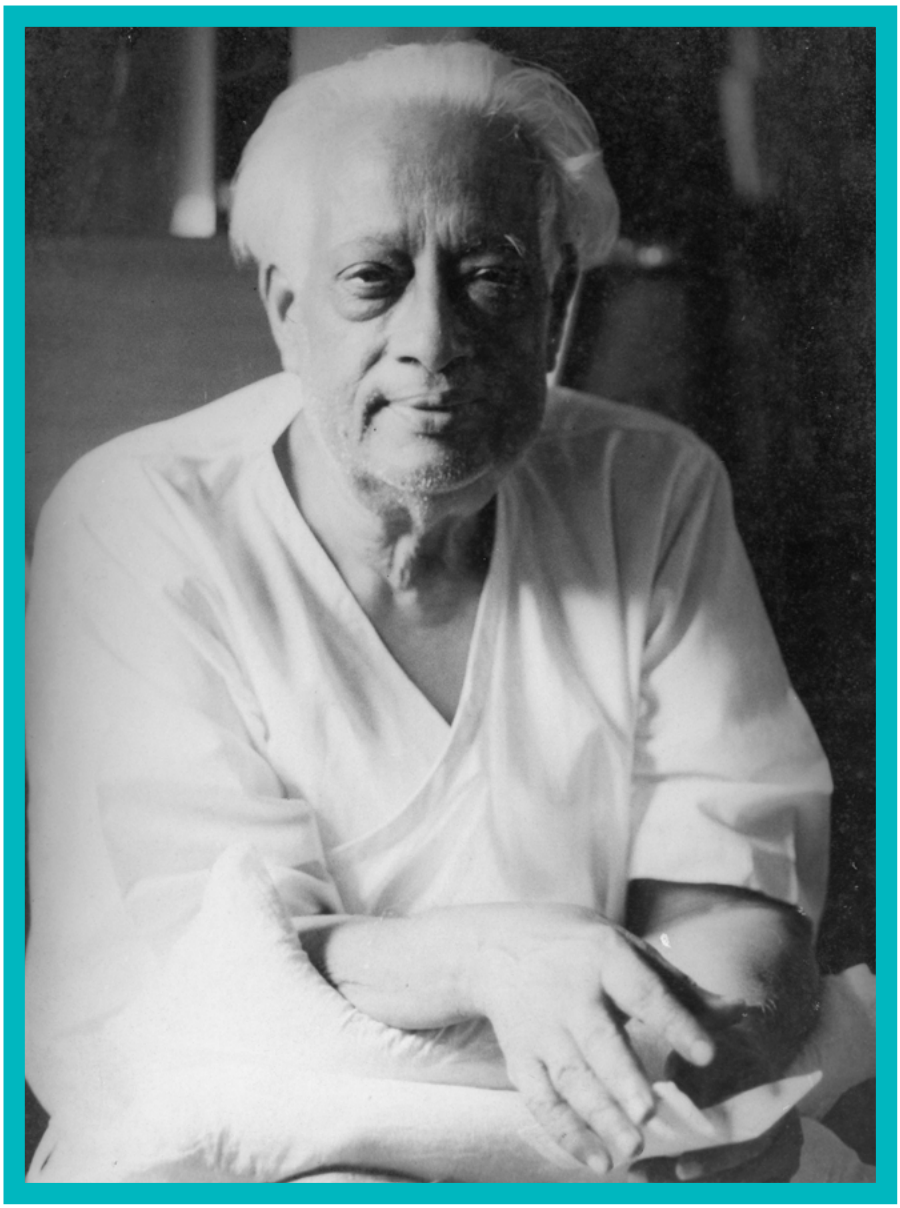
The Centre has celebrated and organized several important events. The open day was celebrated on 2nd January 2023, following the birthday of Prof. Satyendra Nath Bose with science enthusiasts from diverse spheres of life participating in the event. A virtual tour of the Bose archive has been created, which was inaugurated on 13th June 2023, the Centre's foundation day. To recognize the teaching excellence, from this year Excellence in Teaching recognition has been introduced to be given to Centre's teachers on foundation day. The students demonstrated the high quality of their academic and cultural performance during the Bose fest organized in March 2023. The 26th S. N. Bose Memorial Lecture was organized, which was given by Prof. Deepak Dhar, the first Indian theoretical physicist, to be awarded the coveted Boltzmann Medal (the highest recognition in statistical physics).

Cutting-edge research activities in areas of Quantum Field Theory, Gravitational Physics, Observational Astronomy and Astronomical instrumentation, Quantum Information and Foundations, Statistical Physics, Physical and Quantum Chemistry interfacing with Biological Molecules, Ionic Liquids and Energy Harvesting Materials, Quantum Condensed Matter Physics employing experimental, theoretical and computational tools continue. Several of the scientific stories have been highlighted in DST media cell, as well as covered in their news magazine. Centre's alumni have found placements in IIT and Universities making us proud. The Centre maintained a steady performance as third among the top DST institutes, as per Nature Index ranking. The research achievements of the faculties have been recognized nationally and internationally. A few noteworthy ones are, Professor Anjan Barman has been awarded the prestigious 'Royal Society Wolfson Visiting Fellowship' by The Royal Society, UK. Prof. Tanusri Saha-Dasgupta, has joined the Executive Editorial Board of J.Phys Materials, IOP Science, and Editorial Board of Physical Review B. Dr. Manik Pradhan, has been selected for the Chellaram Foundation Diabetes Research Award-2022 in the Basic Science Category for the development of novel diagnostic strategy for diabetes mellitus and application-driven basic research in biomedical science using laser spectroscopy. Centre maintains its high publication track record with 253 journal publications (~ 8 per faculty), and 10 other publications. 25 students have submitted PhD and 23 have been awarded PhD.

Centre has signed an MoU with CDAC for the establishment of 650 TF supercomputing hub in S.N.Bose Centre. Work is going on in full swing for its implementation. Once the machine is installed it will not only cater to the computational needs of the Centre, but will also cover the computational needs of the Institutes in and around Kolkata. Under the joint SNB-IFW collaborative programme, five students visited IFW, Dresden and worked on projects jointly supervised by faculties from SNB and IFW. The next joint meeting of SNB and IFW is planned to take place in November 2023 at S.N.Bose Centre. The second joint meeting of SNB and IITB for collaborative exchange research took place in January 2023, which has created a vibrant exchange programme.

I congratulate all my colleagues, staff and students of the Centre for the achievements. I also put on record my gratitude to the members of the Governing body and academic advisory committee for their continuing support. The new academic advisory committee has taken over and a 2-day meeting of the committee was organized with exciting and fruitful scientific discussion among members and SNB faculties. I am sure the Centre will attain new heights in the coming days under their able guidance.

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



S N Bose
Photo credit: Sambhu Shaha

Dean (Faculty)

In the year 2022-23, the Centre was involved in several academic activities related to scientific collaborations, hosting national and international conferences, workshops, schools, organizing outreach programmes, refurbishing of the Bose Archives, etc. 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 was 253.

Throughout the year, the centre organized numerous seminars and 05 (five) nos. distinguished lectures on Illustrious Indian Scientists in Pre-independence Era delivered by reputed Scientists and 16th C.K. Majumdar Memorial lecture by Prof. Anthony K Cheetham. 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. In the current year **05** new extramural projects were sanctioned in addition to **35** ongoing projects.

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

1. **Prof. Anjan Barman, Senior Professor --**
   - Featured in top 2% most cited scientists' list released by Stanford University in 2022.

2. **Dr. Avijit Chowdhury, Assistant Professor --**
   - Outstanding Reviewer award (2022), Materials Research Express, IOP Science
   - Outstanding Reviewer award (2022), Printable and Flexible Electronics, IOP Science

3. **Dr. Barnali Ghosh (Saha), Scientist 'F'--**
   - "Outstanding Women Researcher" in Condensed Matter Physics and Materials VIWA 2023, by Venus International foundation, India, Centre For Women Development, on 4th March 2023.
   - "Outstanding Scientist Award" in the International Conference for Award Winners in Engineering, Science, and Medicine INSO 2023, Pondicherry, India.
   - Received 2022 ACS Publication Peer Reviewer Certificate of Recognition & Appreciation.

4. **Prof. Kalyan Mandal, Senior Professor –**
   - Two months (May-June 2022) fellowship for renewed research stay in Germany from Humboldt Foundation.

5. **Dr. Manoranjan Kumar, Professor --**
   - Best reviewer award for Pramana.

6. **Dr. Nitesh Kumar, Assistant Professor --**
   - Selected as a leader to lead a Max Planck-India Partner Group for 5 years with a total funding of 100000 euros

7. **Dr. Pradip S Pachfule, Assistant Professor --**
   - Listed in Stanford University's global list of the world's top 2% of scientists in chemistry and materials science (2022)

8. **Dr. Sakuntala Chatterjee, Associate Professor --**
   - Invited by European Physical Society to act as co-editor for the journal Europhysics Letters
   - Invited to join European Physical Society as a member.

9. **Prof. Samir Kr Pal, Senior Professor --**
   - Abdul Kalam Technology Innovation National Fellowship 2018 (Indian National Academy of Engineering: INAE) Extension for another two years
   - Chairman of Expert Committee of Global Innovation & Technology Alliance (GITA)

10. **Prof. Soumen Mondal, Professor --**
    - Selected as one of the External Committee Member of the Academic Committee of Presidency University.
11. **Dr. Suman Chakrabarty, Associate Professor --**
    - Editorial Board member of Dialogue: Science, Scientists, and Society published by the Indian Academy of Sciences, Bengaluru
    - Review Editor on the Editorial Board of Biophysics (specialty section of Frontiers in Physics, Frontiers in Physiology and Frontiers in Molecular Biosciences)
12. **Prof. Tanusri Saha Dasgupta, Senior Professor --**
    - Joined the Editorial Board of Physical Review B, featured in the Vigyan Vidushi book
13. **Prof. Gautam De, Emeritus Professor (Till 14.01.2023) --**
    - Received "Ganpule Award – 2022" from Indian Ceramic Society.
    - External Member of CRNN (Calcutta University) PhD committee (continued).

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

- Dr. Manik Banik, Associate Professor, DPCS – 13.06.2022
- Dr. Arijit Haldar, Assistant Professor, DPCS – 05.09.2022
- Dr. Saquib Shamim, Assistant Professor, CMMP – 06.10.2022
- Dr. Suman Chowdhury, DST Inspire Fellow, CMMP – 10.10.2022
- Dr. Sujoy Ghosh, DST Inspire Fellow, CMMP – 09.03.2023

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

- Dr. M. Sanjay Kumar, Visiting (Hon.) Fellow, PCS – 01.08.2022 (Termination of contract)
- Dr. Debanjan Bose, Ramanujan Fellow, AHEP – 14.11.2022 (Termination of contract)
- Prof. P. K. Mukhopadhyay, Visiting (Hon.) Fellow, CMMP – 31.12.2022 (Termination of contract)
- Prof. Ranjan Choudhury, Visiting (Hon.) Fellow, CMMP – 31.12.2022 (Termination of contract)
- Prof. S. S. Manna, Visiting (Hon.) Fellow, PCS – 31.01.2023 (Termination of contract)

Total numbers of Regular / Inspire / Ramanujan / Visiting / Emeritus Faculty etc as on date –

- Regular Faculty - 32
- Inspire Faculty – 3
- Ramanujan Fellow – 1
- Raja Ramanna Fellow – 1
- Ramalingaswami Re-entry Fellow - 1
- Emeritus Professor – 1
- Visiting Professor – 1
- Adjunct Faculty / Fellow – 5

Total no of PDRA / RA / Project Scientists etc. as on date –

- PDRA (SNB Funded) – 30
- RA / NPDF / SRA etc. – 10
- Bridge Fellow (SNB Funded) - 10

Anjan Barman
Dean (Faculty)

Dean, Academic Programme

An important part of the mandate of our Centre is to train young scientists for research in the basic sciences. Numerous distinguished alumni bear witness to a vibrant research atmosphere created by, and for, the student researchers at the Centre. During the two previous academic years, 2020-21 and 2021-22, research and teaching institutions were badly affected by the COVID-19 outbreak all over the world and we were no exception. However, by taking proper precautions and following strict protocols, the Centre was able to resume functioning in the year 2021-22 and could take watchful steps back to normality during the year 2022-23.

Starting 2022, examinations were held in the physical mode, maintaining protocols of distance and mask as necessary. Classes were held in the physical mode as well, following necessary protocols. Some classes were held in the hybrid mode. I am happy to say that we have successfully passed the Covid-19 ordeal and are now getting back to normalcy in our academic activities.

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 2022-23, a total of **28** scholars joined the PhD programme of the Centre. Of these, **5** joined Astrophysics and Cosmology, **10** joined Chemical, Biological and Macromolecular Sciences, **10** joined Condensed Matter Physics and Material Science, and **3** joined Theoretical Sciences. Of the total, **3** came from the Centre's own Integrated PhD programme. Furthermore, **1** student joined the SNBNCBS-IISER (K) joint PhD programme. Apart from these, **11** 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 few students from the Centre will soon visit the IFW for 3-6 months working on joint projects agreed upon under the MoU. A few students have already 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 **23** students was awarded their PhD degrees during this academic year and another **25** submitted their PhD theses. Several conferences were organized by the Centre, as well as 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 2022-2023

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

1st Semester *(New Subject Code w.e.f. Academic Year: 2022-2023)*:

- PHY 401, Mathematical Methods, Sunandan Gangopadhyay;
- PHY 403, Classical Dynamics, Tapas Baug;
- PHY 405, Quantum Mechanics I, Amitabha Lahiri;
- PHY 407, Computational Methods in Physics, Subhrangshu S Manna;
- PHY 491, Basic Laboratory I, Samir Kumar Pal & Soumen Mondal.

2nd Semester *(New Subject Code w.e.f. Academic Year: 2022-2023)*:

- PHY 402, Electromagnetic Theory, Thirupathaiah Setti;
- PHY 404, Statistical Mechanics, Sakuntala Chatterjee;
- 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 *(Old Syllabus)*:

- PHY 301, Atomic & Molecular Physics, Anjan Barman & Rajib Kumar Mitra;
- PHY 302, Condensed Matter Physics, Nitesh Kumar & Prabhat Mondal;
- PHY 303, Advanced Quantum Mechanics & Applications, Manoranjan Kumar & Arijit Haldar;
- PHY 304, Project Research II, Faculty Supervisors;
- PHY 305, Nuclear & Particle Physics, Ramkrishna Das & Subhendra Mohanti, PRL.

4th Semester *(Old Syllabus)*:

- PHY 401, Project Research III, Faculty Supervisors;
- PHY 403, Astrophysics & Astronomy, Ramkrishna Das & Soumen Mondal;
- PHY 405, Biological Physics, Manoj Mandal;
- PHY 407, Advanced Quantum Field Theory, Sunandan Gangopadhyay & Rabin Banerjee;
- PHY 413, Quantum Information Theory, Manik Banik;
- PHY 416, Soft Matter, Jaydeb Chakrabarti;
- PHY 491, Methods of Experimental Physics, Nitesh Kumar, Pradip S Pachfule, Ramkrishna Das & Kalyan Mandal (Coordinator)

Ph.D. Course Work Programme

(New Subject Code w.e.f. Academic Year: 2022-2023)

- PHY 601, Research Methodology, Rabin Banerjee & Pratip Kumar Mukhopadhyay;
- PHY 602, Review of the Topical Research, Faculty Supervisors;
- PHY/CB 691, Project Research, Faculty Supervisors;
- ♦♦ PHY 603, Condensed Matter Physics, Nitesh Kumar & Prabhat Mandal;
- ♦♦ PHY 604, Astrophysics, Soumen Mondal & Ramkrishna Das;
- PHY 616, Observational Techniques in Astronomy, Ramkrishna Das # Tspas Baug;
- ♦♦ PHY 624, Quantum Information Theory, Manik Banik;
- PHY 628, Mesoscopic Physics , Atindra Nath Pal & Saquib Shamim;
- CB 624, Physical Chemistry: Theory & Experiment; Ranjit Biswas
- ♦♦ CB 626, Fundamentals of Biophysics, Manoj Mandal;
- ♦♦ CB 627, Molecular Physics & Spectroscopy, Rajib Kumar Mitra & Anjan Barman;
- CB 628, Stochastic Processes in Physics & Chemistry, Gautam Gangopadhyay;
- CB 631, Advanced Numerical Methods & Simulation, Suman Chakrabarty;
- ♦♦ CB 641, Surfaces & Interfaces, Jaydeb Chakrabarti;

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

Ph.D. THESIS SUBMITTED

1. ***Synthesis, Characterization, Physical Property Studies & Applications Of Perovskite Halide***, Avisek Maity, Supervisor: Barnali Ghosh (Saha), in the University of Calcutta, in May, 2022

2. ***Various Aspects Of Positive Maps In Quantum Information Theory,*** Bihalan Bhattacharya, Supervisor: Archan S Majumdar, in the University of Calcutta, in May, 2022
3. ***A Multiwavelength Study Of Galactic Star-forming Regions***, Alik Panja, Supervisor: Soumen Mondal, in the University of Calcutta, in May, 2022
4. ***Studies of Some Biophysical Processes Using Ultrafast Spectroscopic Techniques***, Partha Pyne, Supervisor: Rajib Kumar Mitra, in the University of Calcutta, in May 2022
5. ***Understanding Physical Properties Of M-dwarfs: Optical And Near-IR Spectroscopic Studies***, Dhrimadri Khata, Supervisor: Soumen Mondal & Ramkrishna Das, in the University of Calcutta, in May, 2022
6. ***Understanding the Atmosphere of Brown Dwarfs and Low Mass Stars***, Samrat Ghosh, Supervisor: Soumen Mondal, in the University of Calcutta, in May, 2022
7. ***Generalised Entropy In Dynamical System And Information Theory***, Souma Mazumdar, Supervisor: Partha Guha, in the University of Calcutta, in June, 2022
8. ***Spectroscopic Studies On Functional Nanohybrids and Their Potential Biological Applications***, Arpan Bera, Supervisor: Samir Kumar Pal, in the University of Calcutta, in June, 2022
9. ***Theoretical Investigations of Superconducting Pairing Mechanisms in Correlated Fermionic Systems***, Koushik Mandal, Supervisor: Ranjan Chaudhury & Manoranjan Kumar, in the University of Calcutta, in June, 2022
10. ***Studies of hydrodynamics and uctuations in mass transport processes***, Dhiraj Tapader, Supervisor: Punyabrata Pradhan, in the University of Calcutta, in June, 2022
11. ***Growth, Characterization, Optoelectronic And Thermal Properties Of Novel Germanium Nanostructures***, Vishal Kumar Aggarwal, Supervisor: Manik Pradhan & Arup K Raychaudhuri, in the University of Calcutta, in July, 2022
12. ***12. Study of Novae Properties***, Ruchi Pandey, Supervisor: Ramkrishna Das, in the University of Calcutta, in July, 2022
13. ***Properties of materials at interfaces***, Edwine Tendong, Supervisor: Tanusri Saha Dasgupta & Jaydeb Chakrabarti, in the University of Calcutta, in July, 2022
14. ***Opto-electronic, Electrical and Spectroscopic Studies of Some Two-Dimensional Material***, Didhiti Bhattacharya, Supervisors: Samit Kumar Ray & Rajib Kumar Mitra, in the University of Calcutta, in July, 2022
15. ***Ultrafast Spin Dynamics in Magnetic Thin Films and Heterostructures***, Surya Narayan Panda, Supervisor: Anjan Barman, in the University of Calcutta, in August, 2022
16. ***Aspects of Quantum Correlations in Information Processing***, Shounak Datta, Supervisor: Archan S Majumdar, in the University of Calcutta, in September, 2022
17. ***Applications of the functional renormalization group in cosmology and black hole thermodynamics***, Rituparna Mandal, Supervisor: Sunandan Gangopadhyay, in the University of Calcutta, in November, 2022
18. ***Synthesis, Characterization, Transport and Electronic Structure Studies of Transition Metal Dichalcogenides***, Indrani Kar, Supervisor: Thirupathaiah Setti, in the University of Calcutta, in December, 2022
19. ***19. Relativistic quantum systems in the framework of quantum information and quantum foundations***, Riddhi Chatterjee, Supervisor: Archan S Majumdar, in the University of Calcutta, in December, 2022
20. ***Large 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, 2023
21. ***Investigation On Nanostructured Piezoelectric Materials For Energy Harvesting***, Snehamoyee Hazra, Supervisor: Barnali Ghosh (Saha), in the University of Calcutta, in January, 2023
22. ***Growth, Structure And Physical Properties Of Strained NdNiO3 Films***, Parushottam Majhi, Supervisor: Barnali Ghosh (Saha) & Arup K Raychaudhuri, in the University of Calcutta, in February, 2023

23. ***Some Applications of Quantum Field Theoretic Dualities to Superconducting Systems***, Shantonu Mukherjee, Supervisor: Amitabha Lahiri, in the University of Calcutta, in February, 2023

24. ***Microscopic insights to relaxation phenomena in proteins***, Abhik Ghosh Moulick, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in March, 2023

25. ***25. Manipulation Of Soft Matter System In Nonequilibrium Conditions***, Rahul Karmakar, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in March, 2023

Ph.D. AWARD RECEIVED

1. ***Synthesis, Physical Properties And Applications of Metal Oxide Semiconductor Nanostructures And Thin Films***, Chandan Samanta, Supervisor: Barnali Ghosh (Saha), in the University of Calcutta, in April, 2022

2. ***Studies On Therapeutic Potential Of Various Nanomaterials And Ethnobotanical Ingredients In Preclinical Disease Model***, Aniruddha Adhikari, Supervisor: Samir Kumar Pal, in the University of Calcutta, in May, 2022

3. ***Investigation Of Temperature And Frequency Dependent Electrical Transport Phenomena At The Interface Of Bilayered Ferromagnetic – Ferroelectric Thin Films And Related Issues***, Subhamita Sengupta, Supervisor: Arup K Raychaudhuri, in the University of Calcutta, in June, 2022

4. ***On some theories on quantum space-time and matter and their plausible implications***, Sayan Kumar Pal, Supervisor: Biswajit Chakraborty, in the University of Calcutta, in June, 2022

5. ***Study Of Various Quantum Information Theoretic Resources And Their Applications***, Ananda Gopal Maity, Supervisors: Archan S Majumdar & Manik Banik, in the University of Calcutta, in June, 2022

6. ***Microfluidic-Assisted Optical Spectroscopic Studies on Biomolecular Recognition in Physiologically Relevant Engineered Environments***, Dipanjan Mukherjee, Supervisor: Samir Kumar Pal, in the University of Calcutta, in June, 2022

7. ***Spectral and Timing Properties of Class Variable Source GRS 1915+105 Using Two-Component Advective Flow Solution***, Anuvab Banerjee, Supervisor: Sandip K Chakrabarti, in the University of Calcutta, in July, 2022

8. ***Some aspects of quantum mechanics and quantum field theory on quantum space-time***, Partha Nandi, Supervisor: Biswajit Chakraborty, in the University of Calcutta, in July, 2022

9. ***Studies On Ultrafast Dynamics And Spectroscopic Investigations On Fluorescent Probes In Bimolecular And Biomimetic Recognition***, Sk Imadul Islam, Supervisor: Rajib Kumar Mitra, in the University of Calcutta, in July, 2022

10. ***Ultrafast Spin Dynamics in Ferromagnetic Patterned Nanostructures and Multilayers***, Anulekha De, Supervisors: Anjan Barman & Rajib Kumar Mitra, in the University of Calcutta, in August, 2022

11. ***Thermodynamics of Low-Dimensional Interacting Quantum Systems: A Hybrid Exact Diagonalization and Density Matrix Renormalization Group Study***, Sudip Kumar Saha, Supervisor: Manoranjan Kumar, in the University of Calcutta, in September, 2022

12. ***Synthesis And Characterization Of Nanoscale Alloys And Metal Oxides For Potential Application In Catalysis***, Arnab Samanta, Supervisors: Samir Kumar Pal & Subhra Jana, in the University of Calcutta, in October, 2022

13. ***Investigation Of Optical Beam Shifts For Two-Dimensional (2D) Materials***, Akash Das, Supervisor: Manik Pradhan, in the University of Calcutta, in October, 2022

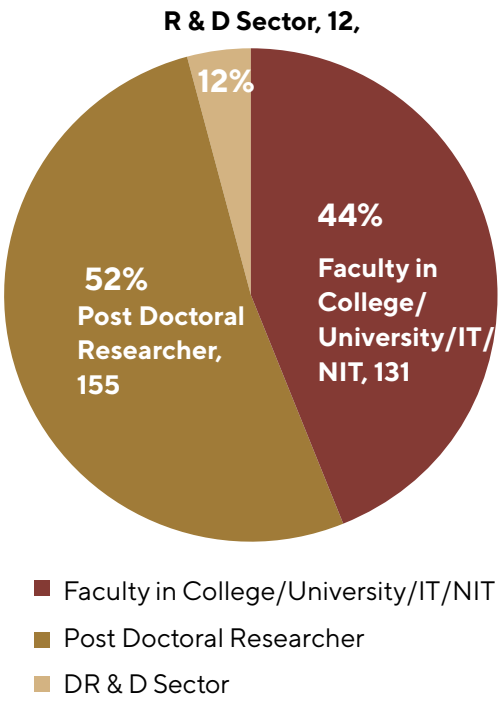
14. ***Aspects of Holographic Entanglement Entropy and Complexity***, Sourav Karar, Supervisors: Sunandan Gangopadhyay & Archan S Majumdar, in University of Calcutta, in October, 2022

15. ***Spectral And Temporal Properties Of Super-Massive Black Holes In Light Of Two Component Advective Flows***, Prantik Nandi, Supervisor: Sandip K Chakrabarti, in the University of Calcutta, in November, 2022

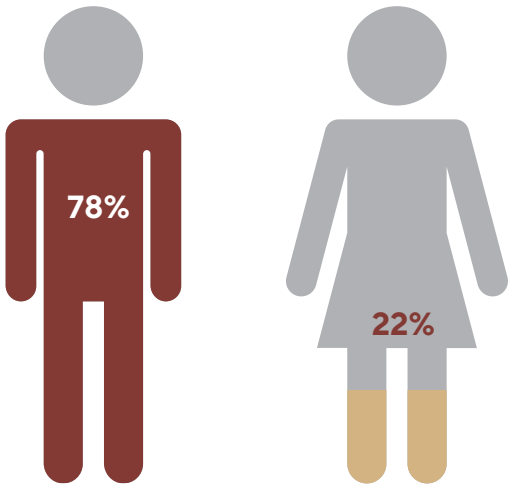
16. ***First Principles Study On Novel and Functional Materials***, Shreya Das, Supervisor: Tanusri Saha Dasgupta, in the University of Calcutta, in November, 2022

17. ***Microscopic studies on biomolecular complexes***, Sasthi Charan Mandal, Supervisor: Jaydeb Chakrabarti, in the University of Calcutta, in November, 2022
18. ***Multiwavelength Studies of Planetary Nebulae***, Rahul Bandyopadhyay, Supervisor: Ramkrishna Das, in the University of Calcutta, in November, 2022
19. ***Spin Dynamics in Ferromagnetic Nanostructures***, Kartik Adhikari, Supervisor: Anjan Barman, in Jadavpur University, in 2022
20. ***Spin Dynamics in 2D and 3D Confined Magnetic Structure and Thin Film Heterostructures***, Sourav Sahoo, Supervisor: Anjan Barman, in the University of Calcutta, in January, 2023
21. ***Improvement in Rheological Response of Transition Metal Oxide Based Magnetic Fluids***, Priyanka Saha, Supervisor: Kalyan Mandal, in the University of Calcutta, in January, 2023
22. ***Solar Energy Harvesting In A Photoelectrochemical Cell: Development Of Photoanodes Based On Earth Abundant Materials***, Dipanjan Maity, Supervisor: Kalyan Mandal, in University of Calcutta, in February, 2023
23. ***Some Studies On The Effects Of Crowding Agents On The Structure, Functionality And Activity Of Biomolecules***, Saikat Pal, Supervisor: Rajib Kumar Mitra, in the University of Calcutta, in February, 2023

STATUS OF CURRENT AFFILIATION OF PHD AWARDEES



MALE FEMALE RATIO OF PHD AWARDEES



RESEARCH SCHOLARS - Ph.D. PROGRAMME (by Year of Joining)

	VISITING RESEARCHER	SUPERVISOR	
2016-2017:			
1	Sk Imadul Islam (UGC)	Rajib Kumar Mitra	till 31/07/2022
2	Sasthi Charan Mandal (CSIR)	Jaydeb Chakrabarti	till 22/12/2022
3	Partha Nandi	Biswajit Chakraborty	till 25/07/2022
4	Sayan Kumar Pal (UGC)	Biswajit Chakraborty	till 25/07/2022
5	Akash Das (UGC)	Manik Pradhan	till 31/12/2022
6	Saikat Pal (CSIR)	Rajib Kumar Mitra	till 31/12/2022
7	Priyanka Saha (INSPIRE)	Kalyan Mandal	till 12/12/2022
8	Dipanjan Maity (CSIR)	Kalyan Mandal	till 14/12/2022
9	Subhamita Sengupta (UGC)	Barnali Ghosh(Saha) (O)	till 30/06/2022
10	Sumanti Patra	Priya Mahadevan	till 31/07/2022

	SENIOR RESEARCH FELLOW	SUPERVISOR	
2016-2017:			
11	Koushik Mandal (UGC)	Manoranjan Kumar (O)	till 31/05/2022
12	Bihalan Bhattacharya (INSPIRE)	Archan S Majumdar	till 08/06/2022
2017-2018:			
13	Edwine Tendong (TWAS-BOSE)	Tanusri Saha Dasgupta	till 02/08/2022
14	Souma Mazumdar	Gautam Gangopadhyay (O)	till 31/07/2022
15	Anirban Mukherjee (INSPIRE)	Punyabrata Pradhan	
16	Shubhadip Moulik (CSIR)	Atindra Nath Pal	
17	Vishal Kumar Aggarwal	Arup Kumar Raychaudhuri & Manik Pradhan	till 31/07/2022
18	Arundhati Adhikari	Anjan Barman	
19	Partha Pyne	Rajib Kumar Mitra	till 31/07/2022
20	Parushottam Maji	Arup Kumar Raychaudhuri & Barnali Ghosh (Saha)	till 14/02/2023
21	Didhiti Bhattacharya	Samit Kumar Ray & Rajib Kumar Mitra	till 31/07/2022
22	Koustav Dutta (INSPIRE)	Anjan Barman	till 31/01/2023
23	Amrit Kumar Mondal	Anjan Barman	
24	Sk Saniur Rahaman (UGC)	Manoranjan Kumar	
25	Rituparna Mandal (INSPIRE)	Sunandan Gangopadhyay	till 25/07/2022
26	Abhik Ghosh Moulik (INSPIRE)	Jaydeb Chakrabarti	
27	Arpan Bera (CSIR)	Samir Kumar Pal	till 31/03/2023
28	Biswajit Pabi (INSPIRE)	Atindra Nath pal	
29	Dhrubajyoti Majhi (INSPIRE)	Ranjit Biswas	
30	Indrani Kar	Thirupathaiah Setti	till 13/03/2023
31	Jayanta Mondal (INSPIRE)	Ranjit Biswas	
32	Rafiqul Alam (INSPIRE)	Atindra Nath Pal	
33	Rahul Karmakar (INSPIRE)	Jaydeb Chakrabarti	
34	Shubhrasish Mukherjee (INSPIRE)	Samit Kumar Ray & Atindra Nath Pal	till 13/03/2023

	SENIOR RESEARCH FELLOW	SUPERVISOR	
35	Siddhartha Biswas (INSPIRE)	Soumen Mondal	
36	Sudipta Chatterjee	Barnali Ghosh (Saha)	
2018-2019:			
37	Sumana Pyne	Rajib Kumar Mitra	
38	Dipanjan Mukherjee	Samir Kumar Pal	till 15/05/2022
39	Biswajit Panda	Manik Pradhan	
40	Narayan Chandra Maity (CSIR)	Ranjit Biswas	
41	Shobhan Dev Mandal (CSIR)	Sakuntala Chetterjee	
42	Premashis Kumar	Gautam Gangopadhyay	
43	Anish Das	Biswajit Chakraborty	
44	Md Nur Hasan (CSIR)	Samir Kumar Pal	
45	Tanmoy Chakraborty (CSIR)	Punyabrata Pradhan	
46	Susmita Mondal	Samir Kumar Pal	
47	Deepsikha Das	Punyabrata Pradhan & Sakuntala Chetterjee	
48	Prasun Boyal (CSIR)	Priya Mahadevan	
49	Debayan Mondal (CSIR)	Priya Mahadevan	
50	Jyotirmoy Sau (UGC)	Manoranjan Kumar	
51	Monalisa Chatterjee (INSPIRE)	Manoranjan Kumar	
52	Susmita Changdar (UGC)	Thirupathaiah Setti	
53	Pratap Kumar Pal (CSIR)	Anjan Barman	
54	Shivam Mishra (INSPIRE)	Priya Mahadevan	till 06/01/2023
2019-2020:			
55	Krishnendu Patra	Priya Mahadevan	
56	Ria Saha	Rajib Kumar Mitra	
57	Krishnendu Sinha	Suman Chakraborty	
58	Amrita Mondal	Ranjit Biswas	
59	Subhajit Singha	Rajib Kumar Mitra	
60	Soma Dutta	Anjan Barman	
61	Kanchan Meena (CSIR)	Prosenjit Singha Deo	
62	Sreya Pal (CSIR)	Anjan Barman	
63	Manodip Routh	Manoranjan Kumar	
64	Abhinandan Das	Suman Chakrabarty	
65	Subhajit Kar	Ramkrishna Das	
66	Anirban Paul (CSIR)	Jaydeb Chakrabarti	
67	Ardhendu Pal	Manik Pradhan	
68	Gesesew Reta Habtie (TWAS-BOSE)	Ramkrishna Das	
2020-2021:			
69	Rajib Kumbhakar (INSPIRE)	Soumen Mondal	
70	Shashank Shekhar Pandey (CSIR)	Archan S. Majumdar	
71	Sudipta Mitra	Ranjit Biswas	
72	Aishwaryo Ghosh (INSPIRE)	Tanusri Saha Dasgupta	

	SENIOR RESEARCH FELLOW	SUPERVISOR	
73	Manoj Gupta (CSIR)	Tanusri Saha Dasgupta	
74	Shinjini Paul (INSPIRE)	Priya Mahadevan	
75	Koushik Pradhan	Tanusri Saha Dasgupta	
76	Indrajit Ghose	Amitabha Lahiri	
77	Riya Barick	Amitabha Lahiri	
78	Rik Niranjan Mukherjee (INSPIRE)	Ranjit Biswas & Pradip K Ghorai (IISER-K)	
79	Suchetana Mukhopadhyay (INSPIRE)	Anjan Barman & Chiranjit Mitra (IISER-K)	
80	Ankit Mandal (INSPIRE)	Prasanta Panigrahi (IISER-K) & Sunandan Gangopadhyay	
81	Ariful Hoque (CSIR)	Tapas Baug	
82	Sanuja Kumar Khuntia (UGC)	Priya Mahadevan	
83	Chandradip Khamrai (CSIR)	Sakuntala Chatterjee	
84	Ritwick Sarkar (CSIR)	Urna Basu	
85	Ramesh Pramanik (CSIR)	Sakuntala Chatterjee	

	JUNIOR RESEARCH FELLOW	SUPERVISOR	
2021-2022:			
86	Avijit Mandal	Ramkrishna Das	
87	Bivas Mallick (INSPIRE)	Archan S. Majumdar	
88	Saheli Mukherjee	Archan S. Majumdar	
89	Nishant Garg	Tapas Baug	
90	Soumyadipta Chakraborty	Manik Pradhan	
91	Chandan Kumar	Anjan Barman	
92	Arunanshu Panda	Nitesh Kumar	till 13/03/2023
93	Raj Gupta (CSIR)	Kalyan Mandal	till 30/06/2022
94	Saikat Mitra	Avijit Chowdhury and Barnali Ghosh (Saha)	
95	Sayan Ghosh (INSPIRE)	Manoranjan Kumar	
96	Shivam Jani	Priya Mahadevan	
97	Soumik Das	Avijit Chowdhury	till 02/08/2022
98	Soumya Ghorai (UGC)	Thirupathaiah Setti	
99	Sourabh Saha (INSPIRE)	Manoranjan Kumar	
100	Sourav Sarkar (INSPIRE)	Kalyan Mandal	
101	Rupayan Saha	Punyabrata Pradhan	
102	Saheli Samanta	Kalyan Mandal	till 26/12/2022
103	Snehamoyee Hazra	Barnali Ghosh (Saha)	till 11/01/2023
104	Bikash Chandra Mishra (CSIR)	Pradip S. Pachfule	
2022-2023:			
105	Aman Das (UGC)	Tapas Baug	
106	Aritra Marick (UGC)	Rajib Kumar Mitra	
107	Shah Imtajul Haque (UGC)	Rajib Kumar Mitra	
108	Dayal Das (UGC)	Atindra Nath Pal	

	JUNIOR RESEARCH FELLOW	SUPERVISOR	
109	Mukul Biswas (UGC)	Avijit Chowdhury	
110	Subhajit Mondal (UGC)	Saquib Shamim	
111	Sk Sahil	Ramkrishna Das	
112	Sudip Pramanik	Soumen Mondal	
113	Abhirup Nayak	Rajib Kumar Mitra	till 16/12/2022
114	Anusree Sen	Rajib Kumar Mitra and Jaydeb Chakrabarti	
115	Bidhan Kumbhakar (UGC)	Pradip S. Pachfule	
116	Indrayani Patra (UGC)	Manik Pradhan	
117	Pallabi Roy	Sakuntala Chatterjee and Gautam Gangopadhyay	
118	Sabuj Mandal	Jaydeb Chakrabarti	
119	Soustav Bose	Ranjit Biswas	till 07/11/2022
120	Sreyan Bhowmick	Suman Chakrabarty	
121	Sutanu Mukhopadhyay	Suman Chakrabarty	
122	Anutosh Biswas	Manoranjan Kumar and Tanusri Saha Dasgupta	
123	Anyesh Saraswati	Nitesh Kumar	
124	Bikram Baghira (UGC)	Anjan Barman	
125	Madhurita Das	Priya Mahadevan	
126	Monmoy Molla	Tanusri Saha Dasgupta	till 26/08/2022
127	Rajesh Jana	Avijit Chowdhury	
128	Subhankar De	Atindra Nath Pal	
129	Swapnamoy Pramanik (UGC)	Avijit Chowdhury	
130	Govind Lal Sidhardh (CSIR)	Manik Banik	
131	Sahil Gopalkrishna Naik (CSIR)	Manik Banik	
132	Prosanta Sarkar (UGC)	Tanusri Saha Dasgupta and Goutam Dev Mukherjee (IISER-K)	
133	Muhammad Usman Shehu (TWAS-BOSE)	Tapas Baug	
134	Dorothy Museo Mwanzia (TWAS-BOSE)	Soumen Mondal	

RESEARCH SCHOLARS - INTEGRATED Ph.D. PROGRAMME (by year of joining)

	VISITING RESEARCHER	SUPERVISOR	
2014-2015:			
135	Ananda Gopal Maity	Archan S. Majumdar	till 23/07/2022
136	Sourav Sahoo	Anjan Barman	till 31/07/2022
2016-2017:			
137	Arnab Samanta	Samir Kumar Pal	till 15/09/2022

	SENIOR RESEARCH FELLOW	SUPERVISOR	
2014-2015:			
138	Ruchi Pandey	Ramkrishna Das	till 31/07/2022
2015-2016:			
139	Anupam Gorai	Kalyan Mandal	

	SENIOR RESEARCH FELLOW	SUPERVISOR	
140	Atul Rathod	Punyabrata Pradhan (O)	
141	Shantonu Mukherjee	Amitabha Lahiri	till 28/02/2023
142	Sudip Majumdar	Anjan Barman & Rajib Kumar Mitra	
143	Surya Narayan Panda	Anjan Barman	till 31/07/2022
144	Swarnali Hait	Kalyan Mandal	
2016-2017:			
145	Achintya Low	Thirupathaiah Setti	
146	Ankur Srivastav	Sunandan Gangopadhyay	
147	Anwesha Chakraborty	Biswajit Chakraborty	
148	Sayan Routh	Thirupathaiah Setti	
149	Neeraj Kumar	Sunandan Gangopadhyay	
2017-2018:			
150	Nivedita Pan	Samir kumar Pal	
151	Riju Pal	Atin pal	
152	Samir Rom	Tanusri Saha Dasgupta	
153	Shubham Purwar	Thirupathaiah Setti	
154	Manjari Dutta	Sunanadan Gangopadhyay	
2018-2019:			
155	Soham Saha	Kalyan Mandal	
156	Animesh Hazra	Punyabrata Pradhan	
157	Avik Sasmal	Jaydeb Chakrabarti	
158	Ishita Jana	Kalyan Mandal	
159	Anirban Roychowdury	Sunandan Gangopadhyay	
160	Soumen Mandal	Manik Pradhan	
161	Rajdeep Biswas	Tanusri Saha Dasgupta	
162	Arnab Chakraborty	Amitabha Lahiri	

	JUNIOR RESEARCH FELLOW	SUPERVISOR	
2019-2020:			
163	Ajay Sharma	Sakuntala Chatterjee and Debanjan Bose	
164	Arnab Paul	Tanusri Saha Dasgupta	
165	Banik Rai	Nitesh Kumar	
166	Dibyendu Maity	Amitabha Lahiri	
167	J Sridhar Mohanty	Kalyan Mandal	
168	Jayarshi Bhattacharya	Gautam Gangopadhyay	
169	Sagar Kumar Maity	Suman Chakrabarty	
170	Soham Sen	Sunandan Gangopadhyay	
171	Soumyabrata Hazra	Archan S. Majumdar	till 20/07/2022
172	Saurav Kantha	Amitabha Lahiri	
	2020-2021:		
173	Ananya Chakraborty	Manik Banik	

JUNIOR RESEARCH FELLOW		SUPERVISOR	
174	Pritam Roy	Archan S. Majumdar	
175	Sudip Chakrabarty	Archan S. Majumdar	
176	Devangshu Roy	Prosenjit Singha Deo	

PART TIME RESEARCH SCHOLARS – Ph.D. PROGRAMME		
177	Ashis Saha, Kalyani University, under Sunandan Gangopadhyay	
178	Sukanta Bhattacharyya, West Bengal State University, under Sunandan Gangopadhyay	

PROJECT FELLOWS / ASSISTANTS / TRAINEES	SUPERVISOR	
2019-2020:		
Arun Kumar Das (Project SRF)	Archan S. Majumdar	
Subhankar Bera (Project SRF)	Archan S. Majumdar	
2020-2021:		
Suranjana Chakraborty (Project Assistant)	Anup Ghosh	
2021-2022:		
Neha Bhattacharyya (Project Research Staff)	Samir Kumar Pal	till 31/03/2023
Ria Ghosh (Project SRF)	Samir Kumar Pal	
Arnab Mukherjee (Project JRF)	Archan S. Majumdar	
Soumyadeep De (Project Assistant)	Ali Hossain Khan	till 31/07/2022
Avanti Chakraborty (Project Assistant)	Ali Hossain Khan	

	INTEGRATED Ph.D. PROGRAMME	SUPERVISOR	
2020-2021:			
	Rajdwip Bhar		til 31/10/2022
2021-2022:			
	Anish Chaudhuri		
	Debraj Dutta		
	Sayari Bhattacharya		
	Debendra Meher		
	Partha Patra		
	Prapti Mukherjee		
	Prerak Gupta		
	Shrabasti Banerjee		
	Souvik Paul		
2022-2023:			
	Arpita Jana		
	Dipyendu Dhar		
	Keshav Saw		
	Najrul Ansary		
	Rakesh Ghosh		
	Rudra Prosad Sarkar		

	INTEGRATED Ph.D. PROGRAMME	SUPERVISOR	
	Sakshi Chaudhary		
	Shaheerah Shahid		
	Sourav Mandal		
	Sumit Yadav		
	Trisha Mishra		

Amitabha Lahiri
Dean, Academic Programme

Extended Visitors and Linkage Programme

General Activities

IMPACT-2022: The Alumni Meet

The Centre organized IMPACT-2022: The Alumni Meet on 28th May, 2022 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 was also a panel discussion for creating new opportunities in learning for future development and self-scrutinize the performance with respect to cutting edge research in academia & industry. The programme was followed by cultural events by the research scholars of the Centre.

Foundation Day

The Centre celebrated its Foundation Day on 13th June. On this occasion, Prof. Umakant D. Rapol, Dept. of Physics, Indian Institute of Science Education and Research, Pune delivered lecture on '*Bose-Einstein Condensation*'.

Interactive Session

Ms. Sheena Mishra Ghosh (Consultant Psychologist) conducted interactive session to discuss on the mental health condition in the neo normal with the research scholars on 23.05.2022.

VISITORS AND LINKAGE PROGRAMME

OUTREACH ACTIVITY

National Technology Day 2022

The Centre observed National Technology Day on 11th May 2022. Dr. B. N. Jagatap, Professor, Department of Physics, Indian Institute of Technology Bombay, Mumbai and the Chairman, Governing Body, SNBNCBS delivered the welcome address. Prof. Samit K Ray, Adjunct Professor, SNBNCBS briefed on Centre's technological activities. Prof. Indranil Manna, JC Bose Fellow and Vice Chancellor, Birla Institute of Technology (BIT) delivered lecture on '*Science-Engineering-Technology Synergy and the Role of INAE*'. Prof. Suman Chakraborty, Professor, Mechanical Engineering, Indian Institute of Technology- Kharagpur delivered lecture on '*Flipping with the Flow - Perspectives of Puzzling Fluid Dynamics and Human Health*'.

Open Day 2023

High school, graduate, and postgraduate science students, budding research scholars and physics teachers were exposed to cutting-edge scientific research work conducted by the S. N. Bose National Centre for Basic Sciences during an "Open Day" organised on the occasion of the 129th birth anniversary of Prof. Satyendra Nath Bose. A popular science lecture by Prof. Anirban Kundu, a Professor of Physics at Calcutta University, explained about dark matter, black holes, and Unified Field Theory organised to connect to the common people through the showcasing of some of the being done here. Director Prof. Tanusri Saha Dasgupta gave an overview of the diverse areas of research being carried out at the Centre. The Dean, Dr. Amitabha Lahiri, reminded the audience that S. N. Bose's seminal paper "Planck's Law and Light Quantum Hypothesis" had been published in 1924. In these hundred years, science has progressed in leaps and bounds. S.N. Bose Centre has been keeping pace with the latest developments and, in many cases, leading from the front.

The visitors were taken 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. 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. X-Ray crystallography was one of the favourite areas of research pursued by S. N. Bose. The visitors also got a glimpse of the Cray supercomputer at the supercomputing hub of the Centre. 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.

National Science Day 2023

A total of 75 under graduate students participated in the programme with great enthusiasm. The inaugural session was followed by popular science talk on "*Living with Stars*" delivered by Prof. Dibyendu Nandi, Indian Institutes of Science Education and Research Kolkata. Later the participants visited the S. N. Bose archive. There were two competitive events namely Inter-college quiz contest and Inter-college poster competition.

Educational Visit

Students of M. Sc. Electronics (2nd Semester) along with their teachers from Dhanamanjuri University, Imphal, Manipur have visited the S. N. Bose National Centre for Basic Sciences during 10-11 October, 2022 as part of their External Academic Tour. The academic visit comprising of scientific talks by research scholars, telescopic view of planets and stars, visit to the experimental laboratories and S. N. Bose Archive has been successfully completed with great interest and enthusiasm.

Summer Research Programme:

Sl. No.	Name	Affiliation	Joined under dept. at SNB	Guide at SNB
1	Koustav Panda	University of Calcutta	AHEP	Dr. Atindra Nath Pal
2	Deblina Das	IIT (ISM), Dhanbad	AHEP	Dr. Barnali Ghosh (Saha)
3	Hareshbhai Rajubhai Jadav	Sardar Patel University,Gujarat	AHEP	Dr. Barnali Ghosh (Saha)
4	Debolina Biswas	St. Xavier's College (Autonomous), Kolkata	AHEP	Dr. Debanjan Bose
5	Rupam Samanta	Inter-University Centre for Astronomy and Astrophysics (IUCAA) - Savitribai Phule Pune University (SPPU)	AHEP	Dr. Debanjan Bose
6	Anshuman Sahoo	NISER, Bhubaneswar	AHEP	Dr. Nitesh Kumar
7	Arushi Kumar	Vellore Institute of Technology, Vellore	AHEP	Dr. Ramkrishna Das
8	Md. Samsur Rahaman	SKBU	AHEP	Dr. Ramkrishna Das
9	Shouvik Mondal	Rajabazar Science College	AHEP	Dr. Ramkrishna Das
10	Sampriti Roy	University of Calcutta	AHEP	Dr. Sunandan Gangopadhyay
11	Debalina Kar	Banaras Hindu University	AHEP	Dr. Tapas Baug
12	Subhradeep Karmakar	SKBU	AHEP	Dr. Tapas Baug
13	Abhinav M	Central University of Punjab	AHEP	Dr. Thirupathaiah Setti
14	Riddhima Sadhu	Birla Institute of Technology, Mesra	AHEP	Dr. Thirupathaiah Setti
15	Nandita Debnath	University of Calcutta	AHEP	Prof. Archan S. Majumdar
16	Soumit Roy	RKMVERI	AHEP	Prof. Archan S. Majumdar
17	Soumili Nath	University of Calcutta	AHEP	Prof. Priya Mahadevan
18	Swapneswar Bisoi	Maharaja Sriram Chandra Bhanja Deo University, Baripada	AHEP	Prof. Prosenjit Singha Deo
19	Kritartha Dey	IIT (ISM), Dhanbad	AHEP	Prof. Soumen Mondal
20	Priyank Tripathi	Kumaun University	AHEP	Prof. Tanusri Saha Dasgupta
21	Rajasree Maitra	Jadavpur University	CBS	Dr. Ali Hossain Khan
22	Ushasi Datta	University of Kalyani	CBS	Dr. Ali Hossain Khan
23	Swetha Shivakumar	NIT, Surathkal	CBS	Dr. Manoj Mandal
24	Ishita Ghosh	Banaras Hindu University	CBS	Dr. Pradip S. Pachfule
25	Adway Majumdar	National Institute Of Science Education & Research, Bhubaneswar	CBS	Dr. Suman Chakrabarty
26	Tisha Dash	Indian Institute of Science Education and Research, Kolkata	CBS	Dr. Suman Chakrabarty

Sl. No.	Name	Affiliation	Joined under dept. at SNB	Guide at SNB
27	Uma Ganguly	University of Calcutta	CBS	Dr. Suman Chakrabarty
28	Amit Roy	Assam University, Silchar	CBS	Prof. Gautam Gangopadhyay
29	Bhavna Kuli	IIT (BHU), Varanasi	CBS	Prof. Goutam De
30	Souvik Pramanick	Ramakrishna Mission Vivekananda Centenary College, Rahara	CBS	Prof. Manik Pradhan
31	Muskan Sharma	National Institute of Technology, Sikkim	CBS	Prof. Ranjit Biswas
32	Soumya Dasgupta	NISER, Bhubaneswar	CMMP	Dr. Atindra Nath Pal
33	Gaurab Samanta	Ramakrishna Mission Residential College	CMMP	Dr. Avijit Chowdhury
34	Sagnik Ghosh	IIT Guwahati	CMMP	Dr. Avijit Chowdhury
35	Nilachal Chakrabarti	Indian Institute of Technology, Gandhinagar	PCS	Dr. Urna Basu
36	Monali Roy	University of Calcutta	PCS	Prof. Punyabrata Pradhan

SEMINAR AND COLLOQUIA PROGRAMME (SCOLP)

Bose Fest 2022

The Centre celebrated Bose Fest 2022 – The annual celebration of science during 27-29 April, 2022. Nominated research scholars and postdoctoral fellows presented their oral and poster presentations. Photo Fest and in-house cultural programme were also organized as part of the celebration.

Bose Fest 2023

The Centre celebrated Bose Fest 2023 – The annual celebration of science during 1-3 March, 2023. Nominated research scholars and postdoctoral fellows presented their oral (45 nos.) and poster (34 nos.) presentations. Photo Fest, cultural programme were also organized as part of the celebration.

Seminar Type	Date	Speaker & Affiliation	Title
16th CKM Memorial Lecture	08.12.2022	**Sir Anthony K. Cheetham** Professor, FRS, Materials Research Laboratory, University of California; Department of Materials Science and Engineering, National University of Singapore	*Recent Developments in Hybrid Perovskites and Related Materials*
Series of poster talk on :: Illustrious Indian Scientists in Pre-independence Era	01.04.2022	**Sibaji Raha** Ramanujan Fellow, Bose Institute	*Jagadis Chandra Bose: His Life, His Times and His Legacy*
	06.05.2022	**Partha P Majumdar** National Science Chair (Scientific Excellence), Government of India, Distinguished Professor and Founder, National Institute of Biomedical Genomics, Kalyani, Emeritus Professor, Indian Statistical Institute, Kolkata, Honorary Professor, Indian Institute of Science Education & Research, Mohali, President, Indian Academy of Sciences	*Prasanta Chandra Mahalanobis : An Architect of Statistical Science and Our National Development*
	27.05.2022	**Bikash Ch. Sinha** INSA Senior Scientist and Ex- Director, SINP and VECC	*Homi J Bhaba, Colossus, a timeless icon*
	15.07.2022	**Kaliprasanna Dhara** Retired Associate Professor, Calcutta University	*ASIMA CHATTOPADHYAY : VARATIYA VESHAJA UDVIDER EK ANANYA ANWESHAK*
	22.07.2022	**Ranjit Biswas** Senior Professor, SNBNCBS	*Satyendranath : Beyond Science :* সত্যেন্দ্রনাথ : বিজ্ঞান পেরিয়ে |

Seminar Type	Date	Speaker & Affiliation	Title
Bose Colloquium	01.12.2022	**Ashutosh Sharma** Institute Chair Professor Department of Chemical Engineering, Indian Institute of Technology, Kanpur & President elect (2023-25), Indian National Science Academy (INSA) & Former Secretary to the Government of India Department of Science and Technology	Navigating Complexity by Scientific Common Sense
	18.01.2023	**Puru Jena** Professor, Virginia Commonwealth University, Richmond, Virginia	Cluster-based Functional Materials – A Paradigm shift in Design and Synthesis
	27.02.2023	**Jean-Pascal Sutter** Research Director, CNRS, Toulouse, France	From magnetic anisotropy to molecular magnets: A journey into the coordination chemistry of pentagonal bipyramidal complexes
Institute Colloquium	05.04.2022	**Gautam Basu** Senior Professor, Dept. of Biophysics, Bose Institute	Minor conformation-triggered intermolecular interactions
	06.04.2022	**Indra Dasgupta** Senior Professor, School of Physical Sciences, IACS	The Challenges and Prospects in Modeling Strongly Correlated Systems
	20.07.2022	**Jayasimha Atulasimha** Professor, Virginia Commonwealth University, USA	Classical and Quantum Computing with Spins and Spin Ensembles
	25.08.2022	**Bhaskaran Muralidharan** Professor, Electrical Engineering Department, Indian Institute of Technology Bombay	The search for the elusive Majorana modes: conductance gap closure and the topological gap protocol
	30.09.2022	**Shankar P. Das** Professor, School of Physical Science, JNU, Delhi	Complexity and entropy crisis in the amorphous glassy state
	30.11.2022	**Partha Ghose** NASI Sr. Scientist & Distinguished Fellow at the Tagore Centre for Natural Sciences and Philosophy, Kolkata,	Unification of Gravity and Electrodynamics
	09.12.2022	**Dipankar Bhattacharya** Distinguished Astrophysicist Professor, Ashoka University	Astrosat: The Indian Astronomy Mission
	13.12.2022	**Sibasish Ghosh** Professor, The Institute of Mathematical Sciences, Chennai	Negativity of Wigner distribution function as a measure of incompatibility
	07.02.2023	**Satrajit Adhikari** Senior Professor, IACS & Adjunct Professor, IISER Kolkata, HOD CCRES	Role of Electron-Nuclear Coupling on Photoelectron Spectra, Reactive Scattering Processes and Phase Transition of Solids
Special Talk	09.12.2022	**Dr. Marie-Gabrielle MEDICI** Scientist, University of Nice	Dew condensation and harvesting: potential source of drinking water. New challenge for some arid countries
Departmental Seminars	19.04.2022	**Soumya De** Assistant Professor, School of Bioscience IIT Kharagpur	*Insights into structure and dynamics of folded and disordered proteins by NMR spectroscopy*
	26.04.2022	**Padmakar Singh Parihar** Professor, Indian Institute of Astrophysics, Bengaluru	*Tools and Techniques for Characterizing a New Astronomical Observatory*

Seminar Type	Date	Speaker & Affiliation	Title
	26.04.2022	**Ranjit Biswas** Senior Professor, SNBNCBS	*Deep Eutectic Solvents: New Excitements and Our Understanding*
	04.05.2022	**Amit Kumar Agarwal** Associate Professor, Department of Physics. IIT Kanpur	*Topological phase transitions, Nonlinear transport, and plasmons in Moire super lattices*
	19.05.2022	**Tanmoy Paul** Assistant Professor, Chandannagar College, Dept. of Physics	*Inflationary magnetogenesis with reheating phase from higher curvature coupling*
	24.05.2022	**Asmita Kumari** Post-Doctoral Fellow, Harish Ch. Research Institute, Allahabad	*Luders bounds of Leggett-Garg inequalities, quantum channel, PT symmetric evolution and arrow-of-time*
Departmental Seminars	20.06.2022	**Gourab Ghoshal** Associate Professor, Physics & Astronomy Stephen Biggar '92 and Elizabeth Asaro '92 Fellow in Data Science, University of Rochester	*A Physics Approach to Study Urban Systems*
	21.06.2022	**Shraddha Mishra** Assistant Professor, IIT, BHU	*Role of intrinsic and extrinsic inhomogeneities in active systems*
	22.06.2022	**Subhankar Bedanta** Associate Professor, School of physics, NISER, Bhubaneswar	*Spin to charge conversion with heavy metals, topological insulators and antiferromagnets*
	23.06.2022	**Sabyasachi Roy Chowdhury** Postdoctoral Researcher, University of South Dakota Vermillion, South Dakota, USA	*Investigating Molecular Geometries of Transition Metal Complexes by Multireference Methods*
	27.06.2022	**Rupak Mukherjee** Associate Research Physicist, Princeton Plasma Physics Laboratory, Princeton University, USA	*How computational physics is shaping nuclear fusion reactors*
	29.06.2022	**Subhash Bose** Postdoctoral Fellow, OSU Center for Cosmology and Astro-Particle Physics (CCAPP), Ohio State University	*Finding extremes and unusuals from all-sky Supernovae surveys.*
	30.06.2022	**Abhishek Majhi** DST INSPIRE Faculty, ISI, Kolkata	*Resolving the singularity by looking at the dot and demonstrating the undecidability of the continuum hypothesis*
	05.07.2022	**Debasish Chaudhuri** Associate Professor G INSTITUTE OF PHYSICS, BHUBNESWAR	*Active matter: from single particle trajectory to collective behavior*
	05.07.2022	**Tamas Kumar Panda** Assistant Professor, Centre for Clean Environment and Department of Chemistry, Vellore Institute of Technology, Vellore campus, Tamilnadu, India	*Mechanochemistry: An Opportunity to do Engineering in Metal Organic Frameworks (MOFs)*
	12.07.2022	**Ali Hossain Khan** RAMANUJAN FELLOW, SNBNCBS	*Designing Two-dimensional Colloidal Nanocrystals for Opto-electronic Applications*
	21.07.2022	**Banibrata Mukhopadhyay** Professor, Department of Physics, Indian Institute of Science, Bangalore	MAGNETICALLY DOMINATED ACCRETION FLOWS TO PROBE BLACK HOLE PROPERTIES
	10.08.2022	**M. Venkata Kamalakar** Associate Professor & Team Leader, Quantum Material Devices Group Department of Physics and Astronomy, Uppsala University	Two-dimensional spin circuits: exploring interfaces and substrates for efficient spin currents and novel devices

Seminar Type	Date	Speaker & Affiliation	Title
Departmental Seminars	11.08.2022	**Tirthankar Banerjee** Research Associate, Department of Applied Mathematics and Theoretical Physics, Centre for Mathematical Sciences, University of Cambridge	Initial conditions and single-file diffusion: compressibility, hyperuniformity and everlasting memory
	19.08.2022	**Sumit Dey** Senior Research Fellow, Department of Physics Indian Institute of Technology Guwahati, India	Thermodynamic and fluid dynamical interpretation of the Einstein-Cartan field equations with respect to a generic null hypersurface
	23.08.2022	**Samrat Ghosh** Scientist CSIR-CLRI, Chennai, India.	Why Charge Transport is Pivotal for the Photocatalytic Hydrogen Evolution in Two-dimensional Porous Organic Semiconductors?
	24.08.2022	**Paramita Dutta** Assistant Professor Theoretical Physics Division, Physical Research Laboratory, Ahmedabad	Bogoliubov Fermi surface and exotic Cooper pairs in j=3/2 superconductors
	26.08.2022	**Ankur Sensharma** Associate Professor of Physics, University of Gour Banga	PERCOLATION IN DISTORTED SQUARE AND SIMPLE CUBIC LATTICES
	05.09.2022	**Anupam Kundu** Associate professor, International Centre for Theoretical Sciences, Bangalore	Hydrodynamics and crossover from diffusive to anomalous transport
	27.09.2022	**Goutam De** Emeritus Professor, S N B N C B S, Kolkata Associate Editor, Journal of Materials Chemistry A; Materials Advances (RSC)	Sharing My Experience as an Associate Editor of Journal of Materials Chemistry A
	30.09.2022	**Sumanta Kundu** Postdoctoral Research Fellow Department of Physics and Astronomy "Galileo Galilei", University of Padova	Machine learning predictions of complex polymer topologies
	10.10.2022	**Aniket Patra** Postdoctoral Researcher, Aarhus University Department of Physics and Astronomy Denmark	Single-Shot Determination of Quantum Phases via Continuous Measurements
	12.10.2022	**Riya Sebait** Ph. D Student, Department of Physics, Sungkyunkwan University, Republic of Korea	Defect-Induced Trion in Monolayer WS2 at Room Temperature
	14.10.2022	**Milan Sil** PDRA - I, SNBNCBS	Exploring Noble Gas Species in the Radiation-Dominated Region
	17.10.2022	**Rahul Debnath** Post-Doctoral Researcher, Quantum Materials and Devices Group, Department Of Physics, Indian Institute Of Science, Bangaluru	Study on optical and electrical transport properties of twisted bilayer transition metal dichalcogenides
	20.10.2022	**Shreyasi Chattopadhyay** MRSC Research Fellow, JTSI group School of Chemistry, University of St. Andrews	Exsolution: approach for emergent nanoparticles towards photo/electro catalysts designing
	31.10.2022	**Biplab Sanyal** Associate Professor (Universitetslektor) Division Head, Materials Theory Division Department of Physics and Astronomy, Uppsala University	Challenges and prospects in two-dimensional FenGeTe2 (n=3, 4, 5) magnets

Seminar Type	Date	Speaker & Affiliation	Title
Departmental Seminars	10.11.2022	**Samik Duttagupta** Associate Professor (E) CMP Division Saha Institute of Nuclear Physics	Spin-orbitronics with metallic antiferromagnets
	10.11.2022	**Prasanta Nayak** Post-Doctoral Fellow, TIFR, Mumbai	The first UVIT study of T-Tauri Stars
	11.11.2022	**Malay Banerjee** Professor, Department of Mathematics & Statistics, IIT Kanpur	Systematic local and global bifurcation analysis for ecological models
	17.11.2022	**Naresh Dadhich** A theoretical physicist, formerly at Inter-University Center for Astronomy and Astrophysics.	On the Buchdahl Stars
	22.11.2022	**Arnab Mukherjee** Professor, Chemistry Department, Indian Institute of Science Education and Research, Pune	Approaching de-novo drug-design using a combination of physics-based and machine learning algorithms
	24.11.2022	**Mir Alimuddin** Chanakya PDF, DPCS, SNBNCBS	Thermodynamic signatures of Quantum Entanglement
	28.11.2022	**Bijay Kumar Agarwalla** Assistant Professor, Department of Physics Indian Institute of Science Education and Research, Pune	Universal bounds on fluctuations in continuous and discrete thermal machines
	02.12.2022	**Some Sankar Bhattacharya** Post Doc Fellow Adiunkt, ICTQT, Gdansk, Poland	Arbitrary Separation in One-way Zero-error Quantum Communication Complexity of Relations with Finite Set of Inputs
	06.12.2022	**Arnab Bose** Postdoctoral Fellow, Dept. of Physics, Johannes Gutenberg Universität, Mainz	Electric field induced novel spin-current generation
	07.12.2022	**Ankit Raj** Postdoctoral Researcher at USIL-NYCU, Taiwan	Towards standardization of Raman spectroscopy: Accurate wavenumber and intensity calibration schemes for absolutely quantitative analysis
	15.12.2022	**Sourav Bhattacharya** Associate Professor, Department of Physics, Jadavpur University	Loops and non-perturbative effects in primordial cosmic inflation
	16.12.2022	**Tamaghna Hazra** Postdoctoral Researcher, Rutgers University	Triplet pairing mechanisms from Hund's-Kondo models - applications to heavy fermion superconductors
	21.12.2022	**Kapildeb Dolui** Post-Doctoral Fellow, Department of Materials Science & Metallurgy, University of Cambridge, UK	Ab-initio spin torque and spin-pumping in spin-orbit-proximitized antiferromagnets
	22.12.2022	**Vishnu Rajagopal** Ph. D Student, School of Physics, University of Hyderabad, Central University	Maximal acceleration in non-commutative space-times
	22.12.2022	**Vijayakumar Chikkadi** Assistant Professor Physics Division, Indian Institute of Science Education and Research Pune	Phase separation of colloidal particles in active suspensions of bacteria
	03.01.2023	**Somesh Chandra Ganguli** Postdoctoral Researcher, Department of Applied Physics, Aalto University School of Science, Espoo, Finland	Designer quantum matter in van der Waals heterostructures

Seminar Type	Date	Speaker & Affiliation	Title
Departmental Seminars	09.01.2023	**Suman G. Das** Research Associate, Institute for Biophysics, University of Cologne, Germany	Biological evolution on a driven disordered fitness landscape
	11.01.2023	**Upamanyu Moitra** Postdoctoral Fellow, High Energy, Cosmology and Astroparticle Physics Section The Abdus Salam International Centre for Theoretical Physics, Strada Costiera, Italy	Self-Similar Gravitational Dynamics, Singularities and Criticality in 2D
	13.01.2023	**Sayantan Bhattacharya** Research Scholar, Physics Department at University of Massachusetts Lowell	Blue Supergiant X-ray Binaries in The Starburst Galaxy IC 10
	16.01.2023	**Mukul Bhattacharya** Eberly Research Fellow at Penn State University	Magnetized outflows as potential sites of heavy element nucleosynthesis and high-energy neutrinos
	17.01.2023	**Bidyut Sarkar** Research Scientist, Molecular Spectroscopy Laboratory, RIKEN, Chemistry and Material Physics Building, Japan	Investigation of structure-dynamics-function relationship of biomolecules with microsecond time resolution
	19.01.2023	**Swapnamay Mondal** Post-doc at Dublin Institute for Advanced Studies, Ireland	Black hole microstates in String Theory
	19.01.2023	**Avijit Misra** Post-doc research fellow, The Weizmann Institute of Science	Work extraction from thermal noise by measurements and nonlinear interactions in quantum optical setups
	31.01.2023	**Ashwani K. Tiwari** Professor, FRSC Dean of International Relations and Outreach Department of Chemical Sciences, Indian Institute of Science Education and Research (IISER) Kolkata	Dynamics of H2O Dissociation on Metal Surfaces
	01.02.2023	**Soumyakanti Bose** Postdoctoral Research Fellow, Seoul National University	Quantum teleportation of optical qubits using Gaussian resources
	02.02.2023	**Chandramouli Chowdhury** A PhD student at ICTS-TIFR	Principle of Holography of Information
	03.02.2023	**Rajib Sarkar** Scientist, Technische Universität Dresden Institut für Festkörper- und Materialphysik Dresden, Germany	Competing orders and spin dynamics: Nuclear probes
	10.02.2023	**Subhasish Mandal** Assistant Professor, Department of Physics & Astronomy, West Virginia University,	First-principles investigation on strongly correlated materials with chemical accuracy using beyond-DFT methods
	14.02.2023	**Shishir Kumar Pandey** AI for Science Institute, Beijing	A Route To Access The Quantum Spin Liquid state In Spin-orbit Coupling Assisted Mott Insulators
	15.02.2023	**Subhayan Roychoudhury** Postdoctoral Researcher, The Molecular Foundry Lawrence Berkeley National Laboratory	COMPUTATIONAL ELECTRONIC STRUCTURE AND X-RAY SPECTROSCOPY: A SYMBIOTIC FRIENDSHIP

Seminar Type	Date	Speaker & Affiliation	Title
Departmental Seminars	21.02.2023	**Andreas Schneemann** Assistant Professor. Technical University Dresden. Dresden, Germany	Side Chain Functionalized Covalent Organic Frameworks –From Facilitated Delamination to Property Engineering
	01.03.2023	**Rajesh Mondal** Postdoctoral Fellow, Tel Aviv University, Tel Aviv-Yafo, Israel	The 21-cm cosmology
	22.03.2023	**Anindita Bera** Post Doctoral Fellow at Institute of Physics, Astronomy and Informatics, Nicolaus Copernicus University, Poland	A class of Bell diagonal entanglement witnesses in C^4 C^4 : optimization and the spanning property
	24.03.2023	**Debarshi Das** Royal Society - Newton International Fellow & Honorary Research Fellow, Department of Physics and Astronomy, University College London, UK	Mass-independent test of genuine quantumness of massive objects.
	30.03.2023	**Rajeswari Roy Chowdhury** DST INSPIRE Faculty, Department of Physics, IISER Bhopal	Unconventional magneto resistive behaviour in layered magnets
	31.03.2023	**Shankar P. Das** Professor of Physics School of Physical Sciences, Jawaharlal Nehru University, New Delhi	Dynamic density functional theory for a Brownian fluid

Visitor's & Associates & Student's Programme :"

VASP Seminar/Webinar Series of "Statistical Mechanics"

Date	Speaker	Affiliation	Title
07-06-2022	**Professor Yael Roichman**	School of Chemistry, Tel Aviv University	*The equation of state of randomly driven colloids*
19-07-2022	**Prof. Valeria Molinero**	The University of Utah	*Elucidating the mechanisms of synthesis of zeolites using molecular simulations*
13-09-2022	**Dr. Aparna Baskaran**	Brandeis University,USA	*Active Matter : Applying the materials physics paradigm to biology*
10-11-2022	**Prof. Christian Maes**	KU Leuven, Belgium	*What is the entropy of a tiger?*
26-12-2022	**Prof. Satya Majumdar**	Laboratoire de Physique Theorique et Modeles Statistiques (LPTMS)	*Stochastic Resetting*
30-01-2023	**Prof. Uriel Frisch**	The French National Centre for Scientific Research	*Leonardo da Vinci, Andrei Kolmogorov and Giorgio Parisi. The energy decay of turbulence from Leonardo to multifractal theory*

VASP Seminar/Webinar Series of "Quantum Materials and Devices"

Date	Speaker	Affiliation	Title
11-05-2022	**Prof. Kamran Behnia**	ESPCI-Paris Science et Lettres University	*On the origin and amplitude of the T-square resistivity in Fermi liquids*
08-06-2022	**Prof. Hidenori Takagi**	Max-Planck Institute for Solid State Research, Germany	*Towards realization of Kitaev Quantum Spin Liquid*
17-08-2022	**Prof. Christian Schonenberger**	Department of Physics and Swiss Nanoscience Institute, University of Basel	*Cooper-pairs are nice, but split ones are even nicer! Why it is interesting to "unpair" a Cooper-pair*

Date	Speaker	Affiliation	Title
19-10-2022	**Prof. Alberto Morpurgo**	University of Geneva	*Ionic Gating of 2D Semiconductors*

A BRIEF REPORT OF CONFERENCES, WORKSHOPS AND EXTENSION PROGRAMMES (CWEP) FROM 01.04.2022 TO 31.03.2023

As per available records, during the period under reference, the following conferences/workshops were conducted at the Centre. A brief report of the workshops/ seminars/discussion meetings are as below:

1. **C.K. Majumdar Memorial Workshop in Physics 2022** was jointly organized by Indian Association of Physics Teachers (Regional Council 15) and S.N. Bose National Centre for Basic Sciences, Kolkata. Duration: 10 days (12.07.2022 to 21.07.2022) through both online and offline mode. The joint Conveners were Dr. Saswati Dasgupta from IAPT and Prof. Kalyan Mandal, Senior Professor from the Centre. The participants were B.Sc 3rd year (Physics Honours) outgoing batch and 1st year M.Sc. (Physics) batch. Total 19 participants participated through offline mode and 14 participants participated through online mode from 27 institutes all over India. Talks on theory were delivered on diverse topics like cosmology, astrophysics, black hole information paradox, quantum computing, condensed matter and computational material science, energy research and development of sensors for medical applications. Some talks were delivered on experiments that could be performed from home using smartphone sensors. On the basis of these experiments, students were asked to perform some tasks at home. In students' session, the participants delivered presentations using power point as well as white board.
2. **National Conference on Electronic Structure (NCES-2022)** held at University of Goa during 14th to 16th November, 2022 (jointly organized by SNBNCBS, TIFR, IOP, Bhubaneswar and CAT, Indore). The Convener from SNBNCBS was Dr. Thirupathaiah Setti. The Conference had 28 talks and 1 special evening lecture in total delivered by the renowned national speakers. Out of the 29 speakers, 5 were women speakers and 2 speakers are from the reserved category. All speakers attended the conference physically. 20 students attended the conference and 11 out of 20 presented the posters. During the conference period overall 60 participants, including the speakers and local faculty from University of Goa participated physically.
3. **APCTP-IACS-SNBNCBS Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization** was jointly organized by the Centre, IACS and APCTP. The Workshop held during 17th to 25th November, 2022 at S.N. Bose National Centre for Basic Sciences. The Convener from the Centre was Prof. Manoranjan Kumar and the organizing committee member was Prof. Priya Mahadevan.
4. **Focused Meeting on Quantum Materials** was organized at the Centre on 24th January, 2023 with a focus on recent developments in magnetism and topological materials. The Convener was Prof. Priya Mahadevan, Senior Professor of the Centre. 10 talks was organized with speakers primarily drawn from the Centre and other institutes in and around Kolkata. In addition there was 12 students presenting posters.
5. **Steady State Phenomena in Soft Matter, Active and Biological Systems** conference during 16th to 18th March, 2023 was organized at Centre. The Conveners were Prof. Jaydeb Chakrabarti, Senior Professor, Prof. Punyabrata Pradhan, Professor, Dr. Sakuntala Chatterjee, Associate Professor and Dr. Urna Basu, Assistant Professor. The purpose of the conference was to expose the young researchers and students to the current development in application of statistical mechanics tools in the areas of soft matter, active matter and biological systems.

ADVANCED POST DOCTORAL RESEARCH PROGRAMME (APRP) : 2022-2023 [as on 31.03.2023]

Sl. No.	Name	Status	Dept.	Mentor
1	Ajit Kumar Sahoo	PDRA –I (from 21.11.2022 --)	CMMP	Prof. Anjan Barman
2	Akhtar Alam	PDRA –I (from 15.11.2022 --)	CBS	Dr. P. S. Pachfule
3	Alik Panja	Bridge Fellow (From 15.09.2022)	AHEP	Dr. Tapas Baug
4	Aravindan V	PDRA –I (from 09.03.2023 --)	CMMP	Prof. Tanusri Saha Dasgupta
5	Arijit Mondal	PDRA –II (from 01.03.2023 --)	PCS	Prof. Jaydeb Chakrabarti
6	Arpan Bhattacharyya	PDRA – I (Till 10.12.2022)	CMMP	Prof. Anjan Barman
7	Arun Kumar Maurya	PDRA –I (from 01.12.2022 --)	CMMP	Prof. Tanusri Saha Dasgupta
8	Ashadul Halder	PDRA – I (from 18.05.2022 --)	AHEP	Prof. Archan Majumdar
9	Ashmita Das	PDRA – III (from 11.05.2022 --)	AHEP	Dr. Sunandan Gangopadhyay
10	Bijoy N	PDRA –I (from 28.11.2022 --)	CMMP	Prof. Priya Mahadevan
11	Buddhadeb Pal	PDRA – I (Till 19.08.2022)	CMMP	Dr. Atindra Nath Pal
12	Didhiti Bhattacharya	Bridge Fellow (From 27.09.2022)	CMMP	Dr. Avijit Chowdhury
13	Dharmesh Jain	PDRA –III (Till 01.04.2022)	PCS	Dr. Sunandan Gangopadhyay
14	Dhrimadri Khara	Bridge Fellow (Till 28.09.2022)	AHEP	Prof. Soumen Mondal
15	Dusmanta Patra	PDRA –I (from 26.04.2021 --)	AHEP	Prof. Soumen Mondal
16	Gargee Bhattacharyya	PDRA –II (Till 05.01.2023)	CMMP	Prof. Priya Mahadevan
17	Ipsita Basu	PDRA –II (Till 27.05.2022)	CBS	Dr. Suman Chakrabarty
18	Indrani Bhattacharya	PDRA –I (Till 27.12.2022)	CBS	Prof. Rajib K Mitra
19	Jayeta Banerjee	PDRA –II (from 01.02.2023 --)	CBS	Prof. Ranjit Biswas
20	Koushik Mondal	PDRA –I (from 30.10.2022 --)	CBS	Prof. Manik Pradhan
21	Mahima Singh	PDRA – I (from 20.07.2022 --)	CMMP	Dr. Nitesh Kumar
22	Mayukh K Ray	PDRA –III (Till 28.02.2023)	CMMP	Dr. Nitesh Kumar
23	Milan Sil	PDRA –I (from 06.05.2022 --)	AHEP	Dr. Ramkrishna Das
24	Mily Kundu	PDRA – I (from 03.02.2023 --)	CMMP	Prof. Kalyan Mandal
25	Mustaque Ali Khan	PDRA – I (from 12.07.2021 --)	CMMP	Dr. Barnali Ghosh (Saha)
26	Partha Pyne	Bridge Fellow (Till 18.01.2023)	CBS	Dr. P. S. Pachfule
27	Piyali Saha	PDRA – I (Till 15.09.2022)	AHEP	Dr. Tapas Baug
28	Priyanka Garg	PDRA – I (Till 30.06.2022)	CMMP	Prof. Priya Mahadevan
29	Prasanta Kundu	PDRA –II (from 26.04.2021 --)	CBS	Prof. Gautam Gangopadhyay
30	Puspendu Barik	PDRA –III (from 10.05.2022 --)	CBS	Prof. Manik Pradhan
31	Ritamay Bhunia	PDRA –III (from 09.02.2023 --)	CMMP	Dr. Avijit Chowdhury
32	Rituparna Mandal	Bridge Fellow (from 09.01.2023--)	CBS	Prof. Gautam Gangopadhyay
33	Ruchi Pandey	Bridge Fellow (Till 23.12.2022)	AHEP	Dr. Ramkrishna Das
34	Saheli Samanta	Bridge Fellow (from 13.03.2023--)	CMMP	Prof. Manoranjan Kumar
35	Samrat Ghosh	Bridge Fellow (from 25.08.2022--)	AHEP	Prof. Soumen Mondal
36	Sambunath Das	PDRA – I (Till 20.03.2023)	CMMP	Prof. Manoranjan Kumar
37	Sk. Md. Obaidulla	PDRA – II (from 01.12.2022--)	CMMP	Dr. Atindra Nath Pal

Sl. No.	Name	Status	Dept.	Mentor
38	Sk. Samir Ahamed	PDRA – I (from 01.02.2023--)	CBS	Dr. Suman Chakrabarty
39	Shibendu Gupta Choudhury	PDRA – I (from 14.02.2023--)	AHEP	Prof. Amitabha Lahiri
40	Shreya Das	Bridge Fellow (Till 25.11.2022)	CMMP	Prof. Tanusri Saha Dasgupta
41	Snehamoyee Hazra	Bridge Fellow (from 27.02.2023--)	CMMP	Dr. Barnali Ghosh (Saha)
42	Subhadip Chakrabarty	PDRA –I (Till 23.01.2023)	CBS	Prof. Rajib K Mitra
43	Soumi Das	PDRA – I (from 20.06.2022--)	PCS	Prof. Jaydeb Chakrabarti
44	Soumya Chakrabarti	PDRA –II (Till 28.10.2022)	PCS	Prof. Amitabha Lahiri
45	Sudip Kr. Saha	Bridge Fellow (Till 27.09.2022)	CMMP	Prof. Manoranjan Kumar
46	Sumanti Patra	Bridge Fellow (Till 28.02.2023)	CMMP	Prof. Priya Mahadevan
47	Sutapa Saha	PDRA – I (from 01.03.2023--)	AHEP	Prof. Archan S Majumdar
48	Tanmoy Paul	PDRA –III (Till 01.08.2022)	CMMP	Prof. Tanusri Saha Dasgupta
49	Tapas Sahoo	PDRA –III (from 10.05.2022 --)	CBS	Prof. Gautam Gangopadhyay
50	Tonima Nandy	PDRA –I (from 06.05.2022 --)	CBS	Prof. Ranjit Biswas
51	Tirthendu Sinha	PDRA – I (from 01.11.2022--)	AHEP	Dr. Tapas Baug
52	Tridib Roy	PDRA – I (from 17.01.2023--)	AHEP	Dr. Ramkrishna Das
53	Tushar Kanti Bhowmik	PDRA – I (from 02.02.2023--)	CMMP	Dr. T. Setti
54	Vishal K Aggaarwal	Bridge Fellow (Till 20.10.2022)	CMMP	Prof. Manoranjan Kumar

NPDF / RESEARCH ASSOCIATE (EXTERNAL FUND) : 2022-2023

Sl. No.	Name	Designation	Status	Dept.	Mentor	Title of the Project
1	Anuvab Banerjee	Research Associate – I	Till 14.11.2022	AHEP	Dr. Debanjan Bose	Study of Astrophysical Sources in Very High Energy Regime using ground-based Gamma ray and Neutrino Telescope
2	Dr. Asmita Kumari	Research Associate – I (Adhoc)	Till 20.03.2022	AHEP	Prof. Archan S Majumdar	Application of Quantum Information
3	Dr. Debashis Saha	National Post-Doctoral Fellow	Till 12.08.2022	AHEP	Prof. Archan S Majumdar	Self-testing of quantum devices and device-independent information processing
4	Dr. Dipayan Sen	Research Associate – III	Till 31.01.2023	CMMP	Prof. Tanusri Saha Dasgupta	J.C. Bose Award (Fellowship)
5	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
6	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)

Sl. No.	Name	Designation	Status	Dept.	Mentor	Title of the Project
7	Dr. Jayeta Banerjee	National Post-Doctoral Fellow	Till 30.12.2022	CBS	Prof. Manik Pradhan	Theoretical and experimental investigations on transition metal dichalcogenide based surface plasmon resonance structure with applications in sensing
8	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
9	Dr. Partha Nandi	Research Associate – I (Adhoc)	Till 30.11.2022	AHEP	Prof. Archan S Majumdar	Application of Quantum Information
10	Dr. Sanjukta Paul	Research Associate – I	Till 06.12.2022	CMMP	Prof. Priya Mahadevan	Twistronics with transition metal dichalogenides
11	Dr. Soumendu Datta	Research Associate – III	From 25.08.2021	CMMP	Prof. Tanusri Saha-Dasgupta	J.C. Bose Award (Fellowship)
12	Dr. Soumya Bhattacharya	Research Associate – I	From 04.04.2022	AHEP	Prof. Rabin Banerjee	Gauge and Gravitational Symmetries in Nonrelativistic Theories : Formalism and Applications
13	Dr. Sourav Chakraborty	Research Associate – I (Adhoc)	From 05.12.2022	CMMP	Prof. Manoranjan Kumar	Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature
14	Dr. Sumit Nandi	Research Associate – I	Till 04.07.2022	AHEP	Prof. Archan S Majumdar	Application of Quantum Information
15	Dr. Sumit Halder	Research Associate – I	Till 02.12.2022	CMMP	Prof. Manoranjan Kumar	Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature
16	Shreya Das	Research Associate – I (Adhoc)	Till 09.07.2022	CMMP	Prof. Tanusri Saha-Dasgupta	J.C. Bose Award (Fellowship)
17	Dr. Upasana Das	National Post-Doctoral Fellow	From 26.12.2022	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 / DST (INSPIRE) / RAMANUJAN FELLOW etc.: 2022-2023

Sl. No.	Name	Status	Dept.
1	Prof. Rabin Banerjee	Raja Ramanna Fellow	AHEP
2	Prof. Goutam De	Emeritus Professor, till 15.01.2023; Visiting Professor from 16.01.2023	CBS
3	Prof. Prabhat Mandal	Emeritus Professor	CMMP
4	Prof. Subhrangshu Sekhar Manna	Visiting (Honorary) Fellow, till 31.01.2023	PCS
5	Prof. Ranjan Chaudhury	Visiting (Honorary) Fellow, till 31.12.2022	CMMP
6	Prof. P.K. Mukhopadhyay	Visiting (Honorary) Fellow, till 31.12.2022	CMMP

Sl. No.	Name	Status	Dept.
7	Prof. M. Sanjay Kumar	Visiting (Honorary) Fellow, till 01.08.2022	PCS
8	Prof. Samit Kr. Ray	Adjunct Faculty	CMMP
9	Prof. Partha Guha	Adjunct Faculty	PCS
10	Dr. Goutam Sheet	Adjunct Fellow	CMMP
11	Dr. Subhro Bhattacharjee	Adjunct Fellow	CMMP
12	Dr. Indranil Sarkar	Adjunct Fellow	CMMP
13	Dr. Anup Ghosh	DST INSPIRE Faculty	CMMP
14	Dr. Dipanwita Majumdar	DST INSPIRE Faculty	CMMP
15	Dr. Suman Chowdhury	DST INSPIRE Faculty, from 10.10.2022	CMMP
16	Dr. Sujoy Kr. Ghosh	DST INSPIRE Faculty, from 09.03.2023	CMMP
17	Dr. Debanjan Bose	Ramanujan Fellow, till 14.11.2022	AHEP
18	Dr. Ali Hossain Khan	Ramanujan Fellow	CBS
19	Dr. Manoj Mandal	Ramalingaswami Re-entry Fellow	CBS

Nibedita Konar

Debashish Bhattacharjee

Rupam Porel

Members of Academic Section

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.

1. 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
2. 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
3. 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

Science enthusiasts from schools and colleges participated in the 'Open Day' on 2nd January 2023

Academic visit by the students and teachers of Department of Electronics, Dhanamanjuri University, Manipur during 10-11 October, 2022.

Centre celebrated Bose Fest 2023 during 1-3 March, 2023

Talk by Prof. Christian Maes, KU Leuven, Belgium on 10th November, 2022

Talk by Prof. Sibaji Raha, Bose Institute, Kolkata on Jagadis Chandra Bose in the lecture series: *'Illustrious Indian Scientists in Pre-independence Era'* on 1st April, 2022.

APCTP -IACS-SNBNCBS Workshop held during 17-25 November 2022.

Centre's participation in the "9th Indian National Exhibition Cum-Fair 2022" at Patuli, Kolkata during 4-8 August, 2022.

Talk by Prof. Ashutosh Sharma, Indian Institute of Technology Kanpur & Former DST Secretary, Chairman of SERB & TDB on 1st December 2022.

Prof. Sir Anthony K. Cheetham, FRS, Materials Research Laboratory, University of California delivered the 16th C. K. Majumdar Memorial Lecture on 8th December 2022.

Bose Colloquium lecture delivered by Prof. Kalachand Sain, Director, Wadia Institute of Himalayan Geology on 30th January 2023.

Public Lecture by Prof. Dipankar Bhattacharya, Head of the Department, Physics, Ashoka University on Dec 12, 2022.

National Science Day 2023 was celebrated at SNBNCBS, Kolkata on 28 February 2023.

SNBNCBS is one of the participants of DST Pavilion at ISC-2023, Nagpur during 3-7 January 2023).

SNBNCBS has participated in the "West Bengal State Science and Technology Congress, 2023" at Science City, Kolkata from 28th February to 1st March 2023.

Students of Kendriya Vidyalaya visited Centre on Jan 17, 2023 for Curtain Raiser Ceremony of the '8th India International Science Festival (IISF)-2022'.

12th Vidyasagar Satyendra Nath Bose National Workshop on Advances in Physics: Theories & Applications-2023 held at Vidyasagar University, Midnapore during 28 February to 2nd March 2023.

Registrar

The Centre has rendered administrative support to its academic activities through its administrative and technical staff members who have very professionally and sincerely carried out their duties for making the various activities of the Centre in the year 2022-2023 successful. The Centre at present has staff strength of 23 in permanent, 9 in temporary and 29 in contractual category as on 31st March 2023, 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 administrative sections of the Centre. The Centre has maintained close liasion with the Department of Science and Technology and other ministries and have replied to their various queries. 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 the CAG Audit Team and Audit Queries. The Hindi Cell of the Centre has been functioning effectively and the Centre undertakes substantial administrative work in hindi and makes sincere efforts to implement and follow the provision of Official Language Act.

No cases related to vigilance have been reported during the period of 2022-2023. The Centre has also adhered to the norms of the Right to Information Act and so far has received 10 (ten) cases under the said Act in the last financial year all of which has 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.

As part of Vigilance Awareness Week 2022 during 31st October 2022 to 6th November 2022, the Centre organised Vigilance Pledge and an invited talk by Dr. S.K.Sadangi, IRSS, Principal Chief Material Manager, Chittaranjan Locomotive Works and an Essay Competition (Topic: "Corruption Free India for a developed 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 – Ms. Anwesha Chakraborty, Senior Research Fellow.
- 2nd Prize – Mr. Sudip Chakraborty, Junior Research Fellow.
- 3rd Prize – Mr. Sreyan Bhowmick, Junior Research Fellow.

The Centre celebrated 'Swachhta Pakhwada' from 1st May 2022 to 15th May 2022. As a part of the Pakhwada on 02.05.2022 the Centre organised mass Swachhta pledge taking ceremony, mass cleaning of Main Office Building, Guest House, Students' Hostels etc., was carried out. Collection of wastes and awareness rally in Centre premises was carried out along with awareness campaign about no use of plastics. Posters titled "Zero Plastic, Green Campus" were pasted in all notice boards and all prominent places of the Centre. Weeding out of old records was done. A motivational talk/lecture titled "Solid and Liquid Waste Management" was delivered by Prof. S.K.Pal, Senior Professor of the Centre. An Essay Competition on "How can we make Clean and Healthy India" was also organised. An invited lecture by Ms. Reema Banerjee, Programme Director, Centre for Environment & Education (East) on the occasion of 'World Technology Day' was also organised. A short drama titled "Swachhta in Workplace" was also organised by the staff and students of the Centre.

The Centre also celebrated the International Yoga Day on 21st June 2022 at Dining Hall of the Basundhara followed by a Yoga Competition with enthusiastic participation from the staff and students of the Centre.

A two day in-house training programme was organised for administrative staff members on Organisational Behaviour and Interpersonal Effectiveness on 4th & 5th August 2022 at the Centre. Faculty from Institute of Secretariat Training and Management, Department of Personnel & Training, New Delhi conducted the training programme.

Meetings of the Statutory Committees of the Centre held during FY 2022-23 :

i. The 65th Governing Body (GB) meeting of the Centre was held in hybrid mode on 09.09.2022.

ii. The 43rd Finance Committee (FC) meeting of the Centre was held on 07.09.2022.

iii. The 31st Academic & Research Programme Advisory Committee (ARPAC) meeting of the Centre was held on 06.03.2022.

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 available 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 Room and Dining Hall and Kitchen with modern facilities. 'Bhagirathi' also has an equipped Doctor's chamber from where the Medical Cell operates. The Centre has two hostels by the name 'Radhachura' and 'Krishnachura' and an Essential Staff Quarter (Subarnarekha) which provides hostel accommodation to approximately 32 and 122 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. The Centre provides accommodation to Post Doctoral Fellows, on request. The Integrated Hostel Building and Transit Quarter by the name 'Basundhara' is being moderately put into use through its dining hall facilities and housing of few faculty members, summer students 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.

While concluding, I express my sincere thanks to the three Deputy Registrars of Administration, Finance and Academic sections, all 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 day to day 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

Hindi (Rajbhasha) Implementation in the Centre

Activities of the Hindi Cell

The Centre implemented the provisions of the Official Language Act in the year 2022-23. 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 and important policy documents of the Centre have been translated in Hindi and are available in the Centre's hindi website. 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 2022. 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 – Mr. Shivam Mishra, Senior Research Fellow.
- 2nd Prize – Mr. Sabyasachi Mondal, Attendant.
- 3rd Prize – Mr. Shashank Shekhar Pandey, Junior Research Fellow.

On 14th September 2022 "Hindi Diwas Samaroh" was organised; Guest Lecturer, Shri M.K.Singh, IPS Officer, Kolkata, Dr. Parna Tarafdar, Assistant Professor, Hindi Department, Bangabashi College, Kolkata and Shri L.K.Singh, Pradhyapak, Rajbhasha Bibhag, Kolkata delivered a talk on the said occasion.

The Centre also organised four 'Hindi Workshops' pertaining to each quarter during 2022-2023: i) Talk on "Hindi Tankan ke Vividha Rup aur Karyalyeen Patrachar me Hindi ka Sahaj Prayog" by Shri Jitendra Prasad, Deputy Director, Hindi Shikshan Yojana, Rajbhasha Bibhag, Kolkata on 29.06.2022; ii) Talk on "Bartaman Paripreksshay me Hindi & Bharatiya Bhashao ka Bigyan aur Praddyoyogiki Bhasha Banane Sambandhe Chunatiya aur Samadhan" by Dr. Rajiv Kumar Rawat, Varishtha Hindi Adhikari, IIT, Kharagpur on 26.09.2022; iii) Talk on "Rajbhasha Hindi Ke Vikash me Paribhashik Shabdabali Ka Mahatvya" by Shri Ajay Kumar Prasad, Rajbhasha Prabandak, Reserve Bank of India, Kolkata on 06.12.2022; iv) Talk on "Rajbhasha Hindi: Paramparik Gyan se Artificial Intelligence aur uski Vyabhaharikata " by Shri Rajesh Kumar Shaw, Mukhya Prabandak (Rajbhasha), Coal India Limited, Kolkata on 17.03.2023.

Shohini Majumder
Registrar

COMMITTEES (As on 31.03.2023)

Governing Body

Prof. B.N.Jagatap Professor Department of Physics IIT Bombay, Mumbai	Chairman
Dr. Srivari Chandrashekhar Secretary Department of Science & Technology Government of India, New Delhi	Member
Prof. Prasanta K Panigrahi, Professor Department of Physical Sciences (DPS) Indian Institute of Science Education and Research, Kolkata	Member
Prof. Pallab Banerjee Professor Materials Science Centre, IIT, Kharagpur	Member
Dr. D.S. Ramesh Director IIG, Navi Mumbai	Member
Prof. Manoj Kumar Harbola Professor Dept. of Physics, IIT, Kanpur	Member
Shri Vishvajit Sahay Additional Secretary & Financial Advisor Department of Science & Technology Government of India, New Delhi	Member
Shri H.K. Dwivedi, IAS The Chief Secretary, Govt. of Wets Bengal	Member
Prof. Tanusri Saha-Dasgupta S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. (Dr.) Uday Bandopadhyay Director Bose Institute, Kolkata	Member
Prof. Tapas Chakraborty Director (Additional Charge) Indian Association for Cultivation of Science Kolkata	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Non-Member Secretary

Finance Committee

Prof. Tanusri Saha-Dasgupta Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Shri Vishvajit Sahay Additional Secretary & Finance Advisor Department of Science & Technology New Delhi	Member
Prof. Somak Raychaudhury Vice-Chancellor, Ashoka University (One Nominee of the Academic & Research Programme Advisory Committee	Member
Prof. Pallab Banerjee Professor Materials Science Centre, IIT, Kharagpur	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member Secretary

Academic & Research Programme Advisory Committee

Prof. Praveen Chaddah Former Director UGC-DAE Consortium for Scientific Research Indore	Chairman
Prof. Somak Raychaudhury Vice – Chancellor, Ashoka University	Member
Prof. Sanjay Puri Professor, JNU, New Delhi	Member
Prof. Amitabha Raychaudhuri Professor Emeritus, Calcutta University, Kolkata	Member
Prof. Satrajit Adhikari Professor, IACS, Kolkata	Member
Prof. Gautam Basu Former Senior Professor, Bose Institute, Kolkata	Member
Prof. S.M.Yusuf Scientific Officer (H+), BARC, Mumbai	Member
Prof. Tanusri Saha-Dasgupta Director S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Anjan Barman Dean (Faculty) S. N. Bose National Centre for Basic Sciences Kolkata	Member

Prof. Amitabha Lahiri Dean (Academic Programme) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Non –Member Secretary
Dr. Sunandan Gangopadhyay Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Punyabrata Pradhan Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Priya Mahadevan Head, Department of Condensed Matter Physics and Material Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Rajib K Mitra Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee

Building Committee

Prof. Tanusri Saha-Dasgupta Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairperson
Mr. Asim Sinha Chief Engineer (Retired), Electrical, CPWD	Member
Dr. R.K.Joshi Scientist 'F' Autonomous Institution Division Department of Science & Technology, New Delhi	Member
Dr. Tapash Kr. Roy Associate Professor, Dept. of Civil Engineering and Superintending Engineer (Acting), Indian Institute of Engineering Science and Technology Shibpur.	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member- Secretary

Mr. Mithilesh Pande Campus Engineer cum Estate Officer, SNBNCBS, Kolkata	Special Invitee
Mr. Suman Saha Deputy Registrar (Finance) SNBNCBS, Kolkata	Special Invitee

Consultative Advisory Committee

Prof. Tanusri Saha-Dasgupta Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairperson
Prof. Anjan Barman Dean (Faculty) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Amitabha Lahiri Dean (Academic Programme) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Punyabrata Pradhan Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Dr. Sunandan Gangopadhyay Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Rajib K Mitra Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Priya Mahadevan Head, Department of Condensed Matter Physics and Material Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member
Mr. Debashish Bhattacharjee Deputy Registrar (Administration) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Mr. Suman Saha Deputy Registrar (Finance) S. N. Bose National Centre for Basic Sciences Kolkata	Member

Ms. Nibedita Konar Deputy Registrar (Academic) S. N. Bose National Centre for Basic Sciences Kolkata	Member - Secretary

Official Language Implementation Committee

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

Academic members 2022-23

ACADEMIC MEMBERS (REGULAR FACULTIES) : 2022-2023

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
10	Jaydeb Chakrabarti	Senior Professor : PCS
11	Prosenjit Singha Deo	Professor : PCS
12	Soumen Mondal	Professor : AHEP
13	Rajib Kumar Mitra	Professor : CBS
14	Manik Pradhan	Professor : CBS
15	Punyabrata Pradhan	Professor : PCS
16	Barnali Ghosh (Saha)	Scientist 'F'
17	Manoranjan Kumar	Professor : CMMP
18	Sakuntala Chatterjee	Associate Professor : PCS
19	Ramkrishna Das	Associate Professor : AHEP
20	Sunandan Gangopadhyay	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 [From 13.06.2022]	Associate Professor : PCS
25	Sanjoy Choudhury	Scientist 'D'
26	Urna Basu	Assistant Professor : PCS
27	Tapas Baug	Assistant Professor : AHEP
28	Nitesh Kumar	Assistant Professor : CMMP
29	Avijit Chowdhury	Assistant Professor : CMMP
30	Pradip S Pachfule	Assistant Professor : CBS
31	Arijit Haldar [From 05.09.2022]	Assistant Professor : PCS
32	Saquib Shamim [From 06.10.2022]	Assistant Professor : CMMP

ADVANCED POST DOCTORAL RESEARCH PROGRAMME (APRP) : 2022-2023 [as on 31.03.2023]

Sl. No.	Name	Status	Dept.	Mentor
1	Ajit Kumar Sahoo	PDRA –I (from 21.11.2022 --)	CMMP	Prof. Anjan Barman
2	Akhtar Alam	PDRA –I (from 15.11.2022 --)	CBS	Dr. P. S. Pachfule
3	Alik Panja	Bridge Fellow (From 15.09.2022)	AHEP	Dr. Tapas Baug
4	Aravindan V	PDRA –I (from 09.03.2023 --)	CMMP	Prof. Tanusri Saha Dasgupta
5	Arijit Mondal	PDRA –II (from 01.03.2023 --)	PCS	Prof. Jaydeb Chakrabarti
6	Arpan Bhattacharyya	PDRA – I (Till 10.12.2022)	CMMP	Prof. Anjan Barman
7	Arun Kumar Maurya	PDRA –I (from 01.12.2022 --)	CMMP	Prof. Tanusri Saha Dasgupta
8	Ashadul Halder	PDRA – I (from 18.05.2022 --)	AHEP	Prof. Archan Majumdar
9	Ashmita Das	PDRA – III (from 11.05.2022 --)	AHEP	Dr. Sunandan Gangopadhyay
10	Bijoy N	PDRA –I (from 28.11.2022 --)	CMMP	Prof. Priya Mahadevan
11	Buddhadeb Pal	PDRA – I (Till 19.08.2022)	CMMP	Dr. Atindra Nath Pal
12	Didhiti Bhattacharya	Bridge Fellow (From 27.09.2022)	CMMP	Dr. Avijit Chowdhury
13	Dharmesh Jain	PDRA –III (Till 01.04.2022)	PCS	Dr. Sunandan Gangopadhyay
14	Dhrimadri Khata	Bridge Fellow (Till 28.09.2022)	AHEP	Prof. Soumen Mondal
15	Dusmanta Patra	PDRA –I (from 26.04.2021 --)	AHEP	Prof. Soumen Mondal
16	Gargee Bhattacharyya	PDRA –II (Till 05.01.2023)	CMMP	Prof. Priya Mahadevan
17	Ipsita Basu	PDRA –II (Till 27.05.2022)	CBS	Dr. Suman Chakrabarty
18	Indrani Bhattacharya	PDRA –I (Till 27.12.2022)	CBS	Prof. Rajib K Mitra
19	Jayeta Banerjee	PDRA –II (from 01.02.2023 --)	CBS	Prof. Ranjit Biswas
20	Koushik Mondal	PDRA –I (from 30.10.2022 --)	CBS	Prof. Manik Pradhan
21	Mahima Singh	PDRA – I (from 20.07.2022 --)	CMMP	Dr. Nitesh Kumar
22	Mayukh K Ray	PDRA –III (Till 28.02.2023)	CMMP	Dr. Nitesh Kumar
23	Milan Sil	PDRA –I (from 06.05.2022 --)	AHEP	Dr. Ramkrishna Das
24	Mily Kundu	PDRA – I (from 03.02.2023 --)	CMMP	Prof. Kalyan Mandal
25	Mustaque Ali Khan	PDRA – I (from 12.07.2021 --)	CMMP	Dr. Barnali Ghosh (Saha)
26	Partha Pyne	Bridge Fellow (Till 18.01.2023)	CBS	Dr. P. S. Pachfule
27	Piyali Saha	PDRA – I (Till 15.09.2022)	AHEP	Dr. Tapas Baug
28	Priyanka Garg	PDRA – I (Till 30.06.2022)	CMMP	Prof. Priya Mahadevan
29	Prasanta Kundu	PDRA –II (from 26.04.2021 --)	CBS	Prof. Gautam Gangopadhyay
30	Puspendu Barik	PDRA –III (from 10.05.2022 --)	CBS	Prof. Manik Pradhan
31	Ritamay Bhunia	PDRA –III (from 09.02.2023 --)	CMMP	Dr. Avijit Chowdhury
32	Rituparna Mandal	Bridge Fellow (from 09.01.2023--)	CBS	Prof. Gautam Gangopadhyay
33	Ruchi Pandey	Bridge Fellow (Till 23.12.2022)	AHEP	Dr. Ramkrishna Das
34	Saheli Samanta	Bridge Fellow (from 13.03.2023--)	CMMP	Prof. Manoranjan Kumar
35	Samrat Ghosh	Bridge Fellow (from 25.08.2022--)	AHEP	Prof. Soumen Mondal
36	Sambunath Das	PDRA – I (Till 20.03.2023)	CMMP	Prof. Manoranjan Kumar
37	Sk. Md. Obaidulla	PDRA – II (from 01.12.2022--)	CMMP	Dr. Atindra Nath Pal
38	Sk. Samir Ahamed	PDRA – I (from 01.02.2023--)	CBS	Dr. Suman Chakrabarty

Sl. No.	Name	Status	Dept.	Mentor
39	Shibendu Gupta Choudhury	PDRA – I (from 14.02.2023--)	AHEP	Prof. Amitabha Lahiri
40	Shreya Das	Bridge Fellow (Till 25.11.2022)	CMMP	Prof. Tanusri Saha Dasgupta
41	Snehamoyee Hazra	Bridge Fellow (from 27.02.2023--)	CMMP	Dr. Barnali Ghosh (Saha)
42	Subhadip Chakrabarty	PDRA –I (Till 23.01.2023)	CBS	Prof. Rajib K Mitra
43	Soumi Das	PDRA – I (from 20.06.2022--)	PCS	Prof. Jaydeb Chakrabarti
44	Soumya Chakrabarti	PDRA –II (Till 28.10.2022)	PCS	Prof. Amitabha Lahiri
45	Sudip Kr. Saha	Bridge Fellow (Till 27.09.2022)	CMMP	Prof. Manoranjan Kumar
46	Sumanti Patra	Bridge Fellow (Till 28.02.2023)	CMMP	Prof. Priya Mahadevan
47	Sutapa Saha	PDRA – I (from 01.03.2023--)	AHEP	Prof. Archan S Majumdar
48	Tanmoy Paul	PDRA –III (Till 01.08.2022)	CMMP	Prof. Tanusri Saha Dasgupta
49	Tapas Sahoo	PDRA –III (from 10.05.2022 --)	CBS	Prof. Gautam Gangopadhyay
50	Tonima Nandy	PDRA –I (from 06.05.2022 --)	CBS	Prof. Ranjit Biswas
51	Tirthendu Sinha	PDRA – I (from 01.11.2022--)	AHEP	Dr. Tapas Baug
52	Tridib Roy	PDRA – I (from 17.01.2023--)	AHEP	Dr. Ramkrishna Das
53	Tushar Kanti Bhowmik	PDRA – I (from 02.02.2023--)	CMMP	Dr. T. Setti
54	Vishal K Aggaarwal	Bridge Fellow (Till 20.10.2022)	CMMP	Prof. Manoranjan Kumar

NPDF/ RESEARCH ASSOCIATE (EXTERNAL FUND) : 2022-2023

SL. NO.	NAME	DESIGNATION	STATUS	DEPT.	MENTOR
1	Anuvab Banerjee	Research Associate – I	Till 14.11.2022	AHEP	Dr. Debanjan Bose
2	Dr. Asmita Kumari	Research Associate – I (Adhoc)	Till 20.03.2022	AHEP	Prof. Archan S Majumdar
3	Dr. Debashis Saha	National Post-Doctoral Fellow	Till 12.08.2022	AHEP	Prof. Archan S Majumdar
4	Dr. Dipayan Sen	Research Associate – III	Till 31.01.2023	CMMP	Prof. Tanusri Saha Dasgupta
5	Dr. Indrani Bhattacharyya	National Post-Doctoral Fellow	From 28.12.2022	CBS	Prof. Rajib K Mitra
6	Dr. Gargee Bhattacharyya	National Post-Doctoral Fellow	From 06.01.2023	CMMP	Prof. Priya Mahadevan
7	Dr. Jayeta Banerjee	National Post-Doctoral Fellow	Till 30.12.2022	CBS	Prof. Manik Pradhan
8	Dr. Mir Alimuddin	Chanakya PDF	From 13.06.2022	PCS	Dr. Manik Banik
9	Dr. Partha Nandi	Research Associate – I (Adhoc)	Till 30.11.2022	AHEP	Prof. Archan S Majumdar
10	Dr. Sanjukta Paul	Research Associate – I	Till 06.12.2022	CMMP	Prof. Priya Mahadevan
11	Dr. Soumendu Datta	Research Associate – III	From 25.08.2021	CMMP	Prof. Tanusri Saha-Dasgupta
12	Dr. Soumya Bhattacharya	Research Associate – I	From 04.04.2022	AHEP	Prof. Rabin Banerjee
13	Dr. Sourav Chakraborty	Research Associate – I (Adhoc)	From 05.12.2022	CMMP	Prof. Manoranjan Kumar
14	Dr. Sumit Nandi	Research Associate – I	Till 04.07.2022	AHEP	Prof. Archan S Majumdar
15	Dr. Sumit Halder	Research Associate – I	Till 02.12.2022	CMMP	Prof. Manoranjan Kumar
16	Shreya Das	Research Associate – I (Adhoc)	Till 09.07.2022	CMMP	Prof. Tanusri Saha-Dasgupta
17	Dr. Upasana Das	National Post-Doctoral Fellow	From 26.12.2022	CBS	Dr. P. S. Pachfule

EMERITUS / Others Contractual Faculty / DST (INSPIRE) / RAMANUJAN FELLOW etc.: 2022-2023

SL. NO.	NAME	STATUS	DEPT.
1	Prof. Rabin Banerjee	Raja Ramanna Fellow	AHEP
2	Prof. Goutam De	Emeritus Professor, till 15.01.2023; Visiting Professor from 16.01.2023	CBS
3	Prof. Prabhat Mandal	Emeritus Professor	CMMP
4	Prof. Subhrangshu Sekhar Manna	Visiting (Honorary) Fellow, till 31.01.2023	PCS
5	Prof. Ranjan Chaudhury	Visiting (Honorary) Fellow, till 31.12.2022	CMMP
6	Prof. P.K. Mukhopadhyay	Visiting (Honorary) Fellow, till 31.12.2022	CMMP
7	Prof. M. Sanjay Kumar	Visiting (Honorary) Fellow, till 01.08.2022	PCS
8	Prof. Samit Kr. Ray	Adjunct Faculty	CMMP
9	Prof. Partha Guha	Adjunct Faculty	PCS
10	Dr. Goutam Sheet	Adjunct Fellow	CMMP
11	Dr. Subhro Bhattacharjee	Adjunct Fellow	CMMP
12	Dr. Indranil Sarkar	Adjunct Fellow	CMMP
13	Dr. Anup Ghosh	DST INSPIRE Faculty	CMMP
14	Dr. Dipanwita Majumdar	DST INSPIRE Faculty	CMMP
15	Dr. Suman Chowdhury	DST INSPIRE Faculty, from 10.10.2022	CMMP
16	Dr. Sujoy Kr. Ghosh	DST INSPIRE Faculty, from 09.03.2023	CMMP
17	Dr. Debanjan Bose	Ramanujan Fellow, till 14.11.2022	AHEP
18	Dr. Ali Hossain Khan	Ramanujan Fellow	CBS
19	Dr. Manoj Mandal	Ramalingaswami Re-entry Fellow	CBS

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

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 *[joined on 02.05.2022]*
Bijoy Kumar Pramanik	Junior Assistant (Guest House)
Bhupati Naskar	Library Stack Assistant
Siddhartha Chatterjee	Upper Division Clerk
Swarup Dutta	Project Assistant
Sushanta Kumar Biswas	Driver *[superannuated on 28.02.2023]*
Partha Mitra	Attendant *[superannuated on 31.07.2022]*
Amit Ghosh	Attendant *[joined on 01.06.2022]*
Swapan Ghosh	Attendant
Rajarshi Barman	Attendant
Sabyasachi Mondal	Attendant
Suprobhat Naskar	Attendant *[joined on 17.02.2023]*

PERSONNEL WITH TEMPORARY STATUS

Dulal Chatterjee	Attendant (Maintenance)
Somnath Roy	Attendant (Accounts) *[superannuated on 30.04.2022]*
Sudhanshu Chakraborty	Attendant (Technical Cell)
Hiralal Das	Cleaner
Kartick Das	Cleaner
Motilal Das	Cleaner
Prakash Das	Cleaner
Ramchandra Das	Cleaner
Biswanath Das	Gardener
Nimai Naskar	Gardener

PERSONNEL ON CONTRACTUAL APPOINTMENT

A.K.Sarkar	Advisor (Finance)
B.S.Panda	Consultant (Legal)
Ayan Deb	Assistant Engineer (Electrical)
Sutapa Basu	PS to Registrar
Abhijit Ghosh	Junior Computer Engineer
Sagar Samrat De	Junior Computer Engineer
Deblina Mukherjee	Junior Computer Engineer
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
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. Debarghya Ghosh – Technical Assistant
Mr. Sourav Sinha – Technical Assistant
Mr. Aditya Maitra – Technical Assistant
Mr. Subhabrata Das – Mechanic
Mr. Gobinda Das – Driver
Mr. Pintu Saha – Driver

Medical Cell (Consultant Physicians)

Dr. Chayan Bhattacharya	Authorised Medical Officer
Dr. Sarbani Bhattacharya	Medical Officer
Dr. Tridib Kumar Sarkar	Doctor of Homeopathy

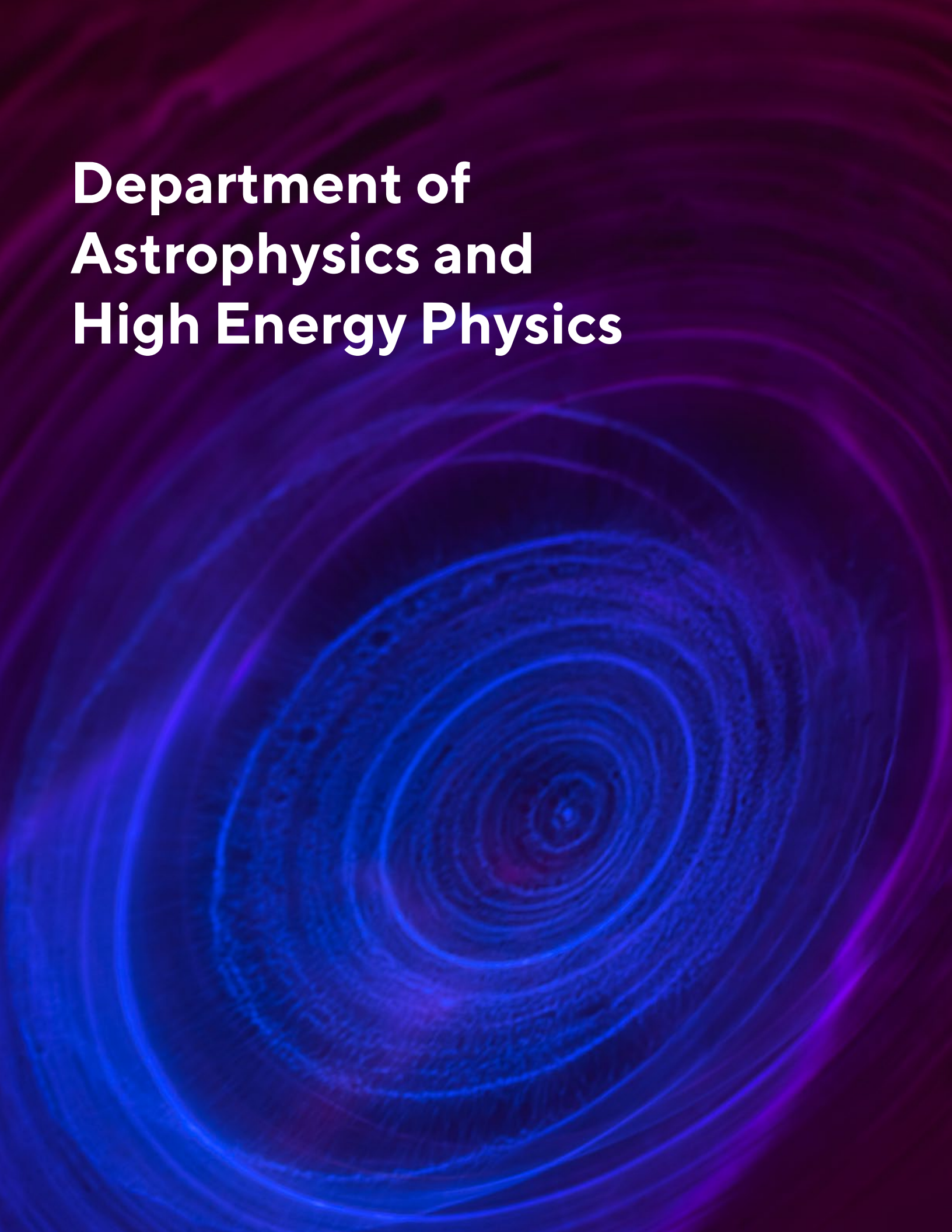
Staff members of the Centre

Staff members, Administrative Section

Staff members, Purchase Section

Staff members, Computer Services Cell

Department of Astrophysics and High Energy Physics



Department of
Astrophysics and High Energy Physics

Sunandan Gangopadhyay

Department profile indicators

Table A: Manpower and resources

Number of faculty members	6
Number of Post –doctoral research associate (centre+project)	14
Number of Ph.D students	49
Number of other project staff	0
Number of summer students	14
Projects (ongoing)	4

Table B: Research Activities indicators

Number of research papers in Journals	47
Number of Book-chapters/books	0
Number of other publications	1
Number of Ph.D students graduated (submitted+degree awarded)	11+5=16
Number of M.Tech/M.Sc projects	5

Table C: Academic activities and linkage

Number of courses taught by faculty members	15	
Number of Visitors (non –associates)	0	
Number of associates	0	
Number of Seminars organized	20	
Number of Conference/Symposia/Advanced Schools organized	5	
Number of talks delivered by members of department in conferences/Symposia	National	18
	International	2

Most important research highlights

- The dynamics of fermions on a curved spacetime using a first order formulation of gravity using tetrads and spin connection have been explored.
- Some consequences of the interaction between fermions and vortices when the degrees of freedom of the system are confined to a 2-d surface have been investigated. This work was published in Nuclear Physics B, 986, 116050, 2023.
- The late time cosmology of the Friedmann-LeMaitre-Robertson-Walker universe have been looked at taking into account quantum gravitational effects in the renormalization group flow approach to quantum gravity. This work was published in European Physical Journal Plus, 137, 1110, 2022.
- Propagation of gravitational waves in the late time Universe with the presence of structure have been investigated. In particular, the effect of inhomogeneities on the observables associated with the gravitational waves sources, employing the Buchert's framework of averaging have been studied. This work was published in Journal of Cosmology and Astroparticle Physics, 6, 021, 2022.
- Investigation of the global 21-cm brightness temperature in the context of viscous dark energy models have been carried out. This work was published in Journal of Cosmology and Astroparticle Physics, 2022, 049, 2022.
- A protocol for certification of arbitrary d-outcome quantum measurements in a setup comprising of a preparation followed by two measurements in sequence have been established.
- A new model of relativistic quantum analogue of the classical Otto engine in the presence of a perfectly reflecting boundary have been introduced. It has been shown that in spite of the reduced work output, the efficiency of the engine remains unaltered even in the presence of the boundary. This work got published in Journal of High Energy Physics, 2022, 105, 2022.
- Bell's inequality violation by dynamical Casimir radiation in a circuit quantum electrodynamical set-up have been shown. This work got published in Physical Review A, 106, 042224, 2022
- The phenomenon of acceleration radiation exhibited by an atom falling into a quantum corrected Schwarzschild black hole have been explored. The horizon brightened acceleration radiation entropy (HBAR) for this quantum corrected black hole geometry is obtained. The HBAR entropy has a form identical to that of Bekenstein-Hawking black hole entropy along with universal quantum gravity corrections. This work got published in Physical Review D 105, 085007, 2022.
- The virtual transition of an atom-mirror system with the simultaneous emission of two scalar photons, where the atom and the mirror admit a relative acceleration between them, have been examined.
- The thermodynamics of a Born-Infeld AdS black hole using inputs from the dual boundary field theory have been studied in details. This work got published in PRD 106, 026005, 2022.
- Spectroscopic study of different astronomical objects, e.g. Novae, Planetary Nebulae, massive stars etc. have been investigated. The data are analyzed and modeled using different astronomical codes.
- The evolution of the optical spectra of RS Ophiuchi over a month after its most recent (2021) outburst have been studied.
- The photodissociation region have been investigated around planetary nebulae by constructing a grid model with different varying parameters, e.g. effective temperature, source luminosity; density of the nebula.
- To produce superflare events, the required magnetic field strength, which is coming out in order of a few 100 G, have been calculated. Such superflares have a strong effect on the habitability of planets around M-dwarfs.
- The optical R-band (700 nm) polarization observations of LDN 1616 cometary cloud developed by massive OB stars have been analysed.

Summary of research activities

Investigations carried out in the theoretical physics side :

It has been shown earlier that dualizing a 3+1-d boson-fermion system leads to fermions and vortices interacting via a higher gauge field through a non-local term. Some consequences of that interaction when the degrees of freedom of the system are confined to a 2-d surface have been explored. It has been shown that the vortices are now attached to the fermions via their spin magnetic

moment in a way similar to the phenomenon of flux attachment in Chern-Simons gauge theory coupled to matter.

The dynamics of fermions on a curved spacetime using a first order formulation of gravity using tetrads and spin connection have been considered. Earlier it has been shown that this resulted in usual Einstein gravity, but with an effective four-fermion interaction, when the torsion part of the spin connection eliminated. The group in our department have shown that when passing through a thermal background of matter, the generic form of this interaction contributed to the effective neutrino mass, which would affect the neutrino oscillation parameters.

The group in the department have also studied the late time cosmology of the FLRW universe, taking into account quantum gravitational effects in the renormalization group flow approach to quantum gravity. The quantum corrected scale factor, energy density, and entropy production at late times were calculated and it was found that different choices of cut-off functions resulted in different late time cosmologies. In another work, the quantum corrected two-body Newtonian gravitational potential was considered to derive the modified Friedmann equations starting from the non-relativistic conservation of kinetic energy and potential energy for an infinitesimal mass. It was found that the scale factor behaves like the classical one for dust and radiation, but differs noticeably in the case of a cosmological constant dominated universe.

The propagation of gravitational waves in our late time Universe with the presence of structure was considered. The effect of inhomogeneities on the observables associated with the gravitational waves sources, employing the Buchert's framework of averaging was investigated. It has been shown that the variation of the gravitational wave amplitude with respect to red shift can deviate significantly in comparison with that of the standard cosmological model. The result signifies the importance of local inhomogeneities on precision measurements of parameters of gravitational wave sources.

Investigate of the global 21-cm brightness temperature in the context of viscous dark energy (VDE) models was considered. The bulk viscosity of dark energy perturbs the Hubble evolution of the Universe which could cool baryons faster, and hence, alter the 21-cm brightness temperature. Bounds on the VDE model parameters which can account for the observational excess of the EDGES experiment were obtained by members of the group.

Certification of quantum devices received from unknown providers is a primary requirement before utilizing the devices for any information processing task. In this context a protocol for certification of arbitrary d-outcome quantum measurements in a setup comprising of a preparation followed by two measurements in sequence was given.

A new model of relativistic quantum analogue of the classical Otto engine in the presence of a perfectly reflecting boundary was introduced. It has been shown that in spite of the reduced work output, the efficiency of the engine remains unaltered even in the presence of the boundary.

The phenomenon of acceleration radiation exhibited by an atom falling into a quantum corrected Schwarzschild black hole was investigated. The excitation probability of an atom with the simultaneous emission of a photon satisfies the equivalence principle when compared to the excitation probability of a mirror accelerating with respect to an atom. The validity of the equivalence principle for a generic black hole geometry was demonstrated. The horizon brightened acceleration radiation entropy (HBAR) for this quantum corrected black hole geometry was obtained. The HBAR entropy has a form identical to that of Bekenstein-Hawking black hole entropy along with universal quantum gravity corrections.

The near horizon aspects (and beyond) of a black hole metric, belonging to a large class of static spherically symmetric black holes was investigated.The near horizon approximation leads to conformal symmetry in the problem. In the study, going beyond the near horizon approximation was implemented, which breaks the conformal symmetry associated with the near horizon physics of the black hole geometry. It was observed that even without the consideration of the conformal symmetry, the modified equivalence relation holds. The probability of virtual transition retains its Planck-like form with the amplitude getting modified due to the beyond near horizon approximation.

The thermodynamics of a Born-Infeld AdS black hole using inputs from the dual boundary field theory was investigated. Here, the cosmological constant and Newton's gravitational constant were varied along with the Born-Infeld parameter in the bulk.

Investigations carried out in the observational astrophysics side :

Study of 2021 outburst of RS Ophiuchi (RS Oph): RS Oph is a well-known Galactic recurrent nova with an average recurrence time-scale of about 15 years. The system has a CO-type white dwarf (WD) with a mass in the range of 1.2 – 1.4 times solar mass. The WD is most likely increasing in mass due to the accumulation of a fraction of accumulated matter on its surface. Eventually, it may approach the Chandrasekhar limit and explode as a Type Ia supernova. We have studied the evolution of the optical spectra of RS Oph, over a month after it's most recent (2021) outburst. From the evolution of line widths an expanding shocked material into the winds of the red giant companion was detected. This expands freely for 4 days, and afterwards, the shock velocity decreased monotonically with time. The spectra were modeled using the photoionization code CLOUDY.

Stars form in clustered environments within giant molecular clouds. Internal gravitational dynamics prompts cloud fragmentation, with each fragment then collapsing and leading to the onset of prestellar core formation. Alternatively, propagation of the ionizing or explosive shocks from massive stars may compress neighboring clouds, hence triggering the next generation star formation. Molecular clouds exhibit complex geometries, including substructures such as sheets and filaments to elongated networks. The turbulence from expanding H II regions near a filamentary molecular cloud can generate sequential waves of star-forming cores along the long axis of the filament on either side of an H II region, The young protostars are preferentially aligned along the filamentary axis, bearing the imprint of fragmentation of the parental cloud. We study the star formation activity around H II region Sh2-112, is illuminated by the massive star(O8 V)BD+45 3216. The associated molecular cloud extends in angular scales of 2°.0 × 0°.83, corresponding to linear sizes of 73 pc by 30 pc, along the Galactic longitude. The high-resolution (30″) extinction map reveals a chain of dust clumps aligned with the filament-like structure with an average extinction of AV∼2.78 mag, varying up to a maximum of∼17 mag. Our analysis led to identification of a rich population(∼500)of young(average age of ∼1 Myr)stars, plus a numerous number(∼350)of Hα emitters, spatially correlated with the filamentary clouds. Located near the edge of the cloud, the luminous star BD+45 3216 has created an arc-like pattern as the ionizing radiation encounters the dense gas, forming a blister-shaped morphology. Three distinct young stellar groups, all coincident with relatively dense parts of the cloud complex, signifying ongoing star formation were found.

Optical R-band (700 nm) polarization observations of LDN 1616 cometary cloud developed by massive OB stars were analysed. Individual plane-of-sky position angles do not show any preferred alignment. However, their mean values for a 5x5 square-arc-minutes gird follow the large-scale cloud structure. Such alignment indicates a possible scenario for the initial direction of the magnetic field lines perpendicular to the direction of the ionizing radiation and might have been dragged later.

Sunandan Gangopadhyay

Head,
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; Thesis submitted
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. Saurav Kantha; Some applications of quantum field theory to condensed matter physics (tentative); Under progress
6. Sagar Maity; Collapse and singularity in Einstein-Cartan gravity; Under progress

b) Post-Docs

1. Soumya Chakrabarti; Gravitation and Cosmology
2. Shibendu Gupta Choudhury; Gravitation and Cosmology

Teaching

1. Autumn semester; Quantum Mechanics I; Integrated PhD; 11 students

Publications

a) In journals

1. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta, *Pushforwards and gauge transformations for categorical connections*, Theory and Applications of Categories, 38(25), 1015, 2022
2. Rituparna Mandal, Sunandan Gangopadhyay and **Amitabha Lahiri**, *Cosmology with modified continuity equation in asymptotically safe gravity*, The European Physical Journal Plus, 137, 1110, 2022
3. Soumya Chakrabarti and **Amitabha Lahiri**, *Scalar-fermion interaction as the driver of cosmic acceleration*, Physics of the Dark Universe, 37, 101121, 2022
4. Shantonu Mukherjee and **Amitabha Lahiri**, *Spin-flux attachment by dimensional reduction of vortices*, Nuclear Physics B, 986, 116050, 2023
5. Rituparna Mandal, Sunandan Gangopadhyay, **Amitabha Lahiri**, *Newtonian cosmology from quantum corrected Newtonian potential*, Physics Letters B, 839, 137807, 2023
6. Indrajit Ghose, Riya Barick and **Amitabha Lahiri**, *Neutrino Oscillation Caused by Spacetime Geometry*, Letters in High Energy Physics, 2023, 349, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Beyond Standard Model Physics from Chiral Torsion, HSF-India meeting; Jan 17, 2023; SNBNCBS; 20 min
2. Duality, vortex strings, and fermion pairing; Aug 30, 2022; IFW, Dresden; 40 min

Administrative duties

1. Dean (Academic Programme)
2. Chairman, Grievance redressal committee, SNBNCBS

Conference / Symposia / Schools organized

1. Two day meeting on HSF-India; Jan 16, 2023; SNBNCBS; Jan 16-17, 2023

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

1. IISER Thiruvananthapuram; Sl. No. 1; National
2. University of Connecticut; Sl. No. 1; International

Outreach program organized / participated

1. Talk delivered on "Gauge invariance in quantum mechanics" at the C.K. Majumdar Memorial Summer Workshop, 13 July 2022, SNBNCBS
2. Talk delivered on "Quark Confinement and Superconductivity" at the "Contemporary issues in Physics" refresher course workshop for college teachers, 24 February, 2023, Jadavpur University

Areas of Research

Quantum Field Theory, Gravitation, Mathematical Physics

Quantum Field Theory: We had shown earlier that dualizing a 3+1-d boson-fermion system leads to fermions and vortices interacting via a higher gauge field through a non-local term. Now we explored some consequences of that interaction when the degrees of freedom of the system are confined to a 2-d surface. We showed that the vortices are now attached to the fermions via their spin magnetic moment in a way similar to the phenomenon of flux attachment in Chern-Simons gauge theory coupled to matter. We also show that such flux attached particles exhibit fractional statistical behaviour like anyons. Thus our model provides a realization of anyons without Chern-Simons theory.

In another work, we considered the dynamics of fermions on a curved spacetime using a first order formulation of gravity using tetrads and spin connection. We had earlier shown that this resulted in usual Einstein gravity, but with an effective four-fermion interaction, when the torsion part of the spin connection was eliminated. Here we showed that when passing through a thermal background of matter, the generic form of this interaction contributed to the effective neutrino mass, which would affect the neutrino oscillation parameters.

Gravitation and cosmology: We studied the late time cosmology of the Friedmann-LeMaitre-Robertson-Walker universe, taking into account quantum gravitational effects in the renormalization group flow approach to quantum gravity.We calculated the quantum corrected scale factor, energy density, and entropy production at late times and found that different choices of cut-off functions result in different late time cosmologies. In another work, we considered the quantum corrected two-body Newtonian gravitational potential and derived the modified Friedmann equations starting from the non-relativistic conservation of kinetic energy and potential energy for an infinitesimal mass. We found that the scale factor behaves like the classical one for dust and radiation, but differs noticeably in the case of a cosmological constant dominated universe.

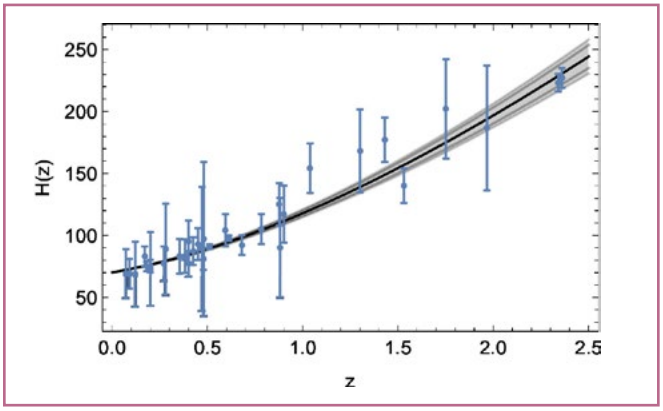


Fig. Plot of the reconstructed Hubble parameter H(z) as a function of redshift along with observational data points. The thick black line is for best fit parameter values and the gray regions are for associated 2σ and 3σ confidence regions.

We also studied the effect on cosmology of a fermionic field with a Yukawa-type interaction with a scalar, as well as self interactions. We found that the fermion density decays with cosmic time. We computed the behaviour of various cosmological parameters and compared them with observational data, resulting in some constraints on the scalar-fermion interaction profile and on the overall cosmological dynamics.

Mathematical physics: As part of a long-running programme of studying categorical gauge theories based on fiber bundles on the space of directed paths on a manifold, we investigated the pushforward of a categorical connection from one bundle to another. For the case of categorical bundles arising from decorated path spaces in principal bundles, we found that the pushforward was equivalent to a traditional gauge transformation plus an affine translation.

Plan of Future Work Including Project

1. Quantum Field Theory: I plan to continue working on the interacting electron vortex system. In particular, we plan to investigate what happens at interfaces of such systems when a flux tube ends at the interface, or when electrons and vortices confined to the interface interact. We plan to use the dualised version of the system found earlier, as well as the undualised version, depending on the problem at hand.
2. We plan to investigate further consequences of the four-fermion interaction which appeared in our investigations of the dynamics of fermions on curved spacetimes. We plan to calculate its effect on neutrino oscillations and also on parity-violating processes in high energy particle physics.
3. Gravitation: We plan to investigate the effect of spacetime torsion and the associated four-fermion interaction on models of collapse. It seems that collapse of a fermionic gas, in which the particles obey Dirac equation, has not been investigated before.
4. Mathematical physics: We plan to continue our work on categorical geometry and its application to categorical gauge theory and also to extend it to applications in other physical theories.

Any other Relevant Information including social impact of research

1. Like all research in basic science, my work adds to what we know about the universe and the theories that describe it. It leads to answers of questions about how particles with half-integer spin, like electrons and neutrinos, are affected by curved space time. It will suggest corrections that have to be added to predictions of scattering cross-sections of high energy particles and provide new explanations for matter-antimatter asymmetry seen in the universe. My works suggest a path from fundamental physics of electrons and photons, described by quantum field theory, to low energy quantum physics of superconducting systems. They also provide some idea of how to use theories of quantum gravity in cosmological models. In mathematics my work contributes to the geometrical understanding of the description and dynamics of extended objects like charged strings. In addition, 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
archan@bose.res.in

Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

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

b) Post-Docs

1. Debashis Saha; Quantum Foundations
2. Debarshi Das; Quantum Information
3. Ashadul Halder; Gravitation and Cosmology
4. Sumit Nandi; Quantum Foundations
5. Sutapa Saha; Quantum Information

c) External Project Students / Summer Training

1. Soumit Roy; A study on Quantum Information Theory
2. Nandita Debnath; Magnetic field induced Schrodinger cat states in quantum Hall systems

Teaching

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

Publications

a) In journals

1. 1. Debarshi Das, Ananda G. Maity, Debashis Saha, and **A. S. Majumdar**, *Robust certification of arbitrary outcome quantum measurements from temporal correlations*, Quantum, 6 716, 2022
2. 2. Shashank Shekhar Pandey, Arnab Sarkar, Amna Ali and **A.S. Majumdar**, *Effect of inhomogeneities on the propagation of gravitational waves from binaries of compact*

objects, Journal of Cosmology and Astroparticle Physics, 6, 021, 2022

3. =Arnab Mukherjee, Sunandan Gangopadhyay and **A. S. Majumdar**, *Unruh quantum Otto engine in the presence of a reflecting boundary*, Journal of High Energy Physics, 2022, 105, 2022
4. Ashadul Halder, Shashank Shekhar Pandey and **A.S. Majumdar**, *Global 21-cm brightness temperature in viscous dark energy models*, Journal of Cosmology and Astroparticle Physics, 2022, 049, 2022
5. Riddhi Chatterjee and **A. S. Majumdar**, *Bell-inequality violation by dynamical Casimir photons in a superconducting microwave circuit*, Physical Review A, 106, 042224, 2022
6. Subhankar Bera, Ananda G. Maity, Shiladitya Mal, and **A. S. Majumdar**, *Role of nonclassical temporal correlation in powering quantum random access codes*, Physical Review A, 106, 042439, 2022
7. Arun Kumar Das, Debarshi Das, Shiladitya Mal, Dipankar Home and **A. S. Majumdar**, *Resource-theoretic efficacy of the single copy of a two-qubit entangled state in a sequential network*, Quantum Information Processing, 21, 381, 2022
8. Sumit Nandi, Debashis Saha, Dipankar Home, and **A. S. Majumdar**, *Wigner-approach-enabled detection of multipartite nonlocality using all different bipartitions*, Physical Review A, 106, 062203, 2022
9. A. Chanda, A. Halder, **A. S. Majumdar** and B. C. Paul, *Late time cosmology in f(R,G) gravity with exponential interactions*, The European Physical Journal C, 83, 23, 2023
10. Subhankar Bera, Shashank Gupta and **A. S. Majumdar**, *Device-independent quantum key distribution using random quantum states*, Quantum Information Processing, 22, 109, 2023
11. Shashank Gupta, Debashis Saha, Zhen-Peng Xu, Adán Cabello, and **A. S. Majumdar**, *Quantum Contextuality Provides Communication Complexity Advantage*, Physical Review Letters, 130, 080802, 2023

b) Independent publications of student/s

1. Shubhayan Sarkar and Debashis Saha, *Demonstration of quantum correlations that are incompatible with absoluteness of measurement*, Physical Review A, 107, 022226, 2023
2. Shashank Gupta, *Genuine three qubit Einstein-Podolsky-Rosen steering under decoherence: revealing hidden genuine steerability via pre-processing*, Quantum Information Processing, 22, 49 2023
3. Yash Wath, M. Hariprasad, Freya Shah & Shashank Gupta, *Eavesdropping a quantum key distribution network using sequential quantum unsharp measurement attacks*, The European Physical Journal Plus, 138, 54, 2023
4. Debarshi Das and Somshubhro Bandyopadhyay, *Quantum communication using a quantum switch of quantum switches*, Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, 478, 2266, 2022
5. Pratapaditya Bej, Arkaprabha Ghosal, Arup Roy, Shiladitya Mal, and Debarshi Das, *Creating quantum correlations in generalized entanglement swapping*, Physical Review A, 106, 022428, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. QuEST Theme I Workshop; Apr 2, 2022; IISER Mohali; 60 mins
2. National Symposium on Quantum Computing, Quantum Information Science and Quantum Technology; Apr 12, 2022; IIIT Hyderabad; 60 mins
3. Training Programme on Quantum Computing; May 25, 2022; Institte of Technology, Ahmedabad; 120 mins
4. International Conference on Quantum Information and Quantum Technology; Jun 24, 2022; IISER Kolkata; 60 mins
5. Workshop on Quantum Metrology and Quantum Information Processing; Aug 25, 2022; CDAC Kolkata; 45 mins
6. Brainstormimng session on Quantum Science and Technologies; Nov 11, 2022; RRI Bangalore; 25 mins
7. IITB-SNBNCBS Collaborative meeting; Jan 9, 2023; IIT Bombay; 30 mins
8. Distinguished Lecture on recent developments in quantum information science; Mar 3, 2023; Adamas University; 60 mins

9. 12th Field Theoretic Aspects of Gravity (FTAG) conference; Mar 17, 2023; BIT Mesra; 45 mins

Administrative duties

1. HoD, DAHEP up to February 28, 2023

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

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

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

1. Jadavpur University; Sl. No. 2; National
2. National Centre for Theoretical Sciences, Taiwan; Sl. No. 6, 7; International
3. Bose Institute, Kolkata; Sl. No. 7, 8,15,16; National
4. North Bengal University; Sl. No. 9; National
5. Qu Nu Labs, Bangalore; Sl. No. 10; National
6. Universitat Siegen, Germany; Sl. No. 11; International
7. Universidada de Sevilla, Spain; Sl. No. 11; International
8. Centre for Theoretical Physics, Poland; Sl. No. 12; International
9. IISER Tirupati; Sl. No. 14; National

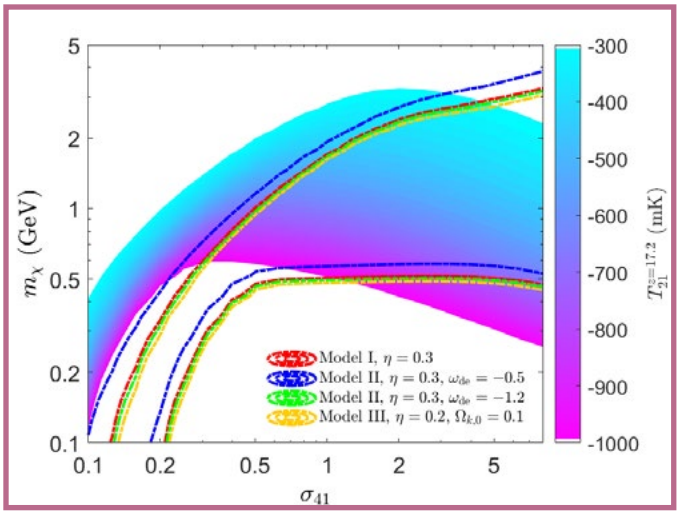
Outreach program organized / participated

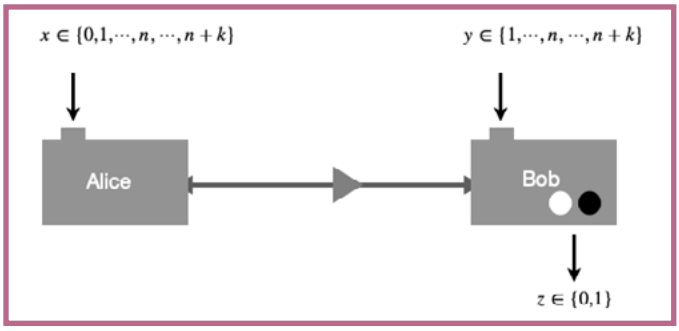
1. Topical Research School on Quantum Foundation and Information , ABN Seal College, Cooch Behar, March 14-16, 2023

Areas of Research

Gravitation and cosmology; Quantum Information and Foundations

We consider the propagation of gravitational waves in our late time Universe with the presence of structure. We investigate the effect of inhomogeneities on the





observables associated with the gravitational waves sources, employing the Buchert's framework of averaging. We show that the variation of the gravitational wave amplitude with respect to redshift can deviate significantly in comparison with that of the standard cosmological model. Our result signifies the importance of local inhomogeneities on precision measurements of parameters of gravitational wave sources.

We investigate the the global 21-cm brightness temperature in the context of viscous dark energy (VDE) models. The bulk viscosity of dark energy perturbs the Hubble evolution of the Universe which could cool baryons faster, and hence, alter the 21-cm brightness temperature. We obtain bounds on the VDE model parameters which can account for the observational excess of the EDGES experiment.

Certification of quantum devices received from unknown providers is a primary requirement before utilizing the devices for any information processing task. We establish a protocol for certification of arbitrary d-outcome quantum measurements in a setup comprising of a preparation followed by two measurements in sequence. We propose new temporal inequalities compatible with noninvasive-realist models and show that any non-zero quantum advantage of 'n-to-1' random access

code is equivalent to the violation of the corresponding temporal inequality. We show that for any quantum state and observables producing contextuality, there exists a communication task with quantum advantage. We show how to convert each of these communication tasks into a semi-device independent protocol for quantum key distribution.

We introduce a new model of relativistic quantum analogue of the classical Otto engine in the presence of a perfectly reflecting boundary. We show that in spite of the reduced work output, the efficiency of the engine remains unaltered even in the presence of the boundary. We study Bell's inequality violation by dynamical Casimir radiation in a circuit quantum electrodynamical set-up. We show that Bell violation can be observed in this set-up up to 40 mK temperature as well as up to 65 % signal loss.

Plan of Future Work Including Project

1. 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.
2. 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 any quantum advantage 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.
3. 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. 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.

Rabin Banerjee

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Guidance of Students/Post-Docs/ Scientists

a) Post-Docs

1. Soumya Bhattacharya; Galilean symmetries in gauge theories and gravity

b) External Project Students / Summer Training

1. Anish Chaudhuri; Applications of Noether's theorem in modern perspective (July-Sept. 2022) & Fractons from exactly solvable spin models to tensor gauge theories (Sept- Dec. 2022)

Teaching

1. 1st semester Ph.D.; Research methodology; Ph.D.; 28 students; P. K. Mukhopadhyay (Co-teacher)
2. 4th semester IPh.D.; Advanced quantum field theory; M.Sc.; 4 students; Sunandan Gangopadhyay (Co-teacher)

Publications

a) In journals

1. **Rabin Banerjee**, *Dual description of gauge theories from an iterative Noether approach*, Nuclear Physics B, 981, 115875, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Discussions with Prof. B. Muthukumar and his group. Gave a seminar on: Pedagogic introduction to nonrelativistic field theories; 15 Feb. 2023; Physics Department, Pondicherry University; 11-16 Feb. 2023

Areas of Research

Non-relativistic symmetries in gauge theory and gravity

Here we have used a generalized Noether's prescription to extract all the conserved currents and their conservation laws in space dependent shift symmetric theories. By coupling the scalar fields to the gauge fields, we have established a number of identities among the currents that show a dual image when the complete interaction theory is taken into account. By following a modified minimal prescription that is also supported by an iterative Noether method, the coupling is accomplished in terms of vector fields. This approach also demonstrates that couplings can be created using higher rank tensor gauge fields, which have recently been mentioned in relation to fractons. Through particular duality maps that link the various fields (gauge, electric, and magnetic) in the two scenarios, we are able to demonstrate equivalence partial between these descriptions (using vector or tensor fields). It is established that the Gauss law, the Faraday law, and the Ampere law are all in one to one correspondences for both the scenarios. For lagrangians with linear and quadratic shift symmetries, explicit calculations are given.

In the next part of our research, we provide a new formulation of the Galilean relativistic Maxwell theory. We first put forward a set of mapping relations, derived systematically, that connect the covariant and contravariant vectors in the Lorentz relativistic and Galilean relativistic formulations. Exploiting this map, we construct the two limits of Galilean relativistic Maxwell theory from usual Maxwell's theory in the potential formalism for both contravariant and covariant vectors

which are now distinct entities. Field equations are derived and their internal consistency is shown. The entire analysis is then performed in terms of electric and magnetic fields for both covariant and contravariant components. The interplay between the covariant and the contravaraint indices that leads to an interchange of the electric and the magnetic limits of the theory is a new feature observed here. Duality transformations and their connection with boost symmetry are discussed which reveal a rich structure. The notion of twisted duality, which we noticed for the first time in the galilean theory, is introduced. Next we consider gauge symmetry, construct Noether currents and show their on-shell conservation. We also discuss shift symmetry under which the Lagrangian is invariant, where the corresponding currents are now on-shell conserved. At the end we analyse the theory by including sources for both contravariant and covariant sectors. We show that sources are now off-shell conserved.

Plan of Future Work Including Project

As a next part of our previous research, we would consider the galilean relativistic Proca theory. Exploiting the mapping relation that we have derived for galilean relativistic Maxwell theory, we hope to construct the two limits of Galilean relativistic Proca theory from usual Proca theory in the potential formalism for both contravariant and covariant vectors which are now distinct entities. An action formalism would be derived from which the field equations are obtained and their internal consistency shown. Next we like to construct Noether currents and show their on-shell conservation. Analogues of Maxwell's electric and magnetic fields would be introduced to recast the entire analysis in terms of these fields. Finally we hope to discuss Stuckelberg embedded Proca model in the Galilean framework.

Ramkrishna Das

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Rahul Bandyopadhyay; Multi Wavelength Study of Planetary Nebulae; Awarded
2. Ruchi Pandey; Study of Novae Properties; Thesis submitted
3. Dhrimadri Khata; Understanding Physical Properties Of M-dwarfs; Thesis submitted; Prof. Soumen Mondal (Co-supervisor)
4. Gesesew H. Reta; Understanding Novae Phenomena; Under progress
5. Subhajit Kar; Study of Massive Stars; Under progress
6. Abhijit Mandal; Planetary Nebulae; Under progress
7. Md. Sahil; Study of Massive Stars; Under progress

b) Post-Docs

1. Milan Sil; Formation of molecules in Novae ejecta
2. Tridib Roy; Compact objects and related phenomena

c) External Project Students / Summer Training

1. Shouvik Mondal; Stellar Spectroscopy
2. Arushi Kumar; Transient Phenomena
3. Samsur Rahaman; Astronomical Telescopes and Detectors

Teaching

1. Autumn semester; Nuclear & Particle Physics (PHY 305); Integrated PhD; 10 students; with Prof. Subhendra Mohanty (Co-teacher)
2. Spring semester; Advanced Laboratory Method (PHY 491); Integrated PhD; 10 students; with Dr. Nitesh Kumar, Dr. Pradip Pachfule (Co-teachers)
3. Spring semester; Astronomy & Astrophysics (PHY 403); Integrated PhD; 10 students; with Prof. Soumen Mondal (Co-teacher)
4. Spring semester; Astrophysics (PHY 604); PhD; 6 students; with Prof. Soumen Mondal (Co-teacher)
5. Spring semester; Astronomical Observational Techniques (PHY 616); PhD; 9 students; with Dr. Tapas Baug (Co-teacher)

Publications

a) In journals

1. Ruchi Pandey, Gesesew R Habtie, Rahul Bandyopadhyay, **Ramkrishna Das**, François Teyssier, Joan Guarro Fló, *Study of 2021 outburst of the recurrent nova RS Ophiuchi: Photoionization and morphokinematic modelling*, Monthly Notices of the Royal Astronomical Society, 515, 4655, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk on "What does a Telescope tell ?", C. K. Majumdar Memorial Workshop in Physics 2022; Jul 19, 2022; SNBNCBS; 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
7. Member, SNBNCBS Organizing Committee of JEST 2023

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); DST; 5 years; Co-PI
2. Astro-tourism and Sustainable Biodiversity Management for Socioeconomic Upliftment of Tribal People around Panchet hill, Purulia"(under process); DST SEED; 3 years; Co-PI

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

1. François Teyssier, ARAS Eruptive Stars Group; Sl. No. 1; International
2. Joan Guarro Flo, ARAS Eruptive Stars Group; Sl. No. 1; International

Outreach program organized / participated

1. Organized Sky Watching Programme, C K Majumdar Memorial Workshop in Physics, SNBNCBS
2. Organized Sky Watching Programme on the "Open Day", 2nd January 2023, SNBNCBS

Areas of Research

Observational studies of novae and variable stars, planetary nebulae, massive stars, modeling spectra, 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. Here, I discuss two results that we obtained during the past year.

1. Study of 2021 outburst of RS Ophiuchi (RS Oph): RS Oph is a well-known Galactic recurrent nova with an average recurrence time-scale of about 15 years. The system has a CO-type white dwarf (WD) with a mass in the range of 1.2 – 1.4 times solar mass. The WD is most likely increasing in mass due to the accumulation of a fraction of accumulated matter on its surface. Eventually, it may approach the Chandrasekhar limit and explode as a Type Ia supernova. We have studied the evolution of the optical spectra of RS Oph, over a month after it's most recent (2021) outburst. From the evolution of line widths we detect an expanding shocked material into the winds of the red giant companion. which expands freely for ~4 days, and afterwards, the shock velocity decreased monotonically with time as v ∝ t^(−0.6). The spectra were modeled using the photoionization code CLOUDY. From the The best-fitting model we have estimated values of several parameters and elemental abundances.

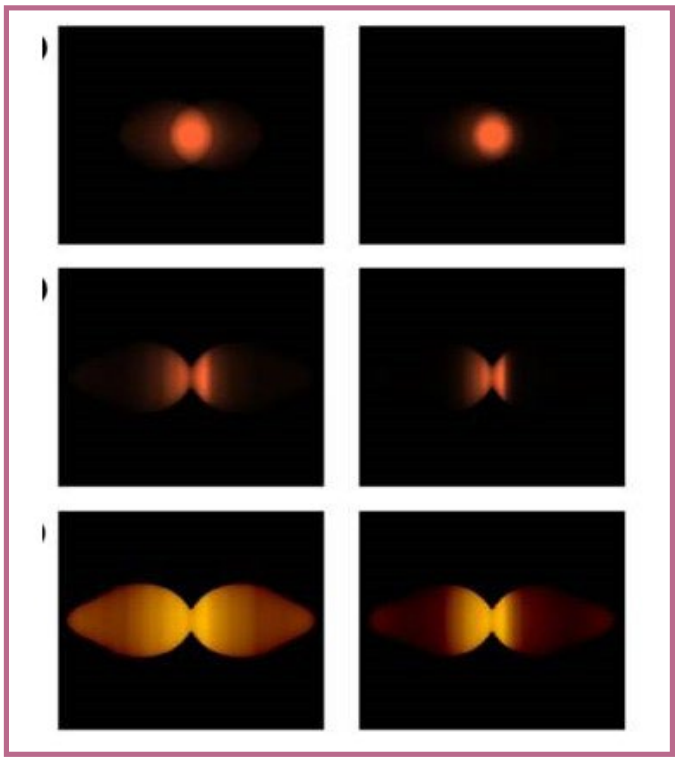

Figure 1. The model images of the ejecta of RS Oph (2021) obtained from the best-fitted 3D morpho-kinematic studies (see Pandey et al. 2022 fro more details).

The 3D morphokinematic modelling shows a bipolar morphology and an inclination angle of i = 30◦ for the RS Oph system (Figure 1).

2. A photodissociation region (PDR) model grid in planetary nebula: PDRs refer to neutral nebular regions within the interstellar medium. PDRs are a major source of infrared (IR) emission in the interstellar medium that consider the paradigm and physical parameters generally observed among PNe. We have studied the PDR regions around planetary nebulae by constructing a grid model with different varying parameters, e.g. effective temperature, source luminosity; density of the nebula; PDR depth; and densities of PAH molecules and amorphous carbon (AC) dust. We study the heating and cooling rates, and the variation of gas kinetic temperature along the PDR depth. We evaluate fluxes of fine structure lines: [O i] 63 μm; [C ii] 158 μm; [C i] 609 μm and flux ratios: [O i] 146/63 μm, [O i] 63/[C ii] 158 μm, and [C i] 609/370 μm, and study their variation in the parameter space. We verify that the correlation found between the [O i] 146/63 μm and [O i] 63/[C ii] 158 μm ratios observed in real PNe is similar to that found from our PN model grid (Figure 2).

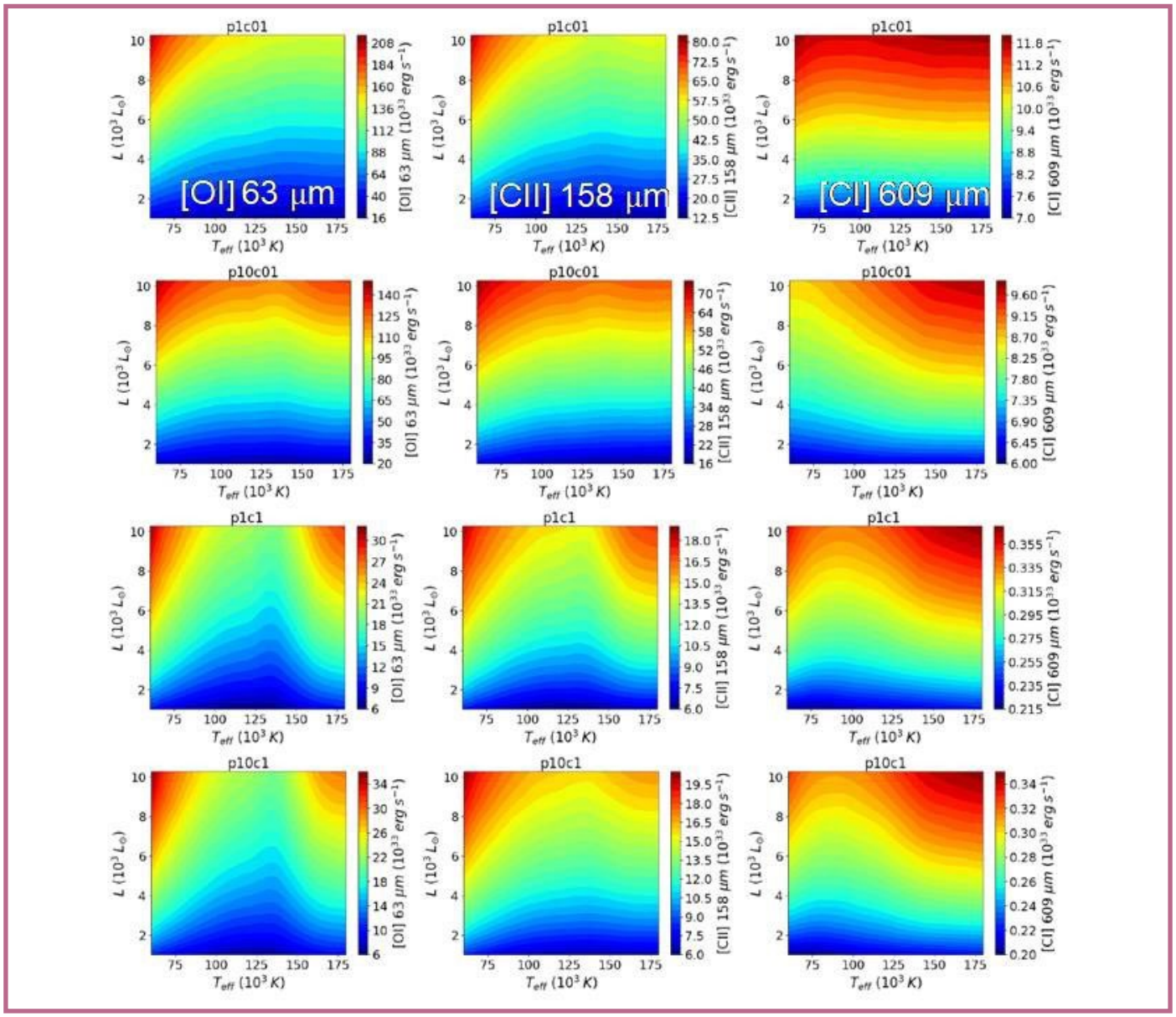

Figure 2: Line intensities under different physical conditions in the PDR region (see Bandyopadhyay & Das, 2023 for more details).

3. The Centre has taken an initiative to build S. N. Bose Observatory at Panchet Hilltop, Purulia. A considerable progress has been made in the previous year. We have measured astronomical seeing t the site with a small seeing monitor. A weather station and a Mobile Observatory have been installed at the site for measuring more precise astronomical seeing and atmospheric parameters.

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, and a considerable progress has already been made. A funding proposal has also been submitted to Department of Science and Technology. A weather station and a mobile observatory have been installed at the site. We are working to measure different parameters for characterizing the site project.

Any other Relevant Information including social impact of research

1. Member, PhD Committee, Presidency University
2. 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

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Astrophysics and High Energy Physics
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Alik Panja; A Multiwavelength Study of Galactic Starforming Regions; Thesis submitted
2. Samrat Ghosh; Understanding the Atmosphere of Brown Dwarfs and Low Mass Stars; Thesis submitted
3. Dhrimadri Khata; Understanding of Physical Properties of M-dwarfs: Optical and Near- IR Spectroscopic Studies; Thesis submitted; Dr. Ramkrishna Das (Co-supervisor)
4. Siddhartha Biswas; Studies of Pre-main Sequence stars in the Galactic Star-formation processes; Under progress
5. Diya Ram; Understanding Stellar Activity in M Dwarfs; Under progress
6. Rajib Kumbhakar; Studies of Atmospheric Properties of Brown Dwarfs and Low Mass Stars; Under progress
7. Sudip Paramanik; Atmospheric properties of Brown Dwarfs and Exta-solar planets; Under progress
8. Aman Das; Atmospheric properties of Brown dwarfs and Exta-solar planets; Under progress
9. Soumita Chakraborty; Understanding of Galactic Star forming Region with Multiwavelength Data; Under progress
10. 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)

b) Post-Docs

1. Dusmanta Patra; Radio wavelength studies of M dwars, Radio Galaxies, AGNs

c) External Project Students / Summer Training

1. Mausam Maity; Understanding variability and atmospheric properties of very low mass stars, brown dwarfs and exoplanets (M.Sc. project)
2. Dibakar Bhowmik; Census of the young stellar population in the galactic star-formation region W5 (M.Sc. project)
3. Kritartha Dey; Light Curve Analysis for the shape estimation of Asteroid using DAMIT (Summer project)

Teaching

1. Autumn semester; Basic Laboratory-I (PHY 191); Integrated PhD; 12 students; with Prof. S. K. Pal (Co-teacher)
2. Spring semester; Astrophysics (PHY 403); Integrated PhD; 12 students; with Dr. Ramkrishna Das (Co-teacher)
3. Spring semester; Astrophysics (PHY 604); PhD; 6 students; with Dr. Ramkrishna Das (Co-teacher)

Publications

a) In journals

1. Alik Panja, Yan Sun, Wen Ping Chen, and **Soumen Mondal**, *Star and Cluster Formation in the Sh2-112 Filamentary Cloud Complex*, The

Astrophysical Journal, 939, 46, 2022

2. Sneh Lata, W P Chen, J C Pandey, Athul Dileep, Zhong-Han Ai, Alisher S Hojaev, Neelam Panwar, Santosh Joshi, **Soumen Mondal**, Siddhartha Biswas, B C Bhatt, *Photometric variable stars in the young open cluster NGC 6823*, Monthly Notices of the Royal Astronomical Society, 520, 1092, 2023

3. Piyali Saha, Archana Soam, Tapas Baug, Maheswar Gopinathan, **Soumen Mondal**, Tuhin Ghosh, *Magnetic fields and young stellar objects in cometary cloud L1616,* Monthly Notices of the Royal Astronomical Society, 513, 2039, 2022

b) Conference proceedings / Reports / Monographs / Books

1. Soumen Mondal, Ramkrishna Das, Tapas Baug, and Mithilesh Pande - "S. N. Bose Astronomical Observatory: A new initiative in the Eastern part of India", Astronomical Society of India (ASI) Vision Document on the Observing facilities, December 2022

Talks / Seminars Delivered in reputed conference / institutions

1. An invited talk on "Understanding of Pre-main Sequence Stars in Galactic Star-Forming Regions" at 3rd star formation meeting at ARIES, Nainital during 4 -7 May 2022; May 6, 2022; An invited talk on "Understanding of Pre-main Sequence Stars in Galactic Star-Forming Regions" at 3rd star formation meeting at ARIES, Nainital during 4 -7 May 2022; 20 minutes

2. A colloquium talk on "Star-formation, Pre-main Sequence Stars and Very Low Mass stars to Brown Dwarfs: Physical Insights"; Aug 24, 2022; Presidency University, Kolkata; 1 hour

3. A poster presention "Young and Active Low-mass stars in Galactic Field and Star-Forming Regions", Soumen Mondal, et al.; Mar 22, 2023; Graphic Hill University, ARIES, Nainital; 22 - 23 March 2023

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 : Board of Studies (BoS), Integrated Ph.D.; Internal Standing Technical Committee (ISTC); member of Project and Patent Cell ; members of Library, Advisory committee of Computer Cell, Faculty Search committee, etc.

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

1. Technical Research Centre (TRC); DST; Janaury 2016 to till date; Co-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 and Sustainable Biodiversity Management for Socioeconomic Upliftment of Tribal People around Panchet hill, Purulia; Submitted to SEED, DST; 3 years; PI

Conference / Symposia / Schools organized

1. 1. National Space Science Exhibition with IISER, Kolkata; Dec 5, 2022; Science City, Kolkata; 5 -11 December 2022

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

1. Wen-Ping Chen, Institute of Astronomy, National Central University, Taiwan; Sl. No. 1, 2; International

2. Yan Sun, Purple Mountain Observatory, Chinese Academy of Sciences, China; Sl. No. 1; International

3. Santosh Joshi, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India; Sl. No. 2; National

4. Sneh Lata, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India; Sl. No. 2; National

5. .Jeewan C. Pandey, Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, India; Sl. No. 2; National

6. B. C. Bhatt, Indian Institute of Astrophysics, Koramangala, Bangalore, India; Sl. No. 2; National

Outreach program organized / participated

1. National Space Science Exhibition with IISER, Kolkata during 5 -11 December 2022 at Science City, Kolkata
2. 2. Science Exhibition in the 30th West Bengal Science & Technology Congress, 2023, on 28 February 2023 and 1 March 2023 held at Science City, Kolata

Areas of Research

Multi-wavelength studies of Galactic star-forming regions and Pre main-sequence stars; (ii) Photometric variabilities of Very Low Mass Stars (VLMs) and Brown Dwarfs; (iii) Spectrpscopic studies of M dwarfs and Giants; (iv) Astronomical Instrumentation

A. Star and Cluster Formation in the Sh2-112 Filamentary Cloud Complex

Stars form in clustered environments within giant molecular clouds. Internal gravitational dynamics prompts cloud fragmentation, with each fragment then collapsing and leading to the onset of prestellar core formation. Alternatively, propagation of the ionizing or explosive shocks from massive stars may compress neighboring clouds, hence triggering the next generation star formation. Molecular clouds exhibit complex geometries, including substructures such as sheets and filaments to elongated networks. The turbulence from expanding H II regions near a filamentary molecular cloud can generate sequential waves of star-forming cores along the long axis of the filament on either side of an H II region, The young protostars are preferentially aligned along the filamentary axis, bearing the imprint of fragmentation of the parental cloud. We study the star formation activity around H II region Sh2-112, is illuminated by the massive star(O8 V)BD+45 3216. The associated molecular cloud extends in angular scales of 2°.0 × 0°.83, corresponding to linear sizes of 73 pc by 30 pc, along the Galactic longitude. The high-resolution (30″) extinction map reveals a chain of dust clumps aligned with the filament-like structure with an average extinction of AV∼2.78 mag, varying up to a maximum of∼17 mag. Our analysis led to identification of a rich population(∼500)of young(average age of ∼1 Myr)stars, plus a numerous number(∼350)of Hα emitters, spatially correlated with the filamentary clouds. Located near the edge of the cloud, the luminous star BD+45 3216 has created an arc-like pattern as the ionizing radiation encounters the dense gas, forming a blister-shaped morphology. We found three distinct young stellar groups, all coincident with relatively dense parts of the cloud complex, signifying ongoing star formation. Moreover, the cloud filament(excitation temperature∼10 K) traced by the CO isotopologues and extending nearly∼80 pc is devoid of ionized gas except at the dense cores(excitation temperature∼28–32 K) wherein significant ionized emission excited by OB stars(dynamical age∼0.18–1.0 Myr) pertains. The radial velocity is dynamic (median∼–3.65 km/s)along the main filament,increasing from Galactic east to west, indicating mass flow to form the massive stars/clusters at the central hubs **(Alik Panja et al. 2022, APJ)** .

B. TESS Photometric Variability of Young Brown Dwarfs in Taurus Star-Forming Region

Brown dwarfs (BDs) are traditionally defined as sub-stellar objects with enough mass to sustain deuterium burning inside their core but not enough for hydrogen burning. Photometric variability of BDs research has received much attention in recent years to understand these young objects' dynamic atmospheric properties and surface features. We present a comprehensive analysis of Transiting Exoplanet Survey Satellite (TESS) high-quality light curves of a few samples of young (∼2 – 3 Myr) brown dwarfs in the Taurus molecular cloud. We aim to search the fast rotation of brown dwarfs and picturized their dynamic atmosphere and surface features. Out of 11 young BDs, we found that 8 72% are periodic in the period range of 1 to 7 days; among them, 3 BDs have a period < 1.5 d and periods of 2 objects are estimated first time. The sinusoidal periodic variations are related to a large sport or group of small spots corotating with the objects. Interestingly, we have detected 4 flare events in 3 young BDs, and one object, MHO 4, shows two flares in two different sectors. From the flared light curves, we have estimated the total bolometric flared energy in a range of 10^{34} to 10^{35} ergs, which are close to the superflare energy range. To produce such kinds of superflare events, we have calculated the required magnetic field strength, which is coming out in order of a few 100 G. Such superflares have a strong effect

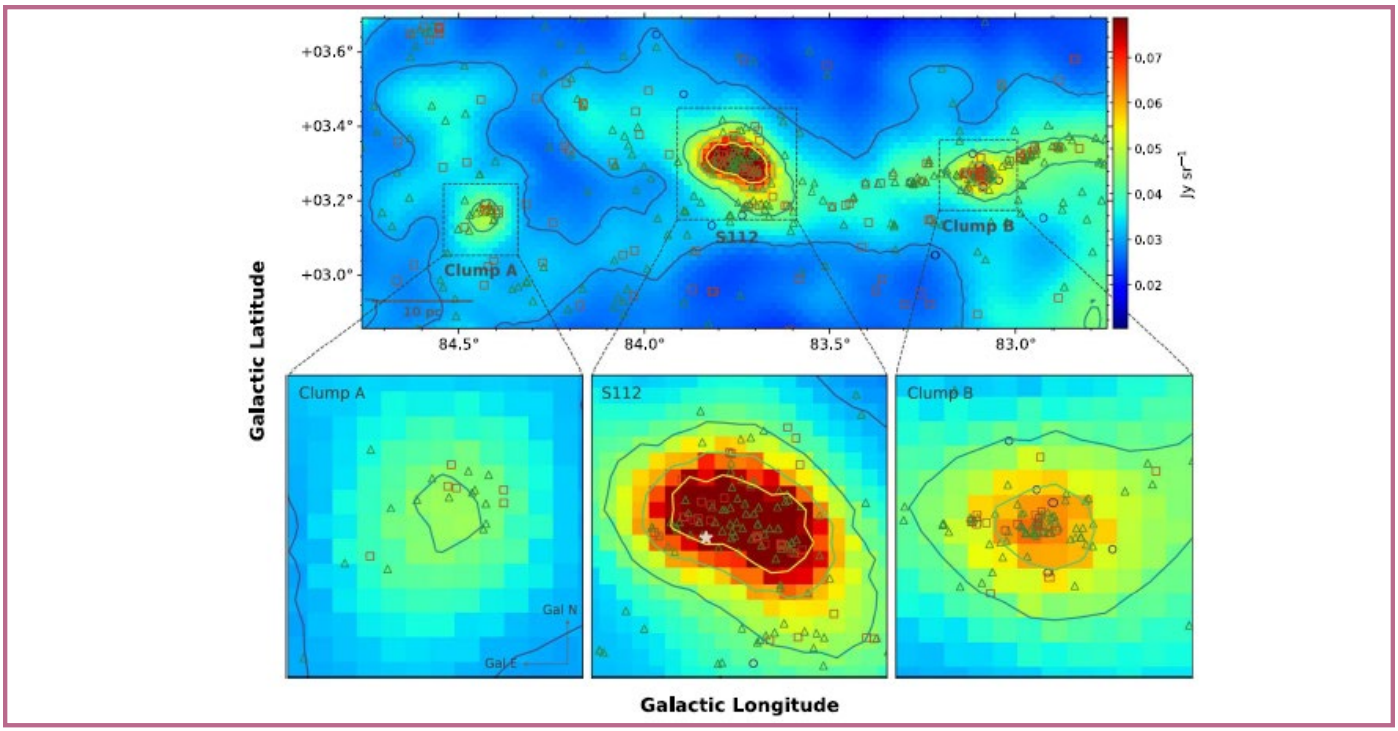

Figure 1: Top: spatial distribution of the YSOs (Class I: red square; Class II: green triangle; transition disk: blue circle) overlaid on the Planck 353 GHz map. The stellar density peaks at three subregions (Clump A, S112, and Clump B) and coincides well with the high-intensity regions. The contour levels are at 0.028, 0.040,0.052, and 0.064 Jy sr–1. Bottom: zoomed-in maps of the three subregions. The main ionizing source BD+45 3216 is represented by a white asterisk symbol.

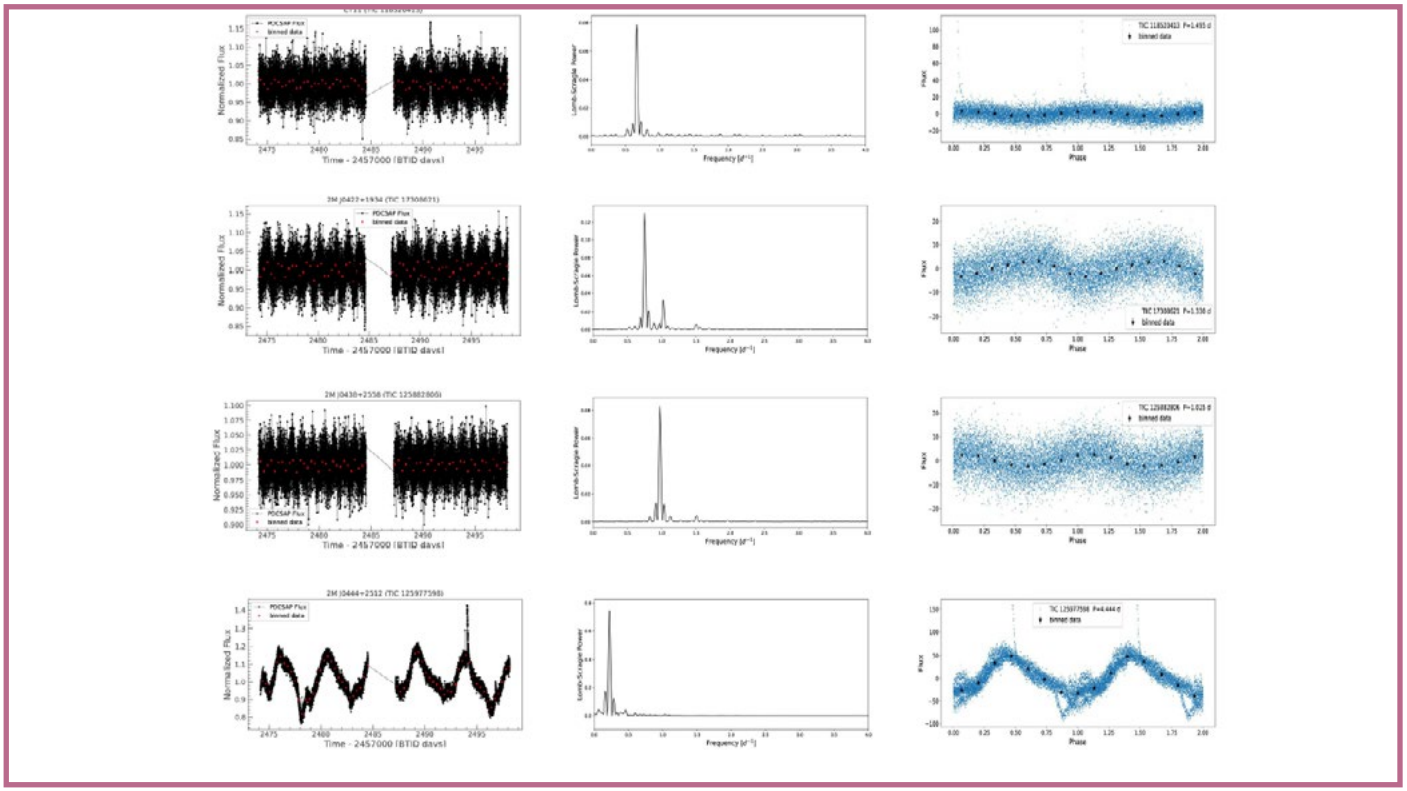

Figure 2: The TESS light curves of Taurus young Brown Dwarfs are shown. Left column: a full light curve in black and red dots representing the binned light curve with binning point 500 min; middle column: Lomb-Scragle periodogram; right column: Phase folded light curve, with most significant peak obtained from the LS periodogram.

on the habitability of planets around M-dwarfs (Rajib Kumbhakar et al., 2023).

Plan of Future Work Including Project

1. Scientific programs in the 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 class 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 star-formation. 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 eastern part of India is planned at Panchet hill, West Bengal to install 1.5-meter telescope, For that, two hectares 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 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 collecting data regular basis. A small observatory with roll-off-roof including telescope control cabin is already installed at the site, and installation of the DIMM system with 12-inch telescope is under process.

Any other Relevant Information including social impact of research

1. Advanced manpower generation (Human resource development) through training of Ph.D./Integrated Ph.D. students for National need in educational sectors as well as a need for National/ International mega projects (like TMT, LIGO, SKA-India etc.).
2. A societal upliftment project on "Astro-tourism and Sustainable Biodiversity Management for Socioeconomic Upliftment of Tribal People around Panchet hill, Purulia" was formulated collaborating with Sidho-Kanho-Birsha University and Krishi Vigyan Kendra, Purulia and submitted to SEED, DST for funding.
3. Scientific awareness programs like National Space Science Exhibition is organized for college, school students and public.
4. 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 is already developed at the Centre, which is looking for potential technology takers. Such a project is intended for societal benefit and valuable Knowledge resource for the food sector and security.

Sunandan Gangopadhyay

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Sourav Karar; Aspects of holographic entanglement entropy and complexity; Awarded; Prof. Archan S Majumdar (Co-supervisor)
2. Rituparna Mandal; Applications of the functional renormalization group in cosmology and black hole thermodynamics; Thesis submitted
3. Ankur Srivastav; Applications of gauge/gravity duality to strongly coupled systems; Under progress
4. Anish Das; Study of geodesics and shadow of black holes; Under progress
5. Neeraj Kumar; Thermodynamics of black holes; Under progress
6. Manjari Dutta; Noncommutative quantum mechanics; Under progress
7. Anirban Roy Chowdhury; Information theoretic quantities from gauge/gravity correspondence; Under progress
8. Soham Sen; Quantum gravity phenomenology; Under progress
9. Suchetana Pal; Features of holographic superconductors; Awarded; Prof. Prasanta Panigrahi (Co-supervisor)

b) Post-Docs

1. Ashmita Das; Unruh-DeWitt detectors, physics of black holes

c) External Project Students / Summer Training

1. Sampriti Roy; General theory of relativity
2. Souvik Paul; Supersymmetric quantum mechanics

Teaching

1. Autumn semester; Mathematical Methods (PHY 102); Integrated PhD; 11 students
2. Spring semester; Advanced Quantum Field Theory (PHY 407); Integrated PhD; 4 students

Publications

a) In journals

1. Soham Sen, Rituparna Mandal, and **Sunandan Gangopadhyay**, *Equivalence principle and HBAR entropy of an atom falling into a quantum corrected black hole*, Physical Review D, 105, 085007, 2022
2. Ashis Saha, **Sunandan Gangopadhyay** and Jyoti Prasad Saha, *Mutual information, islands in black holes and the Page curve*, The European Physical Journal C, 82, 476, 2022
3. Soham Sen, Rituparna Mandal, and **Sunandan Gangopadhyay**, *Near horizon aspects of acceleration radiation of an atom falling into a class of static spherically symmetric black hole geometries*, Physical review D, 106, 025004, 2022
4. Neeraj Kumar, Soham Sen, and **Sunandan Gangopadhyay**, *Phase transition structure and breaking of universal nature of central charge*

criticality in a Born-Infeld AdS black hole, Physical Review D, 106, 026005, 2022

5. Arnab Mukherjee, **Sunandan Gangopadhyay** and A. S. Majumdar, *Unruh quantum Otto engine in the presence of a reflecting boundary*, Journal of High Energy Physics, 2022, 105, 2022
6. Anirban Roy Chowdhury, Ashis Saha, and **Sunandan Gangopadhyay**, *Role of mutual information in the Page curve*, Physical Review D, 106, 086019, 2022
7. Soham Sen, Sukanta Bhattacharyya and **Sunandan Gangopadhyay**, *Path Integral Action for a Resonant Detector of Gravitational Waves in the Generalized Uncertainty Principle Framework*, Universe, 8, 450, 2022
8. Manjari Dutta, Shreemoyee Ganguly and **Sunandan Gangopadhyay**, *Explicit form of Berry phase for time dependent harmonic oscillators in noncommutative space*, Physica Scripta, 97, 105204, 2022
9. Rituparna Mandal, **Sunandan Gangopadhyay** and Amitabha Lahiri, *Cosmology with modified continuity equation in asymptotically safe gravity*, The European Physical Journal Plus, 137, 1110, 2022
10. Rituparna Mandal and **Sunandan Gangopadhyay**, *Black hole thermodynamics in asymptotically safe gravity*, General Relativity and Gravitation, 54, 159, 2022
11. Anish Das, Ashis Saha and **Sunandan Gangopadhyay**, *Shadow of Kottler black hole in the presence of plasma for a co-moving observer*, Classical and Quantum Gravity, 40, 015008, 2023
12. Ashmita Das, Soham Sen, and **Sunandan Gangopadhyay**, *Virtual transitions in an atom-mirror system in the presence of two scalar photons*, Physical Review D, 107, 025009, 2023
13. Neeraj Kumar, Soham Sen, and **Sunandan Gangopadhyay**, *Breaking of the universal nature of the central charge criticality in AdS black holes in Gauss-Bonnet gravity*, Physical Review D, 107, 046005, 2023
14. **Sunandan Gangopadhyay**, Soham Sen and Rituparna Mandal, *Interference and reflection from the event horizon of a quantum corrected black hole*, Europhysics Letters, 141, 49001, 2023
15. Anirban Roy Chowdhury, Ashis Saha and **Sunandan Gangopadhyay**, *Mixed state information theoretic measures in boosted black brane*, Annals of Physics, 452, 169270, 2023
16. Rituparna Mandal, **Sunandan Gangopadhyay**, Amitabha Lahiri, *Newtonian cosmology from quantum corrected Newtonian potential*, Physics Letters B, 839, 137807, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Field Theoretic Aspects of Gravity (FTAG) 2023, Invited talk; Mar 17, 2023; Birla Institute of Technology, Mesra; 3 days

Administrative duties

1. Head of the Department of Astrophysics and High Energy Physics from 1st March, 2023 onwards
2. Member of SCOLP committee, organizing departmental seminars
3. Member of Canteen committee

Areas of Research

Quantum gravity phenomenology, applications of gauge/gravity correspondence, black hole thermodynamics, applications of asymptotically safe gravity to cosmology

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

1. We have investigated the phenomenon of acceleration radiation exhibited by an atom falling into a quantum corrected Schwarzschild black hole. The excitation probability of an atom with the simultaneous emission of a photon satisfies the equivalence principle when we compare it to the excitation probability of a mirror accelerating with respect to an atom. The validity of the equivalence principle for a generic black hole geometry is demonstrated. The horizon brightened acceleration radiation entropy (HBAR) for this quantum corrected black hole geometry is obtained. The HBAR entropy has a form identical to that of Bekenstein-Hawking black hole entropy along with universal quantum gravity corrections. This work got published in PRD D 105, 085007, 2022.

2. We have investigated the near horizon aspects (and beyond) of a black hole metric, belonging to a large class of static spherically symmetric black holes. The near horizon approximation leads to conformal symmetry in the problem. In our study, we go beyond the near horizon approximation, which breaks the conformal symmetry associated with the near horizon physics of the black hole geometry. We observed that even without the consideration of the conformal symmetry, the modified equivalence relation holds. The probability of virtual transition retains its Planck-like form with the amplitude getting modified due to the beyond near horizon approximation. We have then observed the HBAR for a Garfinkle-Horowitz-Strominger black hole. We observed that the HBAR entropy misses out on quantum gravity like corrections while considering the conformal case. However, such corrections emerge when the conformal symmetry gets broken in the beyond near horizon analysis. This work got published in PRD D 106, 025004, 2022.
3. We have also examined the virtual transition of an atom-mirror system with the simultaneous emission of two scalar photons, where the atom and the mirror admit a relative acceleration between them. For the single photon emission, the literature dictates that the transition probabilities of two individual systems, such as an atom accelerating with respect to the mirror and its reverse, turn out to be equivalent under the exchange of the frequencies of atom and the field. Addressing the observational merit of such excitation process, a detectable probability is also reported in the above literature. Our finding dictates that the simultaneous emission of dual photon instead of one, destroys the equivalence between the transition probabilities. This work got published in PRD D 107, 025009, 2023.
4. We have also considered the thermodynamics of a Born-Infeld AdS black hole using inputs from the dual boundary field theory. Here, we have varied the cosmological constant and Newton's gravitational constant along with the Born-Infeld parameter in the bulk. A novel universal critical behaviour of the central charge (occurring in the boundary conformal field theory) in extended black hole thermodynamics for charged black holes has been recently observed, and we have extended this study to Born-Infeld AdS black holes. This work got published in PRD D 106, 026005, 2022.

Plan of Future Work Including Project

1. In future, we would like to extend our ongoing studies further. In particular, we would like to extend our studies for rotating black hole backgrounds. We would also like to understand the role played by linearized quantum gravity in gravitational wave detector systems.

Any other Relevant Information including social impact of research

1. The areas of research in which we are engaged would provide some new insights into the fundamental aspects of theoretical physics. In particular, we believe that these studies would reveal some mysteries about quantum gravity. History has also shown that fundamental investigations usually find applications in the technology sector. Research in theoretical physics would also lead to the development of man power.

Tapas Baug

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Astrophysics and High Energy Physics
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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. Nishant Garg; Role of magnetic fields in star formation; Under progress
3. Muhammad Usman Shehu; Study of star-forming filaments; Under progress

b) Post-Docs

1. Tirthendu Sinha; Young stellar objects
2. Piyali Saha; Galactic star formation and feedback effect
3. Alik Panja (Bridge Fellow); Study of hub-filament structures

c) External Project Students / Summer Training

1. Debalina Kar; Exploring the Rocket effect in BRC 38 (Summer project)
2. Subhradeep Karmakar; Magnetic Field Geometry in Barnard 223 (Summer project)
3. Sayari Bhattacharya; Initial Mass Function in Galactic Star Forming Regions (Summer project)
4. Samrat Roy; Effect of massive stars on their surrounding (M.Sc. project)

Teaching

1. Autumn semester; Classical Dynamics; Integrated PhD; 11 students
2. Spring semester; Observational Techniques in Astronomy; PhD; 8 students; with Dr. Ramkrishna Das (Co-teacher)

Publications

a) In journals

1. L. K. Dewangan, N. K. Bhadari, A. Men'shchikov, E. J. Chung, R. Devaraj, C. W. Lee, A. K. Maity, and **T. Baug**, *IC 5146 Dark Streamer: The First Reliable Candidate of Edge Collapse, Hub-filament Systems, and Intertwined Sub-filaments*, The Astrophysical Journal, 946, 22, 2023
2. Wenyu Jiao, Ke Wang, Thushara G. S. Pillai, **Tapas Baug**, Siju Zhang, and Fengwei Xu, *Fragmentation of the High-mass "Starless" Core G10.21-0.31: A Coherent Evolutionary Picture for Star Formation*, The Astrophysical Journal, 945, 81, 2023
3. Kshitiz K. Mallick, Lokesh K. Dewangan, Devendra K. Ojha, **Tapas Baug**, and Igor I. Zinchenko, *Structure and Kinematics of Sh2-138-A Distant Hub-filament System in the Outer Galactic Plane*, The Astrophysical Journal, 944, 228, 2023
4. Anindya Saha, Anandmayee Tej, Hong-Li Liu, Tie Liu, Namitha Issac, Chang Won Lee, Guido Garay, Paul F Goldsmith, Mika Juvela, Sheng-Li Qin, Amelia Stutz, Shanghuo Li, Ke Wang, **Tapas Baug**, Leonardo Bronfman, Feng-Wei Xu, Yong Zhang, Chakali Eswaraiah, *ATOMS: ALMA three-millimeter observations of massive star-forming regions – XII: Fragmentation and multiscale gas kinematics in protoclusters G12.42+0.50 and G19.88–0.53*, Monthly Notices of the Royal Astronomical Society, 516, 1983, 2022
5. 5. Estrella Guzmán Ccolque, Manuel Fernández-

López, Luis A. Zapata, and **Tapas Baug**, *Possible Explosive Dispersal Outflow in IRAS 16076-5134 Revealed with ALMA*, The Astrophysical Journal, 937, 51, 2022

6. Piyali Saha, G Maheswar, D K Ojha, **Tapas Baug**, Sharma Neha, *Investigation of rocket effect in bright-rimmed clouds using Gaia EDR$_3$*, Monthly Notices of the Royal Astronomical Society: Letters, 515, L67-L71, 2022
7. Jian-Wen Zhou, Tie Liu, **Tapas Baug** et al., *ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions – XI. From inflow to infall in hub-filament systems*, Monthly Notices of the Royal Astronomical Society, 514, 6038, 2022
8. Piyali Saha, Archana Soam, **Tapas Baug**, Maheswar Gopinathan, Soumen Mondal, Tuhin Ghosh, *Magnetic fields and young stellar objects in cometary cloud L1616*, Monthly Notices of the Royal Astronomical Society, 513, 2039, 2022
9. A. Ginsburg, T. Csengeri, **T. Baug** et al., *ALMA-IMF II. Investigating the origin of stellar masses: Continuum images and data processing*, Astronomy and Astrophysics, 662, A9, 2022
10. F. Motte, S. Bontemps, **T. Baug** et al., *ALMA-IMF I. Investigating the origin of stellar masses: Introduction to the Large Program and first results*, Astronomy and Astrophysics, 662, A8, 2022
11. Yaping Peng, Tie Liu, Sheng-Li Qin, **Tapas Baug**, Hong-Li Liu, Ke Wang, Guido Garay, Chao Zhang, Long-Fei Chen, Chang Won Lee, Mika Juvela, Dalei Li, Ken'ichi Tatematsu, Xun-Chuan Liu, Jeong-Eun Lee, Gan Luo, Lokesh Dewangan, Yue-Fang Wu, Li Zhang, Leonardo Bronfman, Jixing Ge, Mengyao Tang, Yong Zhang, Feng-Wei Xu, Yao Wang, Bing Zhou, *ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions – X. Chemical differentiation among the massive cores in G9.62+0.19*, Monthly Notices of the Royal Astronomical Society, 512, 4419, 2022
12. Hong-Li Liu, Anandmayee Tej, Tie Liu, Paul F Goldsmith, Amelia Stutz, Mika Juvela, Sheng-Li Qin, Feng-Wei Xu, Leonardo Bronfman, Neal J Evans, Anindya Saha, Namitha Issac, Ken'ichi Tatematsu, Ke Wang, Shanghuo Li, Siju Zhang, **Tapas Baug**, Lokesh Dewangan, Yue-Fang Wu, Yong Zhang, Chang Won Lee, Xun-Chuan Liu, Jianwen Zhou, Archana Soam, *ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions – IX. A pilot study towards IRDC G034.43+00.24 on multi-scale structures and gas kinematics*, Monthly Notices of the Royal Astronomical Society, 511, 4480, 2022
13. Rong Liu, Tie Liu, Gang Chen, Hong-Li Liu, Ke Wang, Jin-Zeng Li, Chang Won Lee, Xunchuan Liu, Mika Juvela, Guido Garay, Lokesh Dewangan, Archana Soam, Leonardo Bronfman, Jinhua He, Chakali Eswaraiah, Si-Ju Zhang, Yong Zhang, Feng-Wei Xu, L Viktor Tóth, Zhi-Qiang Shen, Shanghuo Li, Yue-Fang Wu, Sheng-Li Qin, Zhiyuan Ren, Guoyin Zhang, Anandmayee Tej, Paul F Goldsmith, **Tapas Baug**, Qiuyi Luo, Jianwen Zhou, Chang Zhang, *ATOMS: ALMA three-millimeter observations of massive star-forming regions – VII. A catalogue of SiO clumps from ACA observations*, Monthly Notices of the Royal Astronomical Society, 511, 3618, 2022
14. Sheng-Li Qin, Tie Liu, Xunchuan Liu, Paul F Goldsmith, Di Li, Qizhou Zhang, Hong-Li Liu, Yuefang Wu, Leonardo Bronfman, Mika Juvela, Chang Won Lee, Guido Garay, Yong Zhang, Jinhua He, Shih-Ying Hsu, Zhi-Qiang Shen, Jeong-Eun Lee, Ke Wang, Ningyu Tang, Mengyao Tang, Chao Zhang, Yinghua Yue, Qiaowei Xue, Shanghuo Li, Yaping Peng, Somnath Dutta, Jixing Ge, Fengwei Xu, Long-Fei Chen, **Tapas Baug**, Lokesh Dewangan, Anandmayee Tej, *ATOMS: ALMA Three-millimeter Observations of Massive Star-forming regions – VIII. A search for hot cores by using C_2H_5CN, CH_3OCHO, and CH_3OH lines*, Monthly Notices of the Royal Astronomical Society, 511, 3463, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Star formation conference; May 4, 2022; ARIES, Nainital
2. C. K. Majumdar Memorial Workshop in Physics 2022; Jul 19, 2022; SNBNCBS
3. ALMA-IMF Large Consortium Meeting; Sep 1, 2022; France (Online)
4. Colloquium at the School of Astrophysics, Presidency University; Sep 21, 2022; Presidency University, Kolkata

Administrative duties

1. Committee Member of CSC-WG
2. Committee Member of New website designing
3. Member of 3 Interview Panels (PhD, IPhD, and Candidacy Test)
4. Committee member and Co-PI of S.N. Bose Astronomical Observatory, and participated in several activities

Membership of Learned Societies

1. Life time member of Astronomical Society of India

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

1. Astro-tourism and Sustainable Biodiversity Management for Socio-economic Upliftment of Tribal People around Panchet hill, Purulia; DST-SEED; 3 year; Co-PI

Conference / Symposia / Schools organized

1. Bose Fest – 2022; Apr 27, 2022; SNBNCBS; 3 days
2. Member of Scientific Organizing Committee, 3rd BINA Workshop, hosted by ARIES, Nainital; Mar 22, 2023; Member of Scientific Organizing Committee, 3rd BINA Workshop, hosted by ARIES, Nainital; 3 days

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

1. L. K. Dewangan (Physical Research Laboratory, Ahmedabad, India); SL. No. 1, 3, 5, 7, 11, 12, 13, 14; National
2. Anandmayee Tej (Indian Institute of Space Science and Technology, Thiruvananthapuram, India); Sl. No. 4, 7, 12, 13, 14; National
3. Devendra K. Ojha (Tata Institute of Fundamental Research, Mumbai, India); Sl. No. 3, 5, 6; National
4. Maheswar Gopinathan (Indian Institute of Astrophysics, Bengaluru, India); Sl. No. 6, 8; National
5. Saurabh Sharma (Aryabhatta Research Institute of Observational Sciences, Nainital, India); Sl. No. 5; National
6. Ke Wang (Kavli Institute for Astronomy and Astrophysics, Beijing, China); Sl. No. 2, 4, 7, 11, 12, 13,14; International
7. Tie Liu (Shanghai Astronomical Observatory, Shanghai, China); Sl. No. 4, 7, 11, 12, 13, 14; International
8. Manuel Fernández López (Instituto Argentino de Radioastronomía, Buenos Aires, Argentina); Sl. No. 4, 6, 5, 9, 10; International
9. Frédérique Motte (Univ. Grenoble Alpes, CNRS, Grenoble, France); Sl. No. 4, 6, 9, 10; International
10. Adam Ginsburg (University of Florida, USA); Sl. No. 4, 6, 9, 10; International

Outreach program organized / participated

1. Participated in Swach-Sagar-Surakshit-Sagar Campaign at Haldia, 17 September, 2022
2. Organized Sky-watching program during the academic visit of 2nd semester M.Sc. Electronics students of Dhanamanjari University, Imphal, 10-11 Oct., 2022
3. Organized and participated in National Space Science Symposium Exhibition, Science City, Kolkata, 6-11 Dec 2022
4. Participated in "Sky watching program during CKM Memorial Workshop, SNBNCBS, 12-21 July, 2022

Areas of Research

Galactic star formation

Massive OB stars (mass > 8 solar mass) can immensely affect the immediate surrounding clouds. Strong ultraviolet radiation from a massive star ionizes the surrounding gas which then develops a shock-front that propagates into the parent molecular cloud. Due to non-uniform cloud structures, this eventually leads to the formation of bright-rimmed clouds, cometary globules, etc (Williams, 1999, MNRAS, 310, 789). Star formation in these structures could be regulated by the orientation and strength of the ambient magnetic fields (Hennebelle & Fromang, 2008, A&A, 477, 9). Magnetohydrodynamic simulations (Henney et al., 2009, MNRAS, 398, 157) showed that an initially perpendicular magnetic field of weak and medium strengths, could be dragged and made

to orient along the cloud structure during the dynamical evolution of the globules. Plane-of-sky morphology of magnetic fields could be studied by polarization observations of background starlight. Anisotropic dust grains, aligned along the interstellar magnetic field lines, preferentially absorb or transmit light and results in a net polarization.

We analyzed optical R-band (700 nm) polarization observations of LDN 1616 cometary cloud developed by massive OB stars. Individual plane-of-sky position angles do not show any preferred alignment. However, their mean values for a 5x5 square-arc-minutes gird follow the large-scale cloud structure (see Figure 1). Such alignment indicates a possible scenario for the initial direction of the magnetic field lines perpendicular to the direction of the ionizing radiation and might have been dragged later. Aligned magnetic fields might further aid in the formation of stars in the cometary cloud (see Saha et al., 2022, MNRAS, 513, 2039).

SNBNCBS is in process of building the very first astronomical observatory (S. N. Bose Astronomical Observatory) in the Eastern zone of India equipped with a 1.5-m optical telescope. I joined as a Co-PI of the project and we submitted a budgetary proposal for the observatory to the Department of Science and Technology, Govt. of India. I also participated in the discussion on design and parameters of the telescope and backend instruments with the manufacturers around the world. Currently, we are in the process of characterizing the necessary atmospheric and astrometric parameters at the Panchet Hilltop, Purulia, the site of the proposed observatory. Recently, we have successfully installed a compact weather station (in November 2022) and established a Mobile Observatory (in March 2023) at the project site. The astronomical seeing values we obtained at the hilltop during last 4-5 months are encouraging (median ~1.5 arcseconds and best ~1.1 arcseconds) and prove the site is well enough for pursuing astronomical observations. We are now in the process of installing a Differential Image Motion Monitor (DIMM) system for further robust measurement of seeing values.

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).

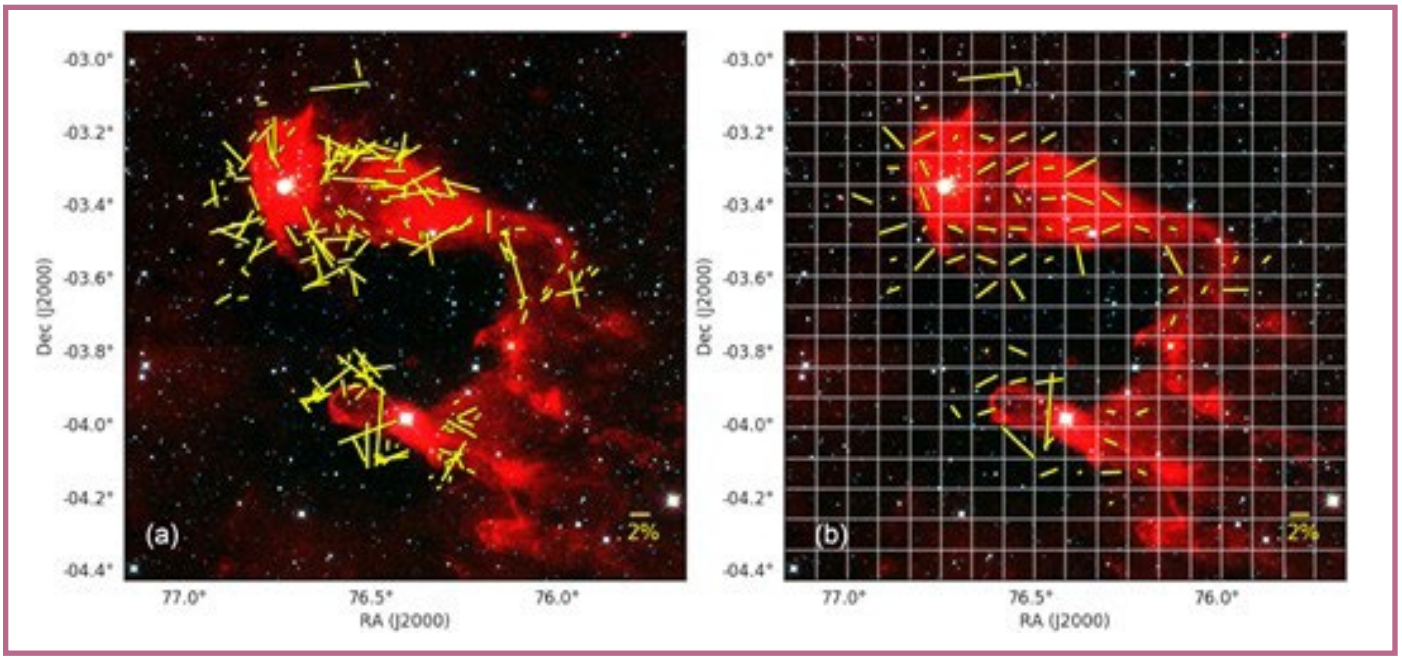


Figure 1: Left: Optical R-band polarization vectors (yellow lines) over-plotted on the color-composite image of LDN 1616 (Red: 12 μm, Green: 4.6 μm, and Blue: 3.5 μm). Right: The mean polarization vectors are over-plotted on the same image as it is shown in the Left. The grids over which the mean values were taken are shown using white colored boxes (Saha et al., 2022).

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. 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. A funding proposal has also been submitted to Department of Science and Technology. I would like to keep on contributing in the development of this telescope project.
3. 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).

Any other Relevant Information including social impact of research

1. Reviewer of the articles in Journal of Astrophysics and Astronomy: Reviewed four articles in this academic year.
2. Reviewer of the observational proposals for 3.6-m Devasthal Optical Telescope and Giant Metrewave Radio Telescope.
3. Contributed to the Vision Document of the Astronomical Society of India that aimed to lay out the collective vision of the Indian astronomy community for the next two decades.

View of Panchet Hill, Purulia, West Bengal

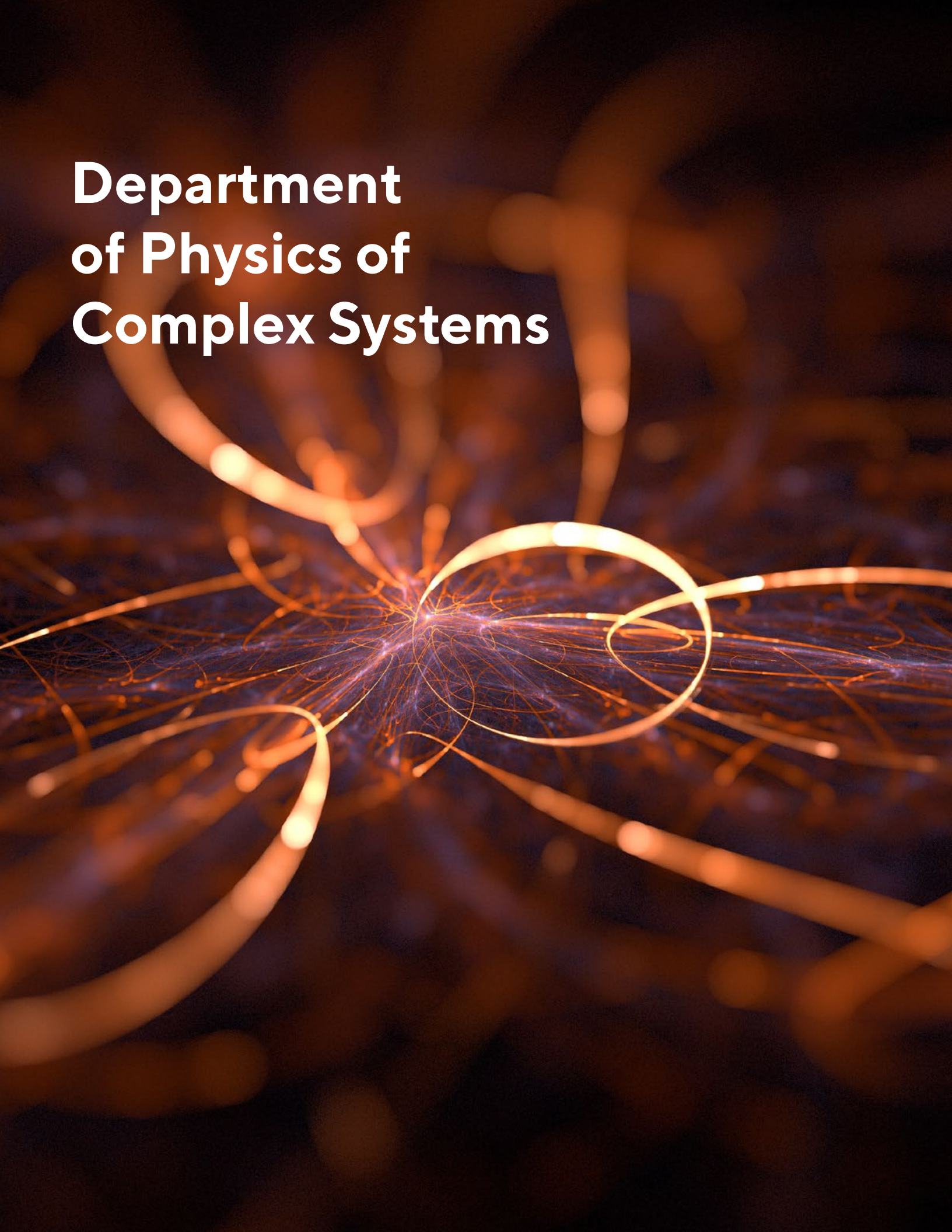
Mobile Observatory

Night sky observation

Weather Station on Panchet Hill top

Scientists on visit

Department of Physics of Complex Systems



Department of Physics of Complex Systems

Punyabrata Pradhan

Department profile indicators

Table A: Manpower and resources

Number of faculty members	7
Number of Post –doctoral research associate (centre+project)	4
Number of Ph.D students	29
Number of other project staff	0
Number of summer students	6
Projects (ongoing)	5

Table B: Research Activities indicators

Number of research papers in Journals	23
Number of Book-chapters/books	0
Number of other publications	0
Number of Ph.D students graduated (submitted+degree awarded)	4+4=8
Number of M.Tech/M.Sc projects	0

Table C: Academic activities and linkage

Number of courses taught by faculty members	12	
Number of Visitors (non –associates)	10	
Number of associates	0	
Number of Seminars organized	10	
Number of Conference/Symposia/Advanced Schools organized	4	
Number of talks delivered by members of department in conferences/Symposia	National	9
	International	14

Most important research highlights

- We have shown that non-Fermi liquids (metals without electron-like quasi-particles) can produce nematic phases that spontaneously break rotational symmetry. Our research was published in the Proceedings of the National Academy of Sciences (PNAS).
- We have demonstrated how the chiral spin-liquid phase of the kagome lattice (an enigmatic phase of matter with topological properties driven by many-body effects) can spontaneously undergo symmetry breaking leading to non-coplanar magnetic orders. Our findings were published as a letter in Physical Review B.

- We have also collaborated with experimental physicists to provide a theoretical understanding of the spin-reorientation transition observed in certain three-dimensional antiferromagnets. This work was published as an article in Physical Review B.
- We propose thermodynamic quantities that capture signatures of genuineness in multipartite entangled states [PRL 129, 070601 (2022)]. Instead of entropy, these quantities are defined in terms of energy -- the difference between global and local extractable works that can be stored in quantum batteries.
- We show that the principle of Information causality -- a generalization of no signalling principle -- offers an information theoretical rational to the self-dual structure of state and effect cones for composite quantum systems [PRL 130, 110202 (2023)].
- Exploration of activity driven energy transport in one dimensional harmonic chains which shows unique features like non-monotonic differential activity and current reversal. (SciPost Phys. 2022, Phys. Rev. E 2023)
- Developing a unifying formalism to study universal long-time dynamics of active particles. (J. Phys. A 2022, J. Stat. Mech. 2023)
- Study of the dynamics of a colloidal particle coupled to a Gaussian field which leads to an emergent confinement-dependent memory. (SciPost Phys. 2022)
- We show that, in the thermodynamic limit, the variance of cumulative bond current up to a time T grows subdiffusively with the powe-law exponent depending on the density regimes considered and, likewise, the power spectra of current and mass at low frequency varies anomalously. The anomalous suppression of fluctuations near criticality signifies a "dynamic hyperuniformity".

Summary of research activities

We use genetic algorithms to explore super-additivity of coherent information of noisy quantum channels [PRA 106, 012432 (2022)]. We find regions in the three-parameter space of qubit Pauli channels where coherent information exhibits this super-additivity feature. In another work, we propose thermodynamic quantities that capture signatures of genuineness in multipartite entangled states [PRL 129, 070601 (2022)]. Instead of entropy, these quantities are defined in terms of energy -- the difference between global and local extractable works that can be stored in quantum batteries. We show that beyond quantum signature of locally quantum no-signalling theories can be revealed in a generalized Bell kind to test [PRA 106, L040201 (2022), Letter]. Accordingly, this suggests requirement of additional information principles along with the local quantum structure and no-signalling principle to isolate quantum correlations. More importantly, our work establishes that these additional principles must be sensitive to the quantum signature of local inputs.

In a foundational work, we analyze the communication utilities of different composite models consisting of locally quantum systems and show that they can lead to distinct utilities in a simple communication game involving two players [PRA 106, 062406 (2022)]. Our analysis establishes that a beyond quantum composite structure can lead to beyond quantum correlations in the time-like scenario and hence welcomes new principles to isolate the quantum correlations from the beyond quantum ones. Finally, we also study the principle of information causality which was proposed as a generalization of no signalling principle [PRL 130, 110202 (2023)]. While this principle is efficiently applied to outcast beyond quantum correlations as unphysical, we show that when utilized properly it can also provide physical rationale toward structural derivation of multipartite quantum systems.

"Nematic phases and elastoresistivity from a multiorbital non-Fermi liquid." PNAS, 120 (2), e2207903120, 2022. We propose and study a two-orbital lattice extension of the Sachdev-Ye-Kitaev model in the large-N limit. The phase diagram of this model features a high-temperature isotropic non-Fermi liquid that undergoes a first-order thermal transition into a nematic insulator or continuous thermal transition into a nematic metal phase, separated by a tunable tricritical point. These phases arise from spontaneous partial orbital polarization of the multiorbital non-Fermi liquid. We explore the spectral and transport properties of this model, including d.c. elastoresistivity, which exhibits a peak near nematic transition, as well as nonzero frequency elastoconductivity. Our work offers a useful perspective on nematic phases and transport in correlated multiorbital systems.

"Chiral broken symmetry descendants of the kagome lattice chiral spin liquid." PRB Letter, 107 (2), L02041, 2023. The breaking of chiral and time-reversal symmetries provides a pathway to exotic quantum phenomena and topological phases. Recent work has extensively explored the resulting emergence of chiral charge orders and chiral

spin liquids (CSLs) on the kagome lattice. Such CSLs are closely tied to bosonic fractional quantum Hall states with anyonic quasiparticles; however, their connection to nearby ordered states has remained a mystery. Here, we use spin-wave theory, parton Gutzwiller wave functions, and exact diagonalization to show that two distinct magnetic orders with uniform scalar chirality--the XYZ umbrella state and the octahedral spin crystal–emerge as competing orders near the CSL. In this letter, we highlight the intimate link between a topologically ordered liquid and broken symmetry states with nontrivial real-space topology.

Active particle dynamics: Active particles are self-propelled agents which consume energy from the 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 set of recent works (Santra, Basu and Sabhapandit, J. Phys. A 2022; J. Stat. Mech. 2023) we have explored certain universal features in the long-time behaviour of generic active particles. We have developed a systematic formulation to perturbatively compute the position distribution of noninteracting active particles in this regime. In another very recent work (Das and Basu, J. Stat. Mech. 2023) we have studied the dynamics of a chirality reversing active Brownian particle, which models the chirality reversing active motion common in many microorganisms and microswimmers. We show that, for such a motion in two dimensions, the presence of the two time-scales set by the rotational diffusion constant and the chirality reversal rate gives rise to four distinct dynamical regimes showing distinct behaviors, which we analytically characterize.

Activity driven transport: The transport properties of an extended system driven by active reservoirs is an issue of paramount importance, which remains virtually unexplored. We address this issue, for the first time, in the context of energy transport between two active reservoirs connected by a chain of harmonic oscillators (Santra and Basu, SciPost Phys. 2022; Sarkar, Santra and Basu, Phys. Rev. E 2023). The couplings to the active reservoirs, which exert correlated stochastic forces on the boundary oscillators, lead to fascinating behavior of the energy current and kinetic temperature profile even for this linear system. We analytically show that the stationary active current (i) changes non-monotonically as the activity of the reservoirs are changed, leading to a negative differential conductivity (NDC), and (ii) exhibits an unexpected direction reversal at some finite value of the activity drive. The origin of this NDC is traced back to the Lorentzian frequency spectrum of the active reservoirs. We provide another physical insight to the NDC using nonequilibrium linear response formalism for the example of a dichotomous active force. We also explore the universal features of stationary states of a chain of harmonic oscillators driven by active forces at the two ends. We consider three most well known dynamics for the active force, namely, active Ornstein-Uhlenbeck process, run-and-tumble process and active Brownian process, all of which have exponentially decaying two-point temporal correlations but very different higher order fluctuations. We show that irrespective of the specific dynamics of the drive, the stationary velocity fluctuations are Gaussian in nature with a kinetic temperature which remains uniform in the bulk. Moreover, we find the emergence of an 'equipartition of energy' in the bulk of the system—the bulk kinetic temperature equals the bulk potential temperature in the thermodynamic limit.

"Probing magnetic anisotropy and spin-reorientation transition in the three-dimensional antiferromagnet Ho0.5Dy0.5FeO3|Pt using spin Hall magnetoresistance." PRB, 106 (10), 104426, 2022. Orthoferrites (RFeO3) containing rare-earth (R) elements are 3D antiferromagnets that exhibit characteristic weak ferromagnetism originating due to slight canting of the spin moments and display a rich variety of spin-reorientation transitions in the magnetic field (H)-temperature (T) parameter space. We present spin Hall magnetoresistance (SMR) studies on ab plate (ac plane) of crystalline Ho0.5Dy0.5FeO3|Pt hybrid at various T. In the room temperature 4 phase, the switching between two degenerate domains occurs at fields above a critical value, Hc≈713 Oe. Under H>Hc, the angular dependence of SMR (scan) yielded a highly skewed curve with a sign-reversal and a rotational hysteresis around the a-axis. For H<Hc, the -scan measurements on the single degenerate domain exhibited an anomalous sinusoidal signal of periodicity 360. Low-T evolution of the SMR curves suggests weakening of the anisotropy possibly due to the T evolution of Fe-R exchange coupling. Below 25K, the SMR modulation showed an abrupt change around the c-axis, marking the presence of a 2 phase. We have employed a simple Hamiltonian and computed SMR to examine the observed skewed SMR modulation. In summary, SMR is found to be an effective tool to probe magnetic anisotropy as well as spin reorientation. Our spin-transport study highlights the potential of Ho0.5Dy0.5FeO3 for future AFM spintronic devices.

Surface specific adsorption of glucose to ZnO: ZnO is bio-safe and hence, may be a potential candidate for

directly using as glucose sensor. This needs to understand the interaction of glucose with four common surfaces,, , (0001) and of ZnO.We carry out molecular dynamics (MD) simulations enhanced by umbrella sampling of a glucose molecule in a solvent over a hydrated ZnO slab. The slab is obtained by quantum mechanical optimization. We observe hydration layers formed above the surfaces affect the approach of glucose to the surfaces. Potential of mean force (PMF) calculations show that surface shows strongest adsorption of adsorption free energy -6.81 kJ/mol towards glucose. Thus, we offer a theoretical understanding on the interactions at the nano-bio junction of glucose and ZnO surfaces. Our study suggests that () surface may be used to fabricate a direct glucose sensor. (Phys. Chem. Chem. Phys., 25, 7805 (2023).)

Model studies on motion of respiratory droplets driven through a face mask : Face masks are used to intercept respiratory droplets to prevent spreading of air-borne diseases. Designing face masks with better efficiency needs microscopic understanding on how respiratory droplets move through a mask. Here we study a simple model on the interception of droplets by a face mask. The mask is treated as a polymeric network in an asymmetric confinement, while the droplet is taken as a micrometer-sized tracer colloidal particle, subject to driving force that mimics the breathing. We study numerically, using the Langevin dynamics, the tracer particle permeation through the polymeric network. We show that the permeation is an activated process following an Arrhenius dependence on temperature. The potential energy profile responsible for the activation process increases with tracer size, tracer bead interaction, network rigidity and decreases with the driving force and confinement length. A deeper energy barrier led to better efficiency to intercept the tracer particles of a given size in the presence of driving force at room temperature. Our studies may help to design masks with better efficiency. (EPL 141 27001, 2023)

A Mechanoelastic Glimpse on Hyaluronan-Coated Extracellular Vesicles: Cancer cells secrete extracellular vesicles (EVs) covered with a carbohydrate polymer, hyaluronan (HA), linked to tumor malignancy. Herein, we have unraveled the contour lengths of HA on a single cancer cell-derived EV surface using single-molecule force spectroscopy (SMFS), which divulges the presence of low molecular weight HA (LMW-HA < 200 kDa). We also discovered that these LMW-HA-EVs are significantly more elastic than the normal cell-derived EVs. This intrinsic elasticity of cancer EVs could be directly allied to the LMW-HA abundance and associated labile water network on EV surface as revealed by correlative SMFS, hydration dynamics with fluorescence spectroscopy, and molecular dynamics simulations. This method emerges as a molecular biosensor of the cancer microenvironment. (J. Phys. Chem. Lett. 13, 8564, 2022)

After application of a step stimulus the receptor activity of an E.coli cell changes sharply to reach an extremal value and the cell is far from adaptation at this time. Surprisingly, our simulations show that the extremal activity is related to the free energy via Boltzmann distribution, which is expected only for adapted states. We perform exact calculation to explain this striking effect. We also make experimentally verifiable prediction that there is an optimum size of the step stimulus at which the extremal response is reached in the shortest possible time.

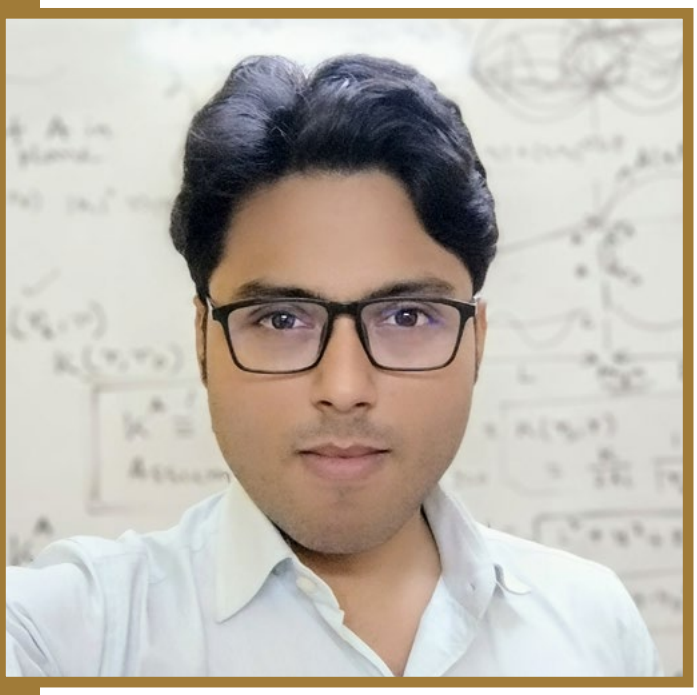
Chemotaxis refers to directed motion in response to a chemical signal. An E.coli cell uses its transmembrane receptors to sense the chemical environment and regulates its run-and-tumble motility to navigate. We use a theoretical model to describe the intracellular signaling network and run-and-tumble motion of the cell. Using extensive numerical simulations we measure the temporal variation of receptor activity and tumbling bias after the application of a step stimulus. We consider the case of step addition (removal) of attractant, i.e. when the attractant level in the environment is suddenly increased (decreased) and then held at that elevated (reduced) level. In the pre-stimulus state and long time after the stimulus is applied, the cell is expected to be in an adapted state with its environment and both activity and tumbling bias assume stationary values. However, these quantities show rapid variation with time immediately after the stimulus is given and reach extremal values at short times. We perform exact calculations to derive the extremal conditions for these quantities and find good agreement with simulations. Interestingly, these extremum conditions show some similarity with an adapted state, although the system is far from adaptation here.

Moreover, the time to reach the extremal response also shows interesting behavior for both activity and tumbling bias. The chemoreceptors have cooperative interaction among themselves which gives rise to receptor clustering. This cooperativity amplifies the input signal and is the reason behind high sensitivity shown by the signaling network. Our simulations show that there is an optimum size of the receptor cluster at which the cell reaches its extremal response in the shortest possible time. We explain the reason behind this interesting effect and we further argue that the same mechanism also yields an

optimum step size of the stimulus at which the extremal response is reached fastest when the receptor cluster size is held fixed. Our numerical simulations verify this prediction. We also propose simple experiments to test our theory.

We study dynamic correlations for current and mass, as well as the associated power spectra, in the one-dimensional conserved Manna sandpile. We show that, in the thermodynamic limit, the variance of cumulative bond current up to a time T grows subdiffusively with the powe-law exponent depending on the density regimes considered and, likewise, the power spectra of current and mass at low frequency varies anomalously. The anomalous suppression of fluctuations near criticality signifies a "dynamic hyperuniformity," characterized by a set of fluctuation relations, in which current, mass, and tagged-particle displacement fluctuations are shown to have a precise quantitative relationship with the density-dependent activity (or its derivative). In particular, the relation between the self-diffusion coefficient, activity and density explains a previous simulation observation *[Eur. Phys. J. B 72, 441 (2009)]* that, near criticality, the self-diffusion coefficient in the Manna sandpile has the same scaling behavior as the activity.

Punyabrata Pradhan
Head,
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) External Project Students / Summer Training

1. Anish Chaudhuri; Student completed their incourse project titled "Studying Fractons in various quantum and classical systems" as a part of the IPhD course PHY 401

Teaching

1. Autumn semester; Advanced Quantum Mechanics & Applications (PHY 303); Integrated PhD; 9 students; with Prof. Manoranjan Kumar (Co-teacher)
2. Autumn semester; Conducted partially with IPhD coursework PHY 303; PhD; 1 student; with Prof. Manoranjan Kumar (Co-teacher)
3. Spring semester; Quantum Mechanics 2 (PHY 406); Integrated PhD; 11 students
4. Spring semester; Project Research III (PHY 401); Integrated PhD; 1 student

Talks / Seminars Delivered in reputed conference / institutions

1. Delivered an invited talk at IISER-Kolkata for the occasion of DPS day celebrations; Mar 18, 2023; IISER Kolkata; 1 day
2. Presented an introductory talk at IIT Bombay as part of a MoU between SNBNCBS and IIT-Bombay; Mar 8, 2023; IIT Bombay; 3 days
3. Delivered an invited talk in the "APCTP IACS SNBNCBS International Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization"; Nov 17, 2022; SNBNCBS; 9 days

Administrative duties

1. Sports coordinator for the centre. Successfully organized several sports tournaments, including 1. Cricket 2. Football 3. Badminton (mixed and singles) In the process of organizing 4. Inter-institute chess 5. Table tennis 6. Carrom
2. Judge for the oral presentations delivered at the BOSE-FEST 2023. BOSE-FEST is a multi day event showcasing the research work of all students and faculty from the centre.
3. Organizer for conducting "Outreach Programmes for the students of SC/ST communities under VASP".

Conference / Symposia / Schools organized

1. Local organizer for "APCTP IACS SNBNCBS International Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization 2022"; Nov 17, 2022; SNBNCBS; 9 days
2. Organizing committee member for "12th Vidyasagar Satyendra Nath Bose National Workshop on Advances in Physics: Theories & Applications-2023" held at Vidyasagar University, Midnapur; Feb 28, 2023; Vidyasagar University, Midnapore, WB; 3 days

Outreach program organized / participated

1. Organizer for conducting "Outreach Programmes for the students of SC/ST communities under VASP"

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 5th September 2022. Recently, we have published original ideas covering various facets of condensed-matter physics. In particular, we have shown that non-Fermi liquids, which are metals without electron-like quasi-particles, can produce nematic phases that spontaneously break rotational symmetry. Our research was published in the Proceedings of the National Academy of Sciences (PNAS). In another work, we have demonstrated how the chiral spin-liquid phase of the kagome lattice (an enigmatic phase of matter with topological properties driven by many-body effects) can spontaneously undergo symmetry breaking leading to non-coplanar magnetic orders. Our findings were published as a letter in Physical Review B. We have also collaborated with experimental physicists to provide a theoretical understanding of the spin-reorientation transition observed in certain three-dimensional anti-ferromagnets. This work was published as an article in Physical Review B.

Plan of Future Work Including Project

1. (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.
2. Exploring the role of topology in quantum systems and its interplay with strong interactions in various condensed matter systems.
3. Understanding the role of magnons and other novel-quasiparticles in quantum spin systems and related platforms.

Any other Relevant Information including social impact of research

1. Our research on "Nematic phases and elastoresistivity from a multiorbital non-Fermi liquid." was highlighted in University of Toronto's recent news page, "https://www.artsci.utoronto.ca/news/condensed-matter-physicists-strange-metals" and covered by various news portals, including "https://www.miragenews.com/new-insight-into-enigmatic-strange-metals-984584/", "https://www.photonicsonline.com/doc/researchers-develop-new-insight-into-the-enigmatic-realm-of-strange-metals-0001"
2. Applied for Startup Research Grant (SRG) under SERB-DST
3. Organizing committee member for upcoming "Bose Statistics Centenary celebrations" scheduled to be held throughout the year 2024
4. Joined SNBNCBS on 5th September 2022. (05.09.2022)

Jaydeb Chakrabarti

Senior Professor
Physics of Complex Systems
jaydeb@bose.res.in

Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Sasthi Charan Mandal; Bio-molucular systems; Awarded
2. Edwin Tendong; Soft matter systems; Thesis submitted; Prof. Tanusri Saha Dasgupta (Co-supervisor)
3. Abhik Ghosh Moulik; Bio-molecular systems; Thesis submitted
4. Rahul Karmakar; Soft matter systems; Thesis submitted
5. Anirban Pal; Bio-molecular systems; Under progress
6. Suravi Pal; Soft matter systems; Under progress
7. Kanika Kole; Bio-molecular systems; Under progress
8. Avik Sasmal; Soft matter systems; Under progress
9. Anusri Sen; Bio-molecular systems; Under progress; Prof. Rajib Kumar Mitra (Co-supervisor)
10. Sabuj Mandal; Soft matter systems; Under progress

b) Post-Docs

1. Aayatti Gupta Mallik; Biomolecular systems
2. Soumi Das; Biomolecular systems

Teaching

1. Autumn semester; Phy 416 and 630; Integrated PhD; 12 students

Publications

a) In journals

1. Abhik Ghosh Moulick and **J. Chakrabarti**, *Correlated dipolar and dihedral fluctuations in a protein*, Chemical Physics Letters, 797, 139574, 2022
2. Jay Prakash Singh, Sudipta Pattanayak, Shradha Mishra, **Jaydeb Chakrabarti**, *Effective single component description of steady state structures of passive particles in an active bath*, The Journal of Chemical Physics, 156, 214112, 2022
3. Piya Patra, Raja Banerjee, **Jaydeb Chakrabarti**, *Effect of biphosphate salt on dipalmitoylphosphatidylcholine bilayer deformation by Tat polypeptide*, Biopolymers, 113, e23518, 2022
4. Abhik Ghosh Moulick and **J. Chakrabarti**, *Conformational fluctuations in the molten globule state of α-lactalbumin*, Physical Chemistry Chemical Physics, 24, 21348, 2022
5. Debashish Paul, Anirban Paul, Dipanjan Mukherjee, Saroj Saroj, Manorama Ghosal, Suchetan Pal, Dulal Senapati, **Jaydeb Chakrabarti**, Samir Kumar Pal, and Tatini Rakshit, *A Mechanoelastic Glimpse on Hyaluronan-Coated Extracellular Vesicles*, The Journal of Physical Chemistry Letters, 13, 8564, 2022
6. Rahul Karmakar, Aishani Ghosal and **J. Chakrabarti**, *Model studies on motion of respiratory droplets driven through a face mask*, Europhysics Letters, 141, 27001, 2023

7. Sasthi Charan Mandal and **Jaydeb Chakrabarti**, *Surface specific adsorption of glucose to ZnO*, Physical Chemistry Chemical Physics, 25, 7805, 2023
8. Manas Mondal, Srabani Chakrabarty, Yi Qin Gao, Dhananjay Bhattacharyya, **Jaydeb Chakrabarti**, *Microscopic model on indoor propagation of respiratory droplets*, Computational Biology and Chemistry, 102, 107806, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Ordering in thermally driven thermo-responsive colloids; Nov 2, 2022; Presidency University
2. Viscoelastic response of an asymmetrically confined fluid; Feb 1, 2023 ; ISPCM,ICTS, Bangalore
3. Talk by Abhik Ghosh Moulik (student): Coarse-grained model of protein with structural informations; Mar 16, 2023; Steady State Phenomena In Soft Matter, Active and Biological Systems, SNBNCBS
4. Talk by Abhik Ghosh Moulik (student): Data Modeling and Computation: Capturing Biomolecular Processes; Oct 31, 2022; CECAM, Lausanne Switzerland
5. Poster by Abhik Ghosh Moulik (student): Microscopic understanding of fatty acid binding with alpha-lactalbumin at molten globule state; Jan 23, 2023; MBU@50, IISc, Bangalore
6. Talk by Rahul Karmakar (student): state structure formation by thermoresponsive particles in presence of temperature difference; Mar 16, 2023; Steady State Phenomena In Soft Matter, Active and Biological Systems, SNBNCBS
7. Poster by Rahul Karmakar (student): studies on motion of respiratory droplets driven through a face mask; Dec 19, 2022; CompFlu 2022,IIT Kharagpur Research park, New town, Rajarhat, Kolkata
8. Poster by Rahul Karmakar (student): Long ranged order formation at hot region using thermoresponsive particles in presence of temperature gradient; Feb 1, 2023; ISPCM,ICTS, Bangalore
9. Poster by Suravi Pal (student):External potential induced mixing of a demixed binary colloids; Sep 22, 2022; Current Trends in Theoretical Chemistry (CTTC) 2023,BARC, Mumbai

Conference / Symposia / Schools organized

1. Steady State Phenomena In Soft Matter, Active and Biological Systems; Mar 16, 2023; SNBNCBS; 03 days

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

1. Simulations on effective interaction mapping of a passive-active colloids mixtures; Sl. No. 2; National

Outreach program organized / participated

1. Talk on: "Molecular dynamics as tool to study condensed phase properties" for Post Graduate students of RKMVERI, Dec 07, 2022
2. Talk and workshop on : "From atoms to proteins: Molecular dynamics as a tool" for UG students at Department of Chemistry, Durgapur Government college, Durgapur, Dec, 12, 2022

Areas of Research

Statistical mechanics of soft matter and bio-molecular systems

I work in the area of application of statistical mechanics tools to understand properties of soft matter and bio-molecular systems. One major tool to this endeavour is molecular simulations including Molecular Dynamics, Monte Carlo, Brownian Dynamics and various smarter simulation techniques. The systems we investigate range from motion of colloids through polymer network, metastability of nearly denatured proteins hyaluronic acid induced changes in membrane elasticity and so on. Here we illustrate on a couple of works.

Motion of colloidal particles through a polymer network: Face masks are used to intercept respiratory droplets to prevent spreading of air-borne diseases. Designing face masks with better efficiency needs microscopic understanding on how respiratory droplets move through a mask. Here we study a simple model on the interception of droplets by a face mask. The mask is treated as a polymeric network in an asymmetric confinement, while the droplet is taken as a micrometer-sized tracer colloidal particle, subject to driving force that mimics the breathing. We study numerically, using

the Langevin dynamics, the tracer particle permeation through the polymeric network. We show that the permeation is an activated process following an Arrhenius dependence on temperature. The potential energy profile responsible for the activation process increases with tracer size, tracer bead interaction, network rigidity and decreases with the driving force and confinement length. A deeper energy barrier led to better efficiency to intercept the tracer particles of a given size in the presence of driving force at room temperature. Our studies may help to design masks with better efficiency. Ref: EPL, 141, 27001, 2023

Molten globule state of a protein: A molten globule (MG) state is an intermediate state of a protein observed during the unfolding of the native structure. The MG state of the protein is induced by various denaturing agents (like urea), extreme pH, pressure, and heat. Experiments suggest that the MG state of some proteins is functionally relevant even if there is no well-defined tertiary structure. Earlier experimental and theoretical studies show that the MG state of a protein is dynamic in nature, where conformational states are interconverted on nanosecond time scales. These observations lead us to study and compare the conformational fluctuations of the MG state to those of intrinsic disordered proteins (IDPs). We consider a milk protein, α-lactalbumin (aLA), which shows an MG state at low pH upon removal of the calcium (Ca^{2+}) ion. We use the constant pH molecular dynamics (CpHMD) simulation to maintain the protonation state of titratable residues at a low pH during the simulation. We use the dihedral principal component analysis, the density based clustering method, and the machine learning technique to identify the conformational fluctuations. We observe metastable states in the MG state. The residues containing the essential coordinates responsible for metastability belong to a stable helix in the crystal structure, but most of them prefer unstructured or bent conformation in the MG state. These residues control the exposure of the putative binding residues for fatty acids. Thus, the MG state of a protein behaves as an intrinsic disorder protein, although the disorder here is induced by external conditions. PCCP, 24, 21348 (2023)

Plan of Future Work Including Project

1. Viscosity of a polymeric system under confinement
2. Understanding conformations of disordered protein in presence of nanoparticle
3. Coarse grained model for protein function
4. Hydration of proteins in complex solvent conditions
5. Steady state behaviour of colloids in a spatio-temporal bias

Manik Banik

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Ram Krishna Patra; Study of quantum resources to devise advanced communication protocols; Under progress
2. Samrat Sen; A study on various discrimination tasks and their implications in quantum information processing; Under progress
3. Sahil Gopalkrishna Naik; Quantum Foundations and Quantum Information Theory; Under progress
4. Govind Lal Sidhardh; Quantum Communication Theory; Under progress
5. Ananya Chakraborty; Quantum Information Theory and Quantum Foundations; Under progress
6. Snehasish Roy Chowdhury; Quantum Information Theory, Quantum Thermodynamics; Under progress; Prof. Guruprasad Kar, Indian Statistical Institute, Kolkata (Co-supervisor)

b) Post-Docs

1. Mir Alimuddin; Quantum Thermodynamics, Quantum Entanglement, Quantum Information Theory, Quantum Foundations
2. Amit Mukherjee; Quantum Foundations, Quantum Entanglement, Quantum Information Theory

Teaching

1. Spring semester; Quantum Information Theory; PhD; 10 students
2. Spring semester; Quantum Information Theory; Integrated PhD; 3 students

Publications

a) In journals

1. Govind Lal Sidhardh, Mir Alimuddin, and **Manik Banik**, *Exploring superadditivity of coherent information of noisy quantum channels through genetic algorithms*, Physical Review A, 106, 012432, 2022
2. Samgeeth Puliyil, **Manik Banik**, and Mir Alimuddin, *Thermodynamic Signatures of Genuinely Multipartite Entanglement*, Physical Review Letters, 129, 070601, 2022
3. Edwin Peter Lobo, Sahil Gopalkrishna Naik, Samrat Sen, Ram Krishna Patra, **Manik Banik**, and Mir Alimuddin, *Certifying beyond quantumness of locally quantum no-signaling theories through a quantum-input Bell test*, Physical Review A, 106, L040201, 2022
4. Samrat Sen, Edwin Peter Lobo, Ram Krishna Patra, Sahil Gopalkrishna Naik, Anandamay Das Bhowmik, Mir Alimuddin, and **Manik Banik**, *Timelike correlations and quantum tensor product structure*, Physical Review A, 106, 062406, 2022
5. Ram Krishna Patra, Sahil Gopalkrishna Naik, Edwin Peter Lobo, Samrat Sen, Govind Lal Sidhardh, Mir Alimuddin, and **Manik Banik**, *Principle of Information Causality Rationalizes Quantum Composition*, Physical Review Letters, 130, 110202, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Invited Talk at 2 - Day Workshop on "Quantum Metrology and Quantum Information Processing"; Aug 26, 2022; CDAC, Kolkata Plot - E-2/1, Block-GP, Sector-V; 60 mins
2. Invited Talk at NIT Durgapur (Department of Mathematics); Nov 7, 2022; Invited Talk at NIT Durgapur (Department of Mathematics); 60 mins
3. Lecture Series at IIIT Hyderabad; Nov 15, 2022; Lecture Series at IIIT Hyderabad; 5*60 mins
4. Invited Talk at IIT Tirupati (Department of Physics); Oct 20, 2022; Online; 60 mins
5. Colloquium Talk at Department of Physics, Presidency University; Feb 1, 2023; Presidency University; 60 mins
6. Invited Talk at Progress in Quantum Science and Technology (PiQuST) organized at IIT Madras; Jan 27, 2023; Invited Talk at Progress in Quantum Science and Technology (PiQuST) organized at IIT Madras; 45 mins
7. Invited Talk at national seminar on "Applied Mathematics in Science & Technology" organized by Department of Applied Mathematics, University of Calcutta; Mar 23, 2023; Rajabazar Science College; 60 mins
8. Invited Talk at IIT Mandi; Nov 22, 2022; Online; 60 mins

Administrative duties

1. Coordinator & Convener of Theoretical Physics Seminar Circuit (TPSC) and Vigyan Jyoti (From 19 September, 2022 onwards)
2. Member of Media Cell of the Centre (From 23 December, 2022 onwards)
3. Convener of the Committee for conducting outreach programmes for the students of SC/ST communities under VASP (From 6 December, 2022 onwards)
4. Member of the Committee constitute for planning of Centenary observation of BOSE STATISTICS

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

1. INSPIRE Faculty Research Grant; DST, SERB; 1 year; PI
2. Chanakya PDF; I-HUB, IISER PUNE; 2 years; PI

Conference / Symposia / Schools organized

1. Topical Research School on "Quantum Foundation and Quantum Information 2023" Jointly organized by A B N Seal College, Cooch Behar and SNBNCBS; Mar 15, 2023; A B N Seal College, Cooch Behar, WB; Three Days

Areas of Research

Quantum Information Theory, Quantum Communication, Quantum Foundations, Reconstruction Programme

One of the research activities of my group during last one year is to understanding the mathematical structure of composite quantum systems. The state-space and effect-space structure for a composite quantum system is postulated among several mathematically consistent possibilities that are compatible with a local quantum description. We study the correlations in time-like scenario to understand the specialty of quantum composition. We analyze the communication utilities of different composite models and show that they can lead to distinct utilities in a simple communication game involving two players. Our analysis thus establishes that a beyond quantum composite structure can lead to beyond quantum correlations in the time-like scenario and hence welcomes new principles to isolate the quantum correlations from the beyond quantum ones.

In a different work, we have invoked the principle of `Information Causality' to understand the self-dual structure of quantum state and effect spaces. The principle of information causality was proposed as a generalization of no signaling principle, and has efficiently been applied to outcast beyond quantum correlations as unphysical. In our work, we show that this principle, when utilized properly, can provide physical rationale toward structural derivation of multipartite quantum systems. Information causality therefore promises an information-theoretical derivation of self duality of the state and effect cones for composite quantum systems.

In another problem we have proposed thermodynamic measures to quantify genuine entanglement in multipartite quantum systems. Instead of entropy, these quantities are defined in terms of energy-particularly the difference between global and local extractable works (ergotropies) that can be stored in quantum batteries.

Some of these quantities suffice as faithful measures of genuineness and to some extent distinguish different classes of genuinely entangled states.

In another problem we have shown that beyond quantum characteristic of locally quantum no-signaling theories can be certified through a quantum-input Bell test. Our work suggests the requirement of additional information principles along with the local quantum structure and no-signaling principle to isolate quantum correlations. It also establishes that the additional principle(s) must be sensitive to the quantum signature of local inputs. We also generalize our results to multipartite locally quantum no-signaling theories and further analyze some interesting implications.

In a different work we have explored superadditivity of coherent information of Pauli channels through genetic algorithms. We characterized the quantum codes that achieve high coherent information, finding several nontrivial quantum codes that outperform the repetition codes for some Pauli channels. For some Pauli channels, these codes display very high superadditivity. We further compared the learning performance of the neural network Ansatz with the raw Ansatz to find that in the three-shot case, the neural network Ansatz outperforms the raw representation in finding quantum codes of high coherent information. We also compared the learning performance of the evolutionary algorithm with a simple particle swarm optimization scheme, and we show empirical results indicating comparable performance, suggesting that the neural network Ansatz coupled with the evolutionary scheme is indeed a promising approach to finding nontrivial quantum codes of high coherent information.

Prosenjit Singha Deo

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Sayan Routh; Superconductivity; Under progress; Thirupathaiah Setti (Co-supervisor)
2. K. Meena; Mesoscopic physics; Under progress

b) External Project Students / Summer Training

1. Sampeswar; Mesoscopic physics

Publications

a) In journals

1. Kanchan Meena and **P. Singha Deo**, *A Mechanism to Attract Electrons*, Advances in Theoretical & Computational Physics, 5(2), 458, 2022
2. Kanchan Meena and **P. Singha Deo**, *Time reversed states in barrier tunneling*, Physica E: Low-dimensional Systems and Nanostructures, 149, 115680, 2023

Areas of Research

Mesoscopic physics

We have shown several direct and indirect ways to experimentally probe time travel. One of them relies on showing that electrons moving back in time can lead to electron-electron attraction.

Punyabrata Pradhan

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Anirban Mukherjee; Studies of hydrodynamics and fluctuations in sandpiles; Under progress
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. Rupayan Saha; Time-dependent properties of interacting self-propelled particles; Under progress
5. Deepshikha Das; Transport in many-particle systems with time-dependent drive; Under progress; Sakuntala Chatterjee (Co-supervisor)

Publications

a) In journals

1. Anirban Mukherjee and **Punyabrata Pradhan**, *Dynamic correlations in the conserved Manna sandpile*, Physical Review E, 107, 024109, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at the international conference "Statistical Physics of Complex Systems" at the ICTS, Bengaluru; Dec 19, 2022; ICTS Bengaluru; 40 mintues
2. Invited talk at the Department of Physical Sciences, IISER Mohali; Jan 31, 2023; IISER Mohali; 1 hour

Administrative duties

1. HOD of the PCS (erstwhile DTS)
2. Member of faculty search committee
3. Chairperson of Newsletter committee
4. Library committee
5. Media cell
6. Various interview committees

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

1. Fluctuation and transport in the models of self-propelled particles; SERB (DST); 3 years; PI

Conference / Symposia / Schools organized

1. Steady state phenomena in soft matter, active and biological systems; Mar 16, 2023; SN bose Centre, Kolkata; 3 days

Areas of Research

Relaxation phenomena in mass transport processes, fluctuation relations far from equilibrium, and single-file diffusion, etc.

Theoretical understanding time-dependent properties of conserved-mass transport processes, ranging from

living to nonliving matter, plays an important role in characterizing systems driven out of equilibrium and is still lacking. Unlike in equilibrium, driven systems break detailed balance and usually are not described by the familiar equilibrium Boltzmann-Gibbs distribution. However, on large scale, the transport properties of these systems, like in equilibrium, are characterized by the two key quantities - the bulk-diffusion coefficient and the mobility (or, equivalently, the conductivity). Indeed, due to the fascinating interplay between drive and dissipation, driven systems can exhibit fascinating collective, and counterintuitive, behavior, such as clustering, "giant" number fluctuations, and anomalous transport. Indeed, in recent years, much effort has been made to comprehend such emergent properties by studying the paradigmatic models, such as mass aggregation processes, sandpile models, and run-and-tumble particles (RTPs), etc. These model systems are amenable to theoretical calculations, but still capture various nontrivial features of more realistic systems found in nature. We primarily investigate the large-scale (hydrodynamic) relaxation and fluctuation properties of density and current in various driven interacting-particle systems as mentioned above.

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 hyper-uniform state of matter,
3. Studies of relaxation and fluctuation phenomena for continuum systems
4. Fluctuation properties of systems consisting of self-propelled particles in the presence of hard walls and disordered potentials, etc.

Any other Relevant Information including social impact of research

1. Man-power development through teaching and training of graduate students

Sakuntala Chatterjee

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Shobhan Dev Mandal; Bacterial Chemotaxis in noisy environment; Under progress
2. Deepsikha Das; Transport in periodically driven systems; Under progress; Punyabrata Pradhan (Co-supervisor)
3. Chandradip Khamrai; Coupled driven systems; Under progress
4. Ramesh Pramanik; E.coli Chemotaxis in a ligand environment with spatio-temporal variation; Under progress
5. Pallabi Roy; Dynamics and energetics of some open chemical and biological systems; Under progress; Gautam Gangopadhyay (Co-supervisor)

b) External Project Students / Summer Training

1. Prerak Gupta; Study of a fluctuating membrane described by Helfrich Hamiltonian

Teaching

1. Spring semester; Statistical Mechanics; Integrated PhD; 11 students
2. Autumn semester; Project Research II; Integrated PhD; 1 student

Publications

a) In journals

1. **Sakuntala Chatterjee**, *Short time extremal response to step stimulus for a single cell E. coli*, Journal of Statistical Mechanics: Theory and Experiment, 2022, 123503, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. "Sensing vs adaptation in bacterial chemotaxis" Invited talk in national conference "NARIPHY"; Aug 25, 2022; IISER Bhopal; 30 minutes
2. Invited to deliver a talk "Signaling noise in bacterial chemotaxis" in international conference "Statistical Biological Physics: from Single Molecule to Cell"; Oct 19, 2022; ICTS Bangalore; 1 hour
3. Invited to give an Institute colloquium "Noise in bacterial chemotaxis" at TIFR-Hyderabad; Nov 21, 2022; TIFR-Hyderabad; 1 hour
4. Presented a talk "Short time extremal response to step stimulus for a single cell E.coli" in "8th Indian Statistical Physics Community Meeting"; Feb 3, 2023 ICTS Bangalore; 12 minutes

Administrative duties

1. Served in many internal committees of the center

Awards, Recognitions, if any

1. 1. Invited by European Physical Society to act as co-editor for the journal Europhysics Letters

2. Invited to join European Physical Society as a member

Membership of Learned Societies

1. Invited to be a member of European Physical Society

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

1. Theoretical investigation of run- and-tumble motion in a noisy environment DST SERB (Matrics); Feb 2020-Feb 2023; PI

Conference / Symposia / Schools organized

1. Steady state phenomena in soft matter, active and biological systems Mar 16, 2023; SNBNCBS; 3 days

Outreach program organized / participated

1. Organized virtual lab visit and online interaction for young girl students from East Midnapore schools to encourage them to choose STEM field in their future career. This initiative was under Vigyan Jyoti scheme of DST

Areas of Research

Nonequilibrium Statistical Physics and Biological Systems

1. **Short time extremal response to step stimulus for a single cell E.coli**

   After application of a step stimulus, in the form of a sudden change in attractant environment, the receptor activity and tumbling bias of an E. coli cell change sharply to reach their extremal values before they gradually relax to their post-stimulus adapted levels in the long time limit. We perform numerical simulations and exact calculations to investigate the short time response of the cell. For both activity and tumbling bias, we exactly derive the condition for extremal response and find good agreement with simulations. We also make experimentally verifiable prediction that there is an optimum size of the step stimulus at which the extremal response is reached in the shortest possible time. In contrast to many experimental and theoretical studies, where long time limit of the post-stimulus recovery is considered, our work highlights the importance of understanding the short time response of the cell. For example, many experiments measure the time-scale over which receptor activity or motor bias show half-way recovery, but we show here it is important to take into account the variation of short time maximal response even before the recovery starts, and useful insights about the adaptation kinetics can be obtained from there. Many of our conclusions can be verified in experiments. The presence of an optimum step size of the stimulus which yields fastest extremal response is quite intriguing and can be directly tested using a tethered assay and fluorescence resonance energy transfer (FRET) based setup. Experimentally it has also been possible to vary the strength of the cooperative interaction among the receptors which ultimately controls the size of the receptor clusters. Therefore it should be possible to check if there is an optimum interaction strength at which activity or CW bias hit their extremal values in the shortest possible time.

2. **Optimum transport in periodically driven systems with short-ranged interactions**

   We study an one dimensional lattice gas model of hardcore particles with nearest neighbor interaction in presence of a time-periodic external potential. Using numerical simulations and mean-field calculations we derive the conditions for optimum transport, i.e. maximum particle current in the system and study how attractive or repulsive interaction among the particles affect these conditions. The current induced by the periodic external drive is opposed by the diffusive current present in the system and as a result of this interplay the system can show current reversal. Presence of nearest neighbor interaction seriously affects the current. We find a repulsive interaction generally enhances the current, while attractive interaction suppresses it. For low density of particles, current increases with the strength of repulsive interaction and maximal current is obtained for strongest possible repulsion, i.e. in the limit of nearest neighbor exclusion. However, for high density of particles, very strong repulsion makes particle movement difficult in an overcrowded environment and in this case maximal current is obtained for somewhat weaker repulsive interaction.

Plan of Future Work Including Project

1. Study of E.coli chemotaxis in a spatio-temporally varying environment
2. Study of ordered and disordered phases of coupled driven systems

Urna Basu

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Ritwick Sarkar; Activity driven transport; Under progress

b) External Project Students / Summer Training

1. Nilachal Chakrabarti; Stochastic active particle dynamics
2. Shrabasti Banerjee; Ising model with dichotomous temperature
3. Debraj Dutta; Run-and -Tumble motion with stochastic tumbling rate

Teaching

1. Autumn semester; PHY 292; Integrated PhD; 1 student
2. Spring semester; PHY 304; Integrated PhD; 1 student
3. Spring semester; PHY 401; Integrated PhD; 1 student

Publications

a) In journals

1. Ion Santra, **Urna Basu** and Sanjib Sabhapandit, *Long time behavior of run-and-tumble particles in two dimensions*, Journal of Statistical Mechanics: Theory and Experiment, 2023, 033203, 2023
2. Ritwick Sarkar, Ion Santra, and **Urna Basu**, *Stationary states of activity-driven harmonic chains*, Physical Review E, 107, 014123, 2023
3. Ion Santra, **Urna Basu** and Sanjib Sabhapandit, *Effect of stochastic resetting on Brownian motion with stochastic diffusion coefficient*, Journal of Physics A: Mathematical and Theoretical, 55, 414002, 2022
4. **Urna Basu**, Vincent Démery, Andrea Gambassi, *Dynamics of a colloidal particle coupled to a Gaussian field: from a confinement-dependent to a non-linear memory*, SciPost Physics, 13, 078, 2022
5. Ion Santra, **Urna Basu** and Sanjib Sabhapandit, *Universal framework for the long-time position distribution of free active particles*, Journal of Physics A: Mathematical and Theoretical, 55, 385002, 2022
6. Ion Santra, **Urna Basu**, *Activity driven transport in harmonic chains*, SciPost Physics, 13, 041, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at the International programme "Statistical Physics of Complex Systems"; Dec 19, 2022; ICTS- TIFR, Bengaluru; 1 week
2. Invited talk at the conference Many facets of statistical field theory (hybrid); Oct 17, 2022; SISSA, Italy; 3 days
3. Invited talk at the thematic programme "Large Deviations, Extremes and Anomalous Transport in Non-equilibrium Systems"; Sep 19, 2022; ESI, University of Vienna, Austria; 2 weeks
4. Invited talk (online) at the ICTP hybrid meeting Non-Markovian Dynamics Far From Equilibrium; May 4, 2022; ICTP, Italy; 3 days
5. Seminar titled "Activity driven energy transport"; Jan 19, 2023; IOP, Bhubaneshwar, India; 1 day

Administrative duties

1. Member of SCOLP
2. Member of CWEP

3. Member of Media Cell
4. Chairperson of Main building housekeeping tendering committee
5. Member of Equity committee
6. Hostel warden
7. Member of admission committee
8. Member of the organizing committee of Statistical Physics seminar series under VASP

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

1. Ramanujan Research Grant; SERB; 5 years; PI

Conference / Symposia / Schools organized

1. VASP Statistical Mechanics seminar by Satya N. Majumdar; Dec 26, 2022; SNBNCBS; 1 day
2. National conference on "Steady state phenomena in soft matter, active and biological systems"; Mar 16, 2023; SNBNCBS; 3 days

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

1. Andrea Gambassi, SISSA, Italy and Vincent Demery, ESPCI, Paris, France; Sl. No. 4; International
2. Sanjib Sabhapandit, Raman Research Institute, India; Sl. No. 1, 3, 5; National

Areas of Research

Statistical Physics

I work in the general area on nonequilibrium statistical physics with current focus in the following areas.

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 studied the dynamics of a chirality reversing active Brownian particle, which models the chirality reversing active motion common in many microorganisms and microswimmers. We show that, for such a motion in two dimensions, the presence of the two time-scales set by the rotational diffusion constant and the chirality reversal rate gives rise to four distinct dynamical regimes showing distinct behaviors. We characterize these behaviors by analytically computing the variance and position distributions.

Activity driven transport: The transport properties of an extended system driven by active reservoirs is an issue of paramount importance, which remains virtually unexplored. Here we address this issue, for the first time, in the context of energy transport between two active reservoirs connected by a chain of harmonic oscillators. The couplings to the active reservoirs, which exert correlated stochastic forces on the boundary oscillators, lead to fascinating behavior of the energy current and kinetic temperature profile even for this linear system. We analytically show that the stationary active current (i) changes non-monotonically as the activity of the reservoirs are changed, leading to a negative differential conductivity (NDC), and (ii) exhibits an unexpected direction reversal at some finite value of the activity drive. The origin of this NDC is traced back to the Lorentzian frequency spectrum of the active reservoirs. We provide another physical insight to the NDC using nonequilibrium linear response formalism for the example of a dichotomous active force. In another recent work, we explore the universal features of stationary states of a chain of harmonic oscillators driven by active forces at the two ends. We consider three most well known dynamics for the active force, namely, active Ornstein-Uhlenbeck process, run-and-tumble process (RTP) and active Brownian process (ABP), all of which have exponentially decaying two-point temporal correlations but very different higher order fluctuations. We show that irrespective of the specific dynamics of the drive, the stationary velocity fluctuations are Gaussian in nature with a kinetic temperature which remains uniform in the bulk. Moreover, we find the emergence of an 'equipartition of energy' in the bulk of the system-the bulk kinetic temperature equals the bulk potential temperature in the thermodynamic limit.

Plan of Future Work Including Project

1. Presently, with my PhD student, I am actively pursuing the study of transport properties of extended systems driven by active reservoirs. We are developing simple models of such active reservoirs, and exploring how the breaking of fluctuation-dissipation theorem affects the transport phenomena, and whether one can unify them using nonequilibrium response formalism. I have also applied for a MATRICS grant which proposes to explore these issues. I am also working on various projects which continue to explore the behaviour of active particles. In particular, I am exploring the behaviour of inertial active particles, and active particles with multiple time-scales.

Department of Chemical and Biological Sciences

Department of Chemical and Biological Sciences

Rajib Kumar Mitra

Department profile indicators

Table A: Manpower and resources

Number of faculty members	Regular = 7 Contractual = 3
Number of Post –doctoral research associate (centre+project)	Centre = 12 Project = 2
Number of Ph.D students	
Number of other project staff	
Number of summer students	11
Projects (ongoing)	15

Table B: Research Activities indicators

Number of research papers in Journals	65
Number of Book-chapters/books	1
Number of other publications	0
Number of Ph.D students graduated (submitted+degree awarded)	4+7
Number of M.Tech/M.Sc projects	

Table C: Academic activities and likeage

Number of courses taught by faculty members	9	
Number of Visitors (non –associates)		
Number of associates		
Number of Seminars organized	15	
Number of Conference/Symposia/Advanced Schools organized	2	
Number of talks delivered by members of department in conferences/Symposia	National	31
	International	4

Most important research highlights

- Molecular Thermodynamic Origin of Substrate Promiscuity in the Enzyme Laccase
- Unravelling the contour lengths of hyaluronan (HA) on a single cancer cell-derived extracellular vehicle (EV) surface using single-molecule force spectroscopy (SMFS), which divulges the presence of low molecular weight HA (LMW-HA < 200 kDa). We also discovered that these LMW-HA-EVs are significantly more elastic than the normal cell-derived EVs.
- Efficient light harvesting in self-assembled organic luminescent nanotubes
- Illustrating the temporal behaviors related to spreading the inhomogeneous control parameter over the spatial domain are illustrated.
- New report on the development of an incoherent broadband (IBB)-SPR probe combining the

wavelength interrogation technique with polarization-multiplexing (PM). This is a new-generation analytical technique with the aim of tracking various real-time chemical and biological molecular interactions occurring at the interfaces.

- Report on the signature of the photonic spin Hall effect in monolayer MoS2 via weak measurement
- Structural changes in the H-bond network and the catalytic cluster itself upon the replacement of Ca2+ with other alkaline earth metals, using a quantum mechanical/molecular mechanical approach.
- Thermo-Resistive Phase Behavior of Trivalent Ion Induced and ion dependent Microscopic Protein-Rich Phases
- The Inner Hydration in Surfactant/Cholesterol Vesicles Differs from the Outer One
- A combined Hz-GHz dielectric relaxation measurements and computer simulations to study the Impact and structure of water in aqueous octanol mixtures
- Report of a spectroscopic detection of lead (Pb); one of the toxic heavy metal pollutants with the help of citrate functionalized gold nanoparticles (Au NPs) followed by development of a low-cost prototype device.
- Sensing Bioavailable Water Content of Granulated Matrices
- "Seeing" invisible volatile organic compound (VOC) marker of urinary bladder cancer: A development from bench to bedside prototype spectroscopic device
- Phosphorylation-Competent Metastable State of Escherichia coli Toxin HipA

Summary of research activities

The department of Chemical and Biological Sciences hosts scientists of varied interests on both fundamental and applied aspects of chemistry, biology and physics. The major strength of the department lies on its multidisciplinary nature as it hosts many states of the art instrumental (mostly spectroscopic) facilities (to mention a few: cavity ring-down spectroscopy, ultrafast fluorescence spectroscopy, THz time domain spectroscopy, dielectric measurements etc.) as well as high power computational facilities. Some of the faculty members of the department have also been actively involved in developing prototypes for commercial applications. The faculty members of the department are working on the following topics:

Prof. Gautam Gangopadhyay works on: Nonlinear non-equilibrium dynamics in Chemical and Biological systems, Stochastic processes in Complex systems, Quantum transport in molecular and Biological processes. This group has recently reported theoretical insight on the Glycolytic Wave Patterns in a Simple Reaction diffusion System with Inhomogeneous Influx and Interplay of energy, dissipation, and error in kinetic proofreading

Prof. Ranjit Biswas makes an integrated approach, based on experiment, simulation, and theory to explore a molecular level understanding of the structure and dynamics of various complex media and their relationship to simple chemical events occurring in them. This group has put forward a combined Hz-GHz dielectric relaxation measurements and computer simulations to study the impact and structure of water in aqueous octanol mixtures. They further combine femtosecond Raman-induced Kerr effect spectroscopy and molecular dynamics to explore Low-frequency spectra of reline and its mixtures with water. A simulation study from this group illustrates the Difference in "Supercooling" Affinity between (Acetamide + Na/KSCN) Deep Eutectics.

Prof. Samir Kumar Pal's focus is on experimental ultrafast spectroscopy and biomedical instrumentation with special reference to Biophysics, Nanotechnology, Bio-mimetics, Bio-nano medicines, Dye-sensitized Solar Cells etc. They have developed several nano-devices and prototypes: for long lasting sterilization effect, Novel Linezolid-Based Oxazolidinones, Prototype Development for Heavy Metal Detection, Sensing Bioavailable Water Content of Granulated Matrices, Non-invasive estimation of hemoglobin, bilirubin and oxygen saturation of neonates, prototype for sensing invisible volatile organic compound (VOC) marker of urinary bladder cancer, portable spectroscopic instrument for multiplexed monitoring of acute water toxicity etc.

Prof. Rajib Kumar Mitra works on Experimental biophysical chemistry and Spectroscopy with special reference to THz and ultrafast spectroscopy, Biomolecules (proteins) and bio-mimetic systems. Their group has reported Trivalent cation-induced phase separation in proteins, their ion specific contribution in hydration, and their thermo resistive phase behavior, The Inner Hydration in Surfactant/Cholesterol Vesicles Differs from the Outer One and Addition of cholesterol alters the hydration at the surface of model lipids. They put forward a combined

experimental and simulation study to conclude A subtle interplay between hydrophilic and hydrophobic hydration governs butanol (de) mixing in water.

Prof. Manik Pradhan works on Laser Spectroscopy and Biomedical Science with special emphasis on Cavity Ring-Down Spectroscopy (CRDS), Cavity Enhanced Absorption Spectroscopy (CEAS) and Wavelength Modulation Spectroscopy (WMS), Nano-bio-photonics including Evanescent-wave Cavity Ring-down Spectroscopy (EW-CRDS) and Surface Plasmon Resonance (SPR). Their group has reported the development of an incoherent broadband (IBB)-SPR probe combining the wavelength interrogation technique with polarization-multiplexing (PM). This is a new-generation analytical technique with the aim of tracking various real-time chemical and biological molecular interactions occurring at the interfaces. An ECQCL based dual-species (CH4/N2O) detection method at 7.8 μm in mid-IR region for simultaneous applications of atmospheric monitoring and breath diagnostics, Signature of the photonic spin Hall effect in monolayer MoS2 via weak measurement, 2D-TMDC-enhanced condensed phase cavity ring-down spectroscopy coupled with surface plasmon resonance for investigation on water isotopologues.

Dr. Suman Chakrabarty works on Computational molecular biophysics and theoretical physical chemistry with special reference to (Bio)molecular recognition and signaling Allostery, Role of water mediated interactions in biology and chemistry Hydrophobic interactions, Self-assembly Context dependent properties of interfacial and confined water, Protein misfolding and aggregation, Nucleation and growth in the context of phase transition like phenomena. Their group has reported Molecular thermodynamic Origin of Substrate Promiscuity in the Enzyme Laccase, Phosphorylation-Competent Metastable State of Escherichia coli Toxin HipA, Efficient light harvesting in self-assembled organic luminescent nanotubes, Modulation of drug binding ability and augmented enzymatic activity of lysozyme stabilized in presence of surface-active ionic liquids.

Dr. Subhasis Haldar works on Single molecule biophysics with special interest in: Mechanical Roles of Chaperone-assisted Protein Folding, Role of Mechanosensitive Proteins in Focal Adhesion-mediated Cellular Processes, Mechanochemical Signalling in Neurodegenerative Pathologies.

Dr. Pradip Pachfule's research interest includes synthesis of novel covalent organic framework (COF), porous polymer networks, metal organic frameworks, catalysis, water splitting, energy harvesting etc.

Rajib Kumar Mitra
Head, Department of Chemical and Biological Sciences

Ali Hossain Khan

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Rudra Chowdhury; Application of 2D nanoplatelets in optoelectronic devices; Under progress; Prof. Abhijit Biswas (Professor & HOD, Department of Radio Physics and Electronics, University of Calcutta) (Co-supervisor)

b) External Project Students / Summer Training

1. Soumyadeep De (Project Student); Co-doping in CdSe nanoplatelets
2. Avanti Chakraborty (Project Student); Heterostructured and doped 2D nanoplatelets
3. Rajasree Maitra (Summer Training 2022); Photodetector and Phototransistor using Colloidal 2D Nanocrystals
4. Ushasi Datta (Summer Training 2022); Impurity Insertion in Colloidal 2D Nanocrystals

Teaching

1. Spring semester 2023; "Surfaces & Interfaces" (Code: CB 641); PhD Coursework; 4 students; Dr. Pradip S. Pachfule (Co-teacher)

Talks / Seminars Delivered in reputed conference / institutions

1. Title of the talk: Designing Two-dimensional Colloidal Nanocrystals for Opto-electronic Applications; Departmental Seminar, Chemical and Biological Sciences, SNBNCBS, Kolkata; July, 12, 2022; Boson & Online; 1 hour

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

Areas of Research

We are targeting to synthesize doped 2D nanocrystals for photonic applications. For this purpose, we have chosen 2D nanocrystals of cadmium selenide (CdSe), often known as the CdSe nanoplatelets (NPLs), as hosts. We have planned to dope two different metal atoms either successively or simultaneously. The aim is to introduce a localized donor and an acceptor state within the CdSe bandgap to tune the dopant emission spectrum towards the NIR region (Figure 1a). For this purpose, we have chosen two types of hetero valent metal ions In^{3+} and Ag^{+} as the dopants, the charge compensation by the heterovalent co-dopants can also enhance the stability of the dopants inside the host. First, we have prepared 4.5 monolayer (ML) thick CdSe nanoplatelets. The monodispersity of the nanoparticles is evident from the absorption and photoluminescence spectra (Figure 1b) and confirmed from TEM analysis (Figure 1b inset). The In^{3+} doping in CdSe NPLs has been done via the growth doping procedure, which gives an additional emission between 550 nm to 650 nm along with the bandage emission peak (Figure 1c). The PL excitation spectra of the CdSe:In NPLs, collected at different dopant emission wavelengths, are largely superposed with the absorption

spectrum of CdSe NPLs (Figure 1d), demonstrating that the dopant emission originates from absorption in the NPLs and confirming the incorporation of indium into the NPLs.

We have also started to work on the phototransistor, based on the colloidal 2D NPLs. Here we also focused to fabricate very thin films of various dielectric materials by sol-gel process, which is a cheap, easy, and controllable

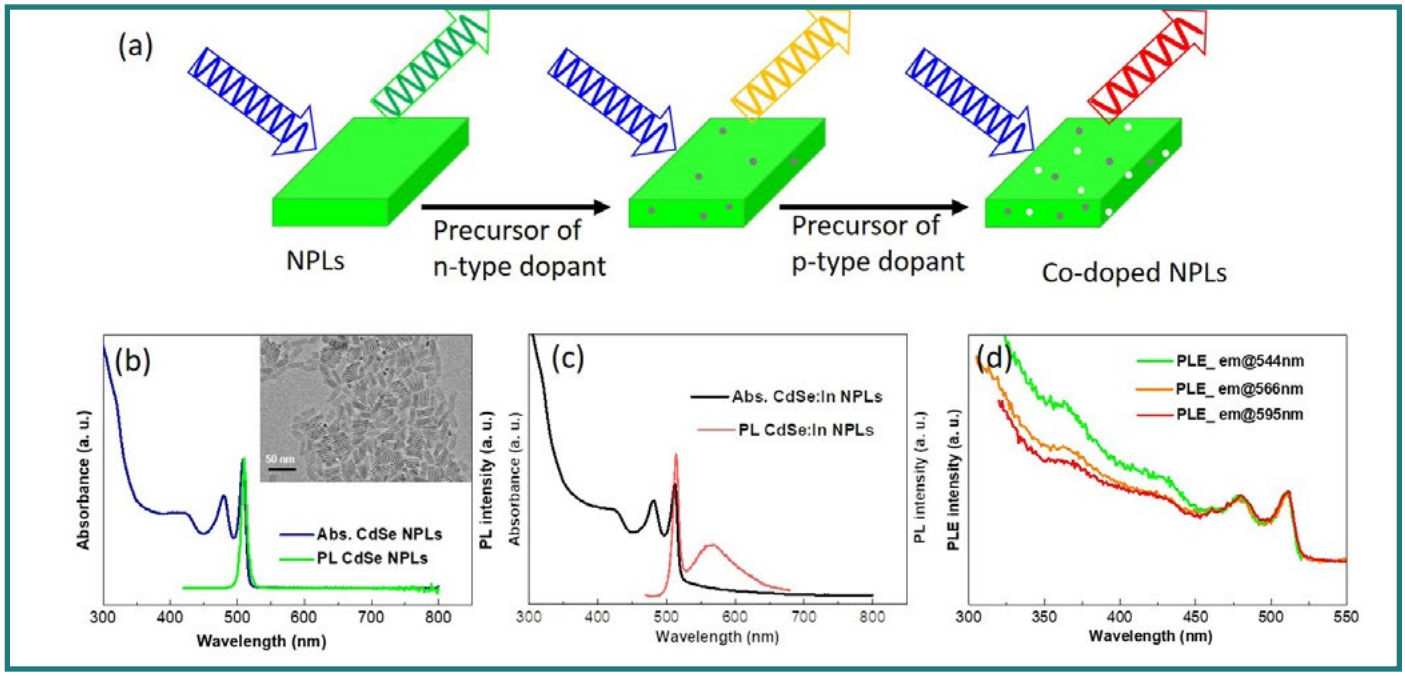

Figure1: (a) Schematic representation of the co-doping strategies. (b) The absorbance and PL spectra of pure 4.5 ML CdSe NPLs. Inset: TEM images of those NPLs. (c) The absorbance and PL of indium-doped CdSe NPLs. The absorbance (black line) spectrum remains the same as the undoped CdSe NPLs. The PL shows a peak at 510 nm due to undoped NPLs, while an additional peak appears at around 570 nm. (d) The PLE spectrum of the CdSe:In NPLs, measured over a range of emission wavelengths, showing the signature of CdSe NPLs. Hence the n-type dopant, indium could be incorporated into the CdSe NPLs.

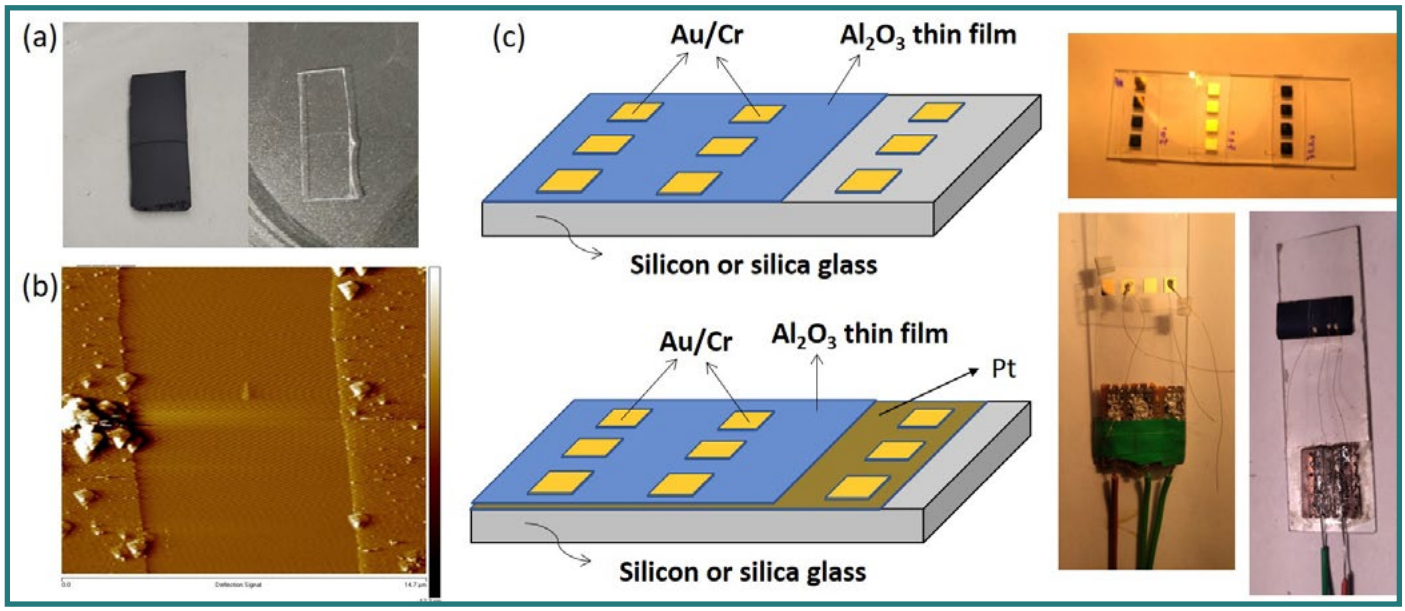

Figure 2. (a) Al_2O_3 thin films on a silicon wafer and silica glass substrate respectively. (b) AFM image of the Al_2O_3 thin films showing the scratch portion and smooth section, used for the thickness measurements. (c) Various device architectures used (in-plane and out-of-plane) for dielectric constant measurements.

method. For example, we fabricated alumina (Al_2O_3) thin film on silicon substrate and silica glass substrate by the Dip coating method and then heated them up to 1000°C (Figure 2a). Surface morphology and thicknesses of the film were analyzed by Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM). We can vary the thickness between 10 nm - 50 nm. Structural characterization and chemical compositional analysis were done by using TEM and XRD. We are now working on electrical measurements using different combinations of electrodes with various device structures.

Plan of Future Work Including Project

We have established the doping of In3+ (n-type dopant) in CdSe NPLs. The p-type dopants like Ag+ need to be incorporated now. So, the next plan is to doping these ions together or successively in the same host. We need to work on the co-doping strategies. Once the co-doping method is established, next we will explore the combination of other possible metal ions, like Ag^+/Cu^+ with In^{3+}/Ga^{3+}/Al^{3+}. Crown or shell deposition will be employed on the co-doped system to improve the PL QY and optical stability. For a closer examination of the carrier dynamics and to identify the dopant states, we will investigate the electron and hole relaxation process of those co-doped NPLs using transient absorption spectroscopy. Finally, those results will be corroborated with the calculated NPL band structure which will allow us to identify the various excited-state transitions in detail. The device-related work will also be pursued side by side.

Gautam Gangopadhyay

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Premashis Kumar; Nonequilibrium Thermodynamics of some nonlinear dynamical systems; Under progress
2. Jayarshi Bhattacharya; Quantum open system and quantum transport; Under progress; Suanandan Gangopadhyay (Co-supervisor)
3. 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

c) External Project Students / Summer Training

1. Amit Roy; Quantum statistical properties of radiation-matter interaction

Teaching

1. Spring semester; Stochastic Processes in Physics and Chemistry, CB-628; Integrated PhD; 3 students

Publications

a) In journals

1. Premashis Kumar and **Gautam Gangopadhyay**, *Glycolytic Wave Patterns in a Simple Reaction-diffusion System with Inhomogeneous Influx: Dynamic Transitions*, ChemPhysChem, 24, e202200643, 2023
2. Premashis Kumar, Kinshuk Banerjee and **Gautam Gangopadhyay**, *Interplay of energy, dissipation, and error in kinetic proofreading: Control via concentration and binding energy*, Physica A: Statistical Mechanics and its Applications, 603, 127735, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. An International Conference on Theoretical Chemistry Meeting: Structure and Dynamics (TCMSD-2022) 26th - 29th May, 2022 IACS, Kolkata, India; May 29, 2022; An International Conference on Theoretical Chemistry Meeting: Structure and Dynamics (TCMSD-2022) 26th - 29th May, 2022 IACS, Kolkata, India; 26th - 29th May, 2022 IACS, Kolkata, India
2. Nonequilibrium Thermodynamics of Open Chemical Reaction Network: Pattern, Instabilities and Chimera; Dec 6, 2022; Mathematics Department, Bharathidasan University, Online; Dec 6, 2022
3. Nonequilibrium steady state thermodynamics of Reaction Network of chemical waves AT Steady state phenomena in soft matter active and biological systems(SSPSM), 16-18 March'2023 at SNBNCBS; Mar 16, 2023; Nonequilibrium steady state thermodynamics of Reaction Network of

chemical waves AT Steady state phenomena in soft matter active and biological systems(SSPSM), 16-18 March'2023 at SNBNCBS; 16-18 March'2023

4. Thermodynamics of Open Chemical Reaction Network, One Day Seminar on Nonlinear Dynamical Systems; Sep 22, 2022; St. Xavier's College, Mathematics Department,Kolkata; 22nd Sept'2022

Administrative duties

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

Membership of Learned Societies

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

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

1. Dr. Kinshuk Banerjee, AJC Bose College, Kolkata West Bengal; Sl. No. 2; National
2. Dr. Anirban Karmakar, Taldi College, Kolkata West Bengal; Exciton transport in photosynthetic complex dimers A Karmakar, G Gangopadhyay Journal of Chemical Sciences 135 (2), 44 2023; National
3. Dr. Soma Saha, Presidency University; Submitted work on A minimal kinetic model for the interpretation of complex catalysis in single enzyme molecules Prasanta Kundu, a Soma Saha, b and Gautam Gangopadhyay; National

Areas of Research

Theoretical Chemistry

My broad Research Interest is in Theoretical Chemistry, with special emphasis on the following topics:

i. Stochastic processes in Chemical and Biological Systems; heterogeneous enzyme catalysis and ion-channel problems.

ii. Studies on quantum dynamics and quantum transport processes in molecular systems.

iii. Nonlinear dynamics and Reaction-diffusion systems in Chemistry and Biology.

In our work on Thermodynamics of Chemical wave we are more interested in Chemical wave in Biology which is crucial in spreading information rapidly to synchronize and coordinate biological events. Again we have shown how local dynamics in open Reaction-diffusion setting can be formalized to study time dependent Free energy and entropy production or dissipative structure. In the present context our task is to identify free energy, dissipation and work spent to sustain wave propagation to study Thermodynamic perspectives in: (i) Chemical process of nonequilibrium steady state dynamics, specially instabilities, patterns and chimera formation and (ii) nonconservative forces generated by the chemostats.

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 transitions and chaos in hererogeneous glcolysis reaction-diffusion systems(PK,GG) (iii) 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)
3. Our next plan is to study on Dynamic disorder due to nonlinear dynamical critical points in bio-chemical rhythms, specially on (i) Estimation of Dynamic disorder through cooperative kinetic mechanism(PKundu,SS,GG)

Goutam De

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Guidance of Students/Post-Docs/ Scientists

a) External Project Students / Summer Training

1. Bhavna Kuli; Gold Nanoparticle doped Alumina-Titania films on Glass

Teaching

1. Taught summer intern the basic sol-gel chemistry (both theory and experimental) to prepare thin films and bulk ceramics.
2. Hands on training was given to one PhD student on the synthesis of sol and preparation of thin dielectric films using the dip-coating process.

Publications

a) In journals

1. Atin Pramanik, Shreyasi Chattopadhyay, **Goutam De** and Sourindra Mahanty, *Design of Cuboidal* $FeNi_2S_4$*-rGO-MWCNTs Composite for Lithium-Ion Battery Anode Showing Excellent Half and Full Cell Performances*, Batteries, 8(12), 261, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Delivered inauguration and scientific lectures as a Chief Guest at the inauguration ceremony of the "Workshop on Particle Characterization Techniques (PCT-2022)" held at the Institute of Science & Technology, Sathyabama University, Chennai. Lecture title: "Superhydrophobic Surfaces"; 30/05/2022; Online, 1 hour
2. Invited talk delivered at the International Conference on Ultrasonics and Material Science for Advanced Technology (ICUMSAT-2022) held during August 01-03, 2022. Lecture title: "Superhydrophobic Surfaces: Basic Concepts and Applications"; 02/08/2022; Telangana University; 30 mins
3. Lecture delivered at the S. N. Bose National Centre for Basic Sciences, Kolkata; Lecture title: "Sharing my experience as an Associate Editor of Journal of Materials Chemistry A"; 27/09/2022; Online; 1 hour
4. Delivered a lecture at the "Workshop on Interpretation of Instrumental Methods (WIIM-2023)" jointly organized by Sathyabama Institute of Science and Technology and CSIR - NML Madras Centre, Chennai. on 6th January 2023. Lecture title: "Importance of materials characterization in scientific research"; 06/01/2023; Online; 45 mins
5. As an Associated Editor of Journal of Materials Chemistry A, delivered 3 lectures at the Royal Society of Chemistry (RSC) symposium held at different Indian institutions (IIT Bombay, IISc Bangalore, IIT Indore) during January 16-20, 2023. The symposiums were jointly organized by the RSC and the respective institutions. Lecture title: 'Nanomaterials by wet chemistry'; 16/01/2023, IIT Bombay, 30 mins; 17/01/2023, SSCU, IISc., 30 mins; 20/01/2023, IIT Indore, 30 mins

Awards, Recognitions, if any

1. Received "Ganpule Award – 2022" from Indian Ceramic Society
2. External Member of CRNN (Calcutta University) PhD committee (continued)

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

1. CSIR-Central Glass & Ceramic Research Institute, Kolkata; National
2. Indian Institute of Technology, Roorkee; National

Outreach program organized / participated

1. Attended several Webinars

Areas of Research

Synthesis & evaluation of functional nanomaterials and coatings

(i) Data analysis of our collaborative work on the fabrication of washable super-hydrophilic/hydrophobic coatings based-on SiO_2-ZnO nanoparticles on cotton fabrics with controlled water contact angles.

(ii) Review work on the "Design Potential and Future Prospects of Lead-free Halide Perovskites in Photovoltaic Devices" in collaboration with IIT Roorkee.

(iii) Manuscript preparation of a paper "Design of cuboidal $FeNi_2S_4$-rGO-MWCNTs composite for lithium-ion battery anode showing excellent half and full cell performances" (with CSIR-CGCRI).

(iv) Under the work "Gold nanoparticle doped in alumina-titania films on glass", several sols and films were prepared by the sol-gel process. Using the dip-coating technique Al_2O_3-TiO_2 and Au doped Al_2O_3-TiO_2 films were prepared on glass substrates. The heat-treated films were characterized by UV- visible spectroscopy, grazing incidence X-ray diffraction and ellipsometry.

(v) Work on the development of very thin alumina films of thickness 20 - 30 nm on glass and silicon wafers has been undertaken in the reporting period because such dielectric thin films may find applications as dielectric gate for micro and optoelectronic devices. Al_2O_3 is very promising dielectric material due to its several useful characteristics like high mechanical strength, thermal and chemical stability, wide band gap, high electrical resistivity, good thermal conductivity and optical transparency (UV, visible and near-infrared region), low refractive index, high electric field strength, reliable conduction band offset to semiconductor substrates, and fantastic dielectric properties. These features of Al_2O_3 make it more impressive technologically. However, we realized that for the application as dielectric gate with low power dissipation and low leakage current a suitable thickness should be of the order of 20 - 30 nm. However, to prepare uniform alumina films of such low thickness is difficult by a conventional wet chemistry (sol-gel) method. In this work we have successfully prepared very thin uniform Al_2O_3 films of desired thickness values (i.e. 20 - 30 nm) using aluminium tri-sec butoxide as a precursor by controlling the hydrolysis-condensation rate at the sol stage. The as-prepared films were heat-treated at several temperatures (500, 800, 1000°C) to study the morphology evolution. The films were characterized by UV-visible and FTIR spectrometry, AFM, XRD, SEM and TEM.

Plan of Future Work Including Project

1. The results of the work 'superhydrophobic coatings on cotton fabrics' will be communicated
2. Submission of a manuscript on the 'self-cleaning antireflecting coatings on solar cover glass'
3. Work related to the development of very thin alumina films of thickness 20 – 30 nm for a possible application as dielectric gate for microelectronics

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 Board member on 22/06/2022 (online).
3. Manuscript handling of the Royal Society of Chemistry (RSC) journals, *Journal of Materials Chemistry A and Materials Advances* as Associate Editor.
4. Nominated several names of Indian researchers (including SNBNCBS) to the RSC journal (Journal of Materials Chemistry) as 'Emerging Investigators'.
5. Published 2 papers during the reporting period from my work done at INST Mohali: (i) K. Justice Babu, G. Kaur, A. Shukla, A. Kaur, H. Bhatt, N. Ghorai, G. De, H. N. Ghosh, *In situ $CsPbBr_3$ Architecture Engineered in the Electrospun Fibers and Its Ultrafast Charge Transfer Dynamics,* Materials Advances 3, 6566-6576, 2022; (ii) N. Ghorai, G. De, H. N. Ghosh, *Plasmon Mediated Electron Transfer and Temperature Dependent Electron–Phonon Scattering in Gold Nanoparticles Embedded in Dielectric Films,* ChemPhysChem, 23, e202200181, 2022.

Manik Pradhan

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

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

b) Post-Docs

1. Jayeta Banerjee; Surface Plasmon Resonance
2. Puspendu Barik; Evanescent-wave Cavity Ring-down Spectroscopy
3. Koushik Biswas; Cavity-enhanced Absorption Spectroscopy

c) External Project Students / Summer Training

1. Souvik Pramanick; Cavity-enhanced Absorption Spectroscopy

Teaching

1. Spring semester; Project Research III (PHY 401); Integrated PhD; 1 student

Publications

a) In journals

1. Ardhendu Pal, Soumyadipta Chakraborty, Biswajit Panda, **Manik Pradhan**, *Elucidating doublet splittings and rotational quantum number-dependent collisional broadenings in $^2\prod_{1/2}$ and $^2\prod_{3/2}$ spin-split sub-bands of NO at 5.2 μm*, Journal of Molecular Spectroscopy, 391, 111719, 2023
2. Jayeta Banerjee and **Manik Pradhan**, *2D-TMDC-enhanced condensed phase cavity ring-down spectroscopy coupled with surface plasmon resonance for investigation on water isotopologues*, Optics Communications, 527, 128956, 2023
3. Biswajit Panda, Ardhendu Pal, Soumyadipta Chakraborty and **Manik Pradhan**, *An EC-QCL based dual-species (CH_4/N_2O) detection method at 7.8 μm in mid-IR region for simultaneous applications of atmospheric monitoring and breath diagnostics*, Infrared Physics & Technology, 125, 104261, 2022
4. Akash Das, Soumen Mandal, and **Manik Pradhan**, *Signature of the photonic spin Hall effect in monolayer MoS_2 via weak measurement*, Journal of the Optical Society of America B, 39(7), 1822, 2022
5. Devdas Karmakar, Sujoy Kumar Mandal, Sumana Paul, Saptarshi Pal, **Manik Pradhan**, Sujoy Datta & Debnarayan Jana, *One-step hydrothermal*

synthesis of Sb2WO6 nanoparticle towards excellent LED light driven photocatalytic dye degradation, Applied Physics A, 128, 689, 2022

6. Jayeta Banerjee, Sudip Mandal, and **Manik Pradhan**, *Polarization-Multiplexed Incoherent Broadband Surface Plasmon Resonance: A New Analytical Strategy for Plasmonic Sensing*, Analytical Chemistry, 94, 6689, 2022

b) Conference proceedings / Reports / Monographs / Books

1. P. Barik and M. Pradhan (2022). All-Optical Detection of Biocompatible Quantum Dots. In: Barik, P., Mondal, S. (eds) Application of Quantum Dots in Biology and Medicine. Springer, Singapore (2022)

Talks / Seminars Delivered in reputed conference / institutions

1. National Conference on Emerging Dimensions in Chemical Sciences (EDCS-23) by Chemical Research Society of India (CRSI) and University of Kalyani; Mar 28, 2023; University of Kalyani; 28-29th March, 2023
2. 15th National Symposium on Radiation and Photochemistry (NSRP-2023) by Indian Society for Radiation and Photochemical Sciences (ISRAPS) at BITS Pilani, Goa, India; Jan 5, 2023; BITS Pilani, Goa; 5-7th January, 2023
3. TIFAC-DSIR-IICB Joint Workshop on Techno-Commercial Assessment of TRL 6 and above Technologies, 2023, IICB Kolkata, India; Sep 23, 2022; IICB, Kolkata; 23rd September, 2022
4. One Day Symposium in Chemical Sciences by Indian Association for the Cultivation of Sciences (IACS) and Chemical Research Society of India (CRSI), Kolkata, India; Jun 4, 2022; IACS, Kolkata; 04th June, 2022
5. C. K. Majumdar Memorial Workshop in Physics 2022 (CKMMWP 2022) at S. N. Bose National Centre for Basic Sciences, Kolkata, India; Jul 12, 2022; SNBNCBS; 12-21 July, 2022

Administrative duties

1. Member of Works Committee
2. Member of Reservation Cell
3. 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." Patent Hearing Report Submission and newly filed on 23/03/2023; E-154/730/2023/KOL; Applied
2. "A system for monitoring hemodialysis efficacy of a subject". Patent Hearing Report Submission and newly filed on 16/02/2023; E-46/272/2023/KOL; Applied

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
5. Member of Indian Physics Association
6. Member of Indian Laser Association
7. Member of Indian Society of Chemists and Biologists
8. Member of Research Society for the Study of Diabetes in India
9. Member of American Association for the Advancement of Science

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; 2018-2022; Co-PI

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

1. D. Karmakar, S. Mandal, S. Paul, S. Pal, M. Pradhan, S. Dutta, D. Jana, "One-step hydrothermal synthesis of Sb2WO6 nanoparticle towards excellent LED light driven photocatalytic dye degradation": Applied Physics A, 128, 777 (2022); Sl. No. 5; National

Outreach program organized / participated

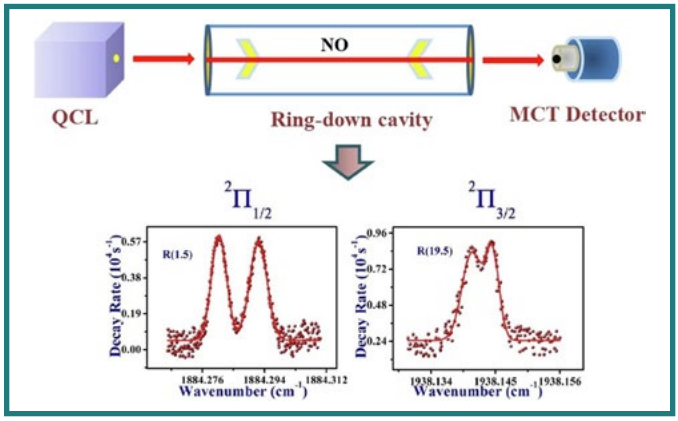
1. TIFAC-DSIR-IICB Joint Workshop on Techno-Commercial Assessment of TRL 6 and above Technologies, 23rd September, 2023, IICB Kolkata, India

Areas of Research

Experimental Laser Spectroscopy, Optics & Photonics, Analytical and Physical Chemistry

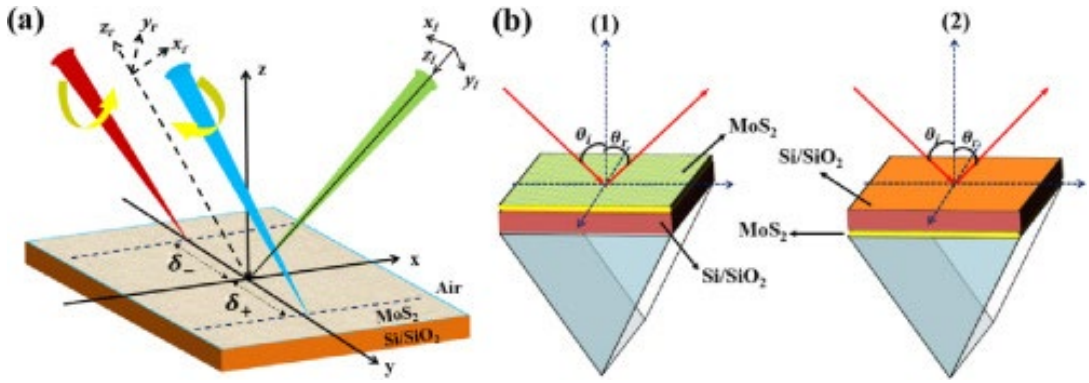
1. High-resolution Spectroscopic Investigation of Λ-doublet Splittings of Nitric Oxide:

High-resolution ro-vibrational spectroscopic features of nitric oxide (NO) are particularly interesting because of the unpaired electron and non-zero nuclear spin of the nitrogen atom. Here, ultra-sensitive cavity ring-down spectroscopy (CRDS) coupled with an external-cavity quantum cascade laser (EC-QCL) radiation source was employed as illustrated below to measure the rotationally-resolved fine structure -doublet splittings between the parity doublet e and f components in the (2∏1/2 - 2∏1/2) and (2∏3/2 - 2∏3/2) allowed sub-bands of the v = 1←0 fundamental vibrational band of NO molecule near 5.2 µm. Subsequently, we determined several principal spectroscopic parameters such as the -doubling constants, vibrational transition dipole moments and the Herman-Wallis coefficients for both e and f -doublet components by probing various R-branch rotational lines (J = 0.5 to 23.5) of the studied spin-split sub-bands of NO associated with spin–orbit interaction. In addition, we performed the pressure broadening effect on the -doublet splittings in collision with three vital perturbing gases at room temperature (296 K) and accurately determined the pressure broadening coefficients, i (e,f) in cm-1atm−1 [(i = He, Ar and Zero air (mainly N2 + O2)] along with their dependence on the rotational quantum number (J). We observed the pronounced collision-induced rotational quantum effect and the result of rotationally inelastic collision in the system for each collision partner. All these measured high-resolution new spectroscopic parameters over 33 ro-vibrational transitions via an EC-QCL based CRDS method will help significantly in interpreting fundamental molecular properties of this diatomic NO molecule.



2. Photonic Spin Hall Effect via Quantum Weak Measurements:

We observed the direct experimental evidence of the photonic spin Hall shift (PSHS) in monolayer MoS2 for a fundamental Gaussian beam via a weak measurement scheme involving definite pre-selection and post-selection spin states as illustrated in the figure below. We find that the PSHS is largely dependent on the angle of incidence, post-selection angles, and polarization states along with specific ways of interaction of the light with the MoS2 surface. Our findings reveal a unique signature linking angular positions at which the spin Hall shifts (SHS) (zero crossing) with the discontinuity in the phase difference of the reflection coefficients further



establishing the connection of the PSHS to the geometric phases of the light. An effective theoretical model is applied to confirm the experimental measurements. This deepens our understanding of the tiny spin-dependent splitting in monolayer MoS2, opening a new route for practical applications of photonic spin Hall effect.

Plan of Future Work Including Project

1. Development of a new quantum weak measurement (QWM) technique for studying angular momentum dependent optical beam shifts in various 2D-materials
2. Fundamental understanding of nuclear spin-isomers and spin-chemistry in gas-phase through high-resolution molecular spectroscopy

Any other Relevant Information including social impact of research

1. A pattern-recognition based clustering approach has been developed for non-invasive diagnosis and classification of various gastric disorders

Manoj Mandal

Ramalingaswami Re-entry Fellow
Chemical and Biological Sciences
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Guidance of Students/Post-Docs/ Scientists

a) External Project Students / Summer Training

1. Swetha Shivakumar; Effect of mutations on the binding affinity of SARSCovid Receptor Binding Domain towards human ACE2: A molecular simulation approach
2. Niravra Chakraborty; Application of Machine Learning to identify protein structure and function

Teaching

1. Spring 2023; Biological Physics; IPhD; 3 students
2. Spring 2023; Fundamentals of Biophysics; PhD; 2 students

Publications

a) In journals

1. **Manoj Mandal**, Keisuke Saito and Hiroshi Ishikita, *Substitution of Ca^{2+} and changes in the H-bond network near the oxygen-evolving complex of photosystem II*, Physical Chemistry Chemical Physics, 25, 6473, 2023
2. **Manoj Mandal**, Keisuke Saito, and Hiroshi Ishikita, *Release of a Proton and Formation of a Low-Barrier Hydrogen Bond between Tyrosine D and D2-His189 in Photosystem II*, ACS Physical Chemistry Au, 2, 423, 2022
3. **Manoj Mandal**, Keisuke Saito and Hiroshi Ishikita, *Release of Electrons and Protons from Substrate Water Molecules at the Oxygen-Evolving Complex in Photosystem II*, Journal of the Physical Society of Japan, 91, 091012, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk in a tropical research school on "The recent trends of research in theoretical and experimental physics"; Title: *Applications of physics and chemistry in biology*; 21st March, 2023; Gurucharan College, Silchar, Assam; 20-23 March, 2023
2. Invited talk at IISC Bangalore on 16th January, 2023; Title: *Water oxidation mechanism and proton coupled electron transfer reactions in photosystem II*; 16th January, 2023; IISC Bangalore; 16th January, 2023
3. Invited talk in a conference on "Recent Advances in Chemistry: Theoretical and Computational Aspects 2022" jointly organized by NIT Meghalaya and NEHU, Shillong; Title: *Role of low-barrier H-bond in proton coupled electron transfer reactions*; November 20, 2022; NEHU, Shillong; November 18-20, 2022

Areas of Research

(i) Quantum Mechanics/Molecular Mechanics (QM/MM)

(ii) Proton-coupled electron transfer

(iii) Water oxidation catalysis

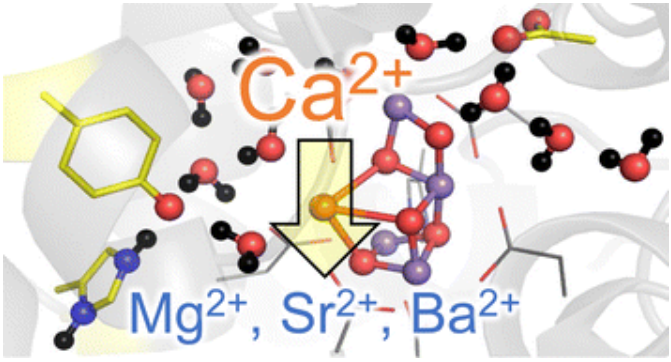
(iv) Protein structure, function, and dynamics

(v) Machine Learning

Oxygen evolution proceeds at the catalytic center of the Mn_4CaO_5 cluster in photosystem II (PSII). The Mn_4CaO_5 cluster has five O atoms, O_1 to O_5; two ligand water molecules at the Mn_4 site, W1 and W2; and two additional water molecules at the Ca site, W3 and W4. To convert two substrate water molecules into O_2, four electrons and four protons must be removed. As electron transfer occurs, the oxidation state of the oxygen-evolving complex, S_n, increases. Release of protons is observed with the typical stoichiometry of 1:0:1:2 for S_0 S_1 S_2 S_3 S_0, and O_2 is evolved in the S_3 to S_0 transition. Electron release is the rate-limiting step in the S_0 to S_1 transition, whereas proton release is the rate-limiting step in the S_2 to S_3 transition.

Ca^{2+}, which provides binding sites for ligand water molecules W3 and W4 in the Mn_4CaO_5 cluster, is a prerequisite for O_2 evolution in photosystem II (PSII). The S_2 to S_3 transition is inhibited in Ca^{2+}-depleted PSII. Ca^{2+} depletion not only causes the alteration of the H-bond network at the Mn_4O_5 and TyrZ moieties but also decreases the redox potential (E_m) of TyrZ significantly due to reorientation of the water molecules in the H-bond network, making electron transfer from the Mn_4CaO_5 cluster to TyrZ uphill. Replacement of Ca^{2+} with any metals except Sr^{2+} inhibits O_2 evolution, although the inhibition mechanism may depend on the metals. Fourier transform infrared (FTIR) studies showed that the double difference S_2/S_1 spectrum was not affected significantly upon the substitution of Ca^{2+} with Mg^{2+} and Sr^{2+}, whereas the vibrational modes of the carboxylate ligand residue disappeared upon substitution with Ba^{2+}. Mg^{2+} and Ba^{2+} are unlikely to bind competitively with Ca^2. Although the radius of Ca^{2+} is one of the key factors, it remains unclear what property of Ca^{2+} is specifically required for O_2-evolving activity among alkaline earth metals. To understand the specificity of Ca^{2+}-PSII and the irrelevance of Mg^{2+}-PSII and Ba^{2+}-PSII, we investigated the local geometry of the metal-substituted $Mn_4\mathbf{M}O_5$ cluster (**M** = Mg^{2+}, Sr^{2+}, and Ba^{2+}) in the open-cubane S_2 form by adopting a quantum mechanical/molecular mechanical (QM/MM) approach based on the native Ca^{2+}-PSII crystal structure.

The small radius of Mg^{2+} makes W3 donate an H-bond to W4 in Mg^{2+}-PSII. If an additional water molecule binds



at the large surface of Ba^{2+}, it donates H-bonds with D1-Glu189 and the ligand water molecule at the dangling Mn, altering the H-bond network. Remarkably, the O5...Ca^{2+} distance is shortest among all O5...metal distances irrespective of the radius being larger than that of Mg^{2+}. Furthermore, Ca^{2+} is the only alkaline earth metal that equalizes the O5...metal and O2...metal distances and facilitates the formation of the symmetric cubane structure.

Plan of Future Work Including Project

The recent improved understanding of Mn_4CaO_5 cluster creates a more complex picture and no consensus about the mechanistic understanding of water oxidation and the proton coupled electron transfer in PSII. Whether the proton release from OEC precede electron transfer or occur simultaneously, is under debate. How the electron and proton transfer is supported by fluctuating biological scaffold? What is role of a specific residue in proton and electron transfer? Does the electron flow follow static one-dimensional pathways or dynamic three-dimensional networks? Considering the structure, E_m values and comparing them with experimental results, one can expect to have the exact structure of S_2, S_3 and S_4 states of OEC which are very poorly understood. **The findings of S_2 to S_3 transition mechanism and S_3 state will have a direct impact on possible solution towards the unobserved intermediate states between S_3 and S_0.** TryZ and P_{D1} are far from each other and do not coupled electronically, the same is true for OEC and TyrZ but the **intermediate electron carriers** (pathway) and mechanism are still unknown. Is there superexchange electron transfer? Why electron transfer predominantly occurs along with D1-branches, not the D2-branches, irrespective of the pseudo-C_2 symmetry between the two branches? We would like to try our best to answer these questions in near future.

Pradip S Pachfule

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Bikash Chandra Mishra; Functionalised Covalent Organic Frameworks (COFs) for Visible Light Induced Photocatalysis; Under progress
2. Bidhan Kumbhakar; Metal-Containing Covalent Organic Frameworks for Water Splitting; Under progress

b) Post-Docs

1. Akhtar Alam; Tetrahedral Silsesquioxane Integrated Three Dimensional Covalent Organic Frameworks for Photocatalytic Hydrogen Generation
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. Ishita Ghosh; Olefin-linked Covalent Organic Frameworks (COFs) for Water-Splitting

Teaching

1. Spring semester; CB 641: SURFACES & INTERFACES; PhD; 04 students; with Dr. Ali Hossain Khan (Co-teacher)
2. Spring semester; PHY 491: Methods of Experimental Physics; Integrated PhD; 09 students; with Prof. Kalyan Mandal, Dr. Ramkrishna Das and Dr. Nitesh Kumar (Co-teachers)

Publications

a) In journals

1. Michael Traxler, Sebastian Gisbertz, **Pradip Pachfule**, Johannes Schmidt, Jérôme Roeser, Susanne Reischauer, Jabor Rabeah, Bartholomäus Pieber, Arne Thomas, *Acridine-Functionalized Covalent Organic Frameworks (COFs) as Photocatalysts for Metallaphotocatalytic C–N Cross-Coupling*, Angewandte Chemie, 61, e202117738, 2022
2. Xiaojia Zhao, Qun Li, **Pradip Pachfule**, Zhiya Wang, Shiyin Liu, Weijian Wu, Mingxing Wu, Arne Thomas, *Construction of Covalent Organic Framework Nanofiber Membranes for Efficient Adsorption of Antibiotics*, Small, 2301200, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. 8th International Conference on Metal-Organic Frameworks and Open Framework Compounds; Sep 6, 2022; Dresden, Germany; 20 Minutes
2. Advanced Materials: Emerging Trend and Future Prospects; Jan 9, 2023; Pandit Deendayal Energy University, Gandhinagar, Gujarat; 45 Minutes
3. Online Refresher Course in Advanced Instrumentation (MD); Sep 22, 2022; Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, Maharashtra; 60 Minutes

Administrative duties

1. 1. Member of the 'Hazardous Chemicals Disposal Committee' set up to consider the disposal of chemicals used in various laboratories
2. 2. Member of the 'Poster Committee', established to present the activities of each Research Group in the form of posters to be displayed on the wall adjacent to the office of the Faculty leading the Research Group

Awards, Recognitions, if any

1. Listed in Stanford University's global list of the world's top 2% of scientists in chemistry and materials science (2022)

Membership of Learned Societies

1. Young Associate of the Maharashtra Academy of Sciences: For significant contributions in the field of chemical sciences, awarded as Young Associate of Maharashtra Academy of Sciences, a premier scientific society established in 1976 with the specific objective of promoting science and technology. The selection of 'Young Associate' is a rigorous process for which the applicant must have significant contribution and publication record in the respective research area

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

Conference / Symposia / Schools organized

1. MOF-2022 Young Investigators Symposium (YIS); Sep 2, 2022; Dresden, Germany; 2 Days

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

1. Prof. Arne Thomas, Technical University Berlin, Germany; Type of collaboration: Photocatalytic water splitting and characterization of materials; Sl. No. 1, 2; International
2. Dr. Bartholomäus Pieber, Max Planck Institute of Colloids & Interfaces, Potsdam, Germany; Type of collaboration: Photocatalytic organic transformations; Sl. No. 1; International
3. Dr. Xiaojia Zhao, Hebei Normal University, Shijiazhuang, China; Type of collaboration: Synthesis of materials and water splitting experiments; Sl. No. 2; International

Outreach program organized / participated

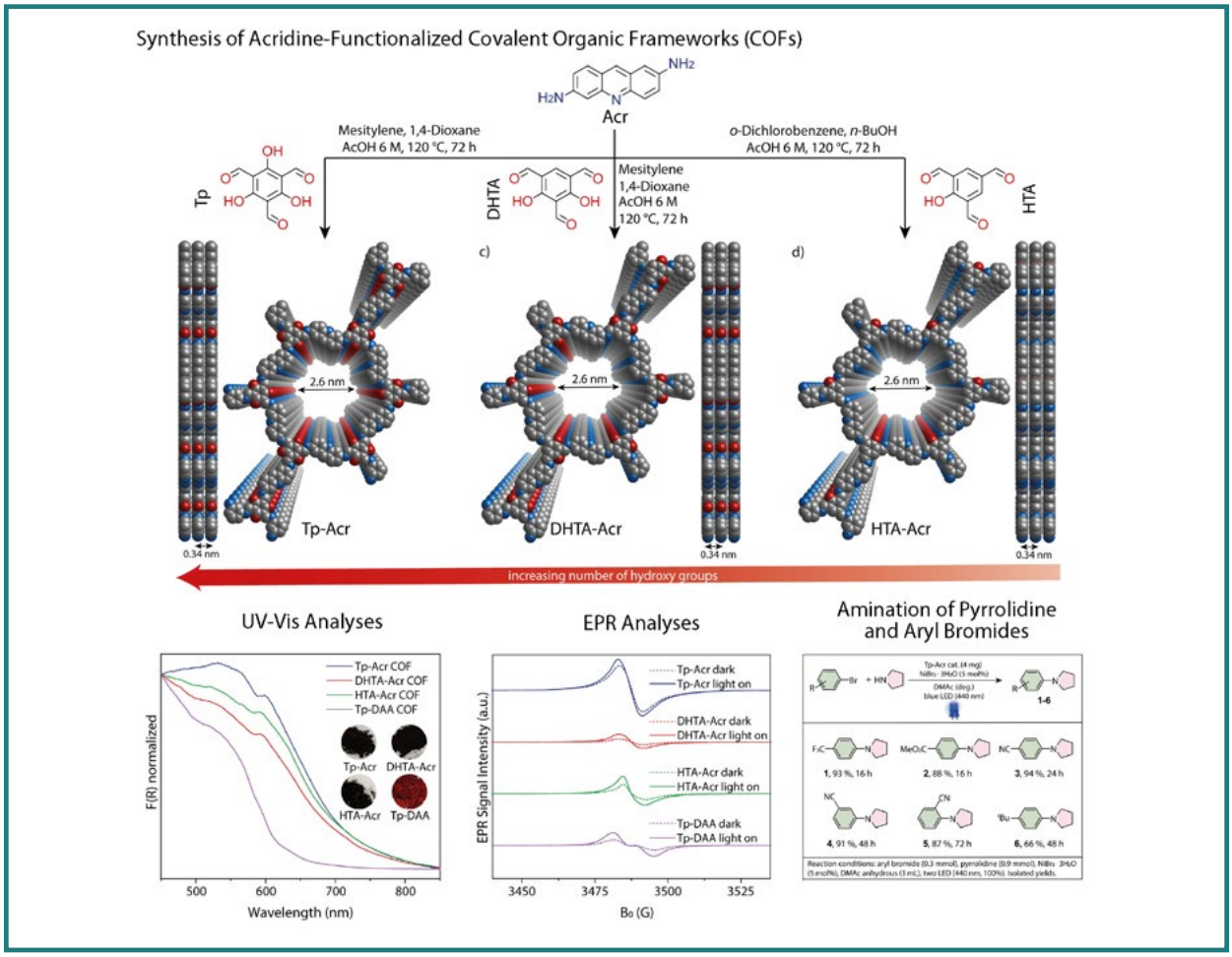
1. Member of the Committee 'Outreach Programmes for the Student of SC/ST Communities under VASP', constituted to conduct outreach programmes for students of SC/ST communities

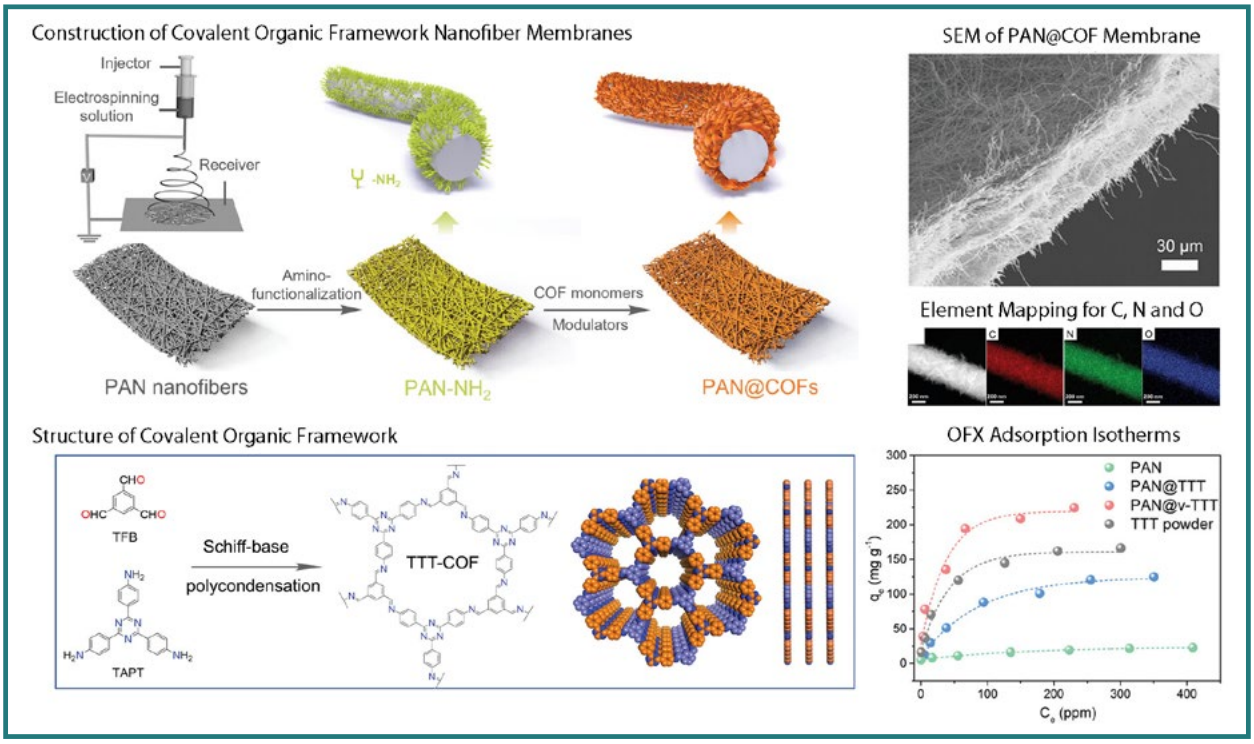
Areas of Research

Covalent Organic Frameworks (COFs), Porous Carbons, Energy Storage, Water Splitting, Heterogeneous Catalysis, Photocatalysis

Covalent organic frameworks (COFs) are structurally tunable, porous and crystalline materials formed by the covalent attachment of small organic building blocks as elementary units. Using the myriad of such building blocks, a wide range of functionalities have been applied to COF syntheses for a variety of applications, including heterogeneous catalysis. To explore the applications of COFs for metal-photocatalytic C-N cross-coupling - an important reaction for the synthesis of drugs - we have investigated the synthesis of a new family of porous and crystalline COFs using a novel acridine linker and benzene-1,3,5-tricarbaldehyde derivatives bearing a variable number of hydroxy groups (Figure 1). With broad absorption in the visible region and radical generation upon light irradiation, the COFs were further applied as photocatalysts in metal-photocatalytic C-N cross-coupling. The fully -ketoenamine-linked COF showed the highest activity due to the increased charge separation upon irradiation. The COF showed good to excellent yields for several aryl bromides, good recyclability and even catalysed the organic transformation in the presence of green light as energy source.

Techniques beyond crystal engineering are essential to produce covalent organic frameworks (COFs) and to explore them for advanced applications. However, COFs are typically obtained as insoluble, unmeltable and thus non-processible microcrystalline powders. Therefore, the implementation of COFs into larger


Synthesis of Acridine-Functionalized Covalent Organic Frameworks (COFs)
Acr
Mesitylene, 1,4-Dioxane
AcOH 6 M, 120 °C, 72 h
o-Dichlorobenzene, n-BuOH
AcOH 6 M, 120 °C, 72 h
Mesitylene
1,4-Dioxane
AcOH 6 M
120 °C, 72 h
Tp
DHTA
HTA
2.6 nm
Tp-Acr
DHTA-Acr
HTA-Acr
0.34 nm
increasing number of hydroxy groups
UV-Vis Analyses
EPR Analyses
Amination of Pyrrolidine and Aryl Bromides
Tp-Acr COF
DHTA-Acr COF
HTA-Acr COF
Tp-DAA COF
F(R) normalized
Wavelength (nm)
Tp-Acr dark
Tp-Acr light on
DHTA-Acr dark
DHTA-Acr light on
HTA-Acr dark
HTA-Acr light on
Tp-DAA dark
Tp-DAA light on
EPR Signal Intensity (a.u.)
B0 (G)


Construction of Covalent Organic Framework Nanofiber Membranes
Injector
Electrospinning solution
Receiver
Amino-functionalization
COF monomers
Modulators
PAN nanofibers
PAN-NH2
PAN@COFs
SEM of PAN@COF Membrane
30 μm
Element Mapping for C, N and O
C
N
O
Structure of Covalent Organic Framework
TFB
TAPT
Schiff-base polycondensation
TTT-COF
OFX Adsorption Isotherms
PAN
PAN@TTT
PAN@v-TTT
TTT powder
Qe (mg g-1)
Ce (ppm)

architectures and structural control at different length scales is a major challenge. To address these issues, a facile strategy has been demonstrated to prepare flexible COF nanofibre membranes (PAN@COF) by in-situ growth of COFs on polyacrylonitrile (PAN) nanofibre substrates via a reversible polycondensation termination approach (Figure 2). The resulting PAN@COF nanofibre membranes with vertically aligned COF nanoplates combine a large functional surface area with efficient mass transport, making them a promising adsorbent for e.g. water purification. The antibiotic pollutant ofloxacin (OFX) is removed from water with a superior absorption capacity of ~236 mg g^{-1} and a removal efficiency of up to 98%. The in-situ growth of COFs on nanofibre membranes was extended to different Schiff base-derived COF materials with different compositions, providing a highly efficient way to construct flexible COF-based membranes for various applications.

In addition, we have explored the applications of nickel-nitrogen doped carbon (Ni-N-C) as an efficient catalyst for the reduction of CO_2 to CO, where the single-site Ni-N_x motif is thought to be the active site. Currently, the group is also investigating the applications of covalent organic frameworks for lithium-sulphur batteries, supercapacitors and photocatalytic water splitting.

Plan of Future Work Including Project

1. Synthesis of covalent organic frameworks for lithium-sulphur batteries: Lithium-Sulphur (Li-S) batteries are a promising alternative energy source as they can provide a higher energy density than current lithium-ion batteries. Porous materials are often used as cathode materials as they can act as a host for sulphur in such batteries. Recently, covalent organic frameworks (COFs) have also been used, but they typically suffer from stability issues, resulting in limited and thus insufficient durability under practical conditions and applications. To overcome these limitations , we propose the synthesis of crystalline and porous imine-linked triazine-based dimethoxybenzene-functionalised COFs with a high-density redox site. As required, the imine linkages will be further post-synthetically transformed to yield a robust thiazole-linked COF using a sulphur-assisted chemical transformation method, while maintaining crystallinity and porosity. We believe that as a synergistic effect of its high crystallinity, porosity and the presence of redox active moieties, the thiazole-linked COFs will exhibit high capacity and long-term stability when applied as a cathode material in a Li-S battery.
2. Synthesis of covalent organic frameworks for supercapacitive energy storage: Covalent organic frameworks (COFs) have recently attracted increasing interest due to their intriguing properties such as low density, high porosity, good crystallinity and the ability to introduce a range of organic functional groups into chemically stable frameworks. Due to these properties, COFs with different functionalities have been tested for various applications such as (photo- and electro-) catalysis, separations, energy storage or drug delivery. In this context, we propose the synthesis of a crystalline and porous dithiophenedione-based COFs, which will be applied as electrode material in supercapacitors. We believe that as a combined effect of high porosity, crystallinity and the presence of redox-active dithiophenedione moieties in the COF backbone, high capacitance with long lifetime could be achieved.
3. Design and synthesis of covalent organic frameworks for photocatalytic water splitting: Photocatalytic water splitting for hydrogen generation is considered critical to the drive towards clean energy, but the inefficiencies of current materials necessitate the development of improved photocatalysts. To improve efficiencies, we aim to synthesise ordered organic network materials - such as microporous and hierarchically structured covalent organic frameworks (COFs) - with particular suitability for photocatalytic water splitting. We believe that these advanced semiconducting materials will enhance visible light absorption and overcome substrate diffusion issues that limit water splitting performance, representing an important step towards novel applications of COFs in the water splitting process.

Rajib Kumar Mitra

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Partha Pyne; Studies of Some Biophysical Processes Using Ultrafast Spectroscopic Techniques; Awarded
2. Didhiti Bhattacharya; Opto-electronic, Electrical and Spectroscopic studies of two dimensional materials; Thesis submitted; Prof. Samit K Ray (Co-supervisor)
3. Sumana Pyne; Application of Ultrafast Spectroscopy in Biological Systems; Under progress
4. Ria Saha; Studies on the Effects of Different Crowding agents on Protein FoldingUnfolding Process and its Kinetics as well as Activity; Under progress
5. Sudip Majumder; Nanomagnetism; Under progress; Prof. Anjan Barman (Co-supervisor)
6. Aritra Marik; Biomolecular hydration in presence of solutes; Under progress
7. Shah Imtajul Haque; Membrane hydration; Under progress

b) Post-Docs

1. Indrani Bhattacharya; Bimolecular hydration
2. Subhash Chandra Makhal; Ultrafast processes in confined environment

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. Sonali Mondal, Sumana Pyne, Partha Pyne, Animesh Patra, **Rajib Kumar Mitra** and Soumen Ghosh, *Interfacial Structure and Electrostatics Related to Solute Activity in a Model Anionic-Surfactant/Polymer Self-Assembly*, Langmuir, 39, 2850, 2023
2. Ria Saha and **Rajib Kumar Mitra**, *Thermo-Resistive Phase Behavior of Trivalent Ion-Induced Microscopic Protein-Rich Phases: Correlating with Ion-Specific Protein Hydration*, Langmuir, 39, 4601, 2023
3. Sumana Pyne, Partha Pynea and **Rajib Kumar Mitra**, *Addition of cholesterol alters the hydration at the surface of model lipids: a spectroscopic investigation*, Physical Chemistry Chemical Physics, 24, 20381, 2022
4. Sumana Pyne, Partha Pyne, **Rajib Kumar Mitra**, *The Inner Hydration in Surfactant/Cholesterol Vesicles Differs from the Outer One: A Spectroscopic Investigation*, ChemPhysChem, 23, e202200337, 2022
5. Ria Saha and **Rajib Kumar Mitra**, *Trivalent cation-induced phase separation in proteins: ion specific contribution in hydration also counts*, Physical Chemistry Chemical Physics, 24, 23661, 2022

6. Subhadip Chakraborty, Partha Pyne, **Rajib Kumar Mitra** and Debasish Das Mahanta, *A subtle interplay between hydrophilic and hydrophobic hydration governs butanol (de) mixing in water*, Chemical Physics Letters, 807, 140080, 2022
7. Saikat Pal and **Rajib Kumar Mitra**, *Nonpolar hydrophobic amino acids tune the enzymatic activity of lysozyme*, Biophysical Chemistry, 288, 106842, 2022
8. Didhiti Bhattacharya, Shubhrasish Mukherjee, Atindra Nath Pal, **Rajib Kumar Mitra**, Samit Kumar Ray, *Two-Dimensional $Mo_xW_{1-x}S_2$ Alloys for Nanogenerators Producing Record Piezo-Output and Coupled Photodetectors for Self-Powered UV Sensor*, Advanced Optical Materials, 10, 2200353, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. "Hydration dynamics and its influence in biological system" at the 4th Broadband Extreme Electromagnetic Life Science and Technology Collaborative Study Group on March 8, 2023 at University of Fukui, Far-Infrared Research Center, Fukui, Japan; Mar 8, 2023; Online; 30 min
2. "Investigating Collective Vibrational Dynamics in Soft-materials Using THz Spectroscopy" Colloquium lecture; Feb 20, 2023; University of Fukui, Fukui, Japan; 1 hr

Administrative duties

1. Head, CBS Department
2. Chairman, Covid Task Force, SNBNCBS
3. Faculty in-charge, students affairs
4. Chairman, SCOLP Committee
5. Member, Admission committee
6. Member, Students' Curriculum & Research Evaluation (SCREC) Committee

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

1. Investigation on the Changes in Protein Hydration During Aggregation in Crowded Environment by THz Time Domain and Optical Time Resolved Spectroscopy; SERB-DST; 2020-2023; PI

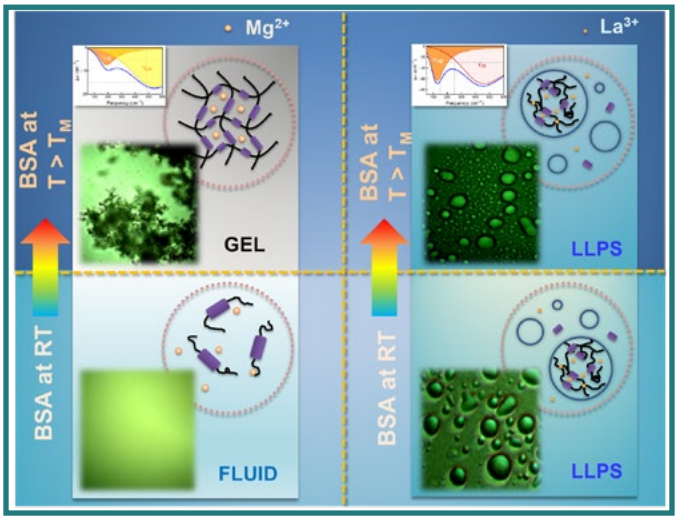
Scientific collaborations with other national / international institutions (based on joint publications)

1. S. Ghosh, Jadavpur University; Sl. No. 1; National
2. D Das Mahanta, University of Texas, Austin; Sl. No. 6; International

Areas of Research

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

1. We investigate protein condensation process in presence of cation(s) of different charge type. We found that trivalent cations offer an intriguing microscopic phase separation (LLPS) in presence of trivalent cations, while such phenomenon is absent in bivalent ions. We have made a detailed experimental analysis on the protein solvation and we found that the it differs significantly in the LLPS phase compared to the protein native phase. Moreover, we observe that these LLPS phases offer an unusual thermo-resistive behaviour compared to the thermo-responsive behaviour observed in presence of bivalent ions.



2. We investigate hydration dynamics around lipid membranes using THz spectroscopy. We observe that depending upon the headgroup of the lipids, the dynamics changes systematically. We also investigated the effect of cholesterol in the membrane dynamics. finally we investigate the effect of alcohols on the membrane dynamics in absence and in presence of cholesterol.

3. The (de)mixing of alcohols (of different carbon chain lengths and branching) with water has been studied extensively using both experiments and simulation. Our observations suggest that the delicate balance between the hydrophobic and hydrophilic interactions between alcohol moieties with water plays the crucial role in such a phenomenon.
4. 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.
5. We have made a detailed experimental and theoretical investigation to understand the molecular mechanism of guanidinium mediated protein denaturation process.

Plan of Future Work Including Project

1. We would continue our study to understanding how molecular co-solutes (salts, ions, small organic molecules etc.) and molecular crowders (PEG, Ficol etc.) interact with biomolecules and affect their biological activity. Such molecular crowders often mimic the real cellular environments. We pay special reference to the effect of various ionic liquids on protein stability. We will make a detailed spectroscopic investigation to underline the hydration behaviour of such complex systems). We will try to make thermodynamic analysis of the processes involved using differential scanning calorimetry measurements.
2. We plan to explore the effect of cholesterol and its biosynthetic precursors on hydration dynamics in membranes and vesicles of different phases and its implications in the complex, evolutionarily fine-tuned biology of cholesterol in membranes and vesicles using THz spectroscopy complemented by time resolved fluorescence approaches. Insights obtained from the proposed experiments would provide with fundamental knowledge in membrane hydration dynamics that could be relevant in the context of various membrane phenomena such as membrane fusion and regulation of lipid-protein interactions in a membrane milieu. We also plan to carry out atomic force microscopy measurements on vesicles (made by lipids and surfactants) in absence and in presence of cholesterol to underline the elastic properties of the interface.
3. We plan to combine two experimental approaches namely THz time domain spectroscopy and ultrafast fluorescence spectroscopy to monitor the expected change in overall hydration of a protein during their self-aggregation. The results of this proposed work would render positive impetus for advancement in the research on the protein-aggregation based neurodegenerative diseases. Among the self-aggregated systems we would study protein aggregation (with a special reference to liquid-liquid phase separation in proteins), fibril formation and on amphiphilic self-aggregates like micelles, vesicles, liposomes etc. We also plan to extend this idea towards intrinsically disordered protein (IDP) also.

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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; Under progress
3. Dhrubajyoti Maji; Computer Simulations of Deep Eutectics; Under progress
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; Pradip K Ghorai, IISER K (Co-supervisor)

b) Post-Docs

1. Tonima Nandy; Small Molecule Inhibition of Amyloidosis
2. Jayeta Banerjee; Application of Surface Plasmon Resonance Spectroscopic Technique to Understand Multicomponent Mixtures

c) External Project Students / Summer Training

1. Muskan Sarma; Molecular Medicine & Cancer Biology

Teaching

1. Spring semester; Physical Chemistry: Theory & Experiments; PhD; 4 students

Publications

a) In journals

1. Sudipta Mitra, Arnab Sil, **Ranjit Biswas** and Suman Chakrabarty, *Molecular Thermodynamic Origin of Substrate Promiscuity in the Enzyme Laccase: Toward a Broad-Spectrum Degrader of Dye Effluents*, The Journal of Physical Chemistry Letters, 14, 1892, 2023
2. Narayan Chandra Maity, Atanu Baksi, Kajal Kumbhakar and **Ranjit Biswas**, *Impact and structure of water in aqueous octanol mixtures: Hz-GHz dielectric relaxation measurements and computer simulations*, Journal of Photochemistry and Photobiology A: Chemistry, 439, 114600, 2023
3. Dibakar Sarkar, Narayan Chandra Maity, Gourav Shome, Kyriakos Gabriel Varnava, Vijayalekshmi Sarojini, Subramanian Vivekanandan, Nirakar Sahoo, Sourav Kumar, Atin Kumar Mandal, **Ranjit Biswas** and Anirban Bhunia, *Mechanistic insight into functionally different human islet polypeptide (hIAPP) amyloid: the intrinsic role of the C-terminal structural motifs*, Physical Chemistry Chemical Physics, 24, 22250, 2022
4. Hideaki Shirota, Juriti Rajbangshi, Maharoof Koyakkat, Atanu Baksi, Mengjun Cao and **Ranjit Biswas**, *Low-frequency spectra of reline and its mixtures with water: A comparative study based on femtosecond Raman-induced Kerr effect spectroscopy and molecular dynamics*

simulations, Journal of Photochemistry and Photobiology A: Chemistry, 437, 114504, 2023

5. Swarup Banerjee, Pradip Kr. Ghorai, Dhrubajyoti Maji, and **Ranjit Biswas**, *Difference in "Supercooling" Affinity between (Acetamide + Na/KSCN) Deep Eutectics: Reflections in the Simulated Anomalous Motions of the Constituents and Solution Microheterogeneity Features*, The Journal of Physical Chemistry B, 126, 10146, 2022
6. Kallol Mukherjee, Kajal Kumbhakar and **Ranjit Biswas**, *Dynamics of a PEG based polymer gel Electrolyte: A combined frequency dependent dielectric relaxation and Time-resolved fluorescence spectroscopic study*, Journal of Molecular Liquids, 360, 119491, 2022
7. Atanu Baksi and **Ranjit Biswas**, *Why do some reactions possess similar reaction rate in wildly different viscous media? A possible explanation via frequency-dependent friction*, Journal of Chemical Sciences, 134, 51, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Satyendranath: Beyond Science; Jul 22, 2022; Silver Jubilee Hall, SNB Centre; 60 minutes
2. Research Methodology in Science; Jun 21, 2022; Berhampore Girls College, Murshidabad; 90 minutes.
3. Deep Eutectics, and Azeotropes: Interesting Aspects and New Findings; Dec 9, 2022; Calcutta University; 90 minutes (Online)
4. Deep Eutectics, and Azeotropes: Some of Our Recent Results; Nov 18, 2022; NEHU, Shillong; 30 minutes
5. Dielectric Relaxation in Ionic Acetamide Deep Eutectics: Simulation Predictions and Comparison with Temperature Dependent Measurements; May 6, 2022; IIT, Kanpur; 60 minutes

Administrative duties

1. Convener/Chairperson, Advanced Postdoctoral Research Program (APRP), SNBNCBS

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

1. A Theoretical Approach to Predict Deep Eutectic Formation: Locating the Lowest Melting Point (Submitted in March 2023); DST(MATRICS_SERB); 3 years; PI

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

1. Journal of Physical Chemistry B, 2022, 126, 10146 – 10155; Sl. No. 5; National
2. Physical Chemistry Chemical Physics, 2022, 24, 22250 – 22262; Sl. No. 3; National
3. Journal of Photochemistry & Photobiology, A: Chemistry, 2022, 437, 114504(1-9); Sl. No. 4; International

Outreach program organized / participated

1. Lecture in Berhampore Girls College on Research Methodology (June, 2022)

Areas of Research

Physical Chemistry & Chemical Physics, Theory-Experiments-Simulations; Deep Eutectic Solvents, Ionic Liquids, Azeotropes, Binary Mixtures, Cryoprotectants

One of our main goals this year was to decompose the total frequency-dependent dielectric relaxation (DR) spectra of a few common ionic deep eutectic solvents (DESs) in order to understand the roles of dipolar, ionic, and cross (ion-dipole) contributions to the experimentally measured DR response. The chosen DESs were (acetamide+LiClO4/NO3/Br) and their DRs investigated in the temperature range, 329≤T/K≤358, via molecular dynamics (MD) simulations. The dipolar contribution, as expected, was found to dominate all the frequency-dependent dielectric spectra over the entire frequency regime, while the other two components together made tiny contributions only. Our simulations predicted, in agreement with experiments, an anion-dependent decrement of the static dielectric constant The frustrated

orientational structure was found to be associated with the anion-dependent damage of the acetamide H-bond network (JCP, 2023, v.158, 174503(1-16)).

We initiated research for exploring a possible connection between the spatio-temporal heterogeneity inherent to a cryoprotectant medium and its cryoprotection ability. For this purpose, structural and dynamical properties of glucose-based cryoprotectant mixtures at different weight percentages of glucose (GL) and ethylene glycol (EG) were investigated via molecular dynamics (MD) simulations. We observed that with increasing glucose content, the hydrogen bond (H-bond) network of EG become partially damaged, enhancing the hydrogen bond (H-bond) network among glucose molecules in the solution. The average number of H-bonds per molecule revealed the propensity of EG to form H-bonds with glucose rather than with a neighboring EG. Simulated first-rank reorientational time correlation function (C_1 (t)) and the structural hydrogen bond autocorrelation function (C_HB (t)) show multi-exponential relaxations. Our simulations also hint at the formation of glucose domain via intraspecies H-bonding. This might be a key feature for the cryoprotection ability of these mixtures and show a way to connect the spatio-temporal heterogeneity to cryoprotection (TCA, 2023, 142, 43(1-15)).

We investigated the thermodynamic origin of why the enzyme laccase is able to degrade a variety of organic molecules that may have adverse impacts on the environment. This ability is termed as substrate promiscuity and this phenomenon was explored via combining spectroscopic experiments, molecular docking and molecular dynamics (MD) simulations. Simulations and the subsequent accounting of various interaction pieces suggested that the diverse selection of dye molecules by laccase may exhibit surprisingly similar binding affinity due to cancellation of different thermodynamic factors. Our results highlight the potential of laccase as a multi-purpose degrader for industrial dye effluents (JPCL, 2023,14, 1892 – 1898).

We explored the microscopic origin of the different abilities of alkali metal ions in exhibiting varying signatures of amorphous characters to ionic deep eutectic solvents. The focus of this work is to provide microscopic explanations of these experimentally observed macroscopic system properties in terms of particle jumps. For this purpose, extensive molecular dynamics simulations have been performed employing (acetamide + Na/KSCN) deep eutectics. The centre-of-mass motion for Na^+ has been found to be more anomalous than that of K^+. In brief, this study highlighted the microscopic origin of the cation dependence observed in time-resolved fluorescence measurements (JPC B 2022, 126, 10146 – 10155).

Plan of Future Work Including Project

1. (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

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Dipanjan Mukherjee; Microfluidic-Assisted Optical Spectroscopic Studies on Biomolecular Recognition in Physiologically Relevant Engineered Environments; Awarded; Prof. Ranjan Das (Co-supervisor)
2. Arpan Bera; Spectroscopic Studies on Functional Nanohybrids and their Potential Biological Application; Thesis submitted
3. Susmita Mondal; Studies on Biochemical and Molecular aspects of Redox Modulatory Theranostic Nanomaterials in Preclinical Disease Model; Under progress
4. Md Nur Hasan; Optical spectroscopy and Ab-initio study on biocompatible nanohybrids for their potential biomedical and environmental applications; Under progress
5. Nivedita Pan; Photophysical Studies on Hybrid nanomaterials for Manifold Applications; Under progress
6. Arnab Samanta; Synthesis and Characterization of Nanoscale Alloys and Metal Oxides for Potential Application in Catalysis; Awarded; Dr. Subhra Jana (Co-supervisor)
7. Lopamudra Roy; Exploration of Optical Methodologies for the Development of Prototypes in the Real-World Applications; Under progress; Prof. Kallol Bhattacharya (Co-supervisor)
8. Amrita Banerjee; Multi-parameter Detection Using Optical Spectroscopy for Monitoring and Control of Bio-medical Anomalies, Food Adulteration and Environmental pollution; Under progress; Prof. Subhadipta Mukhopadhyay (Co-supervisor)
9. Pritam Biswas; Biophysical and Biochemical Investigation on the Structure, Function and Dynamics of Biomolecules Under Physiologically Relevant Environments; Awarded; Dr. Sudeshna Shyam Choudhury (Co-supervisor)

b) External Project Students / Summer Training

1. Neha Bhattacharyya; Spectroscopic Studies on Biomaterials and Development of Small Spectroscopy-based Devices for Potential Application in Biomedical Diagnosis and Therapeutic Strategy
2. Ria Ghosh; In vitro and in vivo Investigations on Self-organized Assemblies for Their Potential Drug Delivery Activity

Teaching

1. Spring semester; PHY491; Integrated PhD; 11 students; Prof. Soumen Mondal (co-teacher)

Publications

a) In journals

1. Ria Ghosh, Soumendra Singh, Aniruddha Adhikari, Susmita Mondal, Dipanjan Mukherjee, Neha Bhattacharyya, Animesh Halder, Maitree Bhattacharyya and **Samir Kumar Pal**, *Synthesis and characterization of a nano-formulation for long lasting sterilization effect*, Materials Today: Proceedings, 80, 1846, 2023
2. M. Shaheer Malik, Shaikh Faazil, Meshari A. Alsharif, Qazi Mohammad Sajid Jamal,

Jabir H. Al-Fahemi, Amrita Banerjee, Arpita Chattopadhyay, **Samir Kumar Pal**, Ahmed Kamal and Saleh A. Ahmed, *Antibacterial Properties and Computational Insights of Potent Novel Linezolid-Based Oxazolidinones*, Pharmaceuticals, 16(4), 516, 2023

3. Ria Ghosh, Dipanjan Mukherjee, Gourab Ghosh, Md Nur Hasan, Arpita Chattopadhyay, Ranjan Das and **Samir Kumar Pal**, *Mimicking cellular fusion in a microfluidic channel via time-resolved chemiluminescence*, Journal of Photochemistry and Photobiology A: Chemistry, 441, 114731, 2023

4. Nivedita Pan, Ria Ghosh, Debdatta Mukherjee, Neha Bhattacharyya, Lopamudra Roy, Amrita Banerjee, Soumendra Singh, Radha Tamal Goswami, Mala Mitra, Arpita Chattopadhyay and **Samir Kumar Pal**, *A Nanosensor-Based Prototype Development for Heavy Metal Detection: A Combined Spectroscopic and Theoretical Study*, IEEE Sensors Letters, 7(2), 1500304, 2023

5. Aniruddha Adhikari, Vinod K. Bhutani, Susmita Mondal, Monojit Das, Soumendra Darbar, Ria Ghosh, Nabarun Polley, Anjan Kumar Das, Siddhartha Sankar Bhattacharya, Debasish Pal, Asim Kumar Mallick and **Samir Kumar Pal**, *Chemoprevention of bilirubin encephalopathy with a nanoceutical agent*, Pediatric Research, 93, 827, 2023

6. Ria Ghosh, Neha Bhattacharyya, Amrita Banerjee, Lopamudra Roy, Debdatta Mukherjee, Soumendra Singh, Arpita Chattopadhyay, Tapan Adhikari and **Samir Kumar Pal**, *Sensing Bioavailable Water Content of Granulated Matrices: A Combined Experimental and Computational Study*, Biosensors, 13, 185, 2023

7. Amrita Banerjee, Ria Ghosh, Tapan Adhikari, Subhadipta Mukhopadhyay, Arpita Chattopadhyay and **Samir Kumar Pal**, *Development of Nanomedicine from Copper Mine Tailing Waste: A Pavement towards Circular Economy with Advanced Redox Nanotechnology*, Catalysts, 13, 369, 2023

8. Amrita Banerjee, Neha Bhattacharyya, Ria Ghosh, Soumendra Singh, Aniruddha Adhikari, Susmita Mondal, Lopamudra Roy, Annie Bajaj, Nilanjana Ghosh, Aman Bhushan, Mahasweta Goswami, Ahmed S. A. Ahmed, Ziad Moussa, Pulak Mondal, Subhadipta Mukhopadhyay, Debasis Bhattacharyya, Arpita Chattopadhyay, Saleh A. Ahmed, Asim Kumar Mallick & **Samir Kumar Pal**, *Non-invasive estimation of hemoglobin, bilirubin and oxygen saturation of neonates simultaneously using whole optical spectrum analysis at point of care*, Scientific Reports, 13, 2370, 2023

9. Amrita Banerjee, Ria Ghosh, Arpan Bera, Subhadipta Mukhopadhyay, Munirah M Al-Rooqi, Ismail I Althagafi, Abdelrahman S Khder, Saleh A. Ahmed, Arpita Chattopadhyay, **Samir Kumar Pal**, *"Nano-Copper": A Potential Remediation of Antibiotic-Resistant Infections*, Journal of Nanomedicine, 6(1), 1058, 2023

10. Gourab Ghosh, Dipanjan Mukherjee, Ria Ghosh, Priya Singh, Uttam Pal, Arpita Chattopadhyay, Mithun Santra, Kyo Han Ahn, P. Mosae Selvakumar, Ranjan Das and **Samir Kumar Pal**, *A novel molecular reporter for probing protein DNA recognition: An optical spectroscopic and molecular modeling study*, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 291, 122313, 2023

11. Pritam Biswas, Aniruddha Adhikari, Uttam Pal, Susmita Mondal, Dipanjan Mukherjee, Ria Ghosh, Rami J. Obaid, Ziad Moussa, Sudeshna Shyam Choudhury, Saleh A. Ahmed, Ranjan Das and **Samir Kumar Pal**, *A combined spectroscopic and molecular modeling Study on structure-function-dynamics under chemical modification: Alpha-chymotrypsin with formalin preservative*, Frontiers in Chemistry, 10, 1-13, 2022

12. Md. Nur Hasan, Felix Sorgenfrei, Nivedita Pan, Dibya Phuyal, Mahmoud Abdel-Hafiez, **Samir Kumar Pal**, Anna Delin, Patrik Thunström, D. D. Sarma, Olle Eriksson, Debjani Karmakar, *Re-Dichalcogenides: Resolving Conflicts of Their Structure-Property Relationship*, Advanced Physics Research, 1(1), 2200010, 2022

13. Susmita Mondal, Monojit Das, Ria Ghosh, Soumendra Singh, Soumendra Darbar, Neha Bhattacharyya, Aniruddha Adhikari, Anjan Kumar Das, Siddhartha Sankar Bhattacharya, Debasish Pal, Asim Kumar Mallick & **Samir Kumar Pal**, *Organ-specific therapeutic nanoparticles generates radiolucent reactive*

species for potential nanotheranostics using conventional X-ray technique in mammals, Applied Nanoscience, 12, 3851, 2022

14. Amrita Banerjee, Dipanjan Mukherjee, Arpan Bera, Ria Ghosh, Susmita Mondal, Subhadipta Mukhopadhyay, Ranjan Das, Hatem M. Altass, Sameer. S. A. Natto, Ziad Moussa, Saleh A. Ahmed, Arpita Chattopadhyay and **Samir Kumar Pal**, *Molecular co-localization of multiple drugs in a nanoscopic delivery vehicle for potential synergistic remediation of multi-drug resistant bacteria*, Scientific Reports, 12, 18881, 2022

15. Neha Bhattacharyya, Dipanjan Mukherjee, Soumendra Singh, Ria Ghosh, Saurav Karmakar, Ankita Mallick, Arpita Chattopadhyay, Pulak Mondal, Tapan Mondal, Debasis Bhattacharyya, Asim Kumar Mallick, Ghulam Nabi, **Samir Kumar Pal**, *"Seeing" invisible volatile organic compound (VOC) marker of urinary bladder cancer: A development from bench to bedside prototype spectroscopic device*, Biosensors and Bioelectronics, 218, 114764, 2022

16. Amrita Banerjee, Soumendra Singh, Ria Ghosh, Md. Nur Hasan, Arpan Bera, Lopamudra Roy, Neha Bhattacharya, Animesh Halder, Arpita Chattopadhyay, Subhadipta Mukhopadhyay, Amitava Das, Hatem M. Altass, Ziad Moussa, Saleh A. Ahmed, **Samir Kumar Pal**, *A portable spectroscopic instrument for multiplexed monitoring of acute water toxicity: Design, testing, and evaluation*, Review of Scientific Instruments, 93, 115105, 2022

17. Debashish Paul, Anirban Paul, Dipanjan Mukherjee, Saroj Saroj, Manorama Ghosal, Suchetan Pal, Dulal Senapati, Jaydeb Chakrabarti, **Samir Kumar Pal**, and Tatini Rakshit, *A Mechanoelastic Glimpse on Hyaluronan-Coated Extracellular Vesicles*, The Journal of Physical Chemistry Letters, 13, 8564, 2022

18. Monojit Das, Susmita Mondal, Ria Ghosh, Pritam Biswas, Ziad Moussa, Soumendra darbar, Saleh A. Ahmed, Anjan Kumar Das, Siddhartha Sankar Bhattacharya, Debasish Pal, Asim Kumar Mallick, Prantar Chakrabarti, Jayanta Kumar Kundu, Aniruddha Adhikari and **Samir Kumar Pal**, *A nano erythropoiesis stimulating agent for the treatment of anemia and associated disorders*, iScience, 25, 105021, 2022

19. Sheik Saleem Pasha, Amrita Banerjee, Sreejesh Sreedharan, Soumendra Singh, Noufal Kandoth, Katherine A. Vallis, **Samir Kumar Pal**, Sumit Kumar Pramanik and Amitava Das, *Ultrasensitive Reagent for Ratiometric Detection and Detoxification of iAsIII in Water and Mitochondria*, Inorganic Chemistry, 61, 13115, 2022

20. Ria Ghosh, Susmita Mondal, Dipanjan Mukherjee, Aniruddha Adhikari, Maitree Bhattacharyya and **Samir Kumar Pal**, *Inorganic-organic Synergy in Nano-hybrids Makes a New Class of Drug with Targeted Delivery: Glutamate Functionalization of Iron Nanoparticles for Potential Bone Marrow Delivery and X-ray Dynamic Therapy*, Current Drug Delivery, 19(10), 991, 2022

21. Nivedita Pan, Sangeeta Ghosh, Md. Nur Hasan, Saleh A. Ahmed, Arka Chatterjee, Jayita Patwari, Chinmoy Bhattacharya, Jihan Qurban, Abdelrahman S. Khder, and **Samir Kumar Pal**, *Plasmon-Coupled Donor–Acceptor Type Organic Sensitizer-Based Photoanodes for Enhanced Photovoltaic Activity: Key Information from Ultrafast Dynamical Study*, Energy & Fuels, 36, 9272, 2022

22. Susmita Mondal, Nivedita Pan, Ria Ghosh, Arpan Bera, Dipanjan Mukherjee, Tuhin Kumar Maji, Aniruddha Adhikari, Sangeeta Ghosh, Chinmoy Bhattacharya, **Samir Kumar Pal**, *Interaction of a Jaundice Marker Molecule with a Redox-Modulatory Nano-Hybrid: A Combined Electrochemical and Spectroscopic Study toward the Development of a Theranostic Tool*, Chem MedChem, 17, e202100660, 2022

23. Lopamudra Roy, Dipanjan Mukherjee, Soumendra Singh, Amrita Banerjee, Neha Bhattacharyya, Animesh Halder, Priya Singh, Subhadipta Mukhopadhyay, Kallol Bhattacharya, Ranjan Das and **Samir Kumar Pal**, *Pico-second resolved Förster resonance energy transfer (FRET) differentiates self-assembled biological macromolecules in aqueous medium*, Chemical Physics Impact, 4, 100081, 2022

24. Arnab Samanta, **Samir Kumar Pal** and Subhra Jana, *Exploring flowery MnO_2/Ag nanocomposite as an efficient solar-light-driven photocatalyst*, New Journal of Chemistry, 46, 4189-4197, 2022

25. Arpan Bera, Md. Nur Hasan, Nivedita Pan, Ria Ghosh, Reem A. Alsantali, Hatem M. Altass, Rami J. Obaid, Saleh A. Ahmed and **Samir Kumar Pal**, *Implementation of surface functionalization of MnS nanoparticles for achieving novel optical properties and improving therapeutic potential*, RSC Advances, 12, 20728, 2022
26. Susmita Mondal, Sayan Bayan, Ria Ghosh, Monojit Das, Aniruddha Adhikari, Dipanjan Mukherjee, Asim Kumar Mallick, Samit Kumar Ray and **Samir Kumar Pal**, *Functionalized Two-Dimensional Carbon Nitride Nanodots Detect and Reverse Lead Toxicity in the Physiological Milieu*, ACS Applied Materials & Interfaces, 14, 27002, 2022
27. Ria Ghosh, Susmita Mondal, Dipanjan Mukherjee, Aniruddha Adhikari, Saleh A. Ahmed, Reem I. Alsantali, Abdelrahman S. Khder, Hatem M. Altass, Ziad Moussa, Ranjan Das, Maitree Bhattacharyya and **Samir Kumar Pal**, *Oral drug delivery using a polymeric nanocarrier: chitosan nanoparticles in the delivery of rifampicin*, Materials Advances, 3, 4622, 2022
28. Arpan Bera, Md. Nur Hasan, Arka Chatterjee, Dipanjan Mukherjee, and **Samir Kumar Pal**, *Dual Sensitization via Electron and Energy Harvesting in a Nanohybrid for Improvement of Therapeutic Efficacy*, ACS Physical Chemistry Au, 2, 171, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Probing Crucial Interfacial Dynamics of Nanohybrids for Emerging Biomedical Functionalities; Jun 19, 2022; Jadavpur University SaltLake Campus; 30 minutes
2. Evolution of Exploration, Mining, Metallurgy and Usage of Copper in India in last 75 years & Future paths; Jul 16, 2022; Ghatsila, Jharkhand; 1 hour
3. Optical Spectroscopy in Nanohybrids: A Ray of Hope for Emerging Cross-disciplinary Research in Health Care; Feb 23, 2023; Assam down town university; 1 hour
4. Transforming Business through Bio-photonics Technology: Innovations, Challenges and Digital Renovation in Healthcare; Feb 24, 2023; Assam Don Bosco University; 1 hour
5. Contemporary Issues of Nano-science and Nano-technology; Jan 9, 2023; Jadavpur University SaltLake Campus; 45 minutes
6. Optical Spectroscopy Explore Nanohybrids for Nanotheranostics Application in Health Care Research; Mar 24, 2023; University of Kalyani, Kalyani, WB; 30 minutes
7. Transforming Business through Bio-photonics Technology: Innovations, Challenges and Digital Renovation in Healthcare; Mar 20, 2023; Techno International New Town, Kolkata, WB; 1 hour
8. Development of Nano-sensor and its Application through Cloud-based Network for Real-time Irrigation to Soil and Plant; Jan 20, 2023; Indian Council of Agricultural Research (ICAR), Bhopal; 45 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. Seeing" Invisible Volatile Organic Compound (VOC) marker of Urinary Bladder Cancer: A Bench to Bedside Prototype Spectroscopic Device, Indian Pat. Appl. (2022); FA/234/KOL/2022; Applied
2. Non-contact Sensing of Water Potential in a Matix Indian Pat. Appl. (2023); 202311021215/2023; Applied

Awards, Recognitions, if any

1. Abdul Kalam Technology Innovation National Fellowship 2018 (Indian National Academy of Engineering: INAE) Extension for another two years
2. Chairman of Expert Committee of Global Innovation & Technology Alliance (GITA)

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. Development of an industrial process for the large-scale production of retro reflective material for potential applications in display labels; Holoflex Limited; 2 years; PI
2. Development of Nano Sensor and its Application through Cloud Based Network for Real Time Irrigation to Soil and Plant; Indian Council of Agricultural Science Fund (ICAR); 3 years; Co-PI
3. Emergent Phenomena in 2D Heterostructures; DST India; 5 years; Co-PI
4. Development and optimization of plasmonics based low cost, ultrasensitive sensors for real world application: Prospect in the field of regional environmental pollution monitoring; West Bengal Pollution Control Board; 2 years; Co-PI

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

1. Professor Samit Kumar Ray, Department of Physics, Indian Institute of Technology, Kharagpur; Sl. No. 26; National
2. Professor Ranjan Das, Department of Chemistry, West Bengal State University; Sl. No. 3, 11, 23, 27; National
3. Dr. Debjani Karmakar, Bhabha Atomic Research Centre, Trombay, Mumbai, India; Sl. No. 12; National
4. Dr. Sudeshna Shyam Choudhury (Bhattacharya) Department: Microbiology & Envs, St.Xavier's College, 30 Park Street, Kolkata 700 016; Sl. No. 11; National
5. Professor Asim Kumar Mallick, NRS Medical College, Kolkata, 700014, India; Sl. No. 13, 26; National
6. Dipankar Das Sarma (D D Sarma), Solid State and Structural Chemistry Unit, Indian Institute of Science Bangalore, India; Sl. No. 12; National
7. Olle Eriksson, Professor at Department of Physics and Astronomy, Materials Theory, Uppsala University, Sweden; Sl. No. 12; International
8. Professor Saleh Ahmed, Umm Al-Qura University · Department of Chemistry, Saudi Arabia; Sl. No. 2, 8, 9, 11, 14, 16, 18, 21, 25, 27; International

Outreach program organized / participated

1. Scientific Creativity, inspirational talk in Jagadis Bose National Science Talent Search (JBNSTS) on 21st and 23rd June 2022
2. Scientific Creativity, inspirational talk in Jagadis Bose National Science Talent Search (JBNSTS) on 27th March 2023

Areas of Research

Biophysics, Nanotechnology, Biomedical Instrumentation, Biomimetics, Dye-sensitized Solar Cells, 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

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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; Phosphorylation code Under in RhoGDI regulation; 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

b) Post-Docs

1. Sk. Samir Ahamed; Quantum chemical studies of ionic liquids

c) External Project Students / Summer Training

1. Adway Majumdar; Mechanism of protein-ligand interactions
2. Tisha Dash; Self-assembly of amphipathic molecules
3. Uma Ganguly; Nucleation and growth during crystallization

Teaching

1. Autumn semester; CB 631: Advanced Numerical Methods & Simulation; PhD; 14 students
2. Autumn semester; PHY 304: Project Research II; Integrated PhD; 2 students
3. Spring semester; PHY 401: Project Research III; Integrated PhD; 1 student
4. Autumn semester; PHY 292: Summer Project Research I; Integrated PhD; 1 student

Publications

a) In journals

1. Prayasee Baruah, Dhiman Ray, Ibemhanbi Konthoujam, Abhinandan Das, **Suman Chakrabarty**, Kripamoy Aguanb and Sivaprasad Mitra, *Therapeutic opportunities of surface-active ionic liquids: a case study on acetylcholinesterase, citrate synthase and HeLa cell lines*, New Journal of Chemistry, 46, 20419, 2022
2. Dhiman Ray, Imocha Rajkumar Singh, Anindita Bhatta, Abhinandan Das, **Suman Chakrabarty**, Sivaprasad Mitra, *Modulation of drug binding ability and augmented enzymatic activity of lysozyme stabilized in presence of surface-active ionic liquids*, Journal of Molecular Liquids, 367, 120356, 2022
3. Sk Imadul Islam, Partha Pyne, Dipak Kumar Das, Shounak Mukherjee, **Suman Chakrabarty**, and Rajib Kumar Mitra, *Molecular Insight into Dye–Surfactant Interaction at Premicellar Concentrations: A Combined Two-Photon Absorption and Molecular Dynamics Simulation Study*, Langmuir, 38, 3105-3112, 2022
4. Neelesh C. Reddy, Rajib Molla, Pralhad Namdev Joshi, Sajeev T. K., Ipsita Basu, Jyotsna

Kawadkar, Neetu Kalra, Ram Kumar Mishra, **Suman Chakrabarty**, Sanjeev Shukla & Vishal Rai, *Traceless cysteine-linchpin enables precision engineering of lysine in native proteins*, Nature Communications, 13, 6038, 2022

5. Rajalaxmi Sahoo, Dibyendu Maity, D. S. Shankar Rao, **Suman Chakrabarty**, C. V. Yelamaggad, and S. Krishna Prasad, *Dimer-parity-dependent odd-even effects in photoinduced transitions to cholesteric and twist grain boundary smectic-C* mesophases: Experiments and simulations*, Physical Review E, 106, 044702, 2022
6. Kavya Mrudula Tadepalli, **Suman Chakrabarty**, Pramod Patil, and Rajnish Kumar, *Design of CO_2 Thickeners and Role of Aromatic Rings in Enhanced Oil Recovery Using Molecular Dynamics*, Langmuir, 39, 989, 2023
7. Sudipta Mitra, Arnab Sil, Ranjit Biswas and **Suman Chakrabarty**, *Molecular Thermodynamic Origin of Substrate Promiscuity in the Enzyme Laccase: Toward a Broad-Spectrum Degrader of Dye Effluents*, The Journal of Physical Chemistry Letters, 14, 1892, 2023
8. Bhawna Pandey, Krishnendu Sinha, Aditya Dev, Himal K. Ganguly, Smarajit Polley, **Suman Chakrabarty** and Gautam Basu, *Phosphorylation-Competent Metastable State of Escherichia coli Toxin HipA*, Biochemistry, 62, 989, 2023
9. Shubhra Kanti Bhaumik, Dibyendu Maity, Ipsita Basu, **Suman Chakrabarty** and Supratim Banerjee, *Efficient light harvesting in self-assembled organic luminescent nanotubes*, Chemical Science, 14, 4363, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Chemical Dynamics in Complex Systems (CDCS-2022); May 6, 2022; Online; 3 days
2. Recent Advances in Chemistry: Theoretical and Computational Aspects 2022; Nov 18, 2022; NEHU, Shillong; 3 days
3. Molecular simulation: Focus on Method; Dec 13, 2022; TIFR, Hyderabad; 2 days
4. International conference on an Interdisciplinary Approach to Biological Sciences (IABS 2023); Feb 1, 2023; IACS, Kolkata; 3 days
5. 10th meeting of the Asia Pacific Association of Theoretical and Computational Chemists (APATCC-10); Feb 19, 2023; Quy Nhon, Vietnam; 5 days
6. Kaleidoscope: A Discussion Meeting in Chemistry; Jul 28, 2022; Udaipur; 4 days
7. Intersection of Theory and Computation in Chemistry (ITCC – 2022); Jul 1, 2022; IISER Kolkata; 1 day
8. Theoretical Chemistry Meeting: Structure and Dynamics (TCMSD-2022); May 26, 2022; IACS, Kolkata; 4 days
9. Invited lecture at JNCASR, Bengaluru; Feb 16, 2023; Invited lecture at JNCASR, Bengaluru; 1 day

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)

Awards, Recognitions, if any

1. Editorial Board member of Dialogue: Science, Scientists, and Society published by the Indian Academy of Sciences, Bengaluru
2. Review Editor on the Editorial Board of Biophysics (specialty section of Frontiers in Physics, Frontiers in Physiology and Frontiers in Molecular Biosciences)

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
2. Molecular mechanism of regulation of Rho GTPases through phosphorylation of RhoGDI: Towards unraveling the "phosphorylation code"; SERB, India; 3 years; PI

Conference / Symposia / Schools organized

1. Designing Catalysts on Computers (DCC22); Dec 2, 2022; IACS, Kolkata; 2 days

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

1. Collaboration with Prof. Sivaprasad Mitra from NEHU, Shillong on the effect of surface-active ionic liquids on enzymes; Sl. No. 1, 2; National
2. Collaboration with Prof. Vishal Rai from IISER Bhopal on precision engineering of lysine in native proteins; Sl. No. 4; National
3. Collaboration with Profs. S. K. Prasad and D. S. Shankar Rao from Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru on dimer-parity-dependent odd-even effects in photoinduced transitions in liquid crystals; Sl. No. 5; National
4. Collaboration with Prof. Rajnish Kumar from IIT Madras on enhanced oil recovery; Sl. No. 6; National
5. Collaboration with Prof. Gautam Basu from Bose Institute, Kolkata on phosphorylation-competent metastable state of Escherichia coli toxin protein HipA; Sl. No. 8; National
6. Collaboration with Prof. Supratim Banerjee from IISER Kolkata on efficient light harvesting in self-assembled organic luminescent nanotubes; Sl. No. 9; National

Areas of Research

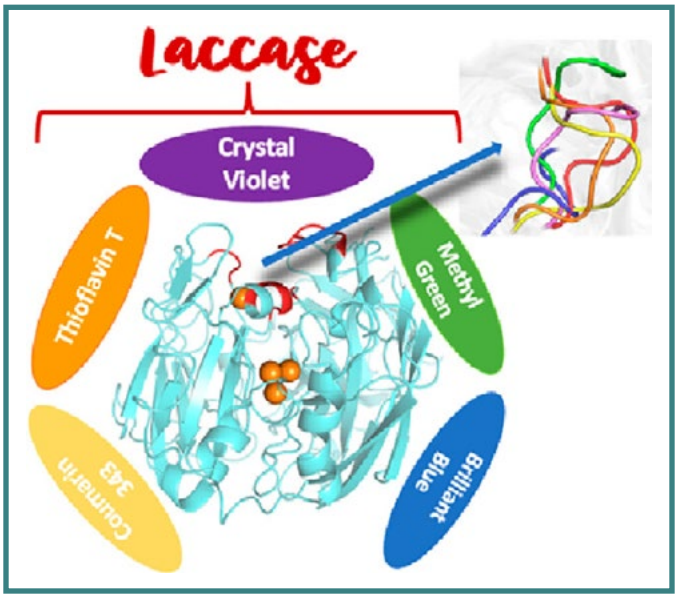
Theoretical and computational physical chemistry, computational molecular biophysics

We use a combination of classical molecular dynamics (MD) simulation and enhanced sampling methods to understand the connection between structure, interaction, dynamics and function of complex (bio) molecular systems and phase transition related phenomena in soft condensed matter systems. We collaborate with several experimental research groups to validate our theoretical/computational work and/or to provide a molecular mechanism behind the experimental observations.

A few representative examples where we have made significant contributions recently are:

1. Molecular Thermodynamic Origin of Substrate Promiscuity in the Enzyme Laccase: Toward a Broad-Spectrum Degrader of Dye Effluents

In collaboration with Prof. Ranjit Biswas (SNBNCBS, Kolkata), we have elucidated the molecular thermodynamic origin of the substrate promiscuity in the enzyme laccase using a combination of steady-state UV–visible absorption spectroscopy, molecular docking, and molecular dynamics (MD) simulation studies. We have considered the interaction of laccase with five dye molecules with varying charge, size, and shape. The spectroscopic studies confirm that all of these dyes can be degraded by laccase. Using MD simulations, we have demonstrated the presence of various distinct conformations of a loop in the protein active site that can accommodate the wide range of dye molecules. We have also shown that the diverse selection of dye molecules may exhibit surprisingly similar binding affinity due to



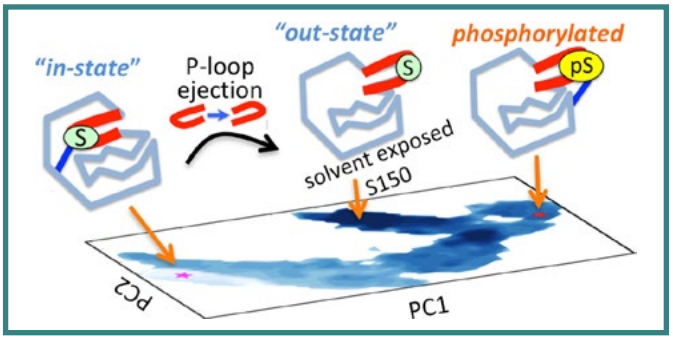
cancellation of different thermodynamic factors. Our results highlight the potential of laccase as a multipurpose degrader for industrial dye effluents.

Reference: *J. Phys. Chem. Lett.* **14**, 1892 (2023)

2. Phosphorylation-Competent Metastable State of Escherichia coli Toxin HipA

Phosphorylation is a post-translational modification mechanism that alters the functional state of many proteins. The Escherichia coli toxin HipA becomes inactivated upon autophosphorylation of Ser150. Interestingly, Ser150 is phosphorylation-incompetent in the crystal structure of HipA since it is deeply buried ("in-state"), although in the phosphorylated state it is solvent exposed ("out-state"). To be phosphorylated, a minor population of HipA must exist in the phosphorylation-competent "out-state" (solvent-exposed Ser150), not detected in the crystal structure of unphosphorylated HipA. In collaboration with Prof. Gautam Basu (Bose Institute, Kolkata), we have established the presence of some phosphorylation competent metastable conformational states of the HipA protein that are partially exposed to solvent. Our results not only suggest a mechanism of HipA autophosphorylation but also add to a number of recent reports on unrelated protein systems where the common proposed mechanism for phosphorylation of buried residues is their transient exposure even without phosphorylation.

Reference: *Biochemistry* **62**, 989 (2023)



3. Efficient Light Harvesting in Self-assembled Organic Luminescent Nanotubes

In collaboration with the group of Prof. Supratim Banerjee (IISER Kolkata) we have studied the molecular mechanism of formation and structural aspects of luminescent organic nanotubes derived from the co-assembly of cyanostilbene (CS) based cationic supramolecular polymers and bio-polyanion heparin, a known anticoagulant. Our MD simulations provide molecular level structural information of these supramolecular polymers.

Reference: *Chemical Science* **14**, 4363 (2023)

Plan of Future Work Including Project

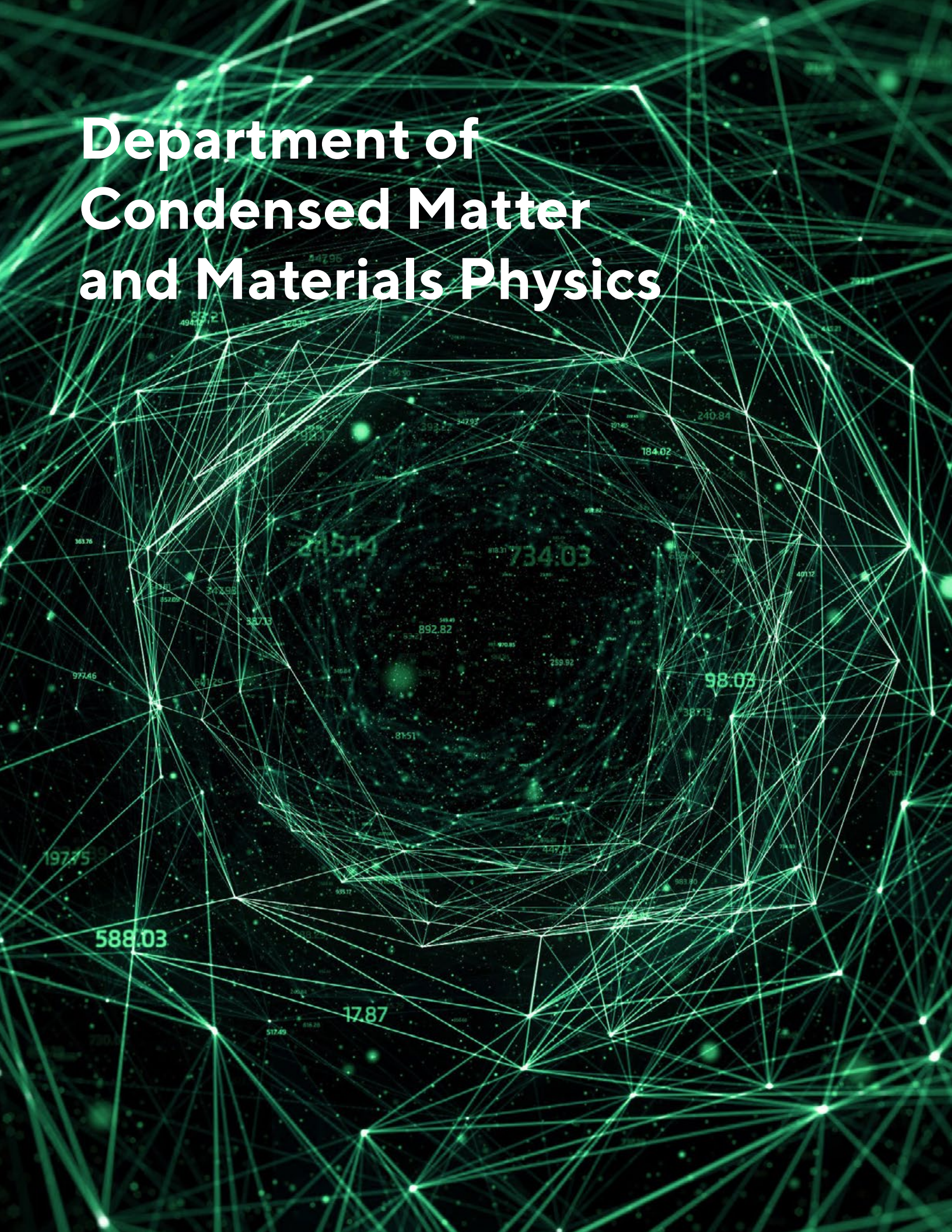
1. Machine learning in chemical physics and biophysics: Our group is actively pursuing the area of development and application of machine learning algorithms towards problems like: (i) prediction of physicochemical properties of molecules from their 2D/3D structures (this project is sponsored by the MATRICS scheme of SERB, India), (ii) on-the-fly detection of local crystalline order (distinct phases) in a metastable amorphous phase (e.g. supercooled liquid) in the context of nucleation of crystals from solution, and (iii) identification of collective variables (reaction coordinates) for enhanced sampling of rare events.
2. Molecular mechanism of phosphorylation code operating in the protein-protein interactions between RhoGDI and Rho GTPases: This project has been sponsored by the ECR scheme of SERB, India. We have also initiated collaboration with Prof. Ruth Nussinov (NCI, USA) on this project.
3. Development of a computational protocol / strategy to identify allosteric hotspots and inhibitors for challenging drug targets including protein-protein interfaces/interactions (PPI)

Any other Relevant Information including social impact of research

1. Our collaborative research on (i) substrate promiscuity in the enzyme laccase, and (ii) efficient light harvesting in self-assembled organic luminescent nanotubes have been highlighted by DST Media Cell as well as some popular media in the form of scientific stories.


APOLLO ENGINEE
MUFFLE FURNACE

Department of Condensed Matter and Materials Physics



Department of Condensed Matter and Materials Physics

Priya Mahadevan

Department profile indicators

Table A: Manpower and resources

Number of faculty members	Regular = 12 Contractual = 4
Number of Post –doctoral research associate (centre+project)	28
Number of Ph.D students	77
Number of other project staff	1
Number of summer students	14 (External)
Projects (ongoing)	18

Table B: Research Activities indicators

Number of research papers in Journals	86
Number of Book-chapters/books	1
Number of other publications	6
Number of Ph.D students graduated (submitted+degree awarded)	8 (Thesis Submitted)+8 (Ph.D. degree awarded)
Number of M.Tech/M.Sc projects	1

Table C: Academic activities and likeage

Number of courses taught by faculty members	15	
Number of Visitors (non –associates)		
Number of associates		
Number of Seminars organized	34	
Number of Conference/Symposia/Advanced Schools organized	10	
Number of talks delivered by members of department in conferences/Symposia	National	38
	International	6

Most important research highlights

- The group of Anjan Barman has investigated ultrafast demagnetization in thin film heterostructures of Ta/Co20Fe60B20/SiO2 and found a direct relationship between the variation of demagnetization and the Gilbert damping, indicating interface spin-transport as the dominant mechanism.
- The group of Atindranath Pal examined transport through ferrocene and found a significantly high conductance at room temperature originating from resonant transport.
- The group of Avijit Chowdhury has proposed ternary nanocomposites of functionl layered materials to suppress photogenerated carrier recombination while augmenting the photocatalytic performance by harnessing the entire UV, visible and the near infrared part of the spectrum.

- The group of Barnali Ghosh has made a gated optical detector working in the visible wavelength with single crystals of $CH_3NH_3PbBr_3$.
- The group of Kalyan Mandal has investigated the anomalous Hall effect in different Co based topological Heusler compounds and found that they are dominated by the intrinsic Berry phase mechanism.
- The group of Manoranjan Kumar has found that the spin–1/2 chain with ferromagnetic nearest neighbour exchange and antiferromagnetic second neighbour exchange is found to support two spin-Peierls instabilities depending on the frustration.
- The group of Nitesh Kumar have studied the two-dimensional ferromagnet Cr_5Te_8 and found Neel-type skyrmions through Lorentz microscopy.
- The group of Priya Mahadevan has explained the electric field tunability of the electronic structure of twisted bilayer WSe_2.
- The group of Tanusri Saha-Dasgupta has found unconventional topology in the electronic structure of heterostructures of $LaCoO_3$/$SrIrO_3$.
- The group of T. Setti has shown that the topological properties of Mn3Sn can be tuned by Fe doping.

Summary of research activities

The group of Anjan Barman has been exploring magnetization dynamics in heterostructures involving a nonmagnetic material and CoFeB. By using nonmagnetic materials with different spin-orbit interaction strengths, they find a systematic variation of the ultrafast demagnetization time, remagnetization time and the Gilbert damping with the spin-orbit interaction strength.

The group of Atindranath Pal has been exploring heterostructures of graphene and $MoS_{2x}Se_{2(1-x)}$ alloys as photodetectors and shown that deep level defects play a role on the photodetector performance.

The group of Avijit Chowdhury has been exploring ternary nanocomposites for photocatlysis. They find an improved performance which is associated with the large number of active sites, the broadband absorption capabilities, use of metals that allows faster electron migration, lower interfacial resistance and longer electron lifetimes.

The group of Kalyan Mandal has found a a large reversible magnetocaloric effect and magnetoresistance near room temperature in $Ni_{37-x}Co_{13+x}Mn_{34.5}Ti_{15.5}$, a materials that undergoes a first-order magnetostructural transformation accompanied by a large magnetization change between ferromagnetic austenite phase and antiferromagnetic martensite phases. Optimising the crystallographic compatibility helps to ensure the reversibility.

The group of Manoranjan Kumar has examined the thermodynamics of spin-1/2 chains which have a ferromagnetic nearest neighbour exchange and an antiferromagnetic next neighbour exchange using a combination of exact diagonalisation and density matrix renormalization group studies.

The group of Nitesh Kumar has found an anomalous Hall effect in ZnMnSb, a layered ferromagnet. The mechanism for this however does not fit in with what has been discussed so far, with the transport suggesting a semiconducting nature, while the electronic structure calculations predict the system to be metallic.

The group of Priya Mahadevan has explained the flat band formation in twisted bilayers of WSe2 at small twist angles. Similar sized Moire cells at large twist angles do not have the flat band formation, and this traced to the fact that the dominant fourier components of the Moire potential are associated with the primitive cell. This results in strong zone boundary scattering for small twist angles, while the electronic structure at large twist angles resembles the unperturbed limit.

The group of Tanusri Saha-Dasgupta has explored various binary alloyed nanoparticles and calculated the single atom cluster segregation energies to determine theoretically whether core–shell structures would form. Their analysis suggests that, for very small and very large differences of cohesive energy of the constituents, instead of core–shell structure, mixed and Janus structures are stabilized, respectively.

The group of T. Setti has grown single crystals of $Mn_{2.94}Ge$ single crystals and a of the magnetic properties reveals additional magnetic transitions such as spin-reorientation and ferromagnetic-like transitions below the Neel temperature of 353 K. The Hall data also shows unusual behavior around the spin reorientation transition, indicating very different properties of this compound compound to Mn_3Ge.

Priya Mahadevan

Priya Mahadevan
Head, Department of Condensed Matter and Materials Physics

Anjan Barman
Senior Professor
Condensed Matter and Materials Physics
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

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

b) Post-Docs

1. Arpan Bhattacharyya; Spin-Orbit Effects in
2. Ajit Kumar Sahoo; Spin Dynamics in Ferrimagnetic Materials

c) External Project Students / Summer Training

1. Mahima Ann Paul; Dzyaloshinskii-Moriya Interaction in Perpendicularly Magnetized Nanodots

Teaching

1. Autumn semester; PHY301: Atomic and Molecular Physics; Integrated PhD; 10 students; with Prof. Rajib Kumar Mitra (Co-teacher)
2. Autumn semester; CB 527: Molecular Physics and Spectroscopy; PhD; 6 students; with Prof. Rajib Kumar Mitra (Co-teacher)
3. Spring semester; PHY292: Project Course I; Integrated PhD; 1 student
4. Autumn semester; PHY304: Project Course II; Integrated PhD; 1 student
5. Spring semester; PHY401: Project Research III; Integrated PhD; 2 students

Publications

a) In journals

1. Suchetana Mukhopadhyay, Sudip Majumder, Surya Narayan Panda and **Anjan Barman**, *Investigation of ultrafast demagnetization and*

Gilbert damping and their correlation in different ferromagnetic thin films grown under identical conditions, Nanotechnology, 34, 235702, 2023

2. Amrit Kumar Mondal, Sudip Majumder, Bipul Kumar Mahato, Saswati Barman, Yoshichika Otani and **Anjan Barman**, *Bias field orientation driven reconfigurable magnonics and magnon-magnon coupling in triangular shaped $Ni_{80}Fe_{20}$ nanodot arrays*, Nanotechnology, 34, 135701, 2023

3. Soma Dutta, Surya Narayan Panda, Jaivardhan Sinha, Samiran Choudhury, and **Anjan Barman**, *Role of Spin Transport through the eTa/$Co_{20}Fe_{60}B_{20}$ Interface on its Ultrafast Demagnetization: Implications for Ultra-High-Speed Spin-Orbitronic Devices*, ACS Applied Nano Materials, 5, 17995, 2022

4. Sourav Sahoo, Sucheta Mondal, Samiran Choudhury, Jaivardhan Sinha, **Anjan Barman**, *All-Optical study of Gilbert damping and spin orbit torque in Ta/CoFeB/SiO_2 heterostructures*, Materials Science and Engineering: B, 287 116131, 2023

5. Nirman Chakraborty, Surya Narayan Panda, Ajay K. Mishra, **Anjan Barman**, and Swastik Mondal, *Ferromagnetic $Ni_{1-x}V_xO_{1-y}$ Nano-Clusters for NO Detection at Room Temperature: A Case of Magnetic Field-Induced Chemiresistive Sensing*, ACS Applied Materials & Interfaces, 14, 52301, 2022

6. Pratap Kumar Pal, Sourav Sahoo, Koustuv Dutta, **Anjan Barman**, Saswati Barman, YoshiChika Otani, *Thickness-Dependent Reconfigurable Spin-Wave Dynamics in $Ni_{80}Fe_{20}$ Nanostripe Arrays*, Advanced Materials Interfaces, 9, 2201333, 2022

7. Surya Narayan Panda, Bivas Rana, YoshiChika Otani, **Anjan Barman**, *Role of Spin-Orbit Coupling on Ultrafast Spin Dynamics in Nonmagnet/Ferromagnet Heterostructures*, Advanced Quantum Technologies, 5, 2200016, 2022

8. Suranjana Chakrabarty, **Anjan Barman** and Anup Ghosh, *Anomalous Infrared Absorbance of SO_2: A Perturbation Study of eC-H/D*, The Journal of Physical Chemistry B, 126, 5490, 2022

9. Suranjana Chakrabarty, Samadhan H. Deshmukh, **Anjan Barman**, Sayan Bagchi and Anup Ghosh, *On-Off Infrared Absorption of the S=O Vibrational Probe of Dimethyl Sulfoxide*, The Journal of Physical Chemistry B, 126, 4501, 2022

10. Koustuv Dutta, Surya N Panda, Takeshi Seki, Santanu Pan, Koki Takanashi, **Anjan Barman**, *All-Optical Detection of Spin Pumping and Giant Interfacial Spin Transparency in $Co_2Fe_{0.4}Mn_{0.6}Si$/Pt Heterostructure*, Advanced Quantum Technologies, 5, 2200033, 2022

11. Jayshankar Nath, Alexandru Vladimir Trifu, Mihai Sebastian Gabor, Ali Hallal, Stephane Auffret, Sebastien Labau, Aymen Mahjoub, Edmond Chan, Avinash Kumar Chaurasiya, Amrit Kumar Mondal, Haozhe Yang, Eva Schmoranzerova, Mohamed Ali Nsibi, Isabelle Joumard, **Anjan Barman**, Bernard Pelissier, Mairbek Chshiev, Gilles Gaudin, Ioan Mihai Miron, *Mechanism of Spin-Orbit Torques in Platinum Oxide Systems*, Advanced Electronic Materials, 2101335, 2022

b) Conference proceedings / Reports / Monographs / Books

1. Chapter One - "Spin dynamics in patterned magnetic multilayers with perpendicular magnetic anisotropy" by Mateusz Zelent, Pawel Gruszecki, Mathieu Moalic, Olav Hellwig, Anjan Barman, Maciej Krawczyk in Book series "Solid State Physics", v.73, p.1-51, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Spin Dynamics in Engineered Ferromagnetic Materials, A. Barman, RCPHYS22-23; Feb 15, 2023; Jadavpur University; 60 min

2. Hybrid Magnonics in Ferromagnetic Nanostructures, A. Barman, Seminar on Frontier problems in Nanomagnetism and Spintronics; Feb 9, 2023; IIT Gandhinagar; 60 min

3. Spin Dynamics in Engineered Ferromagnetic Systems for Applications in High-Speed Spintronics and Magnonics, A. Barman, Seminar at ETH Zurich; Feb 6, 2023; ETH Zurich; 60 min

4. Ultrafast Spin Dynamics in Confined Ferromagnetic Systems for Applications in Spintronics and Magnonics, A. Barman, Infosys Condensed Matter

Seminar, Tata Institute of Fundamental Research Mumbai; Oct 17, 2022; TIFT Mumbai; 60 min

5. Spin-Orbit Effect: A New Wing of Spintronics, A. Barman, Summer School on Nanomaterials: Concepts and Applications; Aug 22, 2022; CRNN, University of Calcutta; 60 min
6. Femtosecond Laser Induced Spin Dynamics in Ferromagnetic Thin Films and Heterostructures: Towards Ultrahigh Speed Spintronics, A. Barman, Advanced Magnetic Materials and Applications; Jul 29, 2022; IIT Hyderabad; 45 min
7. Femto- and Picosecond Spin Dynamics in 2D Materials/Ferromagnet Heterostructures, 4th International Conference on Current Trends in Materials Science and Engineering; Jul 28, 2022; IEM Kolkata; 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

Awards, Recognitions, if any

1. Featured in top 2% most cited scientists' list released by Stanford University in 2022

Membership of Learned Societies

1. Member of American Physical Society (APS)
2. Member of Institute of Physics (IOP) UK
3. Life Member of Materials Research Society of India (MRSI)

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

1. Center for Nanomagnetics for Energy Efficient Computing, Communications and Data Storage; Indo-US Virtual Networked Centre; 2019-23; PI
2. Development of strongly spin orbit coupled topological quantum hetero-structures for spintronic application; DST, Nano Mission; 2021-2026; PI

Conference / Symposia / Schools organized

1. Kickoff meeting of the research collaboration between IIT Bombay and SNBNCBS Jun 6, 2022; S. N. Bose National centre for Basic Sciences; 3 days

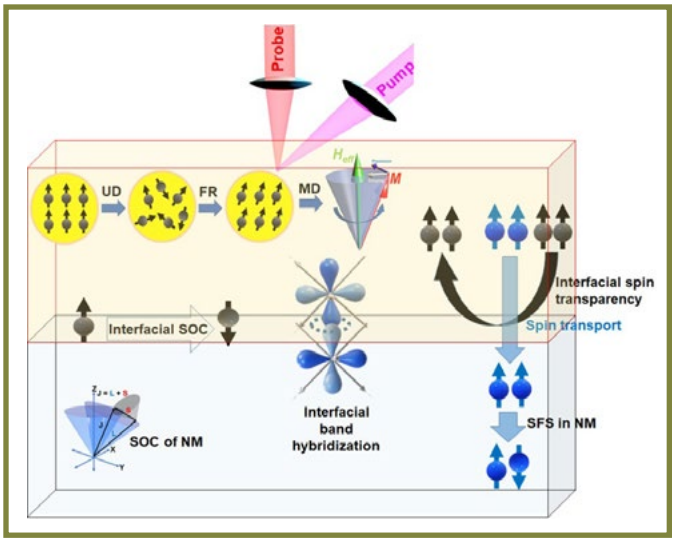
Scientific collaborations with other national / international institutions (based on joint publications)

1. Yoshichika Otani, RIKEN and University of Tokyo, Japan; Sl. No. 2, 6, 7; International
2. T. Seki and K. Takanashi, Tohoku University, Japan; Sl. No. 10; International
3. I. Mihai Miron, Spintec, France; Sl. No. 11; International
4. Swastik Mondal, CGCRI, Kolkata, India; Sl. No. 5; National

Areas of Research

Experimental Condensed Matter Physics; Nanomagnetism; Spintronics; Magnonics; Ultrafast and THz Spectroscopy; Micromagnetic Simulations

Spin-orbitronics: We have investigated magnetization dynamics in different nonmagnet (NM)/$Co_{20}Fe_{60}B_{20}$ heterostructures, where the NM layer varies as Cu, Ta, W, Pt, Ta/Ru/Ta, and Si/SiO_2 that differ in SOC strength. We have observed a systematic variation in ultrafast demagnetization time (τ_m), fast remagnetization time (τ_r) and Gilbert damping parameter (α) with the SOC strength of the underlayer and established an inverse relationship between α and τ_m, τ_r due to the dominant contribution of spin current transport in ultrafast demagnetization and fast remagnetization processes. The spin pumping formalism estimates the effective spin-mixing conductance (G_{eff}) for different interfaces, which signifies that the high SOC strength of underlayers resulted in high G_{eff} indicating more efficient transport of spin current through it (Fig. 1). We have further investigated spin pumping in a ferromagnetic Heusler compound ($Co_2Fe_{0.4}Mn_{0.6}Si$)/Pt heterostructure. The thickness-dependent evolution of Gilbert damping has been modelled using ballistic and diffusive spin transport framework to extract intrinsic spin-mixing conductance and spin-diffusion length. Finally, a giant value of interfacial spin transparency up to 0.87 ± 0.02 combined with small intrinsic damping of 0.0039 ± 0.0004 promote CFMS/Pt heterostructure as a champion material for the development of advanced spin-orbitronic devices.



Magnonics: We have performed a combined experimental and numerical study of the reconfigurable spin-wave dynamics in arrays of ferromagnetic nanostripes by the stripe thickness and external magnetic field strength and orientation. We have observed different uniform, localized and standing spin waves in the nanostripes and their monotonic and non-monotonic variation, including mode merging with these parameters. The observed variations were interpreted using micromagnetic simulation. Further numerical study revealed anisotropic spin-wave propagation in nanostripes for different thicknesses and in different bias-field geometry opening potential applications in magnonic circuit components such as reconfigurable magnonic waveguides and omnidirectional spin-wave emitters. We have further studied the intricate interplay of spin dynamics between two different materials $Co_{50}Fe_{50}$ and $Ni_{80}Fe_{20}$ forming a bi-component magnonic crystal (BMC). Optimally engineered interface leads to interelement exchange coupling combined with the long-range dipolar coupling as confirmed by micromagnetic simulations. These couplings was further tuned by systematic variation of filling fraction of $Co_{50}Fe_{50}$ and $Ni_{80}Fe_{20}$ in the BMC. Moreover, the characteristic properties of spin-wave spectra are highly sensitive to the bias-field strength. Further numerical simulations demonstrate long-distance and high-speed spin-wave propagation in such BMCs and offering diode-like on/off mechanism determined by the applied magnetic field strength.

Ultrafast demagnetization: We have investigated ultrafast demagnetization, remagnetization and damping in β-Ta(t nm)/Co20Fe60B20(d nm)/SiO2(2 nm) thin film heterostructures by systematically varying both the Ta and Co20Fe60B20 thicknesses. Based on experimental results we have established a direct relationship between the variation of demagnetization rate and the Gilbert damping constant, indicating interface spin-transport as the prevailing mechanism for both the ultrafast demagnetization and the damping. At higher thicknesses ($t \geq 7$ nm) of β-Ta, the spin accumulation coefficient is found to be ~ 0.24 eV, which is about 1.8 times less than its value in lower thickness regime ($t < 7$ nm). These results will have important implications towards the evolution of ultra-high-speed spin-orbitronic devices.

Plan of Future Work Including Project

1. We will study magnon-magnon coupling in nanomagnetic systems acting as a tiny cavities for resonant spin-wave (SW) modes which hybridize due to mutual transfer of energy. We will try to tune the coupling by microwave excitation power and geometry of the bias magnetic field which modulate the inter-element dipolar coupling and the ensuing cooperative dynamics.
2. We will further study surface acoustic wave (SAW) driven tripartite magnon-phonon-magnon coupling in nanomagnet array and the transfer of energy from the SAW to the magnons forming hybrid binary magnon polaron. The phase matching condition for this coupling will also be studied.
3. We will investigate a new phenomenon in hybrid magnonics involving coupling between SWs and hybridized phonon-plasmon waves (tripartite mixing of magnons, phonons and plasmons). This acousto-plasmo-magnonics will be studied in an artificial magnonic crystal comprising a two-dimensional periodic array of magnetostrictive nanomagnets deposited on silicon substrate with an intervening thin film of aluminium that acts as a source of surface plasmons. We will also study the presence of parametric amplification in this system involving energy transfer from the hybridized phonon-plasmon modes to the acousto-plasmo-spin wave modes to amplify the latter.
4. The rise of three-dimensional topological insulators (TIs) as a uniquely attractive playground for the observation and control of various spin-orbit effects has ushered in the promising field of topological spintronics. In order to fully exploit their potential as efficient spin-orbit torque generators, it is crucial to investigate the efficiency of spin injection and transport at various topological insulator/ferromagnet interfaces and identify the key

parameters for their optimization. We will investigate efficiency of spin pumping in various TI/ferromagnet thin film heterostructures. We will extract various parameters including spin-mixing conductance, spin diffusion length, spin-fil probability and spin transparency in such heterostructures and will understand the results based upon the interface quality and physical properties.

5. Two dimensional (2D) van der Wall (vdW) magnets are the incentive for new era of spintronics research with unprecedented opportunities. So far, most research on vdW magnets are restricted by cryogenic temperature due to inability of retaining long range magnetic order at room temperature. We will investigate the emergence of spin dynamics in association with phonon dynamics at room temperature in FexGeTe2 (x=3,4,5) flakes employing time-resolved magneto-optical Kerr effect microscope. The high intense femtosecond laser pulse is speculated to establish magnetic ordering in such systems. The photoinduced magnetization will be realized and modulated in the ultrafast demagnetization and GHz frequency precessional dynamics. Further, we will investigate coherent phonon excitation at optical regime and spin-phonon coupling.

Anup Ghosh

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Suranjana Chakaborty; Spectroscopic Studies of Molecules; Under progress; Prof. Anjan Barman (Co-supervisor)

Publications

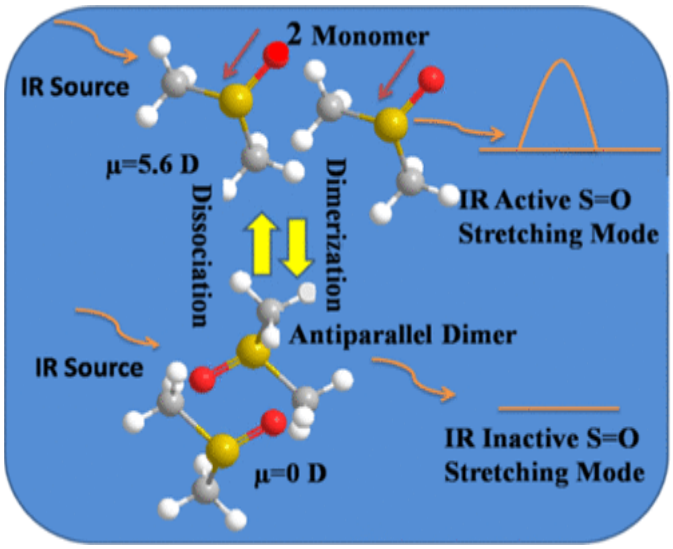
a) In journals

1. Suranjana Chakrabarty, Samadhan H. Deshmukh, Anjan Barman, Sayan Bagchi and **Anup Ghosh**, *On-Off Infrared Absorption of the S=O Vibrational Probe of Dimethyl Sulfoxide*, The Journal of Physical Chemistry B, 126, 4501, 2022
2. Suranjana Chakrabarty, Anjan Barman and **Anup Ghosh**, *Anomalous Infrared Absorbance of S=O: A Perturbation Study of α-C–H/D*, The Journal of Physical Chemistry B, 126, 5490, 2022
3. Suranjana Chakrabartya and **Anup Ghosh**, *Inconsistent hydrogen bond-mediated vibrational coupling of amide I*, RSC Advances, 13, 1295, 2023

Areas of Research

Inconsistent hydrogen bond-mediated vibrational coupling of amide

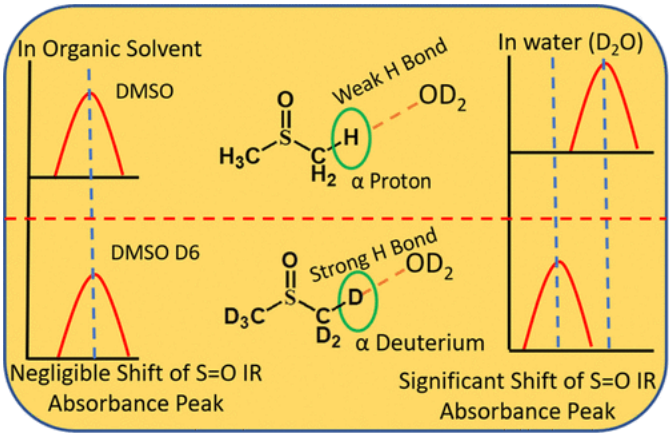
1. On-Off Infrared Absorption of S=O Vibrational Probe of Dimethyl Sulfoxide



Dimethyl sulfoxide (DMSO), a polar solvent molecule, is used in a wide range of therapeutic and pharmacological applications. Different intermolecular interactions, such as dimerization and hydrogen bonding with water, are crucial to understanding the role of DMSO in applications. Herein, we study DMSO in various solvation environments to decipher the environment-dependent dimerization and hydrogen-bonding propensity. We use a combination of infrared spectroscopy, quantum mechanical calculations, and molecular dynamics simulations to reach our conclusions. Although DMSO can exist in a dynamic equilibrium between monomers and dimers, our results show that the relative intensity of the SO stretch and the CH3 rocking modes is a spectroscopic indicator of the extent of DMSO dimerization in solution. The dimerization (self-association) is seen to be maximum in neat DMSO. When dissolved in different solvents, the dimerization propensity decreases with increasing solvent polarity. In the presence of a protic solvent, such as water, DMSO forms a hydrogen bond with the solvent molecules, thereby reducing the extent of dimerization. Further, we estimate the hydrogen-bond occupancy of

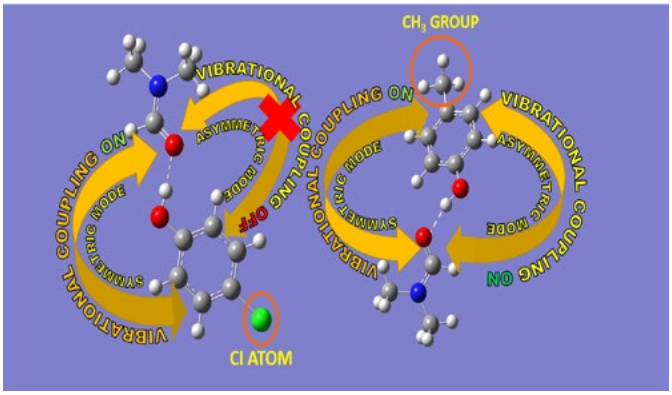
DMSO. Our results show that DMSO predominantly exists as doubly hydrogen-bonded in water.

2. Anomalous Infrared Absorbance of S=O/C=O: A perturbation Study of -H/D



Solvatochromic shifts of SO vibrational probes describe the strength of the surrounding electric fields and the hydrogen bonding status. Herein, we demonstrated how the solvents alter the infrared (IR) spectra of the SO vibrating mode. The experimental measurement of the involvement of -H/D isotopic interactions with different solvents and their effects on the IR absorbance spectra of the vibrational probe provides detailed knowledge of the microsolvation environment despite the complexity of overlapping bands in the spectra. Herein, we discover how the solvents interact differently with DMSO and DMSO-d6, while being electronically and structurally the same. Interestingly, the IR spectrum of the SO mode remains unaltered during -isotopic replacement in the presence of aprotic solvents (acetone, acetonitrile, and dichloromethane), but in strongly coordinating polar solvents (D2O), it is altered remarkably. There is a lack of quantitative information about the influence of the -H atom or -isotopic substitution on the vibrational probe in the literature. Our experiments provide a detailed molecular understanding of the structure of DMSO in DMSO–solvent binary mixtures. As DMSO plays an important role in virtually all subdisciplines of chemistry and biology, we believe that our work will be of interest to a large diversity of studies in these fields.

3. Inconsistent Hydrogen Coupling of Amide Bond Mediated Vibrational I.



Using infrared spectroscopy and density functional theory (DFT) calculations, we scrutinized an amide (dimethylformamide) as a "model" compound to interpret the interactions of amide 1 with different phenol derivatives (para-chlorophenol (PCP) and para-cresol (CP)) as "model guest molecules". We established the involvement of amide I in vibrational coupling with symmetric and asymmetric C=C modes of different phenolic derivatives and how their coupling was dependent upon different guest aromatic phenolic compounds. Interestingly, substitution of phenol perturbed the pattern of vibrational coupling with amide I. The symmetric and asymmetric C=C modes of PC were coupled significantly with amide 1. For PCP, the symmetric C=C mode coupled significantly, but the asymmetric mode coupled negligibly, with amide I. Here, we reveal the nature of vibrational coupling based on the structure of a guest molecule hydrogen-bonded with amide I. Our conclusions could be valuable for depiction of the unusual dynamics of coupled amide-I modes as well as the dependency of vibrational coupling on altered factors.

Plan of Future Work Including Project

1. Structural analysis of G quadruplex/DNA before and after drug binding by using mainly linear infrared (IR) and nonlinear two-dimensional infrared (2D IR) spectroscopy.

Atindra Nath Pal

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Condensed Matter and Materials Physics
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Shubhadip Moulick; Charge and spin transport in hybrid two dimensional nanodevices; Under progress
2. Biswajit Pabi; An investigation of mechanical tunability in single molecular junction; Under progress
3. Shubhrasish Mukherjee; An investigation of electronic and optical properties in 2D semiconductors and their heterostructures; Under progress; Prof. S. K. Ray (Co-supervisor)
4. Rafiqul Alam; An investigation of transport phenomena in topological materials; Under progress
5. Riju Pal; Spintronics with layered materials; Under progress
6. Subhankar De; Transport in single molecular junction; Under progress

b) Post-Docs

1. Buddhadeb Pal; Transport in magnetic 2D materials
2. Sk Md Obaidulla; Growth and characterization large area 2D magnetic and semiconducting materials

c) External Project Students / Summer Training

1. Gourab Samanta - Summer trainee; Creating large area 2D semiconductors with CVD technique
2. Koustav Panda-Summer trainee; creating 2D heterostructure using dry transfer technique
3. Gourab Samanta - Master thesis; Optimization and characterization of van der Waal heterostructure

Teaching

1. Spring semester; PHY628- Mesoscopic Physics; PhD; 8 students; Dr. Saquib Shamim (Co-teacher)

Publications

a) In journals

1. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Atindra Nath Pal**, Rajib Kumar Mitra, Samit Kumar Ray, *Two-Dimensional $Mo_xW_{1-x}S_2$ Alloys for Nanogenerators Producing Record Piezo-Output and Coupled Photodetectors for Self-Powered UV Sensor*, Advanced Optical Materials, 10, 2200353, 2022
2. Biswajit Pabi and **Atindra Nath Pal**, *An experimental set-up to probe the quantum transport through a single atomic/ molecular junction at room temperature*, Pramana, 97, 8, 2023
3. Shubhrasish Mukherjee, Didhiti Bhattacharya, Samit Kumar Ray, and **Atindra Nath Pal**, High-Performance Broad-Band Photodetection Based on Graphene–$MoS_{2x}Se_{2(1-x)}$ Alloy Engineered Phototransistors, ACS Applied Materials & Interfaces, 14, 34875, 2022
4. Shubhadip Moulick, Rafiqul Alam, and **Atindra Nath Pal**, *Sensing Remote Bulk Defects through Resistance Noise in a Large-Area Graphene Field-Effect Transistor*, ACS Applied Materials & Interfaces, 14, 51105, 2022

5. Satyabrata Bera, Suman Kalyan Pradhan, Md Salman Khan, Riju Pal, Buddhadeb Pal, Sk Kalimuddin, Arnab Bera, Biswajit Das, **Atindra Nath Pal**, Mintu Mondal, *Unravelling the nature of spin reorientation transition in quasi-2D vdW magnetic material, Fe_4GeTe_2,* Journal of Magnetism and Magnetic Materials, 565, 170257, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at QMAT 3, IITK (2022); Sep 18, 2022; IIT Kanpur; 5 days
2. Invited talk at 'Modern Trends in Molecular Magnetism- MTMM3'; Dec 11, 2022; IIT Kharagpur; 3 days
3. Invited talk at 'FS PHY-2023' at IISER TVM; Feb 24, 2023; Invited talk at 'FS PHY-2023' at IISER TVM; 3 days
4. Invited seminar at IISc, Physics Department; Mar 13, 2023; Invited seminar at IISc, Physics Department; 1 day

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.

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

1. DST/NM/TUE/QM-10/2019; DST-Nanomission; 5 years (since March 2023); PI

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

1. Prof. S. K. Ray (IIT Kgp) and Prof. R. K. Mitra (SNBNCBS); Sl. No. 1; National
2. Prof. S. K. Ray (IITKgp); Sl. No. 3; National
3. Mintu Mondal (IACS); Sl. No. 5; National

Areas of Research

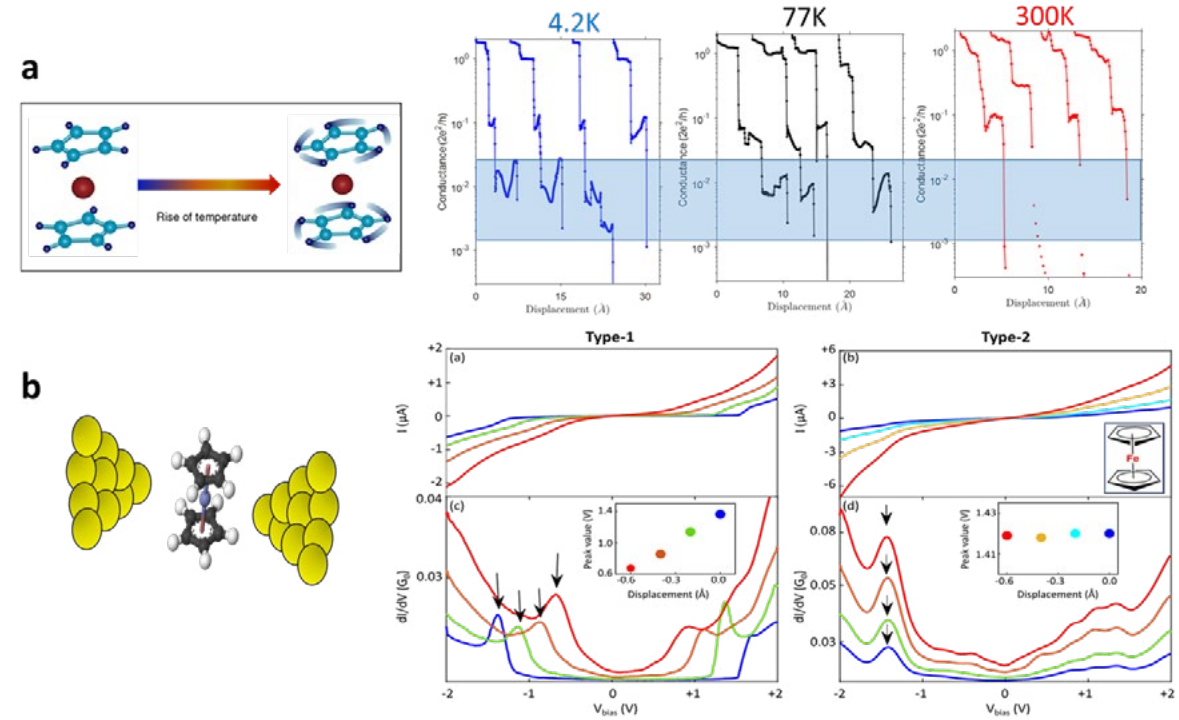
Experimental condensed matter physics

A. Transport through single molecular junction: We have progressed significantly this year with several new results. Using a Ferrocene based organo-metallic molecule, we observed significantly high conductance at room temperature exhibiting resonant transport (under review, Nanoscale). We then observed that the orientation of the molecule inside the junction determines mechanical gating (Under review in Nano Letter). In another experiment in collaboration, we predicted the optimal condition for atomic chain formation in gold (under review, Nanoscale). We also published a paper based on the custom-designed technique (Pramana, 97, 8 (2022)). One PhD student, Mr. Biswajit Pabi was ready to submit his thesis and another new PhD student has joined the team.

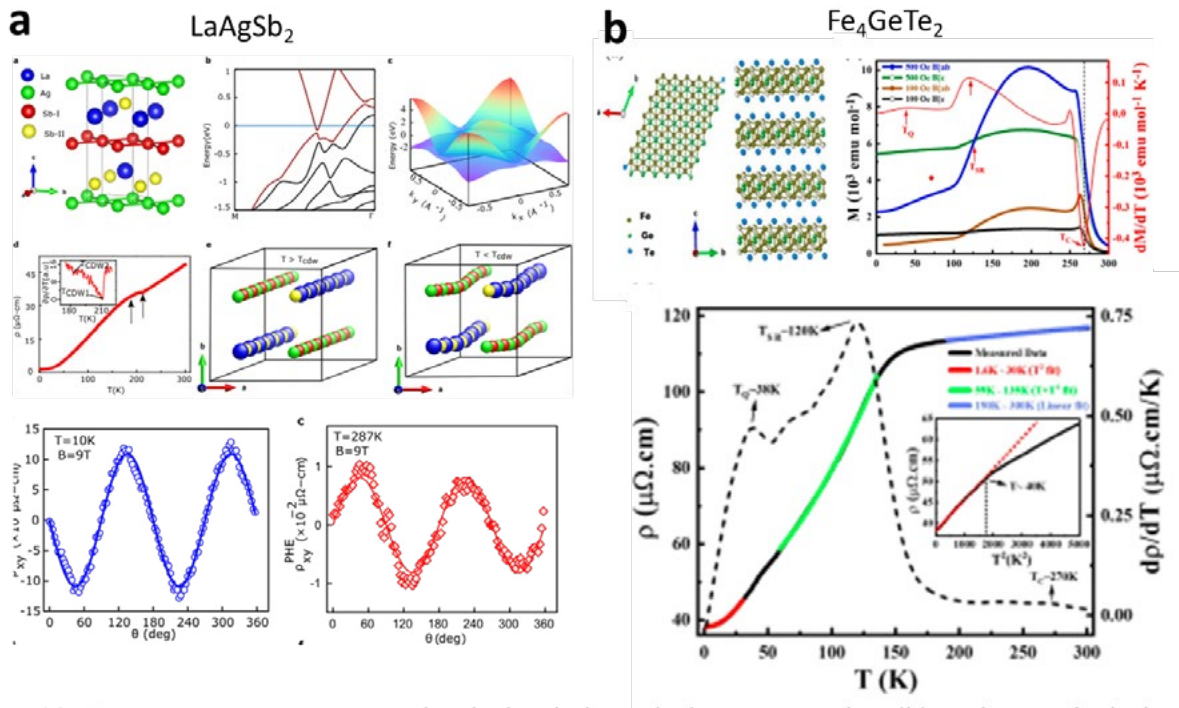
B. Optoelectronics with 2D materials: We have published new experimental results in graphene/ TMD based photodetector by using alloys of MoS2xSe2(1-x) showing the role of deep level defects on photodetector performance (ACSAMI, 2022). Furthermore, we have been able to tune the Exciton-Plasmon Coupling can in a 2D Hybrid Phototransistors providing superior photoresponse (arXiv:2303.06692). Mr. Shubhrsish Mukherjee was ready to submit his thesis working in this area.

C. Transport through 2D ferromagnet: We have started exploring the transport properties of van der Waal ferromagnet. The magnetotransport behavior in Fe4GeTe2 system having two magnetic transitions, exhibits unusual electronic transitions leading to distinct transport behavior (arXiv:2303.07440).

D. Transport through emerging quantum materials: In another study, we have observed significant planar Hall effect in a semi-Dirac metal, LaAgSb2, possessing charge density wave. Further theoretical calculations show that the sign change might be associated with a nontrivial topological transition (submitted).



(a) Unusual temperature dependent conductance in Au/Ferrocene/Au junction, arising due to temperature induced ring rotation effect in Ferrocene. (b) Sensitivity of mechanical Gating effect on the orientation of the molecule, probed by the high bias differential conductance measurement.



(a) Transport measurements and calculated theoretical structures describing the topological transitions driven by the CDW transition in $LaAgSb_2$. (b) Temperature dependent resistivity in Fe4GeTe2 exhibiting different scattering mechanism in different temperature regime. .

Plan of Future Work Including Project

1. Transport through Single molecular junction: We have already shown that Ferrocene is a promising organometallic molecule for single molecular junction. Hence, studying more functional molecule to understand the metal-metal interaction in a molecular junction will be one of our future goals. We are in the process of developing shot noise measurement to understand the number of conduction channels. As per the SERB CRG project, we plan to investigate the effect of the asymmetry of the molecule and the presence of a dipole moment along the molecule on the electronic transport properties of this highly conductive molecular junction. We will compare the conductance of two isomeric molecules, the symmetric and asymmetric molecules by attaching the molecules directly to metallic electrodes with no anchoring side groups. Understanding the dependence between structure and conductance will help us to learn how to control conductance in the atomic scale.
2. Optoelectronics with van der Waal hybrid: We have already shown the tunability of light matter interaction in TMD nanostructure to get superior photo-response. We would like to focus further to tune the light matter interaction in different hybrid. Also, we will focus on magnetic 2D heterostructure to see the effect of spin and magnetic anisotropy on photo-response.
3. Proximity induced effect in quasi-two dimensional heterostructure: We have received the grant for the Thematic unit of Excellence - Quantum materials, Nanomission, DST: CONsortium for Collective and Engineered Phenomena in Topology (CONCEPT). In this proposal we wish to explore two-dimensional heterostructure based on 2D magnetic materials for spintronic application. Also, we plan to investigate triplet Cooper pair proximity effects in a variety of superconductor-ferromagnet (S-F) hybrid systems. The interface between superconductors (S) and ferromagnets (F) can offer the opportunity to find a new class of superconducting spintronic devices. We have already started optimizing the heterostructure fabrication. An optical cryostat will be procured for this purpose.
4. Understanding new quantum phases: We plan to investigate quantum phases of emerging quantum materials like TaS2, 2D Tellurene and the 2D ferromagnets (F4GT) in more details.

Avijit Chowdhury

Assistant Professor
Condensed Matter and Materials Physics
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Anupriya Nyayban; Theoretical studies on the Rb-based all inorganic halides toward photovoltaic applications; Awarded; Subhasis Panda, Department of Physics, NIT Silchar, Assam (Co-supervisor)
2. Nipom Sekhar Das; Organic-Inorganic Layered Nanohybrid Dispersed Ferroelectric Polymer Blend For Bipolar Analog Memristors; Under progress; Asim Roy, Department of Physics, NIT Silchar, Assam (Co-supervisor)
3. 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)
4. Saikat Mitra; Hallide perovskite for optoelectronic applications; Under progress; Barnali Ghosh (Saha) (Co-supervisor)
5. Swapnamay Paramanik; Solar Photocatalysis for dye degradation and H2 evolution; Under progress
6. Rajesh Jana; 2D materials for optoelectronic synaptic devices; Under progress
7. Mukul Biswas; 2D material based triboelectric nanogenerator; Under progress

b) Post-Docs

1. Ritamay Bhunia (PDRA III); Artificial Optic-Synaptic Organ for Different Colored Long-Time Perception
2. Didhiti Bhattacharya (Bridge Fellow); Triboelectric and piezoelectric nanogenerator

c) External Project Students / Summer Training

1. Sagnik Ghosh; 2D Materials-based Devices for Optoelectronic Synapses: A Review
2. Gaurab Samanta; Synthesis and Characterization of Two dimensional Transition Metal Dichalcogenides by Chemical Vapour Deposition

Teaching

1. Spring semester; Electronics & Instrumentation (PHY408); Integrated PhD; 11 students; Kalyan Mandal (Co-teacher)
2. Spring semester; Basic Laboratory II (PHY492); Integrated PhD; 11 students; Kalyan Mandal (Co-teacher)

Publications

a) In journals

1. Suma Das, Trinayana Deka, Pujita Ningthoukhangjam, **Avijit Chowdhury**, Ranjith G. Nair, *A critical review on prospects and challenges of metal-oxide embedded g-C_3N_4-based direct Z-scheme photocatalysts for water splitting and environmental remediation*, Applied Surface Science Advances, 11, 100273, 2022
2. Nipom Sekhar Das, Saikat Mitra, **Avijit Chowdhury** and Asim Roy, *Nonvolatile Memristive Devices Based on In Situ Functionalized Layered rGO-MoS_2 Nanocomposites*, ECS Journal of Solid State Science and Technology, 11, 071003, 2022

3. Anupriya Nyayban, Subhasis Panda, **Avijit Chowdhury**, *The effect of B-site alloying on the electronic and opto-electronic properties of $RbPbI_3$: A DFT study*, Physica B: Condensed Matter, 649, 414384, 2023
4. Suma Das, Soumik Das, Ranjith G. Nair, **Avijit Chowdhury**, *Magnetically separable $ZnFe_2O_4$ grafted g-C_3N_4/rGO ternary nanocomposites for enhanced photo-Fenton catalytic activity under visible light*, Materials Today Sustainability, 21, 100263, 2023
5. Anupriya Nyayban, Subhasis Panda and **Avijit Chowdhury**, *Theoretical Study of Bromide Mixed-$RbPbI_3$ Towards Optoelectronic Applications*, Journal of Electronic Materials, 52, 3146, 2023

b) Conference proceedings / Reports / Monographs / Books

1. N S Das, K K Gogoi, A Chowdhury, A Roy, Investigation of optical and structural properties of synthesized graphene oxide and thermally reduced graphene oxide, Materials Today: Proceedings 76 (2023) 160–165
2. N S Das, N K Das, A Chowdhury, A Roy, Electrical studies of thermally annealed reduced graphene oxide polymer nanocomposites, Materials Today: Proceedings 74 (2023) 329–333

Talks / Seminars Delivered in reputed conference / institutions

1. Layered Nanohybrid Embedded Polymer Composites for Memristive Applications; Mar 20, 2023; Gurucharan College Silchar; 1h

Administrative duties

1. Theoretical Physics Seminar Circuit: Member
2. Attendant Recruitment: Chairman
3. Bose Fest (27-29 April 2022): Judging 40 short talks and 30 posters deliver/ or presented by the students
4. Faculty In-charge of research/ teaching laboratories: i. CKM Laboratory: Jt. In-charge ii. Atomic Layer Deposition and Rapid Thermal Annealing: In-charge iii. TRC Chemical Laboratory: In-charge

Patents Taken and Process Developed with Details

1. A system for manufacturing paraffin-based PCM composites for latent thermal energy storage, Barman Pranjan, Bhagwat Virendra Vishnu, Chowdhury Avijit, Das Biplab, Das Nipom Sekhar, Debbarma Sumita; German Patent, File number DE: 20 2022 101 525.2; Granted

Awards, Recognitions, if any

1. Outstanding Reviewer award (2022), Materials Research Express, IOP Science
2. Outstanding Reviewer award (2022), Printable and Flexible Electronics, IOP Science

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 (File Number: CRG/2022/001145); DST-SERB; 3 Years (March 09, 2023- to date); PI

Conference / Symposia / Schools organized

1. Topical Research School on Current Trends in Theoretical and Experimental Physics; Mar 20, 2023; Department of Physics, G.C. College, Silchar; 04 days

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

1. Dr. Subhasis Panda, NIT Silchar, Assam, India; Sl. No. 3, 5; National
2. Prof. Asim Roy, NIT Silchar, Assam, India; Sl. No. 2; National
3. Dr. R G Nair, NIT Silchar, Assam, India; Sl. No. 1, 4; National

Outreach program organized / participated

1. Name: Academic Visit by the MSc students of Dhanamanjuri University, Imphal Duration: 02 days, 10-11 October 2022 Role: Coordinator Number of Participants MSc student: 16 Faculty: 03 Activities: The academic visit comprised scientific talks by research scholars, a telescopic view of planets and stars, a screening of a documentary movie on S. N. Bose, a visit to the experimental laboratories, and the S.N. Bose Archive, has been successfully conducted.

Areas of Research

Experimental Condensed Matter Physics and Materials Science

We propose ternary nanocomposites (TNCs) comprising layered functional materials with favorable band edge positions to suppress the photogenerated carrier recombination and augment photocatalytic performance by harnessing the entire UV-visible-near infrared broadband spectrum (Figure 1). A series of easily separable and recyclable g-C_3N_4/rGO/$ZnFe_2O_4$ (CNGZF) TNCs were developed by modulating the g-C_3N_4 mass fraction. The heterogeneous photo-Fenton performances of the TNCs were evaluated in the discoloration of methylene blue with/ or without H_2O_2 under visible light. The photocatalytic efficacy of TNCs with a mass ratio of 2:1:1 (i.e., 2-CNGZF) surpasses the individual merits of their counterparts, g-C_3N_4 and $ZnFe_2O_4$ by 11.08 and 2.91 times, respectively, and binary composite CNZF (g-C_3N_4/$ZnFe_2O_4$) by 2.34 times in dye degradation. The enhanced photocatalytic performances are corroborated by a large number of induced active sites, resulting from special dimension effects of the layered nanosheets, broadband absorption capabilities of the co-catalysts, and accelerated electron migration through the metallic counterparts. Electrochemical impedance spectroscopy measurements further confirm the lower interfacial charge transfer resistance and prolonged lifetime of electrons in the TNCs. Furthermore, the moderate magnetic properties of the co-catalysts ease the catalyst recovery process, exhibiting excellent stability and durability even after recycling up to four successive runs.

Heterostructures of two-dimensional (2D) layered materials, integrating two or more building blocks with complementing counterparts, can regulate the confinement and transportation of charge carriers via

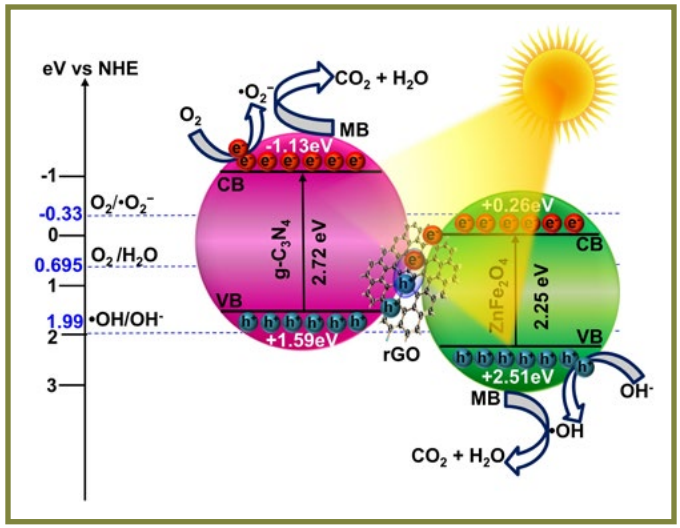

Figure 1 Schematic illustration of the photocatalytic degradation of methylene blue through Z-scheme charge transfer mechanism over the g-C_3N_4/rGO/$ZnFe_2O_4$ TNCs upon visible-light illumination.

vacancy-induced defect and interfacial states. Reduced graphene oxide-molybdenum disulfide (rGO-MoS_2) nanohybrid were fabricated and reinforced with various polymers [PMMA, PVDF, and PMMA-PVDF (20:80) blend] to study the resistive memory properties in a metal-insulator-metal configuration (Figure 2). The SEM analysis presents a hierarchical 3D flower-like MoS_2 intercalated with rGO nanosheets. TEM image exhibits MoS_2 nanoflakes well interspersed and grafted on layered rGO sheets, forming sandwich heterostructures. Raman analysis shows a higher I_D/I_G ratio for rGO-MoS_2 than rGO, demonstrating numerous defect states in rGO. The XRD analysis of the polymer blend containing rGO-MoS_2 exhibits β-crystal phases with a polarity-dependent

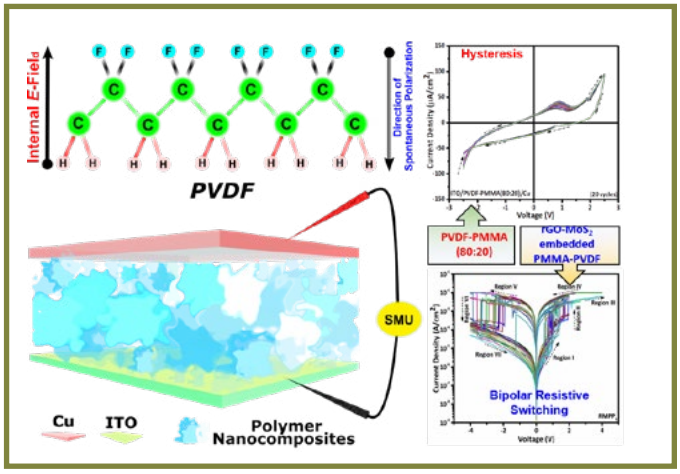

Figure 2 Chemical structure of PVDF showing ferroelectric effect, schematic device structure, and (c) J-V characteristics of polymer blend with or without nanofillers.

internal electric field (*E*-field). The J-V characteristics of pure MoS_2-polymer films display a WORM behavior with a current I_{ON}/I_{OFF} ratio of ~10^2-10^3, in contrast to pristine polymer films exhibiting repeatable electrical hysteresis. Instead, the rGO-MoS_2-based devices display bipolar characteristics (I_{ON}/I_{OFF} ratio of ~10^3-10^4) due to charge transfer interaction with the conductive carbon substrates. The ferroelectric polarization-induced *E*-field coupled with the external bias is responsible for the improved memristive performances. A plausible conduction mechanism is proposed to discuss the carrier transport through the devices.

Plan of Future Work Including Project

1. Memristive synaptic devices suffer from several drawbacks: limited bandwidth communication in storing and processing signals, poor data operation speed, low co-integration density, and high power consumption. Therefore, the synergy between the electrical and optical domains, taking overall advantage of the compact footprint, high bandwidth, and low communication energy, is the only way out for developing energy-efficient computing networks. Our future plan is to fabricate novel active layer-based memtransistors comprising a ferroelectric polymer blend/photoelectric 2D material hybrid system to take overall advantage of the footprints of the electrical and optical realms. The key functionalities of synapses and neurons will be emulated using the analog conduction response of the memtransistors, stimulated via a combination of electronic and photonic pulses. Eventually, the synergy between the electrical (compact footprint, high density) and optical (high bandwidth, low communication energy) domains will emulate the optoelectronic synapses with better energy efficiency and greater tunability.

Barnali Ghosh (Saha)

Scientist-F
Condensed Matter and Materials Physics
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Avisek Maity; "Synthesis, Characterization, Physical Property Studies & Applications of Perovskite Halide"; Thesis submitted
2. Parushottam Majhi; "Structure And Physical Properties Of Strained Metal Oxide Films"; Thesis submitted; Prof. A.K.Raychaudhuri (Co-supervisor)
3. Snehamoyee Hazra, TRC Project, Institute Fellowship since August, 2019; Investigation on Nanostructured Piezoelectric and Ferroelectric materials"; Thesis submitted
4. Sudipta Chatterjee, SERB project, Institute fellow since March 2021; Investigation On Transort And Magneto-Transport Properties of Transition Metal Based Oxides And Alloys; Under progress; Prof. Kalyan Mandal (Co-supervisor)
5. Saikat Mitra, SERB project, Institute fellowship since Jan 2022; Studies of Growth and Physical Properties of Perovskite Halides; Under progress; Dr. Avijit Chowdhury (Co-supervisor)
6. Chandan Samanta; "Synthesis, Physical Properties And Applications Of Metal Oxide Semiconductor Nanostructures And Thin Films"; Awarded

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. Hareshbhai Rajubhai Jadav; Study of Growth, Characterization and Transport Property of La (Lanthanum) doped $NdNiO_3$ Nanostructures
2. Deblina Das; Controlled Growth of 1D Barium Titanate Nanostructures And Study of Their Physical Properties

Teaching

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

Publications

a) In journals

1. Snehamoyee Hazra, Ankita Ghatak, Arnab Ghosh, Subhamita Sengupta, A K Raychaudhuri and **Barnali Ghosh**, *Enhanced piezoelectric response in BTO NWs-PVDF composite through tuning of polar phase content*, Nanotechnology, 34, 045405, 2022
2. Avisek Maity, Sudipta Chatterjee, Arup Kumar Raychaudhuri, and **Barnali Ghosh**, *Gated Photodetector with a Bipolar Response from Single-Crystal Halide Perovskite Using a Polymeric Electrolyte as the Gate Dielectric*, ACS Applied Electronic Materials, 4, 4298, 2022
3. Chandan Samanta, Ankita Ghatak, Arup Kumar Raychaudhuri, and **Barnali Ghosh**, *Surface/ Interface Defect Engineering on Charge Carrier Transport toward Broadband (UV-NIR)*

Photoresponse in the Heterostructure Array of p-Si NWs/ZnO Photodetector, ACS Applied Electronic Materials, 5, 865, 2023

4. Avisek Maity, Sohel Siraj, A K Raychaudhuri, Abhijit Saha and **Barnali Ghosh**, *Low power paper electronics based wearable radiation detector using hybrid halide perovskite ($MAPbBr_3$): A real time monitoring of gamma ray*, Flexible and Printed Electronics, 8, 015010, 2023
5. Sudipta Chatterjee, Jyotirmay Sau, Subrata Ghosh, Saheli Samanta, **Barnali Ghosh,** Manoranjan Kumar and Kalyan Mandal, *Anomalous Hall effect in topological Weyl and nodal-line semimetal Heusler compound Co_2Val*, Journal of Physics: Condensed Matter, 35, 035601, 2022
6. 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 Co_2CrGa, Physical Review B, 107, 125138, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Invited lecture in "DD Transitions: A Discussion Meeting on Electronic Structure of Materials", 5-7 August 2022; Aug 5, 2022; Longhuinos Beach Resort, Colva, Goa, India 5-7 August , 3 days
2. Invited lecture in Workshop on "Techno-commercial Assessment of TRL6 and above Technologies", Jointly organized by TIFAC, DSIR & CSIR-IICB on 23nd September 2022; Sep 23, 2022; CSIR-IICB, Kolkata; 23 September, one day

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 equipment s under Technical Cell
4. Garden and plumbing
5. Various thesis committee
6. Purchase committee
7. Committees related to TRC
8. Various evaluation committees
9. Interview committee
10. Member of Centre's Complaints Committee

Patents Taken and Process Developed with Details

1. Assignment of Deed of Technical Know-how on "Ammonia gas sensor (Visual colour change type)" developed by SNBNCBS, Kolkata has been duly executed on 2nd March 2023. Patent details: "We have invented a new simple technique to trace ammonia based on visual color change which works like pH papers on disposable basis. It is easy to grow in flexible substrate like, paper even in large area for enhance scalability in cost effective manner. Moreover is workable at room temperature with very high selectivity, sensitivity and exhibit very low detection limit down to ~10ppm. It acts as a quick and easy method to detect hazardous gases in work places. As a visual sensor to assess the immediate extent of danger of presence of the NH3 in an ambience, this is a desirable feature. If the concentration is low the sensor takes nearly 10 seconds to respond and this will not lead to detrimental exposure. On the other hand when the concentration is relatively high (~20-25ppm) and it approaches a danger level, the senor quickly turns color within 5 sec and gives a visual warning. For any operator in a hazardous environment this will give an immediate danger signal."; File no:201731000270, Grant no: 316234; Granted
2. "A gas Sensing System for selective detection of nitric oxide (NO) gas at room temperature": The present invention discloses a room-temperature operable, hand-held ZnO/p-Si NWs nitric oxide (NO) gas sensing system and a method for ingenious use of ZnO/p-Si NWs heterojunction. The present invention relates a quick and cheap methods for detection of hazardous gases in work places. The present invention is particularly adapted to exhibit long-lasting reusability, stability and perform the NO gas detection at room temperature and even in an open environment with extremely high sensitivity at least down to 500 ppb. Noise limited sensing resolution down to tens of ppb, in this invention, is indeed a major advancement towards utilization of the sensor in exhaled breath analysis for non-invasive

diagnosis of certain pulmonary diseases such as asthma, bronchitis, airflow limitation leading and chronic obstructive pulmonary disease (COPD). FER received and Hearing has been done in March 2023; 201731038036; Applied

Awards, Recognitions, if any

1. Received "Outstanding Women Researcher" in Condensed Matter Physics and Materials VIWA 2023, by Venus International foundation, India, Centre For Women Development, on 4th March 2023.
2. Received "Outstanding Scientist Award" in the International Conference for Award Winners in Engineering, Science, and Medicine INSO 2023, Pondicherry, India.
3. Received 2022 ACS Publication Peer Reviewer Certificate of Recognition & Appreciation.

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) Edited book series titled "Futuristic Trends in Chemical Material Sciences & Nano Technology"

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. CGCRI, Kolkata; Sl. No. 1, 2, 3, 4; National
2. UGC-DAE-CSR Kolkata; Sl. No. 4; 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

• Study of Photoresponse and gas sensing property in binary oxide hetero junction systems. • Growth and physical property study of perovskite lead halide • Synchrotron X-ray and Neutron diffraction study in complex oxides. • Paper electronic based device for gas sensing activity of perovskite halides • Study on paper electronic based Photo detector of perovskite halides • 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. • Fabrication of single nanowire device of complex oxide systems by using different lithographic techniques and transport measurement on single nanowire. • cross-sectional TEM study in binary and complex oxide nanowires, nanocrystals and thin films • Growth of high performance thin film transistors (TFT) and physical property study

1. Gated Photo detector with bi-polar Response from Single Crystal Halide Perovskite Using Polymeric Electrolyte as Gate Dielectric:

In this work, we show that a gated optical detector working in the visible wavelength region can be made on single-crystal halide perovskite methylammonium lead bromide ($CH_3NH_3PbBr_3$ or MAPB). A polymeric electrolyte (PEO/LiClO4) is used as the gate dielectric, which forms an electric double layer (EDL) at the electrolyte/MAPB interface, leading to high specific gate capacitance and enabling enhanced carrier induction at a low gate bias. The photoresponse of the detector can be enhanced significantly by a large factor (e.g., by a factor of 35) by a bias *Vg* of 10 V. The core gate operation is due to the field effect, and the detector shows the characteristics of a field effect transistor (FET) with bipolar nature, thereby operating with both polarities of the gate bias. This is enabled by the special feature of halide perovskites, that is,

they have appreciable mobility for both types of carriers. It is established that the enhancement of the detector current response occurs due to the synergy of carriers created by illumination as well as the gate when they are present simultaneously, which modifies the near-band-edge trap states close to valence band maxima (VBM) and conduction band minima (CBM) and enhances the carrier mobility. The proposed synergy mechanism is validated by the gate-induced enhancement of the photoluminescence (PL) emission intensity and narrowing of the emission line. One paper Published in ACS Appl. Electron. Mater. 9, 4298, 2022.

2. Enhanced piezoelectric response in BTO NWs-PVDF composite through tuning of polar phase content:

We have fabricated a flexible, environment friendly piezoelectric nanogenerator (PENG) based on the ferroelectric Polyvinylidene fluoride (PVDF) composite incorporated with Barium titanate (BaTiO3) nanowires (NWs) of piezoelectric coefficient d33=308 pmV^{-1}. The single-layered PENG can deliver output power density of 10 μWcm^{-2} and an output voltage of 2 V with a nominal mechanical load of 1 kPa. BaTiO3 (BTO) NWs of different concentrations were incorporated into PVDF to tune the polar phase content, internal resistance, and optimize the output power. We show that there exists a critical value of BTO NWs loading of 15 wt%, beyond which the piezoelectric energy harvesting characteristics of the PVDF nanocomposites decrease. The oxygen vacancies present in the BTO NWs surface attract the fluorine ions of PVDF chain and favour the formation of phase. Theenhanced value of dielectric constant and dielectric loss of BTO-PVDF samples in the low frequency region suggest strong interfacial polarization in the composite system. The fabricated PENG can charge a super-capacitor up to 4 V within 35 s. The origin of the high power output from the BTO (15 wt%)-PVDF composite is attributed to the combined effect of enhanced polar phase content, strong interfacial polarization, and reduced internal resistance. This study provides an effective pathway in enhancing the performance of BTO-PVDF based piezoelectric energy harvesters. One paper Published in Nanotechnology 34, 045405 , 2023

Plan of Future Work Including Project

Part A : Basic Research: i))Synthesis & optical properties, crystallographic structure microstructural study on Perovskite halide systems ii)Physics of Perovskite Oxides: understanding of growth, crystallographic and low temperature transport and magneto transport property iii) Optoelectronics property study on semiconductors iv) Growth and Physical property study on piezoelectric nanostructures iii) Study of interface physics of complex and binary Oxide thin films and multilayers B) Technology Driven Research: Under TRC Project 1) Gas Sensors & Energy devices: Commercialization of Technology developed to be completed i)Development of Hazards gas sensors: It works as visual as well as electrical sensing mode. It could have potential to detect sub ppm capability for real time practical usage will be useful. It is extremely useful for Environment protection as well as health care sector. Modification of prototypes is under process. ii) Development of Energy Devices: Portable power generation system as nanogenerator using piezoelectric nanostructures: publication: Nanotechnology 34 045405, 2023. iii) Development of Radiation detectors: A detector for real time quick monitoring of gamma radiation at work places as well as medical Sciences.

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
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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. J Sridhar Mohanty; Magnetocaloric effect; Under progress
2. Ishita Jana; Multiferroic materials; Under progress
3. Soham Saha; Electrochemical water splitting; Under progress
4. Saurav Sarkar; Magnetic nanostructures; Under progress
5. Anupam Gorai; Microwave properties of ferrites; Under progress
6. Swarnali Hait; Multiferroic materials; Under progress
7. Sudipta Chatterjee; Magnetic topological materials; Under progress; Dr. Barnali Ghosh (Co-supervisor)
8. Saheli Samanta; Magnetocaloric effect; Thesis submitted

b) Post-Docs

1. Mily Kundu; Magnetic topological materials
2. Alo Dutta; Microwave properties of oxide materials

Teaching

1. Spring semester; Electronics and Instrumentation (PHY 408); Integrated PhD; 11 students; Dr. Abhijit Chaudhuri (Co-teacher)
2. Spring semester; Basic Laboratory (PHY 492); Integrated PhD; 11 students; Dr. Abhijit Chaudhuri (Co-teacher)
3. Spring semester; Methods of Experimental Physics (PHY 592); Integrated PhD; Nitesh Kumar, Pradip S Panchule, and Ramkrishna Das (Co-teachers)
4. Spring semester; Magnetism and Superconductivity (PHY 516); Integrated PhD; 5 students; Ranjan Chaudhuri (Co-teacher)
5. Spring semester; Advanced Condensed Matter Physics I (PHY 616); PhD; 4 students; Ranjan Chaudhuri (Co-teacher)

Publications

a) In journals

1. Sudipta Chatterjee, Jyotirmay Sau, Subrata Ghosh, Saheli Samanta, Barnali Ghosh, Manoranjan Kumar and **Kalyan Mandal**, *Anomalous Hall effect in topological Weyl and nodal-line semimetal Heusler compound Co_2Val*, Journal of Physics: Condensed Matter, 35, 035601, 2022
2. Swarnali Hait and **Kalyan Mandal**, *Enhanced ferroelectric, dielectric and magnetodielectric properties of Ba and Y co-doped Bismuth Ferrite nanoparticles*, Physica B: Condensed Matter, 645, 414243, 2022
3. Saheli Samanta, Sudipta Chatterjee, Subrata Ghosh, and **Kalyan Mandal**, *Large reversible magnetocaloric effect and magnetoresistance by improving crystallographic compatibility condition in Ni(Co)-Mn-Ti all-d-metal Heusler alloys*, Physical Review Materials, 6, 094411, 2022

4. Subrata Ghosh, Saheli Samanta, J. Sridhar Mohanty, Jayee Sinha, **Kalyan Mandal**, *Giant room temperature magnetocaloric response in a* $(MnNiSi)_{1-x}(FeNiGa)_x$ *system*, Journal of Applied Physics, 132, 045001, 2022
5. Saheli Samanta, Subrata Ghosh, Sudipta Chatterjee, **Kalyan Mandal**, *Large magnetocaloric effect and magnetoresistance in Fe-Co doped* $Ni_{50-x}(FeCo)_xMn_{37}Ti_{13}$ *all-d-metal Heusler alloys*, Journal of Alloys and Compounds, 910, 164929, 2022
6. Dipanjan Maity, Debashish Pal, Keshab Karmakar, Rupali Rakshit, Gobinda Gopal Khan and **Kalyan Mandal**, *Dual co-catalysts activated hematite nanorods with low turn-on potential and enhanced charge collection for efficient solar water oxidation*, Nanotechnology, 33, 265402, 2022
7. Priyanka Saha, Rupali Rakshit, Anupam Gorai, Dipika Mandal & **Kalyan Mandal**, *Unusual dielectric properties of hollow magnesium ferrite nanospheres: a potential lightweight microwave absorber*, Journal of Materials Science, 57, 4569-4582, 2022

b) Conference proceedings / Reports / Monographs / Books

1. Swarnali Hait, Kalyan Mandal, "Enhancement of Curie temperature of gallium ferrite beyond room temperature by the formation of Ga0.8Fe1.2O3-Y3Fe5O12 composite", AIP Adv. 13 (2023). Conference Name and Details: MMM Conference, 31 October- 04 November 2022, Minneapolis, USA

Talks / Seminars Delivered in reputed conference / institutions

1. "Transition Metal Oxide Nanostructures: Novel properties and possible applications"; May 23, 2022; Microwave Division, Christian-Albrechts-Universität zu Kiel, Kiel, Germany; 1 hour
2. "Magnetism and Magnetic Materials: Bulk to Nano", at C K Majumdar Memorial Summer Workshop in Physics 2022; Jul 20, 2022; SNBNCBS, Salt Lake, Kolkata; 1 hour 15 minutes

Administrative duties

1. Vigilance Officer

Awards, Recognitions, if any

1. Two months (May-June 2022) fellowship for renewed research stay in Germany from Humboldt Foundation

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

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

1. Study of magnetostructural transitions and magnetocaloric effects in intermetallic compounds; SERB DST TARE; 3 years; Co-PI

Conference / Symposia / Schools organized

1. C K Majumdar Memorial Summer Workshop in Physics 2022 12 – 21 July 2022 at SNBNCBS, Salt Lake, Kolkata; Jul 12, 2022; SNBNCBS, Salt Lake, Kolkata; 10 days

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

1. Professor Gobinda Gopal Khan, Tripura Central University, Tripura, India on "Electrochemical water splitting"; Sl. No. 6; National

Areas of Research

Microwave properties of ferrites, Magnetocaloric effect, Electrochemical water splitting

1. Anomalous Hall effect in magnetic topological Heusler compounds:

Three-dimensional topological semimetals (TSMs), new gapless quantum states, have drawn special attention and considerable research activity in condensed matter physics in recent years because they exhibit fundamentally new physical phenomena with potential applications. Among the several

magnetic TSMs, Co2-based magnetic Heusler compounds have piqued the curiosity of researchers due to their high Curie temperature and tunable non-trivial topological characteristics. In our recent works (*PRB 107, 125138 (2023), JPCM 35, 035601 (2023)*), we have investigated the anomalous Hall effect (AHE) in different Co_2-based topological Heusler compounds and found that the AHE is dominated by the intrinsic Berry phase mechanism. We have also noticed that magnitude of AHE in these compounds largely depends on their band structure and the quasi particle (Nodal-line, Weyl or triple-point fermion) excitations present in the system. At present, we are now focusing on tuning these different non-trivial states to achieve large AHE in these compounds.

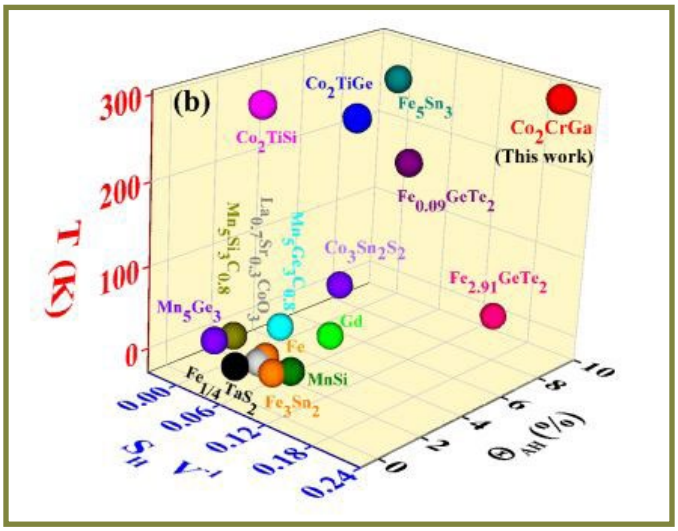

Figure: Anomalous Hall angle (AHA) and anomalous Hall factor (AHF) for Co_2CrGa are plotted as a function of temperature along with other reported metallic ferromagnets.

2. Large reversible magnetocaloric effect and magnetoresistance by improving crystallographic compatibility condition in Ni(Co)-Mn-Ti all-*d*-metal Heusler alloys

All-*d*-metal Ni(Co)-Mn-Ti Heusler systems are the research hotspot due to their magnetoresponsive effects and excellent mechanical properties for potential application. However, the presence of large thermal hysteresis acts as an obstacle to the cyclical operation of this novel material. In our recent work (Phy. Rev. Materials 6, 094411 (2022)), we investigated a large reversible magnetocaloric effect (MCE) and magnetoresistance (MR) near room temperature in $Ni_{37-x}Co_{13+x}Mn_{34.5}Ti_{15.5}$ all-*d*-metal Heusler alloys that undergo a first-order magnetostructural transformation accompanied by a large magnetization change between ferromagnetic austenite phase and antiferromagnetic martensite phases. We demonstrated that large MCE (magnetic entropy change, ΔS_M and adiabatic temperature change, ΔT_{ad}) becomes reversible under the field cycling by reducing hysteresis by crystallographic compatibility conditions between cubic austenite and monoclinic martensite phases and minor hysteresis loop. We are currently directing our attention towards the commercial application of reversible MCE and MR under a moderate magnetic field.

Plan of Future Work Including Project

1. The non-trivial states of magnetic topological Heusler compounds will be tuned to achieve large anomalous Hall effect in these compounds.
2. Since zinc ferrite (ZnFe2O4 or ZFO) can be prepared by easily available cost effective materials and ZFO nanorods are excellent for practical usage on a large scale as a photoanode, we have planned a simple doping technique to manufacture dense ZFO nanorods in this year with higher conductivity and carrier concentration. Efficiency of these nano rod will be further increased by an electrocatalyst over-layer. We also intend to investigate the thin film of gallium ferrite (GaFeO3) as a potential photoanode material. Heterojunction of ZnO nanowires with a variety of ferrite nano-hollowspheres will be prepared which should perform better than virgin ZnO.

Manoranjan Kumar

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Sk Saniur Rahaman; Quantum Phases in Quasi-One Dimensional Frustrated Spin Systems; Under progress; M Sanjay Kumar (Co-supervisor)
2. Monalisa Chatterjee; Topological aspect of Frustrated low dimensional Spin Systems; Under progress
3. Jyotirmoy Sau; Topology in Correlated Systems; Under progress
4. Manodip Routh; Thermal and quantum fluctuations in low dimensional strongly correlated systems; Under progress
5. Sayan Ghosh; Exploring the Quantum & Thermal Fluctuations in Frustrated Strongly Correlated Low Dimensional Systems; Under progress
6. Sourabh Saha; Study of exotic phases in multi-band correlated systems; Under progress
7. Anutosh Biswas; Spin-3/2 AKLT and normal Helsenberg model on a ladder geometry. Kitaev-Heisenberg interaction on Sustry-Sutherland stripe ladder; Under progress; Prof. Tanusri Saha Dasgupta (Co-supervisor)

b) Post-Docs

1. Sumit Halder; Principal component analysis to study the phase behaviour and phase transitions in several classical spin models and quantum systems using the data generated from the classical Monte Carlo and determinant quantum Monte Carlo methods
2. Sambunath Das; Ground state and low-energy excitations of spin-1 system on a Kitaev-Heisenberg ladder
3. Sourav Chakraborty; Investigation of different long range magnetic order within multiorbital Hubbard model

c) External Project Students / Summer Training

1. Sinchan S Rej; Exotic phase in the fustrated spin system

Teaching

1. Spring semester; Advanced Quantum Mechanics (PHY 303); Integrated PhD; 9 students; Dr. Arijit Halder (Co-teacher)

Publications

a) In journals

1. Gaurav K. Shukla, Jyotirmoy Sau, Vishal Kumar, **Manoranjan Kumar**, and Sanjay Singh, *Band splitting induced Berry flux and intrinsic anomalous Hall conductivity in the NiCoMnGa quaternary Heusler compound*, Physical Review B, 106, 045131, 2022
2. Vishal Kumar Aggarwal, Shaili Sett, Jyotirmoy Sau, Ankita Ghatak, **Manoranjan Kumar**, Achintya Singha, and A. K. Raychaudhuri, *Phonons and Thermal Properties of Ge Nanowires: A Raman Spectroscopy Investigation and Phonon Simulations*, The Journal of Physical Chemistry C, 126, 15046, 2022
3. Sudipta Chatterjee, Jyotirmay Sau, Subrata Ghosh, Saheli Samanta, Barnali Ghosh, **Manoranjan Kumar** and Kalyan Mandal, *Anomalous Hall effect*

in topological Weyl and nodal-line semimetal Heusler compound Co_2Val, Journal of Physics: Condensed Matter, 35, 035601, 2022

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 Co_2CrGa, Physical Review B, 107, 125138, 2023
5. Manodip Routh, Sudip Kumar Saha, Manoranjan Kumar, and Zoltán G. Soos, *Spin-Peierls transition of J_1–J_2 and extended models with ferromagnetic J_1: Sublattice dimerization and thermodynamics of zigzag chains in β–$TeVO_4$,* Physical Review B, 105, 235109, 2022
6. Sudip Kumar Saha, Debasmita Maiti, **Manoranjan Kumar** and Zoltan G. Soos, *Density matrix renormalization group approach to the low temperature thermodynamics of correlated 1D fermionic models*, Journal of Magnetism and Magnetic Materials, 552, 169150, 2022
7. Anup Kumar Bera, S. M. Yusuf, Sudip Kumar Saha, **Manoranjan Kumar**, David Voneshen, Yurii Skourski & Sergei A. Zvyagin, *Emergent many-body composite excitations of interacting spin-1/2 trimers*, Nature Communications, 13, 6888, 2022
8. Sambunath Das, Dayasindhu Dey, S. Ramasesha & **Manoranjan Kumar**, *Quantum phase transition in skewed ladders: an entanglement entropy and fidelity study*, The European Physical Journal B, 95, 147, 2022
9. Monalisa Chatterjee, Debasmita Maiti, **Manoranjan Kumar**, *Quantum Phase Diagram of a Frustrated Spin-1/2 Ferro-Antiferromagnetic Normal Ladder*, ChemPhysChem, 24(5), e202200538, 2023
10. Debasmita Maiti, Dayasindhu Dey and **Manoranjan Kumar**, *Study of Interacting Heisenberg Antiferromagnet Spin-1/2 and 1 Chains*, Condensed Matter, 8(1), 17, 2023
11. Sk Saniur Rahaman, Sumit Haldar and **Manoranjan Kumar**, *Machine learning approach to study quantum phase transitions of a frustrated one dimensional spin-1/2 system*, Journal of Physics: Condensed Matter, 35, 115603, 2023
12. Shovan Dan, Binita Mondal, Sudip Kumar Saha, Sudipta Mondal, R. Ranganathan, **Manoranjan Kumar**, and Chandan Mazumdar, *Similar and Dissimilar Properties of Polymorphic Phases of $NdIr_3$*, The Journal of Physical Chemistry C, 126, 16514, 2022
13. Dayasindhu Dey, Aslam Parvej, Sambunath Das, Sudip Kumar Saha, **Manoranjan Kumar**, S Ramasesha & Zoltán G Soos, *Density matrix renormalization group (DMRG) for interacting spin chains and ladders*, Journal of Chemical Sciences, 135, 25, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Spins in Molecular Systems (SIMS - 2022); Dec 2, 2022; IISc Bangalore; 3 days
2. 2nd Asian Conference on Molecular Magnetism (ACMM - 2022); Dec 6, 2022; IISER Bhopal; 4 days
3. Modern Trends in Molecular Magnetism (MTMM - 2022); Dec 11, 2022; IIT Kharagpur; 4 days
4. Invited speaker in Huazhong University of Science and Technology, China; Dec 7, 2022; HUST, China; 1 day (online mode)
5. Correlated and Driven Quantum Matters, IACS, Kolkata; Jan 17, 2023; Correlated and Driven Quantum Matters, IACS, Kolkata; 3 days
6. Physics of Strongly Correlated Electron Systems (PSCES) 2023, IISER Pune; Mar 15, 2023; Physics of Strongly Correlated Electron Systems (PSCES) 2023, IISER Pune; 3 days

Administrative duties

1. Hostel Warden
2. Member of computer centre working committee
3. Member of library purchase committee
4. Member of VASP
5. Jest coordinator from S. N. Bose National Centre for Basic Sciences, Kolkata

Awards, Recognitions, if any

1. Best reviewer award for Pramana

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. International Conference on the Topology in Condensed Matter Systems (ICTCMS - 2022); Feb 21, 2022; SNBNCBS, Kolkata; 3 days
2. APCTP-IACS-SNBNCBS Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization; Nov 17, 2022; SNBNCBS and IACS, Kolkata; 9 days
3. Theoretical Chemistry Meetings: Structure and Dynamics (TCMSD-2022); May 26, 2022; SNBNCBS and IACS, Kolkata; 4 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; International
4. Dr. Satoshi Nishimoto, Institute for Theoretical Solid State Physics,IFW Dresden; International
5. Arup Kumar Raychaudhuri, CSIR- Central Glass and Ceramic Research Institute, Kolkata; National
6. Sanjay Singh, Indian Institute of Technology, BHU; National
7. SM Yusuf, Bhabha Atomic Research Centre, India; National
8. Anup Kumar Bera, Bhabha Atomic Research Centre, India; National
9. Tanusri Saha Dasgupta, S.N. Bose National Centre for Basic Sciences, Kolkata; National
10. Nitesh Kumar, S.N. Bose National Centre for Basic Sciences, Kolkata; National
11. Kalyan Mandal, S.N. Bose National Centre for Basic Sciences, Kolkata; National
12. Suryanarayanasastry Ramasesha, Indian Institute of Science, Bangalore; National
13. Chandan Mazumdar, Saha Institute of Nuclear Physics, Kolkata; National
14. S R Hasan, Institute of Mathematical Science, Chennai; National

Outreach program organized / participated

1. Organizer of colloquium series ("Quantum materials and devices") by distinguished scientists around the world

Plan of Future Work Including Project

1. Frustrated magnetism has been a frontier area of research in condensed matter research, and these systems host varieties of exotic phase. These systems has experienced a tremendous push on both theoretical and experimental fronts since couple of decades. The exotic quantum phases like spin liquid phase, the dimer phase, the vector chiral phase, multipolar phase have unique feature and may be exploited for various technological applications. Recently, kagome lattice, a corner sharing triangle type of structure, is a highly promising material with geometrically frustration, Shastri-Shutherland lattice with ferromagnetic exchange interaction is another interesting system and exhibits many interesting quantum phases. Our group is also interested in topological aspect of low dimensional frustrated magnetic systems. The competition between the thermal and quantum fluctuations are another area of research interest.
2. The Kitaev-Heisenberg model has emerged as a paradigmatic system to investigate the interplay between quantum magnetism and topological order. This model describes a lattice composed of spin-1/2 moments arranged in a ladder geometry, where both Kitaev and Heisenberg exchange interactions are present. The Kitaev term introduces a topological aspect, leading to the formation of Majorana fermions and exotic excitations, while the Heisenberg interaction governs the conventional magnetic ordering. This research aims to explore the intriguing properties and phase transitions exhibited by Kitaev-Heisenberg spin ladders, shedding light on their unique quantum behavior.

Nitesh Kumar

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Banik Rai; Electronic properties and anomalous transport properties of stuffed van der Waals compounds; Under progress
2. Arunanshu Panda; Tree dimensional quantum anomalous Hall effect in layered ferromagnets; Under progress
3. Anyesh Saraswati; Non-linear Hall effect in charge density wave systems; Under progress

b) Post-Docs

1. Mahima Singh; Single crystals growth of layered ferromagnets and their transport properties
2. Mayukh Ray; Electrical transport properties of stuffed $NbSe_2$ compounds

c) External Project Students / Summer Training

1. Anshuman Sahoo; Single crystal growth of Ni-doped Fe_3Sn_2 single crystals and its magnetic properties

Teaching

1. Autumn semester; Condensed Matter Physics, PHY302; Integrated PhD; 18 students; with Prabhat Mandal (Co-teacher)
2. Spring semester; Methods of Experimental Physics, PHY491; Integrated PhD; 9 students; with Kalyan Mandal, Ramkrishna Das, and Pradip S Pachfule (Co-teachers)

Publications

a) In journals

1. K. Manna, **N. Kumar**, S. Chattopadhyay, J. Noky, M. Yao, J. Park, T. Förster, M. Uhlarz, T. Chakraborty, B. V. Schwarze, J. Hornung, V. N. Strocov, H. Borrmann, C. Shekhar, Y. Sun, J. Wosnitza, C. Felser, and J. Gooth, *Three-dimensional quasiquantized Hall insulator phase in* $SrSi_2$, Physical Review B, 106, L041113, 2022
2. 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 Co_2CrGa, Physical Review B, 107, 125138, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Recent Trends in Condensed Matter Physics 2023; Jan 12, 2023; IACS, Kolkata; 45 min

Administrative duties

1. Member of Conferences, Workshops and Extension Programme
2. Media Cell Committee
3. Member of Website Design and Maintenance Committee
4. Member of Disposal of Hazardous Chemicals Committee
5. Member of Hindi Cell
6. Member of Poster for research activities of Campus Committee

Awards, Recognitions, if any

1. Selected as a leader to lead a Max Planck-India Partner Group for 5 years with a total funding of 100000 euros

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

1. From three-dimensional to two-dimensional quantum anomalous Hall effect in ferromagnetic topological quantum materials; DST, SERB, CRG; 3 years; PI
2. Novel quantum states in quasi-one-dimensional materials; Max Planck-India Partner Group; 5 years; PI
3. Search for Novel Magnetic and Topological Materials; DST, DST-RSF joint Project; 3 years; Co-PI

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

1. Prof. Claudia Felser, Max Planck Institute for Chemical Physics of Solids, Dresden, Germany; Sl. No. 1; International
2. Dr. Kaustuv Manna, IIT Delhi; Sl. No. 1; National

Areas of Research

Single crystal growth of quantum materials and investigation of their electronic properties

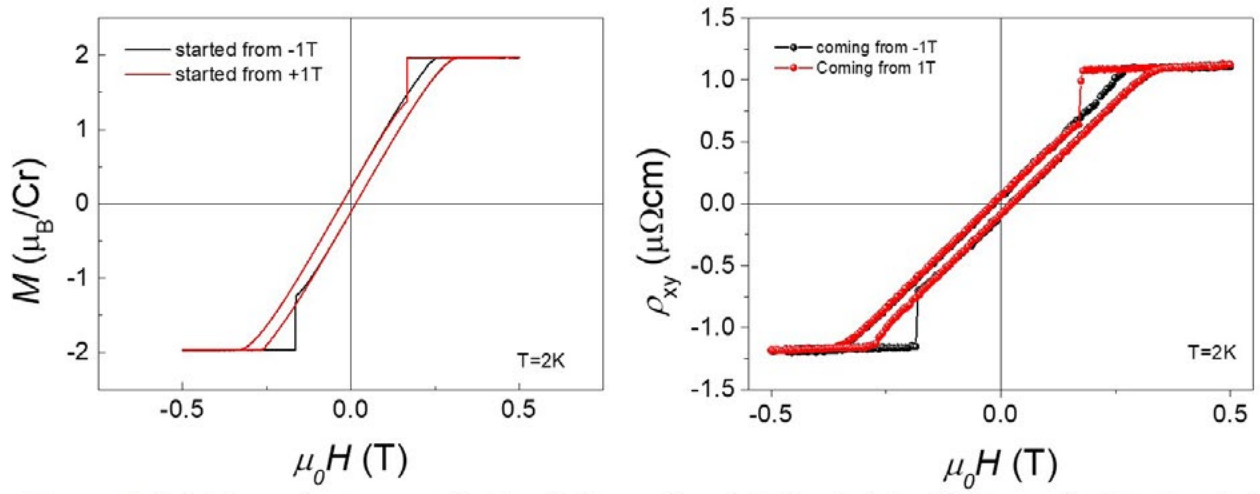
Our research has been based on identifying interesting topological materials, growing their single crystals and measure their bulk magnetotransport properties in order to understand the electronic properties. For this we also take advantage of various spectroscopic techniques, microscopic techniques, neutron diffraction measurements and theoretical calculations in collaboration.

We have studied magnetic and transport properties on the bulk sample of the quasi-two-dimensional (2D) ferromagnet tr-Cr_5Te_8. The single crystals have been grown by self flux. We performed Lorentz transmission electron microscopy (LTEM) experiments in collaboration with Prof. Stuart Parkin, wherein we observed Neel-type skyrmions in our compound. Through various arguments, we established the fact that the compound crystallizes in the non-centrosymmetric space group *P*3*m*1 instead of the previously reported centrosymmetric *P*-3*m*1. We also observed hump-like features in the Hall resistivity curve which has not seen studied in detail in this compound. We find that the hump is highly dependent on the magnetic history and does not represent the presence of topological Hall effect.

We studied the transport properties of single crystals of ZnMnSb, a layered ferromagnet. Having the space group *P4/nmm,* Mn atoms form magnetic square net in ab-plane and they are separated by nonmagnetic Zn and Sb layers along c- direction. It has a ferromagnetic transition at about 298 K. The transport and magnetic measurement indicates that though it shows anomalous Hall effect (AHE), it does not satisfy any of the mechanism which are previously reported. The temperature-dependent resistivity data shows semiconducting nature, which is counterintuitive which is not commensurate with the fact that the system shown finite AHE. The electronic band structure calculation shows conducting nature.

We undertook a systematic investigation of the anomalous Hall effect (AHE) in the ferromagnetic Heusler compound Co_2CrGa using combined experimental and theoretical studies (in collaboration with department colleagues Prof. Kalyan Mandal and Prof. Manoranjan Kumar). The anomalous Hall resistivit is observed to scale near quadratically with the longitudinal resistivity, and further experimental analysis suggests that the AHE in Co_2CrGa is dominated by the intrinsic Karplus-Luttinger (KL) Berry phase mechanism. Experimental results also reveal that the anomalous Hall conductivity (AHC) is as large as ~ 569 S/cm at 10 K with an intrinsic contribution of ~ 526 S/cm and the observed AHC is nearly temperature independent. In addition to the large AHC, we also found an exceptionally large anomalous Hall angle of ~ 8.5 % and a large anomalous Hall factor of ~ 0.23 V^{-1} at room temperature.

In collaboration with Prof. Manoranjan Kumar, we performed a comparative study of the electronic structure of FenGeTe2 (n = 3, 4, 5) to understand their topological properties and transport properties using the first-principles calculations. All three systems show ferromagnetic behaviour and the contribution of various Fe d-orbitals are also studied. In the presence of spin-orbit coupling (SOC), the TRS breaking lifts the degeneracy, leading to a finite Berry curvature (BC). Finite Berry Curvature (BC) contributes to the intrinsic anomalous hall conductivity (AHC) and Nernst conductivity (ANC) of these systems.



Magnetic field dependent magnetization (left panel) and Hall resistivity (right panel) of Cr_5Te_8 single crystal at 2K demonstrating that the hump is not a characteristic of topological Hall effect in this compound.

Plan of Future Work Including Project

1. Pressure is a clean tuning parameter to alter the electronic properties of quantum materials. It is especially important for topological quantum materials since many of such materials are at the verge of topological phase transitions. We will apply hydrostatic pressure by already acquired piston-based cell on single crystals of magnetic and nonmagnetic topological materials and perform magneto-transport measurements. Magnetic systems will include compounds with spin textures where pressure can be used as a tuning parameter to study the appearance or evolution of topological Hall effect, anomalous Hall effect etc. We are also in search of novel room temperature van der Waals materials and tuning there electronic properties with pressure will also be a part of our future studies.
2. We aim to systematically explore the various attributes of quasi-one dimensional systems in the single crystalline form by performing magneto-transport measurements, spectroscopic and theoretical studies. Few of the important aspects which will emerge of this project are novel axionic states by activating the sliding mode in CDW systems, spectroscopic evidence of cubic Dirac dispersion, quasi-quantization of Hall conductivity in bulk single crystals and violation of Wiedemann-Franz law.
3. The ever-increasing demand of energy especially from clean renewable sources, warrants a joint effort from various fronts such as chemistry, materials science and physics in order to identify new materials and understand the band structure is related to the mechanism of catalytic reactions. The field of electrochemical and photoelectrochemical water splitting can in particular get a boost if a systematic testing of topological systems, especially topological semimetals is carried out because of their large electronic mobility. In this project we will carry out the single crystal growth of topological semimetals, perform transport measurements to estimate electronic mobility and then ultimately test them for electrochemical and photoelectrochemical water splitting.
4. Using newly installed Bridgman furnace we will explore electronic properties of various intermetallic topological systems, single crystals of which are not possible to grow by traditional flux growth and CVT methods.

Prabhat Mandal

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Teaching

1. Fall; PHY302; Integrated Ph.D.; 18 students; Dr. Nitesh Kumar (Co-teacher)

Publications

a) In journals

1. Shubhankar Mishra, Aditi Sahoo, Suchanda Mondal, **Prabhat Mandal**, Chandan Kumar Ghosh, Dipten Bhattacharya, *Electric-field-driven resistive transition in multiferroic* $SrCo_2Fe_{16}O_{27}/Sr_3Co_2Fe_{24}O_{41}$ *composite*, Journal of Applied Physics, 131, 204101, 2022
2. Sudip Malick, Arup Ghosh, Chanchal K. Barman, Aftab Alam, Z. Hossain, **Prabhat Mandal**, and J. Nayak, *Weak antilocalization effect and triply degenerate state in Cu-doped CaAuAs*, Physical Review B, 105, 165105, 2022

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

1. Academic Collaboration with Dr. Dipten Bhattacharya of CGCRI, Kolkata, Prof. Z. Hossain of IIT Kanpur; Sl. No. 1 & 2; National

Areas of Research

Involved in setting up crystal growth facilities by molten flux and chemical vapor transport method. We have prepared several Dirac/Weyl and magnetic/CDW van der Waals vdW systems and investigated their magnetotransport and other physical properties. As a result of the strong interplay of magnetism and nontrivial electronic band structure, we have been able to observe several interesting novel phenomena.

We have studied the magnetic properties of $CrCl_3$ under pressure up to 2.5 GPa. On application of pressure the ground state of a $CrCl_3$ bulk single crystal changes from antiferromagnetic (AFM) to ferromagnetic (FM) above 1.1 GPa. Moreover, the saturation field along the easy magnetization axis *ab* plane, H_S^{ab}, reduces to half of the ambient pressure value as pressure exceeds a critical value $P_c \sim 0.9$ GPa. Besides this, the spin-flop field, H_{SF}^{ab}, continuously decreases and disappears above 1.1 GPa, confirming the absence of long-range AFM order at high pressure. Our results indicate a finite canting of Cr^{3+} spins from the *ab*-plane towards *c*-axis in the FM phase of $CrCl_3$. These results clearly suggest that by compression switching of the interlayer magnetic coupling as well as the control of out of plane spin-canting direction of $CrCl_3$ is achievable without changing the stacking order along the *c* axis. In itinerant van der Waals ferromagnet Fe_4GeTe_2 (FGT4), the magnetic and magnetotransport properties have been investigated as functions of temperature and magnetic fields. This vdW compound undergoes a continuous paramagnetic to FM phase transition below = 270.0 K and a pronounced spin reorientation transition at around $T_{SR} \sim 115$ K where the easy axis of magnetization changes its direction from in-plane to out-of-plane. The temperature evolution of magnetization in the FM state is highly anomalous and extremely sensitive to the direction and strength of applied magnetic field. Magnetic entropy change (ΔS) has been estimated in the vicinity of T_C and T_{SR}. ΔS

is found to be almost isotropic around T_C while it shows very unusual behavior and is sensitive to the direction of applied field at temperature close to T_{SR}. These results suggest complex nature of the magnetic ground state of FeGT4, which is possibly due to the presence of multiple inequivalent Fe sites, their ordering and complexity of spin configuration. We observe a very sharp change in several transport coefficients such as Hall resistivity, magnetoresistance near T_{SR} which has been attributed to Fermi surface reconstruction phenomenon due to an interplay between magnetism and band topology.

Magnetic materials with nontrivial spin structures have received considerable attention as they exhibit varieties of novel quantum phenomena. We have studied the detailed magnetic and magnetotransport properties of EuAuSb, an itinerant AFM with very low Néel temperature, T_N~3.5 K. The concomitant change in the field dependence of the electrical resistivity and that of the magnetization suggest that the charge conduction mechanism below and above the T_N is strongly influenced by the spin configuration of the Eu. Below T_N, both longitudinal magnetoresistance (LMR) and transverse magnetoresistance (TMR) are large and positive at low fields, while they are negative at high fields. The Shuvnikov-de Haas oscillation in TMR reveals two Fermi pockets with areas 6 and 12.8×10^{-3} $Å^{-2}$. The quantum oscillation has been analysed to determine several important physical parameters associated with the Fermi surface of EuAuSb.

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Prasun Boyal; Magnetic and topological properties of materials; Under progress
2. Debayan Mondal; Electronic and Structural properties of hybrid perovskites; Under progress
3. Krishnendu Patra; Electronic structure and metal-insulator transitions in transition metal compounds; Under progress
4. Shinjini Paul; Electronic structure of free-standing oxide films; Under progress
5. Sanuja Kumar Khuntia; ELectronic and optical properties of low-dimensional hybrid perovskites; Under progress
6. Shivam Jani; Electronic structure of superlattices of graphene and TMDCs; Under progress
7. Madhurita Das; Electronic structure of twisted bilayers of grapheme; Under progress
8. Shivam Mishra; Electronic and structural properties of semiconductor nanoplatelets; Under progress
9. Joydeep Chatterjee; Electronic, structural and optical properties of semiconductor heterostructures; Thesis submitted
10. Sumanti Patra; Electronic structure of twisted transition-metal dichalcogenide bilayers; Awarded

b) Post-Docs

1. Priyanka Garg; Energy materials
2. Sanjukta Paul; Twisted transition metal dichalcogenide bilayers
3. Bijoy Paul; Energy materials
4. Gargee Bhattacharya; CDW transitions; Topological materials

Publications

a) In journals

1. Sumanti Patra, Prasun Boyal, and **Priya Mahadevan**, *Electric-field-induced metal-semiconductor transitions in twisted bilayers of WSe_2*, Physical Review B, 107, L041104, 2023
2. Rejaul Sk, Debayan Mondal, Imrankhan Mulani, **Priya Mahadevan**, and Aparna Deshpande, *Emergent Negative Differential Resistance with an Undisturbed Topological Surface State*, The Journal of Physical Chemistry C, 126, 16744, 2022
3. Ranjan Kumar Patel, Krishnendu Patra, Shashank Kumar Ojha, Siddharth Kumar, Sagar Sarkar, Akash Saha, Nandana Bhattacharya, John W. Freeland, Jong-Woo Kim, Philip J. Ryan, **Priya Mahadevan** and Srimanta Middey, *Hole doping in a negative charge transfer insulator*, Communications Physics, 5, 216, 2022
4. Shishir K. Pandey, Ashis K. Nandy, Poonam Kumari, and **Priya Mahadevan**, *Microscopic origin of room-temperature ferromagnetism in the double perovskite Sr_2FeReO_6*, Physical Review B, 105, 214422, 2022

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk at Nanoseries (2022), a virtual meeting; Jun 29, 2022 ; online; 3 days
2. Invited talk at Discussion meeting on Electronic structure; Aug 6, 2022; Goa; 3 days
3. Invited talk at Asia Pacific Physics conference, APPC15; Aug 23, 2022; online; 5 days
4. Invited talk at NCES 2022; Nov 14, 2022; Goa University; 3 days
5. Perspective talk at APCTP-IACS-SNBNCBS Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization; Nov 19, 2022; SN Bose centre; 9 days
6. Invited talk at IUMRS-ICA 2023; Dec 21, 2022; IIT Jodhpur; 5 days
7. Invited talk at Emergent phenomena in van der Waal heterostructures; Jan 11, 2023; TIFR; 4 days
8. Invited talk at CARE; Feb 2, 2023; HRI; 3 days
9. Invited talk at CCMP 2023; Feb 6, 2023; PRL; 3 days
10. Invited talk at ICAM 2023; Feb 22, 2023; Goa University; 4 days
11. Invited talk at Perovskite Society of India meeting; Mar 1, 2023; IIT Roorkee; 3 days
12. Invited talk at Physics of strongly correlated electron systems meeting; Mar 16, 2023; IISER Pune; 3 days

Administrative duties

1. Head of the department of Condensed Matter and Materials Physics, Member Computer Services Advisory Cell, Member of various internal evaluation committees.
2. Member of various review committees of DST and SERB

Membership of Learned Societies

1. Member, American Physical Society
2. Fellow, Indian Academy of Sciences
3. Fellow, The World Academy of Sciences

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

1. Electronic structure of free standing membranes of transition metal oxides; SERB-POWER; 2021-2024; PI
2. Twistronics with transition metal dichalcogenides; SERB-IRPHA; 2020-2025; PI
3. Ab-initio search for topological Mott insulators; DST Internal division; 2021-2024; PI

Conference / Symposia / Schools organized

1. Focused meet on Quantum Materials; Jan 24, 2023; SN Bose centre; 1 day

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

1. With Aparna Deshpande of IISER Pune; Sl. No. 2; National
2. With Srimanta Middey, IISc Bangalore; Sl. No. 3; National

Outreach program organized / participated

1. Organiser and speaker at Indian Academy of Sciences workshop on Advanced topics in Condensed Matter Physics, Kongu Engineering college, May (2022)
2. Organiser and speaker at Science Academies Workshop on Magnetism at St. Dominik's college at Kanjirapally, January (2023).

Areas of Research

Electronic structure, magnetism, growth of thin films, energy materials

Recent studies on twisted bilayers of WSe2 at small angles have been seen to sustain zero resistive states in addition to insulating states emerging on doping holes into the valence band. Another interesting aspect that has emerged is the electric field tunability of the properties. While doping into a semiconductor hasn't usually led to exotic ground states, such phenomena are remniscent of

strongly correlated systems where the interplay between the charge, spin, orbital and lattice degrees of freedom lead to various types of ordering in the doped systems which are absent in the undoped parent compound. The large unit cells associated with the twisted structures have led to small Brillouin zones in them, and consequently one expects almost flat dispersionless bands, easily explaining their unusual behavior on doping.

In order to explain the electronic structure of these twisted bilayers, we factored into our description that these were van der Waals materials. This led us to use the labels of the untwisted limit to describe the electronic structure, while simultaneously examining the perturbation introduced by the twisting operation. This was carried out by projecting the eigenfunction for the twisted case onto the unrotated limit. This gives us a measure of the deviation due to the presence of the additional moire potential. We considered a twist angle of 3.48 degree which belongs to the regime in which unusual phenomena have been seen. In addition, we consider 19.03 degree which had a similar sized unit cell. Despite the unit cells being of similar dimensions, we found that at 19.03 degree the low energy electronic structure is mildly perturbed from the untwisted limit. At 3.48 degree, one has an almost flat band split off from a set of dispersive bands, similar to the untwisted limit. These results support a description of the electronic structure of the twisted bilayers as perturbations of the untwisted limit.

The interplay of the interlayer hopping interactions which dominantly contribute at Gamma and the spin-orbit interactions which dominantly contribute at K lead to the valence band maximum to lie at the symmetry point K for WSe2. In addition one finds that the W d{x^2-y^2}/ d{xy} orbitals contribute to the valence band maximum in contrast to Gamma point where one has the W d{z2} orbitals contributing. This leads to a much smaller interlayer hopping interaction between the layers than one had at Gamma point, leading to the energetics being controlled by zone boundary scattering. Projecting the eigenfunctions for the moire cell onto the untwisted limit, we find a pair of flat bands crossing, separated from a set of bands which are quite similar to the untwisted limit. These two crossing bands have been identified by following the charge density as well as plotting the bands along the primitive cell Gamma to K direction, considering equal weight at each point. It has been found that while one of the flat bands is localized on the lower layer, the other is localized on the upper layer. This allows for a modest external electric field to tune the electronic structure and separate the flat bands. This can explain the unusual electric field dependent semiconductor-metal-semiconductor transition that have been seen experimentally.

Plan of Future Work Including Project

1. We have been exploring correlated phenomena in topological materials as there have been predictions of exotic ground states being observed. As a start we have begun by looking at families of topological materials with a square net structure in them and examined their topological properties and the role of a charge density wave in them in determining the topological properties.
2. The role of the stacking on the electronic structure of twisted hombilayers of transition metal dichalcogenides will be examined.
3. We have been examining the phase diagram of freestanding oxide films under strain, electric field and other parameter subspaces.

Saquib Shamim

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Subhajit Mondal; Electrical transport in topological materials; Under progress

Teaching

1. Spring semester; Mesoscopic Physics; PhD; 8 students; with Dr. Atindra Nath Pal (Co-teacher)

Talks / Seminars Delivered in reputed conference / institutions

1. Recent trends in Condensed Matter Physics-2023; Jan 13, 2023; IACS, Kolkata; 45 mins

Administrative duties

1. Judge for the Bose Fest 2023

Conference / Symposia / Schools organized

1. APCTP-IACS-SNBNCBS Workshop on Computational Methods for Emergent Quantum Matter: From Theoretical Concepts to Experimental Realization; Nov 17, 2022; S. N. Bose National Centre for Basic Sciences, Kolkata; 9 days

Outreach program organized / participated

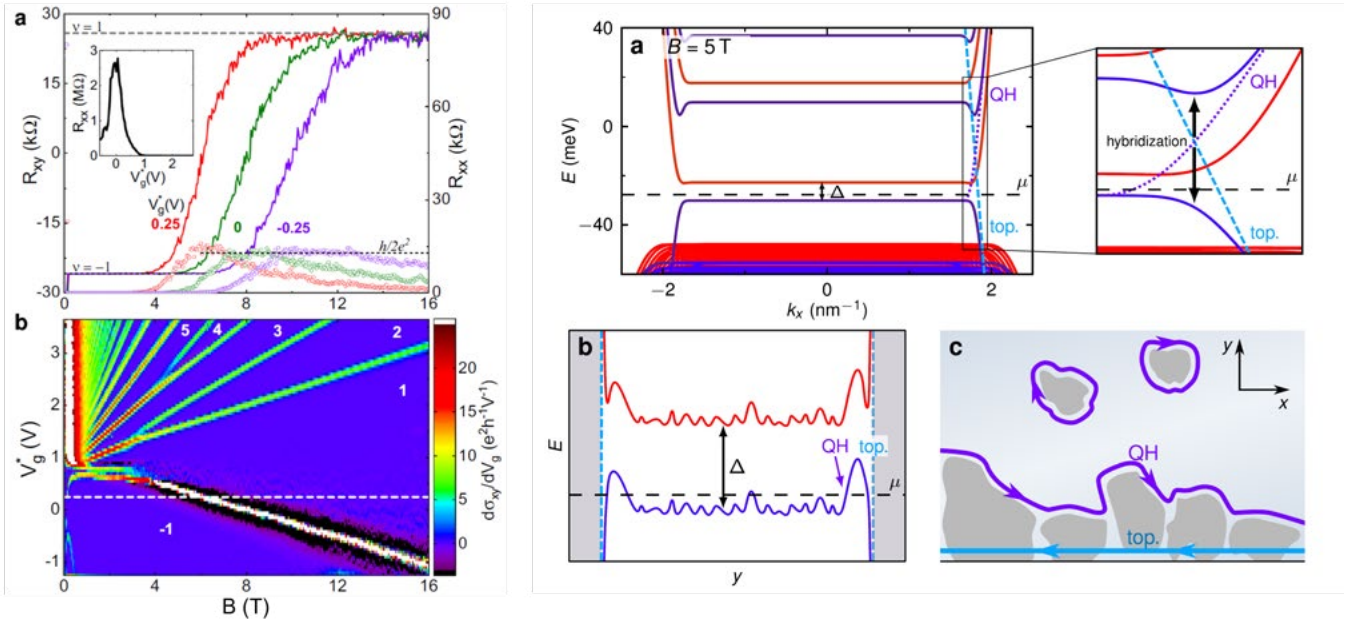
1. Delivered a talk at the 12th Vidyasagar Satyendra Nath Bose National Workshop on Advances in Physics: Theories & Applications (APTA-2023). The participants were mostly B.Sc. and M.Sc. students and the talk was prepared and delivered to initiate curiosity among the students so that they can be motivated to pursue research after their degrees. Joint Convener for the same workshop

Areas of Research

Experimental Condensed Matter Physics

The main research expertise of the group is in low-noise transport measurements at millikelvin temperatures in nano- and mesoscale devices made from various semiconducting materials including topological materials. We use lithographic techniques to fabricate mesoscopic devices from various quantum materials. We use these as tools to explore novel concepts in condensed matter physics. The current interest of the group is the physics of topological materials.

My previous work investigated the response of two-dimensional topological insulators in high perpendicular magnetic fields. Band structure calculations suggest that the inversion of Landau levels, due to which the quantum spin Hall effect was observed in the first place, is destroyed at a critical magnetic field leading to a trivial insulator with a band gap. However, experimentally we observe the absence of a trivial insulating gap in finite-size 2D topological insulators based on HgTe quantum wells. Instead, we observe that the topological edge channel (from the quantum spin Hall effect) coexists with a quantum Hall edge channel at magnetic fields at which the transition from topological to trivial insulator is expected to occur. This happens due to a suitable



potential landscape created by the charge puddles. Charge puddles are small regions of charge which contain bulk carriers. Growth defects, vacancies, and disorders due to various fabrication processes lead to an inhomogeneous potential landscape resulting in the formation of charge puddles when the gate voltage is used to tune the chemical potential into the bulk band gap as shown schematically. Devices fabricated using a novel wet-etch process which results in fewer charge puddles show the expected transition from topological to a trivial insulating state.

Plan of Future Work Including Project

1. Low-frequency noise spectroscopy of quantum materials: Electrically conducting materials are significant components of any device architecture or circuits. Hence it is of utmost importance that the noise characteristics are investigated, which in turn gives important information about the dynamics of the defects in the system. The physical phenomena which cause noise in many systems are also the ones that cause dephasing (for example two-level systems). Thus, our goal here would be to understand the correlation between noise and dephasing, the limitations introduced by the noise present in the system, and to come up with noise-reducing strategies, which may involve modification of the electrostatic environment of the charge carriers, crystallinity of the materials, reduction of defects via various growth techniques, optimization of contacts, etc.

2. Novel physics in van der Waals heterostructures: The research on stacking materials with different properties to create systems with desired functionalities has gained momentum in the last decade with several exciting results such as superconductivity and correlated states in magic-angle twisted bilayer graphene, etc. We plan to explore the possibilities of new atomically thin quantum spin Hall insulators in 1T′ phase of TMDCs as well as in graphene proximitized with high spin-orbit coupled material. We plan to study electrical and thermal transport in twisted bilayer graphene proximitized with high spin-orbit coupled material, where initial investigations have revealed broken symmetry states at half-integer band filling. Another interesting direction that we want to pursue is stack 2D materials with layered 2D magnets to realize Chern insulators and quantum spin liquids.

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Publications

a) In journals

1. Supriya Ghosal, Niladri Sekhar Mondal, **Suman Chowdhury**, Debnarayan Jana, *Two novel phases of germa-graphene: Prediction, electronic and transport applications*, Applied Surface Science, 614, 156107, 2023
2. Krishnanshu Basak, Mainak Ghosh, **Suman Chowdhury** and Debnarayan Jana, *Theoretical studies on electronic, magnetic and optical properties of two dimensional transition metal trihalides*, Journal of Physics: Condensed Matter, 35, 233001, 2023

Talks / Seminars Delivered in reputed conference / institutions

1. Invited talk (online) "Quantum Mechanical Modeling of Materials by Quantum Espresso (IWQMMM-2023)", organized by IEEE Nanocouncil PSIT Student Chapter; 15th -19th March 2023; Online; 30 mins

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

1. Exploration of Thermochromism in 2D transition-metal oxides; DST; 5 years; PI

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

1. Prof. Debnarayan Jana (Department of Physics, University of Calcutta); Sl. No. 1; National

Areas of Research

Carbon's ability to exist in various shapes in different dimensions has sparked interest among researchers globally. There exist various two-dimensional allotropic forms of carbon having diverse networks of rings and polygons. Many of them have intriguing properties that demand special attention. The successful experimental synthesis of Graphene has been able to create a new horizon in the field of material science research. Very soon it has turned out to be a revolutionary material of the post-silicon era. In 2010, a new carbon allotrope which is known as biphenylene network (BPN) has been theoretically predicted by Hudspeth et. al. In 2021 it has been experimentally synthesized by Fan et. al. This material has been found to be metallic in nature. Electronic properties of BPN can be tuned by making its one dimensional derivative. When BPN is functionalized with fluorine and chlorine, the system becomes semiconducting from metallic. The Poisson's ratio of BPN (0.26) is greater than that of graphene (0.15). In this research project, we are trying to predict nitrogen decorated BPN nanosheet. We have considered nitrogen as foreign element because it is the neighboring element of carbon in the periodic table. Therefore the lattice distortion is expected to be small due to the introduction of nitrogen atoms in the system. After analyzing the phonon modes, we have found that this system does not want to remain in its original planar form, rather it becomes corrugated. We have tried both pyrazine and pyrimidine configurations, but the pyrazine configuration has turned out to be the stable configuration.

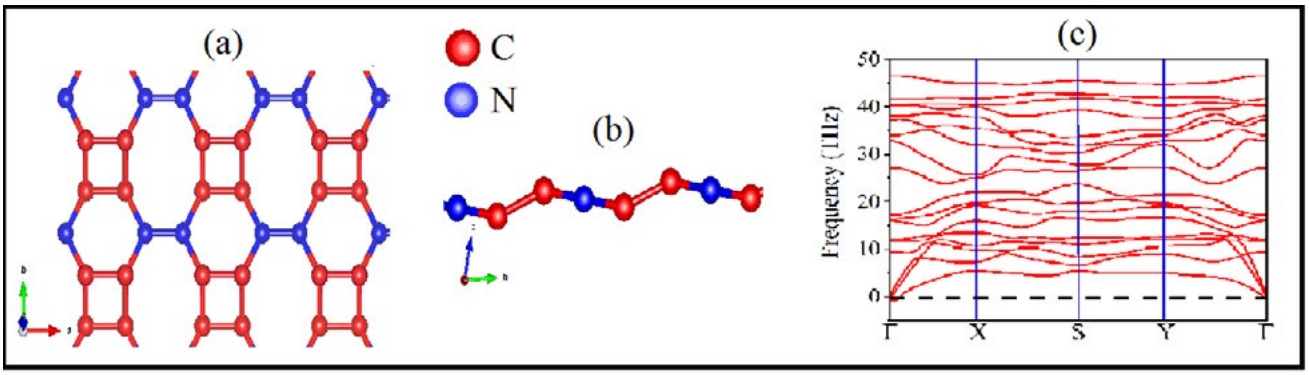

Figure : (a) Top view, (b) side view and (c) phonon band-structure of pyrazine configuration of nitrogen decorated BPN nanosheet.

Plan of Future Work Including Project

1. We have proved that nitrogen decorated BPN nanosheet in the pyrazine configuration is stable. Out next step is to study its electronic and thermal properties. The thermal part consists of the electronic part and the lattice part. The lattice part calculations are generally known to be computationally expensive. In this case, we will apply the machine learning interatomic potential approach. In this approach, the training data set will be generated by running ab-initio molecular dynamics simulation. After the potential gets trained, we will have both the second order and the third order force constants. Using these data as input, we can calculate the lattice part of the thermal conductivity by solving the Boltzman transport equation.

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Guidance of Students/Post-Docs/ Scientists

a) Ph.D. Students

1. Shiladitya Karmakar; First-principles study of technologically indigenous materials; Under progress
2. Samir Rom; Study of heterostructures; Under progress
3. Aishwaryo Ghosh; Application of machine learning in materials; Under progress
4. Manoj Gupta; Study of topological phases; Under progress
5. Koushil Pradhan; Correlated Electron systems; Under progress
6. Arnab Paul; Oxides; Under progress
7. Rajdeep Biswas; Computational Materials Physics, Quantum Materials, Magnetism, 2D materials, Topological properties; Under progress
8. Prosanta Sarkar; Physics under extreme condition; Under progress
9. Shreya Das; Electronic structure of oxides; Awarded

b) Post-Docs

1. Soumendu Datta; Nanomaterials
2. Arun Maurya; Correlated systems
3. Dipayan Sen; Hybrid materials
4. Aravindan V; Oxides

c) External Project Students / Summer Training

1. Priyank Tripathi; Electronic structure of cuprates

Publications

a) In journals

1. Aishwaryo Ghosh, Soumendu Datta, and **Tanusri Saha-Dasgupta**, *Understanding the Trend in Core-Shell Preferences for Bimetallic Nanoclusters: A Machine Learning Approach*, The Journal of Physical Chemistry C, 126, 6847, 2022
2. Hrishit Banerjee, Hermann Schnait, Markus Aichhorn, and **Tanusri Saha-Dasgupta**, *Effect of geometry on magnetism of Hund's metals: Case study of* $BaRuO_3$, Physical Review B, 105, 235106, 2022
3. Hermann Schnait, Daniel Bauernfeind, **Tanusri Saha-Dasgupta**, and Markus Aichhorn, *Small moments without long-range magnetic ordering in the zero-temperature ground state of the double perovskite iridate* Ba_2YIrO_6, Physical Review B, 106, 035132, 2022
4. Anna A. Vorobyova, Igor L. Danilovich, Igor V. Morozov, Alexander N. Vasiliev, Olga S. Volkova, Asif Iqbal, Badiur Rahaman and **Tanusri Saha-Dasgupta**, *Ising-like Magnetism in Quasi-Two-Dimensional* $Co(NO_3)_2{\cdot}2H_2O$, Materials, 15(20), 7066, 2022
5. Tilak Das, Swastika Chatterjee and **Tanusri Saha-Dasgupta**, *First-principles study of water incorporation in Fe-containing wadsleyite*, Physics of the Earth and Planetary Interiors, 333, 106940, 2022
6. A. Vorobyova, I. Danilovich, I. Morozov, Y.

Ovchenkov, A. Vasiliev, O. Volkova, A. Iqbal, B. Rahaman, **T. Saha-Dasgupta**, *Square lattice antiferromagnets (NO)M(NO_3)$_3$ (M = Co, Ni): Effects of anisotropy*, Journal of Alloys and Compounds, 929, 167197, 2022

7. Soumendu Datta, Aishwaryo Ghosh and **Tanusri Saha-Dasgupta**, *First principles insights into the relative stability, electronic and catalytic properties of core–shell, Janus and mixed structural patterns for bimetallic Pd–X nano-alloys (X = Co, Ni, Cu, Rh, Ag, Ir, Pt, Au)*, Physical Chemistry Chemical Physics, 25, 4667, 2023
8. Samir Rom, Santu Baidya, Subhro Bhattacharjee, and **Tanusri Saha-Dasgupta**, *Magnetism and unconventional topology in $LaCoO_3$/$SrIrO_3$ heterostructure*, Applied Physics Letters, 122, 021602, 2023
9. Payel Aich, Shreya Das, Shuvajit Halder, Carlo Meneghini, Desheng Fu, Vasudeva Siruguri, Som Datta Kaushik, Mitsuru Itoh, **Tanusri Saha-Dasgupta**, and Sugata Ray, *Fluorination-Induced Asymmetry in Vacancy-Ordered Brownmillerite: Route to Multiferroic Behavior*, Chemistry of Materials, 35, 991, 2023
10. Shiladitya Karmakar, Rajdeep Biswas, and **Tanusri Saha-Dasgupta**, *Giant Rashba effect and nonlinear anomalous Hall conductivity in a two-dimensional molybdenum-based Janus structure*, Physical Review B, 107, 075403, 2023
11. Dipanjan Mukherjee, Gulmi Chakraborty, Md. Nur Hasan, Uttam Pal, Priya Singh, Tatini Rakshit, Reem I. Alsantali, **Tanusri Saha Dasgupta**, Saleh A. Ahmed, Ranjan Das, Samir Kumar Pal, *Reversible photoswitching of spiropyran in biomolecular interfaces: A combined spectroscopy and computational study*, Journal of Photochemistry and Photobiology A: Chemistry, 430, 113958, 2022

b) Conference proceedings / Reports / Monographs / Books

1. Ordering of Fe2+ In Olivine Under Upper Mantle PT Conditions Z Gholami Mahmoodabadi, S Chatterjee, T Saha-Dasgupta AGU Fall Meeting Abstracts 2022, MR22A-0052

Talks / Seminars Delivered in reputed conference / institutions

1. ICAM, Goa University; Feb 20, 2023; ICAM, Goa University; 40 mins
2. Young Investigators Meet on Quantum Condensed Matter Theory; Oct 31, 2022; NISER, Bhubaneswar
3. International Workshop on Advanced Materials; Feb 18, 2023; RAK, UAE
4. Winter school; Dec 14, 2022; JNCASR
5. Lecture on 44th Foundation Day of IASST; Nov 2, 2022; IASST, Guwahati
6. Lecture at Hyderabad- NASI; Oct 6, 2022; lecture at Hyderabad- NASI

Administrative duties

1. Director

Awards, Recognitions, if any

1. Joined the Editorial Board of Physical Review B, featured in the Vigyan Vidushi book

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

1. J.C.Bose fellowship; SERB; 5 years; PI

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

1. Collaboration with M. Aichhorn, TU Graz, Austria; Sl. No. 2, 3; International
2. Collaboration with Moscow State Univ; Sl. No. 4,6; International
3. Collaboration with S. Chatterjee, IISER K; Sl. No. 5; National
4. Collaboration with S Bhattacharjee, ICTS; Sl. No. 8; National
5. Collaboration with S Ray, IACS; Sl. No. 9; National
6. Collaboration with S.K.Pal, SNB; Sl. No. 11; National

Outreach program organized / participated

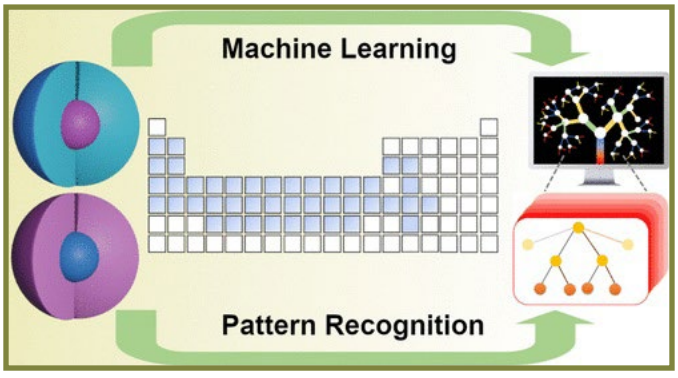
1. 12th Vidyasagar Satyendra Nath Bose National Workshop on "Advances in Physics: Theories & Applications (APTA-2023)" Venue: Vidyasagar University, Midnapore, WB Date: From 28.02.2023 to 02.03.2023

Areas of Research

Computational Materials Physics, Quantum Materials, Magnetism, 2D materials, Topological properties

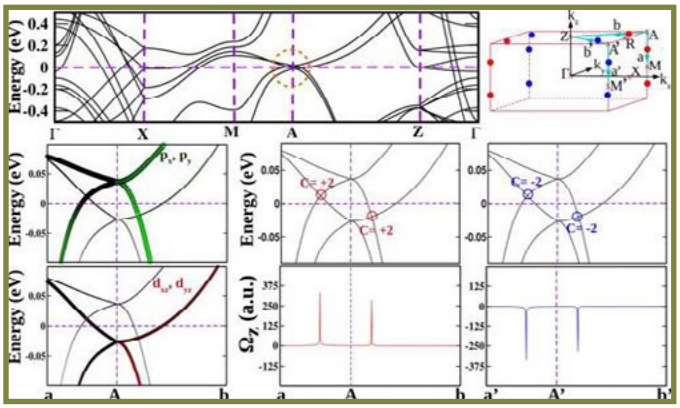
Understanding the Trend in Core–Shell Preferences for Bimetallic Nanoclusters: A Machine Learning Approach

Finding out the driving factors in core–shell preference of nanoscale binary metal alloys is important due to their ubiquitous presence in applications ranging from catalysis to biomedical. We consider binary-alloyed metallic nanoparticles encompassing a vast range of alkali, alkaline, basic, 3d, 4d, and 5d transition metals, and p-block metals and determine the core–shell preference by calculating the segregation energies of single-atom alloy clusters by density functional theory. Application of machine learning to this large database, built on features characterizing the constituents, leads to the identification of four key factors: (i) cohesive energy difference, (ii) atomic radius difference, (iii) coordination number difference, and (iv) magnetism, providing the core-to-shell preference of a given constituent. Interestingly, the relative importance of one key feature over another is found to be decided by the metal type. Our analysis also predicts that, for very small and very large differences of cohesive energy of the constituents, instead of core–shell structure, mixed and Janus structures are stabilized, respectively. Our exhaustive study will be useful in designing bimetallic nanoalloys with specific chemical ordering of the constituent species. (*J. Phys. Chem. C* 2022, 126, 15, 6847–6853)



Magnetism and unconventional topology in $LaCoO_3/SrIrO_3$ heterostructure

Employing first-principles calculations, we provide microscopic insights on the curious magnetic and topological properties of $LaCoO_3/SrIrO_3$ heterostructure, which has been recently synthesized [Kumar Jaiswal *et al.*, Adv. Mater. 34, 2109163 (2022)]. Our computational study unravels transfer of polar charge from $SrIrO_3$ to $LaCoO_3$, thereby reducing the Co valence from 3+ toward 2+, supporting the experimental findings. Our study further reveals the stabilization of the intermediate spin state of Co and strong ferromagnetic Co–Co coupling in the $LaCoO_3$ block of the heterostructure. This, in turn, is found to induce ferromagnetism in the pseudo-tetragonally structured $SrIrO_3$ in the heterostructure geometry, providing an understanding of the origin of magnetism, which is counter-intuitive as both $LaCoO_3$ and $SrIrO_3$ are nonmagnetic in bulk form. Most interestingly, the band structure of ferromagnetic, tetragonal structured $SrIrO_3$ is found to exhibit unconventional topology, manifested as $C = 2$ double Weyl points, which leads to the observed anomalous Hall effect. Our finding of $C = 2$ double Weyl points (see Fig), belonging to the class of charge-2 Dirac points, opens up the possibility of material realization of unconventional topological properties beyond the conventional Dirac and $C = 1$ Weyl points, which calls for future experiments. (*Appl. Phys. Lett.* 122, 021602 (2023))



Plan of Future Work Including Project

1. * Machine learning inspired force field * Magnetism of vacancy ordered double perovskites * Search for Dirac spin liquids * Topological properties for MX3 compounds

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; Under progress
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

b) Post-Docs

1. Tushar Kanti Bhowmik; Investigation of High Tc superconductors and strongly corelated materials

c) External Project Students / Summer Training

1. Riddhima Sadhu; Single Crystal Growth and Characterization of Transition-Metal Dichalcogenides
2. Abhinav M; Tight-Binding Model on 2D systems

Teaching

1. Autumn semester; PHY402: Electromagnetic Theory; Integrated PhD; 11 students

Publications

a) In journals

1. Achintya Low, Susanta Ghosh, Susmita Changdar, Sayan Routh, Shubham Purwar, and **S. Thirupathaiah**, *Tuning of topological properties in the strongly correlated antiferromagnet Mn_3Sn via Fe doping*, Physical Review B, 106, 144429, 2022
2. Susmita Changdar, Susanta Ghosh, Kritika Vijay, Indrani Kar, Sayan Routh, P. K. Maheshwari, Soumya Ghorai, Soma Banik and **S. Thirupathaiah**, *Nonmagnetic Sn doping effect on the electronic and magnetic properties of antiferromagnetic topological insulator $MnBi_2Te_4$*, Physica B: Condensed Matter, 657, 414799, 2023

b) Conference proceedings / Reports / Monographs / Books

1. Effect of Mo doping on the electrical and magnetic properties of antiferromagnetic CrSe, Sayan Routh, Susanta Ghosh, P. K. Maheshwari, P. Singha Deo, S. Thirupathaiah, Materials Today: Proceedings, 65, 342-344 (2022)
2. Single Crystal Growth, Electrical, and Magnetic Properties Studies on Hexagonal CoSe, Shubham Purwar, Sayan Routh, S. Thirupathaiah, Materials Today: Proceedings, 65, 332-334 (2022)
3. Crossover from linear to quadratic magnetoresistance in $NiTe_2$, Indrani Kar and S.

Thirupathaiah, Materials Today: Proceedings, 65, 70-73 (2022)

Talks / Seminars Delivered in reputed conference / institutions

1. Electronic Properties of Some Topological Systems; Aug 30, 2022; IFW Dresden, Germany; 30th August-1st September 2022
2. Topological Properties Tuning with Fe Doping in Kagome Antiferromagnets; Sep 19, 2022; IIT Kanpur; 18th-22nd September, 2022
3. Electronic Properties Studies of Topological Systems; Jan 24, 2023; SNBNCBS; 24th January, 2023

Administrative duties

1. SCOLP Member

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

1. Start-up Research Grants; SERB, DST; 2020-2022; PI
2. CRS Project at UGC-DAE Consortium; UGC-DAE CSR; 2022-2023; PI
3. Indo-Russian Project; SERB, DST; 2022-2025; Co-PI

Conference / Symposia / Schools organized

1. Novel Magnetic and Topological Quantum Materials; Aug 28, 2022; IFW Dresden, Germany; 28th August-3rd September, 2022
2. National Conference on Electronic Structure-2022; Nov 14, 2022; University of Goa, India; 14th-16th November, 2022

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

1. Dr. Soma Banik, RRCAT, India; Sl. No. 2; National

Areas of Research

Experimental Condensed Matter Physics, Topological Quantum Materials

1. Tuning of topological properties in the strongly correlated antiferromagnet Mn_3Sn via Fe doping

In this work, single crystals of $Mn_{3-x}Fe_xSn$ (x=0, 0.25, and 0.35) were systematically studied for their electrical resistivity, magnetic, and topological properties. While Mn_3Sn is found to be metallic in nature up to room temperature with a spin-reorientation driven kink at 260 K, with Fe doping the system shows magnetism induced metal-insulator (MI) transition at 240 K for x=0.25 and 150 K for x=0.35. In addition to MI transition, x=0.35 system shows disorder induced resistivity upturn with a minimum at T_m=50 K. As for the magnetic properties, Mn_3Sn is found to show a sudden drop in magnetization at a spin-reorientation transition temperature of 260 K and spin-glass-like transition below 40 K. On the other hand, with Fe doping ferromagnetic transition has been introduced alongside with enhanced magnetic anisotropy. Also, anisotropic anomalous Hall resistivity has been induced at low temperatures with Fe doping. Particularly, the out-of-plane Hall resistivity (ρ_{zx}) increases with decreasing temperature for all the compositions from 300 K down to their respective magnetic transition temperatures where a sudden change in Hall resistivity is noticed. Though not much change in out-of-plane Hall resistivity is noticed with Fe doping at 2 K, the in-plane Hall resistivity (ρ_{xy}) is gigantically enhanced from -0.25 μΩ-cm to 48 μΩ-cm in going from x=0 to x=0.35. Along with the anomalous Hall resistivity, a large topological Hall resistivity also is observed for both Fe doped systems at 2 K.

2. Unusual Magnetic and Anomalous Hall Properties Observed at Elevated Temperatures in Antiferromagnetic Weyl Semimetal $Mn_{2.94}Ge$

In this contribution, we report on the successful growth of high-quality and nearly stoichiometric $Mn_{2.94}Ge$ single crystals and a thorough study on the magnetic and Hall properties. The magnetic property study reveals additional magnetic transitions such as spin-reorientation (TSR) and ferromagnetic-like transitions below the Neel temperature of 353 K. Let us also emphasize here that these magnetic transitions have not been observed so far in the Mn excess $Mn_{3+\delta}Ge$ systems. Also, consistent with

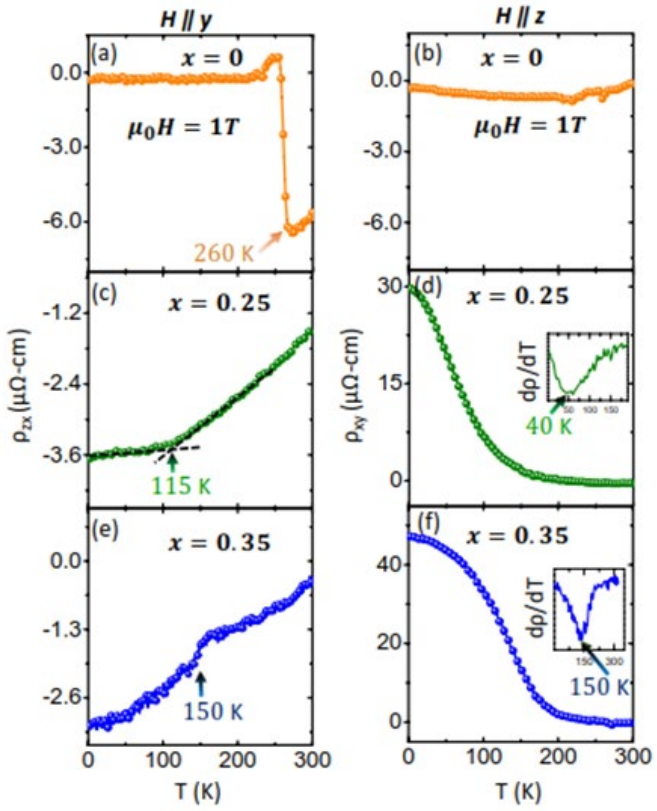


FIG. 5. Out-of plane Hall resistivity (ρ_{zx}) plotted as a function of temperature measured under the field of 1T from (a) x=0, (c) x=0.25, and (e) x=0.35. (b), (d), and (f) show in-plane Hall resistivity (ρ_{xy}) plotted as a function of temperature measured under the field of 1T from x=0, x=0.25, and x=0.35, respectively. Insets of (d) and (f) show the first derivative of their Hall resistivity with respect to temperature.

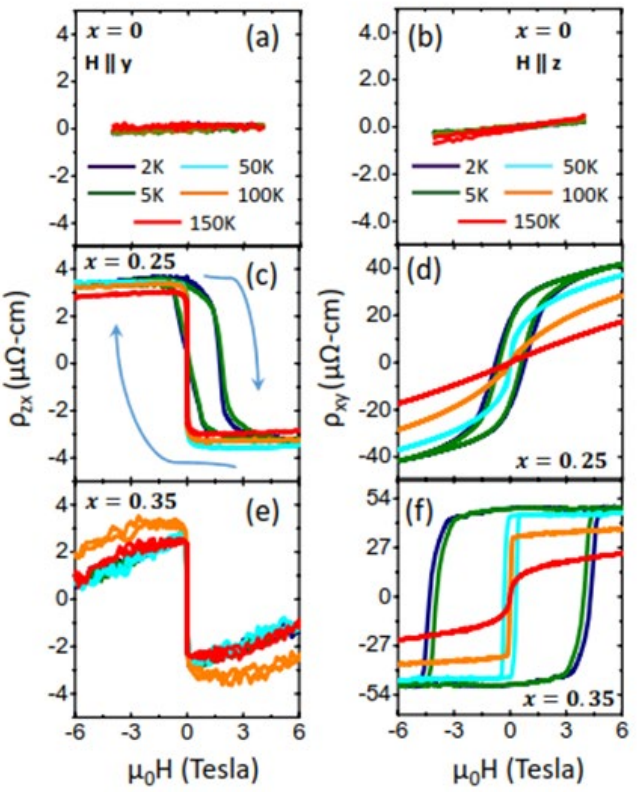


FIG. 6. Field dependent out-of-plane Hall resistivity ρ_{zx} measured at different temperatures from x=0 (a), x=0.25 (c), and x=0.35 (e). Curved blue arrows in (c) indicate field sweeping direction. Similarly, field dependent in-plane Hall resistivity ρ_{xy} measured at different temperatures from x=0 (b), x=0.25 (d), and x=0.35 (f).

the magnetic measurements, the Hall data shows an unusual behavior around TSR. This observation is quite in contrast to the previous studies on these systems, where the AHC gradually decreases with increasing temperature, with the highest AHC found at low temperatures. Our study suggests that the magnetic and Hall properties of the nearly stoichiometric Mn_3Ge are different from those of the excess $Mn_{3+\delta}Ge$ systems.

3. Effect on the Electronic and Magnetic Properties of Antiferromagnetic Topological Insulator $MnBi_2Te_4$ with Sn Doping

We observe that Sn doping reduces the out-of-plane antiferromagnetic (AFM) interactions in $MnBi_2Te_4$ up to 68\% of Sn concentration and above the system is found to be paramagnetic. In this way, the anomalous Hall effect observed at a very high field of 7.8 T in $MnBi_2Te_4$ is reduced to 2 T with 68\% of Sn doping. Electrical transport measurements suggest that all compositions are metallic in nature, while the low-temperature resistivity is sensitive to the AFM ordering and to the doping-induced disorder. Hall effect study demonstrates that Sn actually dopes electrons into the system, thus, enhancing the electron carrier density almost by two orders at 68\% of Sn. In contrast, $SnBi_2Te_4$ is found to be a p-type system. Angle-resolved photoemission spectroscopy (ARPES) studies show that the topological properties are intact at least up to 55\% of Sn as the Dirac surface states are present in the valance band, but in $SnBi_2Te_4$ we are unable to detect the topological states due to heavy hole doping. Overall, Sn doping significantly affects the electronic and magnetic properties of $MnBi_2Te_4$.

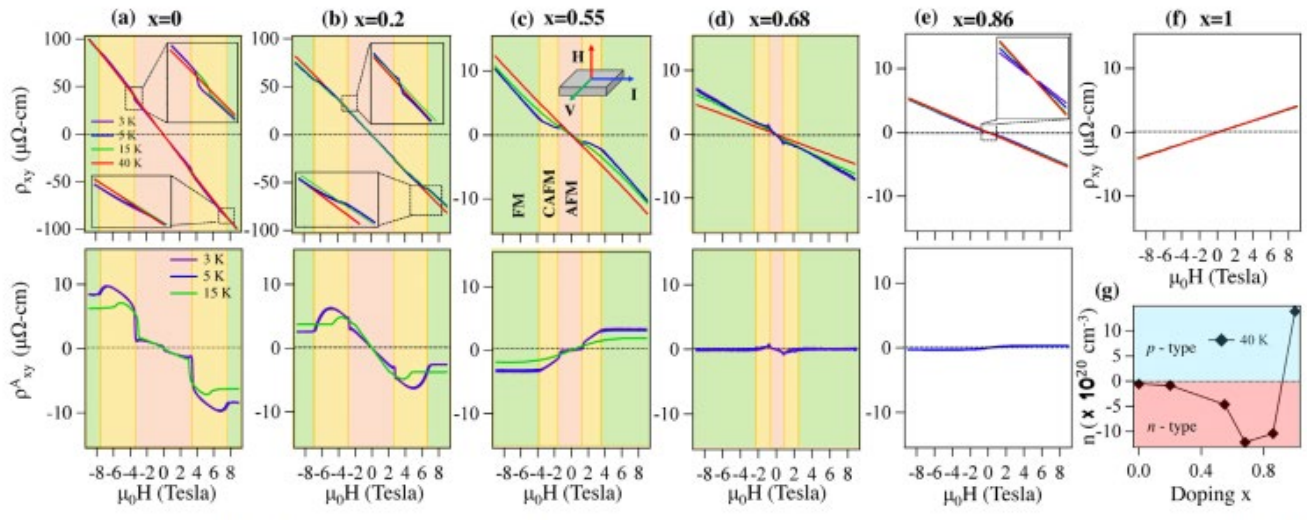


Fig. 6. (a)–(f) Field dependent Hall resistivity (ρ_{xy}) measured at 3, 5, 15, and 40 K. (red, yellow, green, and white colored regions in (a)–(d) represents AFM, CAFM, FM, and PM states of the system, respectively). The lower panels of (a)–(e) shows the anomalous Hall resistivity (ρ^{A}_{xy}) obtained after subtracting the normal Hall resistivity from ρ_{xy}. (g) Charge carrier density (n) plotted as a function of Sn doping concentration.

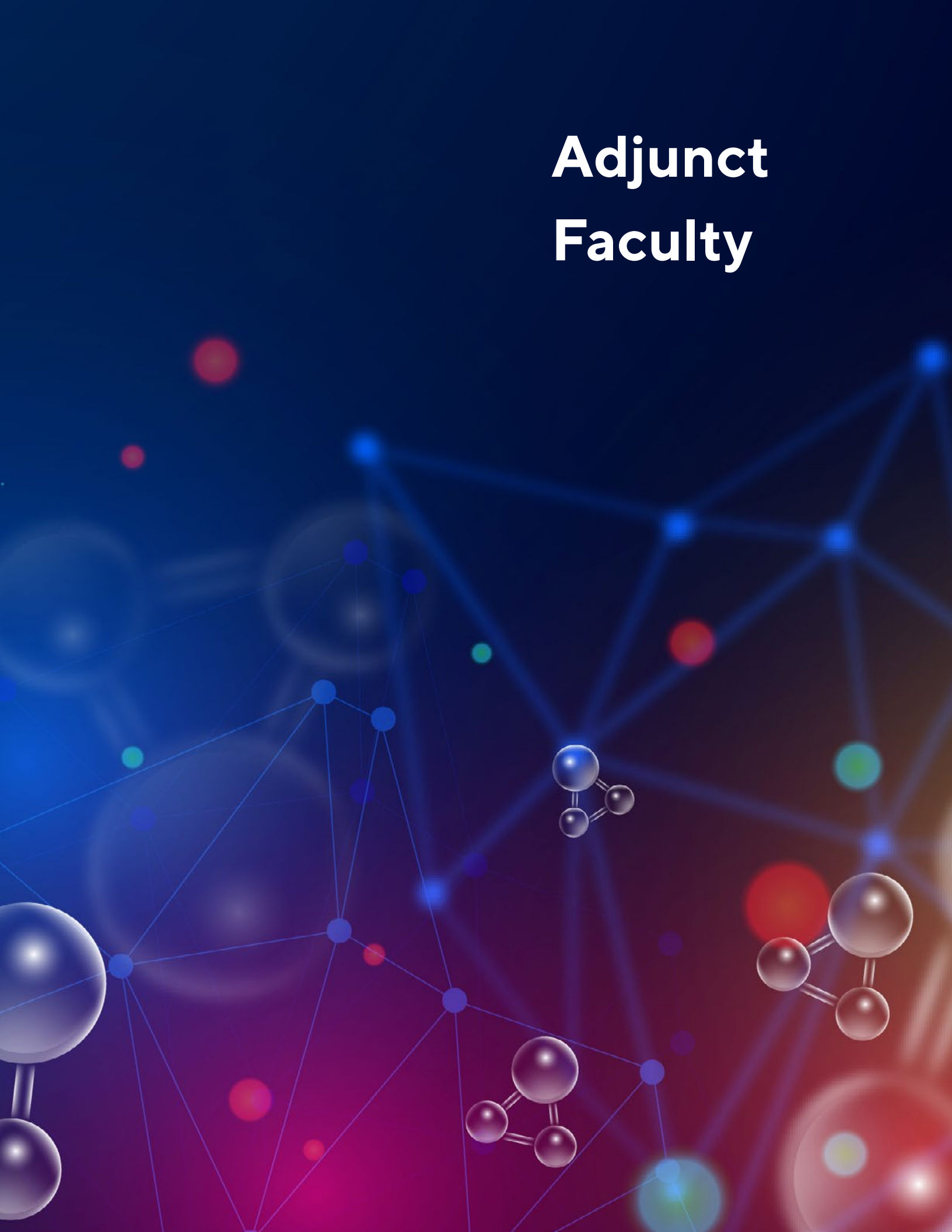
Plan of Future Work Including Project

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.

Any other Relevant Information including social impact of research

1. Beamtime for the ARPES measurements was granted by Soleil Synchrotron Facility during 13th - 20th June, 2022

Adjunct Faculty



Goutam Sheet
Adjunct faculty

Research interest

Goutam's principal research interest includes the experimental investigation of the topologically non-trivial systems (like topological insulators, topological superconductors, Weyl semimetals, Dirac semimetals etc.) using scanning probe microscopy and transport spectroscopy at ultra-low temperatures and high magnetic fields.

Research works done

The demand for energy-efficient nano-scale electronic devices necessitates the development of novel spintronic materials. Next-generation spintronic devices based on van der Waals (vdW) ferromagnets, such as FenGeTe2 (n≥3), hold promise in meeting this challenge. These ferromagnets exhibit near-room temperature ferromagnetism, high electrical conductivity, and ease of integration with other materials due to their layered structure. Dr. Sheet gave the first experimental demonstration of the coexistence of highly spin-polarised Fermi surface and Kondo lattice behavior in these ferromagnets through point contact spectroscopy (PCS) and scanning tunneling microscopy/spectroscopy experiments (STM/S). Studies performed by Dr. Sheet on the mesoscopic junctions of these vdW ferromagnets with conventional superconductors showed the ability of these ferromagnets to generate highly spin-polarized transport current, making them an important family of ferromagnets that satisfy all the requirements for being ideal spin sources in a low-power spintronic device (Rana et al., Physical Review (2022), Rana et al., Physical Review (2023)).

Topological superconductors exhibit Majorana bound states, known as Majorana zero-energy modes (MZMs), at their boundaries or vortex cores. MZMs follow non-Abelian braiding statistics, making them ideal for decoherence-free topological quantum computing. However, the experimental realization of these modes remains challenging due to ambiguity in tunneling experiments. Dr. Sheet proposed a unique setup for detecting and controlling Majorana zero modes by manipulating the number of transport-active nanowires in a multiwire Majorana array using local top gating or mechanical switches. This scheme enables activation or deactivation of the zero-bias conductance peak (ZBCP), providing a robust method for studying MZMs (Rana et al., Journal of Applied Physics, (2022), Rana et al., Journal of Applied Physics, (2023)).

Indranil Sarkar
Adjunct faculty

Research interest

(a) Development and understanding of epitaxial topological and spintronic hetero-structures

(b) Electronic and physical structure correlation with magnetic property and magnetization dynamics

(c) Interface driven quantum phenomena

Research works done

In F.Y. 2022-2023 my group has been engaged in developing heterostructured thin films and nanocrystals for spintronic and magnetization dynamics based application. Following are the major highlights:

a) We have worked towards understanding and development of scheme to engineer interfaces of ferromagnet / heavy metal heterostructures for enhancing spin pumping efficiency. In a spin pumping process, pure spin current is generated due to spin angular momentum conservation across the FM/ HM interface leading to transfer of spin angular momentum from the ferromagnetic layer to the HM layer

In particular we have demonstrated the possibility of achieving large spin mixing conductance of about 8 × 10^{18} m^{-2} and low magnetic damping $_{eff}$ value of about 4 ×10^{-3} in permalloy/ -Tantalum heterostructure. By combining ferromagnetic resonance spectroscopy with X-ray reflectivity and diffraction studies, we have established a correlation between the interfacial crystalline structure and spin pumping efficiency. Through these studies we have proposed how the heavy metal deposition temperature can be tuned to optimize the spin mixing conductance and magnetic damping in these very useful spintronic heterostructures.

b) We have developed a novel class nanocrystals of magnetic alloy namely, Heulser alloy and have demonstrated their capability for generation under application of alternating magnetic field. Through magnetization dynamics and X-ray diffraction studies we have found an important structural parameter related to the product of the strain and the coherent crystallite size. This parameter can be used to efficiently control the structural ordering and the magnetic property of the Heulser compound nanoparticles. The optimization of this product parameter is found to enhance both the structural ordering and magnetic transition temperature in Co_2FeSn Heusler nanoparticles.

Partha Guha
Adjunct faculty

Research interest

- Integrable Systems and Isochronous Dynamical Systems
- Nonlinear Dynamics, Nonlinear ODEs and Nonlinear Vibrations
- Geometrical Mechanics and Mathematical Physics
- Complexity, Generalized Entropy and Information Geometry

Research works done

Studied singular Lagrangian description of the Kill-the Winner ecological model using Jacobi's last multiplier. The Hamiltonian description of this model has been described using constrained geometry and Dirac bracket formalism.

An information-theoretic based on Ihara-Zeta function on a graph has been studied. A dynamical system consists of a billiard is considered, where the re ections are represented by the vertices of the graph. A deep connection between the Ihara entropy and dynamics of billiard has been explored.

Short pulse equation and isochronicity property has also been further studied in a Corrigendum.

At present we are working on \time crystal" problem, which repeat in time as conventional crystals repeat in space.

Journal Publications using SNBNCBS affiliation

1. Sudip Garai, A. Ghose-Choudhury and **Partha Guha**, *On a geometric description of time-dependent singular Lagrangians with applications to biological systems*, International Journal of Geometric Methods in Modern Physics, 19, 2250181, 2022

Samit Kumar Ray

Adjunct faculty

Research interest

Two-dimensional materials, Semiconductor nanostructures, Energy harvesting devices, Plasmonic optical devices

Research works done

The photo response properties of three terminal hybrid devices using ternary alloy $MoS_{2x}Se_{2(1-x)}$ decorated large area graphene in 2D-2D configurations have been studied. The MoSSe device exhibits extremely high photoresponsivity (>10^4 A/W), low noise equivalent power (~10^{-14} W/$Hz^{0.5}$), higher specific detectivity (~ 10^{11} Jones) in the wide UV-NIR (365-810 nm) range with excellent gate tunability. The work demonstrates the large area scalability with wafer-scale production of $MoS_{2x}Se_{2(1-x)}$ alloys, having important implication towards facile and scalable fabrication of high-performance optoelectronic devices.

Synthesized 2D citrate capped polymeric carbonitride nanodots(C-C3N4NDs) from a polymeric graphite carbonitride (g-C3N4) nanosheets. These developed nanodots have the potential to generate room-temperature reactive oxygen species (ROS). The spectroscopic studies indicated that theC-C3N4NDs effectively bind to the accumulated Pb(II). The significant change in absorbance and fluorescence spectra after the formation of a Pb(II)-NDs complex serves as a cost effective and simple method for the detection of lead.

Journal Publications using SNBNCBS affiliation

1. Shubhrasish Mukherjee, Didhiti Bhattacharya, **Samit Kumar Ray**, and Atindra Nath Pal, High-Performance Broad-Band Photodetection Based on Graphene-$MoS_{2x}Se_{2(1-x)}$ Alloy Engineered Phototransistors, ACS Applied Materials & Interfaces, 14, 34875, 2022
2. Susmita Mondal, Sayan Bayan, Ria Ghosh, Monojit Das, Aniruddha Adhikari, Dipanjan Mukherjee, Asim Kumar Mallick, **Samit Kumar Ray** and Samir Kumar Pal, *Functionalized Two-Dimensional Carbon Nitride Nanodots Detect and Reverse Lead Toxicity in the Physiological Milieu*, ACS Applied Materials & Interfaces, 14, 27002, 2022

Subhro Bhattacharjee
Adjunct faculty

Research interest

My research interest spans over various aspects of emergent phenomena in many-body systems. Right now, I am interested in implementation of symmetries and its interplay with many-body entanglement in novel quantum condensed matter phases.

Research works done

In 2022-23, my research focussed on trying to explore the above aspects of interplay of symmetries and entanglement in novel electronic phases. In particular, we explored this in context of

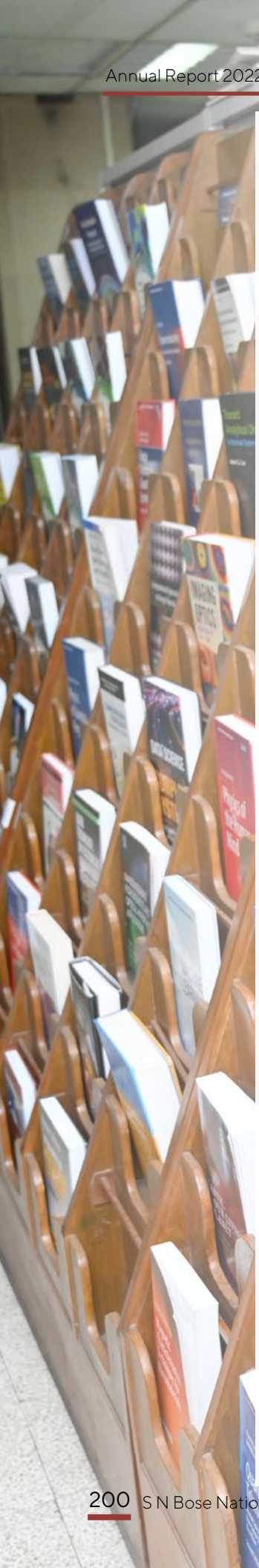
(a) the non-Kramers pyrochlore magnet Pr2Zr2O7 where a spin-orbital liquid is possibly realised at low temperature and magnetic field aided by linear spin-lattice coupling (https://www.nature.com/articles/s41567-022-01816-4) and its possible Raman signatures (https://journals.aps.org/prb/abstract/10.1103/PhysRevB.106.054507),

(b) probing hidden octupolar orders (https://arxiv.org/abs/2211.07666) via noel magnetoelastic coupling, (c) enhanced symmetries due to spin-orbit coupling leading to Dirac fermions with SU(8) symmetry (https://arxiv.org/pdf/2304.07223).

Journal Publications using SNBNCBS affiliation

1. Samir Rom, Santu Baidya, **Subhro Bhattacharjee**, and Tanusri Saha-Dasgupta, *Magnetism and unconventional topology in $LaCoO_3/SrIrO_3$ heterostructure*, Applied Physics Letters, 122, 021602, 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 17056 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.

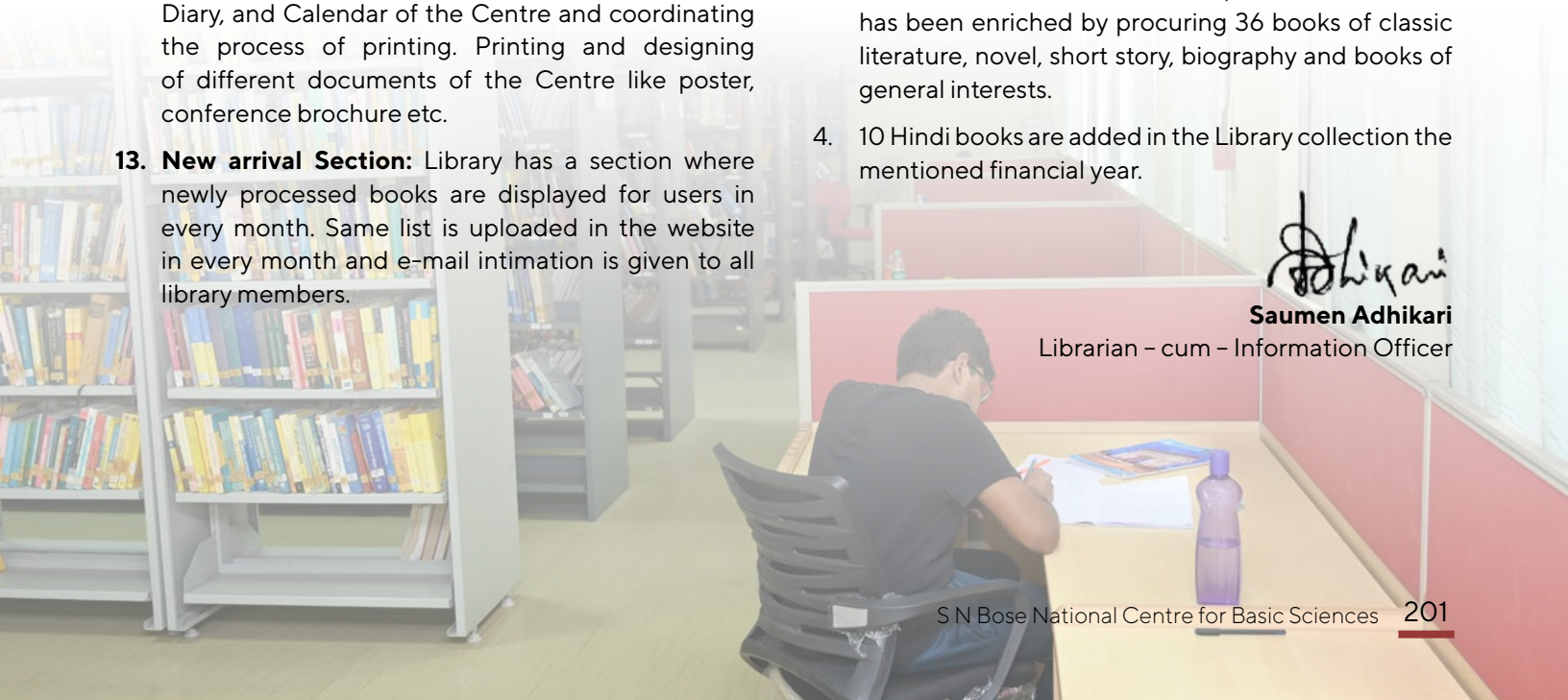
Services

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. 2022-23

1. Approximately 256 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 with multiple way search facility. It is enriched with pre-published version of the published research papers of the S.N. Bose Centre. In this financial year retrospective papers for the years 2021 have been uploaded in the repository.
3. In the Financial Year 2022-2023, the Fiction Section has been enriched by procuring 36 books of classic literature, novel, short story, biography and books of general interests.
4. 10 Hindi books are added in the Library collection the mentioned financial year.



Saumen Adhikari
Librarian – cum – Information Officer

Engineering Section

A. Civil Work

1. Open Discussion Room:

An Open Discussion Room has been constructed at Garden Area opposite of Main Building for academic discussions purpose in open air.

2. Structural Audit:

A Structural Stability Audit for Main Building, Bhaghirathi, Subarnarekha and RCC Overhead Tank in the Centre is conducted by the Jadavpur University.

3. Providing Pipe Line from Deep Tubewell-3 (near Basundhara) to Main Supply Line and Providing, Installation of New Submersible Pump for Deep Tubewell-3:
4. Replacing of Damaged Water Pipe Line at Duct, Krishnachura Hostel.
5. Cleaning of all water storage tanks is being carried out quarterly basis.
6. Customized Wooden Furniture is provided in Furnace Lab-3.
7. Renovation of Room No. -E3/4 of Subarnarekha Building.

B) 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. Providing COVID-19 Special Sanitisation on regular basis as a part of preventive health measure in the common areas of office and hostel buildings.
4. Installation of tri-lingual name plates on the office room doors in the administrative floor of Main Building of the Centre.

C) Electrical

1. 11 KV ELECTRIC SUB-STATION: The Centre has 2 Nos. of indoor type 11KV/0.433KV Electric Sub-stations at its premises which is delivering power through 04 nos. of 630 KVA Transformers.
2. MV-LT Distribution panel : Through the MV-LT Distribution panel, Power is fed at the Main Building, Bhagirathi Guest House, Krishnachura Hostel Building, Basundhara Building, Subarnarekha building (ESQ), Radhachura hostel, 02 Nos. Laboratory Buildings, Pump House including all the street lights.
3. Automatic Power Factor Controller Panels.
4. The Centre has a total capacity of 870 KVAR power factor controllers to reduce the Electricity cost/ power factor benefit from WBSEDCL.
5. The Centre has three numbers of diesel generator set i.e. 320 KVA (TIL Make), 500 KVA (Greaves Cotton Make) & another 750 KVA (Perkins make) for providing 100% electrical power back up on 24X7 basis to all its required places of the Centre in case of power shutdown from the WBSEDCL end or at the time of suitable preventive maintenance of Transformers/Switch Gears etc.
6. The Centre has an average 200 Tr. of VRF Air-Conditioning facility including 600 Nos. (approx.) of Air Conditioning machines of various capacities

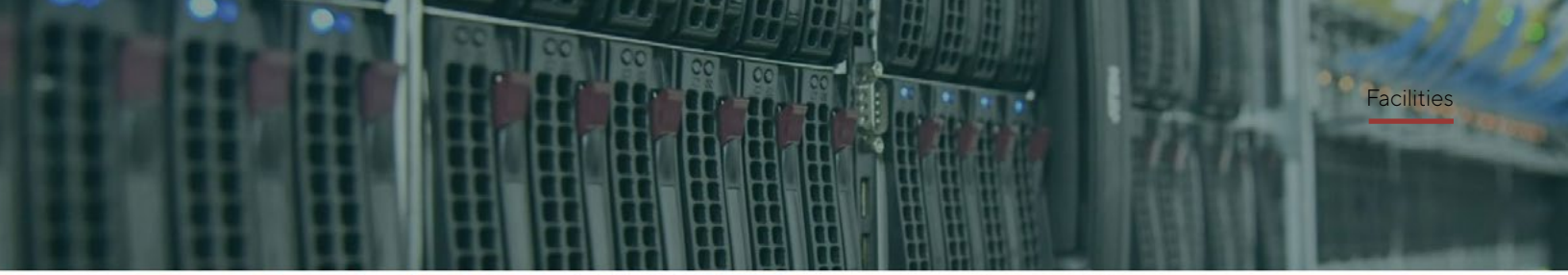
and various makes which need to be maintained and serviced periodically at the various Lab areas, Office spaces and Computer Centre Server Rooms to provide proper cooling effect to the Scientific Instruments for Research facilities at the Centre.

7. Maintenance of 2500 LPD capacity of Solar Water Heating System (SWHS) is done periodically at the Roof Top of Krishnachura Hostel Building for availability of hot water throughout the year.

8. Fire and Water Pumps: There are 02 Nos. of 12.5 H.P. Submersible Motor Pump sets (Bore well Type), 04 Nos. of Centrifugal Pumps, 02 Nos. of 3.0 H.P. openwell type Submersible water pumps, 02 Nos. of 10 H.P. Mono Block pumps for supplying water at the Krishnachura Hostel Building & Basundhara Building. Besides those, there are Fire Pump and Diesel driven pumps each of capacity 75.0 H.P. along with a Jockey Pump of rating 5.0 H.P. for Fire Fighting of Krishnachura Hostel Building and Basundhara Building which are regularly maintained. In addition to that there is an Iron Removal Plant at Pump House, the operation and maintenance for that IR plant is looked after by the Engineering Section.

Mithilesh Kumar Pande
Campus Engineer cum Estate Officer

Staff members, Engineering Section.



Computer Services Cell

Sanjoy Choudhury
Scientist – D

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:

1. **Perusing PhD in Computer Science and Engineering at National Institute of Technology, Meghalaya on Artificial Intelligence and machine learning, IoT and Edge/Fog Computing.**

   Ph.D. Progress: PhD thesis Pre-submitted at National Institute of Technology (NIT), Meghalaya.

   Apart from my principle technical administrative responsibility, I am working on Edge Computing /Fog Computing research on IoT. Edge/Fog computing provides on-demand access to computing resources for end users across the world. It offers services on a pay-as-you-go model through its environment sites that are scattered across diverse geographies. cities to harvest renewable energy sources, and prediction of renewable energy to maximize its usage. The key objectives of this research are as follows:

   1. Investigating effective solution to deal Virtual Machine's (VM) resource allocation for end user requests under overloaded situation while ensuring QoS.
   2. Investigating the interplay QoS and on energy consumption.
   3. Investigating novel scheme for reduction of energy consumption while ensuring QoS on Fog environment.
   4. Developing sustainable dynamic VM placement algorithms for retaining QoS factors.

   This research work will address the limitations of current fog resource allocation approaches: on the one hand, in dealing with fluctuating demand and supply, and on the other hand, in providing greater control to fog end users. The goal is to ultimately enable a more flexible and efficient allocation through market-based mechanisms ensuring the Energy and QoS factors in fog enabled smart cities.

Publication:

1. **Sanjoy Choudhury**, Ashish Kr. Luhach, Waleed Alnumay, Buddhadeb Pradhan and Diptendu Sinha Roy, *A neuro evolutionary scheme for improved IoT energy efficiency in smart cities*, Computers and Electrical Engineering, 104(Part B), 108443, 2022

The Computer Centre is a central facility, which caters to the needs of different academic departments and various sections of the institute. The mission of Computer Centre at SNBNCBS is to create and maintain a computing environment for the pursuit of academic excellence.

Central Computational Resources (2022-23):

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, nine more supercomputers will be installed in top institutes of the country in the coming days. SNBNCBS (S N Bose National Centre for Basic Sciences) will be one institute among those. MoU has been signed between the SNBNCBS, Kolkata and CDAC, Pune for the implementation 830 TF Supercomputer.

S. N. Bose Centre's High Performance Computing facility being listed within top **50 supercomputers (CRAY XE6 & CRAY XC50)** India based on the survey carried out by **CDAC Bangalore**. The cluster has a theoretical performance of **222.40 TF** catering the computational need of the vibrant computational activity 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 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 student evaluation
- Online staff/student leave entry, approval and duty roster
- Online MIS Dashboard
- Gate Pass Management

- Project Portal-for monitoring institute projects
- Student Payment Gateway
- File Tracking System
- Software for Academic Section for Monthly Progress report submisssion
- Video Conferencing and Virtual Class Room

Tools

- Institute General Softwares
- Antivirus Endpoint Protection
- Mathematica
- Mathlab
- MS 365

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

Machine Name	Processor Core	Storage	User
Hybrid System (CPU+GHP)	24 CPU Cores + 14336 GPU cores	4 TB	08
ATHENA	320	-	12
CRAY	7808	255 TB	50
TRC CRAY	960	120 TB	30

State of Art Data Centre

- 1000 Mbps leased line internet connection
- NKN Connectivity including 100 Mbps BSNL Connectivity
- Wi-fi enabled, inter connected campus with 400 nodes
- 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
- Dot-Matrix 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 2022-23:

Prof. Samir Kumar Pal – Convener

Dr. Atindra Nath Pal - Member

Prof. Gautam Gangopadhyay - Member

Prof. Soumen Mondal - 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 renders 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.)
2018-2019	31	4,62,15,993=00
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

Apart from this, the Centre has also received the TRC project during January 2016.

S. N. Bose National Centre for Basic Sciences
Projects during 2022-23

Project Title	PI / Co – PI	Funding Agency	Duration of the Project	Total Sanctioned	Remarks
SERB/BGS/17-18/189 – "Understanding the Growth of Vertically Aligned Nanowires or Nanotubes of Binary Oxides and Physics of Isotopic Fractionation of Gases by them"	Dr. Barnali Ghosh (Saha) – PI Dr. Manik Pradhan – Co. PI	SERB EMR/2017/001990	06-07-2018 to 05-07-2021 Extended for 6 months till 05-01-2022 (No cost extension) Extended by another 3 months till 05-04-2022 (No cost extension)	44,48,969/-	
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 30-09-2023	17,00,000/- (Capital) 97,14,000/- (General)	
DST/PM/17-18/204 – "Electronic, Structural and Optical Properties of Semiconductor Nanoplatelets"	Prof. Priya Mahadevan	DST DST/NM/ NS/2018/18 (G)	28-12-2018 to 27-12-2021 No cost extension till 27-06-2022	30,83,480/-	
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/-	

Project Title	PI / Co – PI	Funding Agency	Duration of the Project	Total Sanctioned	Remarks
IUSSTF/AB/18-19/220 – "Centre for Nanomagnetics for Energy Efficient Computing, Communications and Data Storage"	Prof. Anjan Barman	IUSSTF IUSSTF/JC-030/2018	23-12-2019 to 22-12-2021 No cost extension till 31-03-2023	32,82,850/-	
SERB(DST)/SC/18-19/221 – "Moleceular Mechanism of regulation of Rho GTPases through Phosphorylation of RhoGDI: Towards Unraveling the "Phosphorylation Code" Using Computational Methods"	Dr. Suman Chakrabarty	SERB ECR/2018/002903	16-03-2019 to 15-03-2022 No cost extension up to 14.05.2022	31,96,600/-	
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	
Sarfez/SC/19-20/232 – "Tuning electrostatics and dynamics of the flexible areas of PCSK9 protein towards controlling interactions with LDLR: A computational approach"	Dr. Suman Chakrabarty	Sarfez Cure India	19-06-2019 to 18-06-2022 No cost extension till 18/12/2022	8,24,032/-	
SERB/RKM/19-20/234 – "Investigation on the Changes in Protein Hydration During Aggregation in Crowded Environment by THz Time Domain and Optical Time Resolved Spectroscopy"	Prof. Rajib Kumar Mitra	SERB CRG/2019/000970	06-02-2020 to 05-02-2023	26,56,800/-	
SERB/PP/19-20/237 – "Fluctuation and Transport in the Models of Self Propelled Particles"	Dr. Punyabrata Pradhan	SERB MTR/2019/000386	21-02-2020 to 20-02-2023	6,60,000/-	
SERB/SC/19-20/240 – "Theoretical Investigation of run-and-tumble Motion in a Noisy Environment"	Dr. Sakuntala Chatterjee	SERB MTR/2019/000946	15-02-2020 to 14-02-2023	6,60,000/-	
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/-	
DST(SERB)/TS/19-20/251 – "Effect of Magnetic Moment Reorientation on the Physical and Electronic Properties in antiferromagnetic topological systems, (Mn1-xFex)3Sn and (Mn1-xFex)3Ge"	Dr. T. Setti	SERB SRG/2020/000393	18-12-2020 to 17-12-2022	26,02,800/-	
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/-	

Project Title	PI / Co – PI	Funding Agency	Duration of the Project	Total Sanctioned	Remarks
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 16-02-2024	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(NPDF)/JB/20-21/261 – "Theoretical and experimental investigations on transition metal dichalcogenide based surface plasmon resonance structure with applications in sensing"	Dr. Jayeta Banerjee (Mentor: Dr. Manik Pradhan)	SERB (NPDF) PDF/2020/001422	31-12-2020 to 30-12-2022	16,41,600/-	
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 21-04-2024	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/-	
Holoflex/SKP/21-22/269 – "Development of an industrial process for the large-scale production of retro reflective material for potential applications in display labels"	Prof. S.K. Pal	Holoflex Limited	01-07-2021 to 30-06-2022 Extended Till 31-03-2023	7,80,000/- (9,20,400/- including GST) + 2,26,200/- + 2,26,200/- + 2,26,200/-	
SERB(NPDF)/DS/21-22/270 – "Self-testing of quantum devices and device-independent information processing"	Dr. Debashis Saha	SERB (NPDF) PDF/2020/001682	15-03-2021 to 14-03-2023 Resigned on 12-8-2022	22,36,800/-	
"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 23-03-2023	Amount received 12,70,000/- + 7,23,000/-	
SERB/DB/21-22/271 – "Study of Astrophysical Sources in Very High Energy Regime Using Ground Based Gamma – Ray & Neutrino Telescopes" – Ramanujan Fellowship	Dr. Debanjan Bose	SERB SB/S2/RJN-038/2017	Implemented at SNBNCBS from 04-12-2020 Valid Till: 14.11.2022	Amount received 29,00,000/-	
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	

Project Title	PI / Co – PI	Funding Agency	Duration of the Project	Total Sanctioned	Remarks
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/-	
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/-	
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 Year) 7,56,280/- (2nd 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/-	
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/-	
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	Sanction Date: 06-03-2023	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 31-03-2023 (At SNBNCBS)	Amount Received till date: 11,10,653/-	Chanakya Post-Doctoral Research Fellow: Dr. Mir Alimuddin
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/-	
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/-	

*** Apart from this, the Centre has also received the TRC project during January 2016.

Postdocs & Scientists under Projects; DST INSPIRE Faculty & Others (2022-23)

Sl.	Name	Designation	Project Name	P. I. of Project	Joined on	Appt. upto
1	Anuvab Banerjee,	Research Associate – I, AHEP	Study of Astrophysical Sources in Very High Energy Regime using ground-based Gamma ray and Neutrino Telescope	Dr. Debanjan Bose	01.04.2022	14.11.2022
2	Dr. Asmita Kumari	Research Associate – I (Adhoc), AHEP	Application of Quantum Information	Prof. Archan S Majumdar	21.09.2022	20.03.2023
3	Dr. Debashis Saha	National Post Doctoral Fellow	Self-testing of quantum devices and device-independent information processing	Self [Prof. Archan S Majumdar, Mentor]	15.03.2021	Resigned on 12.08.2022
4	Dr. Dipayan Sen	Research Associate – III, CMMP	J.C. Bose Fellowship	Prof. Tanusri Saha-Dasgupta	01.11.2022	31.01.2023
5	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
6	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
7	Dr. Jayeta Banerjee,	National Post-Doctoral Fellow	Theoretical and experimental investigations on transition metal dichalcogenide based surface plasmon resonance structure with applications in sensing	Self [Dr. Manik Pradhan, Mentor]	31.12.2020	30.12.2022
8	Dr. Mir Alimuddin	Chanakya PDF	Devising Practically implementable enhanced means of communication with the aid of quantum resources	Self [Dr. Manik Banik, Mentor]	13.06.2022	31.03.2024
9	Dr. Partha Nandi	Research Associate – I (Adhoc), AHEP	Application of Quantum Information	Prof. Archan S Majumdar	01.09.2022	30.11.2022
10	Dr. Sanjukta Paul	Research Associate – I CMMP	Twistronics with transition metal dichalogenides	Prof. Priya Mahadevan	07.06.2021	06.12.2022
11	Dr. Soumendu Datta	Research Associate – III, CMMP	J.C. Bose Fellowship	Prof. Tanusri Saha-Dasgupta	25.08.2021	24.08.2023
12	Dr. Sourav Chakraborty	Research Associate – I (Adhoc), CMMP	Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature	Dr. Manoranjan Kumar	05.12.2022	30.04.2023
13	Dr. Sumit Nandi	Research Associate – I, AHEP	Application of Quantum Information	Prof. Archan S Majumdar	05.07.2021	04.07.2022

Sl.	Name	Designation	Project Name	P. I. of Project	Joined on	Appt. upto
14	Dr. Sumit Halder	Research Associate – I, CMMP	Exploring Quantum and Thermal fluctuations in Frustrated Magnets at Low Temperature	Dr. Manoranjan Kumar	01.09.2021	Resigned on 02.12.2022
15	Shreya Das	Research Associate – I (Adhoc), CMMP	J.C. Bose Fellowship	Prof. Tanusri Saha-Dasgupta	10.01.2022	09.07.2022
16	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	25.12.2024

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
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	**Dr. Debanjan Bose**	Ramanujan Fellow (Transferred from IIT, KGP)	*Study of Astrophysical Sources in Very High Energy Regime using Ground based Gamma Ray & Neutrino Telescope*	Self	04.12.2020	14.11.2022
4	**Prof. Rabin Banerjee**	Raja Ramanna Fellow	*Gauge and Gravitational Symmetries in Nonrelativistic Theories : Formalism and Applications*	Self	03.05.2021	02.05.2024
5	**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
6	**Dr. Ali Hossain Khan**	Ramanujan Fellow (Transferred from INST, Mohali)	*Doped 2D Nanocrystals for Photonic Applications*	Self	01.11.2021	31.03.2026
7	**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
8	**Dr. Sujoy Kr. Ghosh**	DST INSPIRE Faculty	*Self-powered bio-resorbable Implantable device*	Self	09.03.2023	08.03.2028

List of students under project

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	Suranjana Chakrabarty	Project Assistant	Anup Ghosh	CMMP	Ultrafast 2D-IR Spectroscopy on the Structural Dynamics of DNA/G Quadruplex	13.10.2020	31.12.2023		31.12.2023	31.12.2023	
2	Madhurita Das	Project JRF (Ad-hoc)	Priya Mahadevan	CMMP	Twistronics with transition metal dichalcogenides	14.01.2022	6 Months		29.03.2025	13.07.2022	
			DEPT. TOTAL					2			
1	Neha Bhattacharyya	Research Staff (Project)	Samir Kumar Pal	CBS	Development of an industrial process for the large-scale production of retro-reflective material for potential applications in display labels	14.01.2022	Till the end of the project		(Extended till 31.03.2023)	31.03.2023	31.03.2023
2	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	
3	Soumyadeep De	Project Assistant (Ad-hoc)	Ali Hossain Khan	CBS	Doped 2D Nanocrystals for Photonic Applications	17.01.2022	6 Months		31.03.2026	16.07.2022	24.04.2022
	Soumyadeep De	Project Assistant	Ali Hossain Khan	CBS	Doped 2D Nanocrystals for Photonic Applications	25.04.2022	1 Year from the date of joining		31.03.2026	24.04.2023	31.07.2022
4	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	24.04.2023	
5	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	
			DEPT. TOTAL					**5**			

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	Arun Kumar Das	Project JRF	Archan S Majumdar	APHEP	Applications of Quantum Information	16.10.2019	Till the end of the project		23.04.2022 (Extended till 30.09.2023)	30.09.2023	
2	Subhankar Bera	Project JRF	Archan S Majumdar	APHEP	Applications of Quantum Information	03.10.2019	Till the end of the project		23.04.2022 (Extended till 30.09.2023)	30.09.2023	
3	Arnab Mukherjee	Project JRF	Archan S Majumdar	APHEP	Quantum Heat Engines	12.11.2021	11.11.2023		21.04.2024	11.11.2023	
			DEPT. TOTAL					**3**			
			TOTAL						**10**		

Samir Kumar Pal
Convenor, Project & Patent Cell

Technical Research Centre (TRC)

The **Technical Research Centre (TRC)**, funded by the Department of Science & Technology (DST), Ministry of Science & Technology, Government of India at S. N. Bose National Centre for Basic Sciences was 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 harnessable 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 Modeling 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 :

A. The TRC extended Phase (Phase II):

Prof. Soumen Mondal (Nodal Officer); Prof. Tanusri Saha Dasgupta; Prof. Anjan Barman Prof. Samir K. Pal; Prof. Jaydeb Chakrabarti; Prof. Rajib K. Mitra; Dr. Barnali Ghosh Saha; Dr. Atindra Nath Pal and Dr. Suman Chakrabarty.

B. The TRC Phase I :

Prof. Soumen Mondal (Nodal Officer); Prof. Tanusri Saha Dasgupta; Prof. Samir K. Pal; Prof. Ranjit Biswas; Dr. Barnali Ghosh Saha; Dr. Manik Pradhan; Prof. Jaydeb Chakrabarti; Prof. P. K. Mukhopadhyay; Prof. A.K.Raychaudhuri (Nodal Officer till December 2019); Dr. Subhra Jana, Dr. Atindra Nath Pal and Dr. Suman Chakrabarty.

Highlighted Research Activities during 2022-2023:

A. Academic Output :

- Ongoing translational research projects : 29
- Research publications : 51
- Ph. D. degree (Thesis submitted) : 4

B. Number of Patent filed and granted :

Sl.	Title	Inventors	Country	File No.	Status
1.	Digital camera based spectrometric system for point-of-care analysis of ultra-low volume whole blood sample	Samir Kumar Pal	India	201731029433 **Granted Patent No. 393473**	Filed on 19/08/2017 **Granted on: 29/03/2022**
2.	A system for monitoring hemodialysis efficacy of a subject	Santanu Mandal, Chiranjit Ghosh and Manik Pradhan		201731042502 **Granted Patent No. : 431879**	Filed on 27/11/2017 **Granted on: 16/05/2023**

A few prototypes developed under TRC ready for Transfer of Technology :

List of running consultancy projects/Industrial Partners under TRC:

S. No	Particulars of Industrial Partner	Name of the Translational project/technology	Specific role in Development / commercialization etc.
1	EzRex Health Tech Pvt. Ltd.	A low-cost non-contact AJO device	Taker of the technology for commercialization
2	Sarfez Cure India	Study the effect of additives on decomposition kinetics of hydrates	Industrial collaboration initiated
3	Dundee University, Scttoland and and EzRex Health Tech Pvt. Ltd (Consultancy project jointly)	A screening device (Spec-U-Lesion) for the detection of bladder cancer using spectroscopic techniques	Consultancy project jointly

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 experiment facility of SNBNCBS which can be availed by any researcher from our Centre as well as from other institution / laboratories. The details of the available experimental facilities and the terms and conditions for using these facilities are mentioned in the website: https://newweb.bose.res.in/facilities/TechnicalCell/.

1. The activities of Technical Cell during April 2022, March 2023 are reported in the following sections under Technical Cell:

Sl. No.	Name of the equipment	Sl. No.	Name of the equipment
1.	Transmission electron Microscope (TEM) with other attachments	16.	Chemical Lab
2.	Thermo Gravimetry/Differential Thermal Analyzer (TG-DTA)	17.	Ellipsometer
3.	Dynamic Light Scattering(DLS)	18.	Viscometer
4.	Clean Room	19.	Densitymeter
5.	E-beam evaporator	20.	X-ray Diffractometer(XRD) (PANalytical X-PERT PRO)
6.	ICP-RIE	21.	Pulsed Laser Deposition (PLD) Unit
7.	Dual beam FIB/SEM	22.	Helium Leak Detector
8.	Wire Bonder	23.	Liquid Nitrogen and Gases for Laboratory Use
9.	Mask aligner	24.	Fluorescence spectrometer(Fluorolog)
10.	3K Resistivity Measurement Setup	25.	Spevtrofluorometer(Fluoromax)
11.	Field Emission Scanning Electron Microscopy (FESEF) Quanta FEG 250	26.	Fourier Transform Infrared Spectrometer(FTIR)
12.	X-ray Diffraction	27.	Mechanical workshop, Sputtering Unit, Millipore Water
13.	UV Visible Spectrometer(UV-VIS)(2600)	28.	Vibrating Sample Magnetometer (VSM)
14.	UV Visible Spectrometer(UV-VIS)(2450)	29.	Differential Scanning Calorimeter (DSC)
15.	Circular Dichroism (CD)	30.	Atomic Force Microscope (AFM)

II. Support to research activities:

About 81 students of our centre used the above experimental facilities extensively for their Ph.D. thesis work. 10 students completed their M.Sc. / M.Tech. Project work and 19 students did their summer project performing extensive work in technical cell. About 86 external users used our Technical cell facilities for their research work.

III. Support to the technical activities of SNBNCBS

Students of our IPhD programme used our technical cell facilities and performed some of the experiments on X-ray diffraction, UV – VIS spectroscopy, Differential Scanning Calorimetry as a part of their Advanced Experimental course (PHY 391). They did their project works as a part of IPhD curriculum.

IV. Outreach Programme

(a) C. K. Majumder Memorial Summer Workshop 2018 was held during 28th May to 7th June 2018. 30 nos. 3rd year Physics (Hon.) students from different colleges participated in the workshop and performed experiments on X-Ray diffraction, differential scanning calorimetry, Scanning Electron microscope, Vibrating sample Magnetometer of technical cell.

(b) Scientific visit of students from North East: 56 students visited our center on 17th March 2019 and the instruments of Technical Cell were demonstrated to them.

(c) St. Xaviers College visit:

Scientific visit of students from St. Xaviers College on 9th April 2018

V. Major maintenance and up-gradation

VI. Utilization of equipment

ITEM	USAGE (time & hour)	UP TIME %	DOWN TIME %	No. of external users
PLD	1340	90%	10%	NIL
FESEM	900	90%	10%	18
XPERT PRO	910	90%	10%	8
MINI XRD	229	90%	10%	NIL
TG/DTA	510	92%	8%	18
DSC	460	80%	20%	12
AFM	647	85%	15%	19
VSM	1320	90%	10%	11
TEM	300	25%	75%	NIL

VII. Revenue Generation

Revenue generation from the facilities is being done from external users.

Samir Kumar Pal
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 (Mr. Shubhbrata Das) 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: 79. Month wise breakups are given below: (2022 – 2023). There are three major equipment in the workshop: CNC Milling Machine, All Gear Lathe Machine and Welding Machine, procured from the Center's TRC project.

Total job done during APRIL 2022 TO MARCH 2023: 79

Atindra Nath Pal

Atindra Nath Pal
In-charge, 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, 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 for accommodating Centre's students. There is a seminar room within the guest house for hosting small conferences, meetings etc with separate dining facilities. The Guest House also hosts the Medical Cell of the Centre where doctor consultations are available to the 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. 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 provides efficient service and warm hospitality to all the guests staying in it. There are plans for starting a Rooftop Cafeteria on the Terrace at 1st Floor of the Bhagirathi Guest House Building, soon.

Sonajumder

Shohini Majumder
Registrar

Special Days of Celebration

The Centre organized the following events by maintaining all COVID-19 restrictions:

- The national flag was hoisted by the Director on 74th Republic Day on 26th January 2023 and 76th Independence Day on 15th August 2022. Both the occasions were attended by staff and students of the Centre and national anthem was sung to mark the occasions.
- On 2nd January 2023, 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 the same day to commemorate the 130th Birth Anniversary of Prof. Satyendra Nath Bose. On the said occasion, Prof. Anirban Kundu, University of Calcutta gave a Popular Science Talk followed by Science Labs visit, SNBose Archive visit and Planet & Star watching.

The Centre also celebrated the following occasions :-

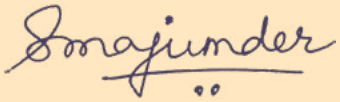
- Rashtriya Ekta Diwas on 31st October 2022 by taking pledge through virtual pledge.
- Constitution Day on 26th November 2022 through on-line pledge taking ceremony followed by an Online Quiz on India-the Mother of Democracy.
- 'Muktangan' organised the following events:-
  - Fresher's Welcome on 23.09.2022.
  - An Intra-Institute Badminton Tournament (both Singles & Doubles) on 27-28 January 2023;
  - An Intra-Institute Football Tournament on 23-25 January 2023.
  - An Intra-Institute Cricket Tournament on 4-5 February 2023.

  All the above mentioned events were a grand success.

BOSE FEST

- On the occasion of 'BOSE FEST 2022' held during 27th April 2022 – 29th April 2022, Family Day was celebrated in the evening of 29th April 2022. On 29th April 2022, the Performing Arts Group of 'Muktangan' organised an in-house programme comprising of individual and group performances of singing, recitation, play and drama at Purbashree Auditorium – EZCC, Salt Lake. The programmes were attended by friends and family members of staff and students and were a huge success. The In-house Bose Fest programme was followed by a gala dinner attended by friends and family members of the staff and students of the Centre. Art & Photography Fest along with Oral & Poster presentations by the students were also held during the Fest.
- On the occasion of 'BOSE FEST 2023' held during 1st March 2023 – 3rd March 2023, Family Day was celebrated in the evening of 3rd March 2023. On 3rd March 2023, 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 and were a huge success. The In-house Bose Fest programme was followed by a gala dinner attended by friends and family members of the staff and students of the Centre. On the evening of 2nd March 2023, renowned Bengali Folk Band 'DOHAR' entertained the audience with their popular numbers. Art & Photography Fest along with Oral & Poster presentations by the students were also held during the above period.

  Both the BOSE FEST (S) were successful.



Shohini Majumder
Registrar

List of Publications

List of Publications 2022-2023

Department of Astrophysics and High Energy Physics

1. Soumya Chakrabarti and **Amitabha Lahiri**, *Scalar-fermion interaction as the driver of cosmic acceleration*, Physics of the Dark Universe, 37, 101121, 2022
2. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta, *Pushforwards and gauge transformations for categorical connections*, Theory and Applications of Categories, 38(25), 1015, 2022
3. Shantonu Mukherjee and **Amitabha Lahiri**, *Spin-flux attachment by dimensional reduction of vortices*, Nuclear Physics B, 986, 116050, 2023
4. Indrajit Ghose, Riya Barick and **Amitabha Lahiri**, *Neutrino Oscillation Caused by Spacetime Geometry*, Letters in High Energy Physics, 2023, 349, 2023
5. Subhankar Bera, Shashank Gupta and **A. S. Majumdar**, *Device-independent quantum key distribution using random quantum states*, Quantum Information Processing, 22, 109, 2023
6. Arun Kumar Das, Debarshi Das, Shiladitya Mal, Dipankar Home and **A. S. Majumdar**, *Resource-theoretic efficacy of the single copy of a two-qubit entangled state in a sequential network*, Quantum Information Processing, 21, 381, 2022
7. Subhankar Bera, Ananda G. Maity, Shiladitya Mal, and **A. S. Majumdar**, *Role of nonclassical temporal correlation in powering quantum random access codes*, Physical Review A, 106, 042439, 2022
8. Ashadul Halder, Shashank Shekhar Pandey and **A.S. Majumdar**, *Global 21-cm brightness temperature in viscous dark energy models*, Journal of Cosmology and Astroparticle Physics, 2022, 049, 2022
9. Shashank Shekhar Pandey, Arnab Sarkar, Amna Ali and **A.S. Majumdar**, *Effect of inhomogeneities on the propagation of gravitational waves from binaries of compact objects*, Journal of Cosmology and Astroparticle Physics, 6, 021, 2022
10. Debarshi Das, Ananda G. Maity, Debashis Saha, and **A. S. Majumdar**, *Robust certification of arbitrary outcome quantum measurements from temporal correlations*, Quantum, 6, 716, 2022
11. Riddhi Chatterjee and **A. S. Majumdar**, *Bell-inequality violation by dynamical Casimir photons in a superconducting microwave circuit*, Physical Review A, 106, 042224, 2022
12. Sumit Nandi, Debashis Saha, Dipankar Home, and **A. S. Majumdar**, *Wigner-approach-enabled detection of multipartite nonlocality using all different bipartitions*, Physical Review A, 106, 062203, 2022
13. A. Chanda, A. Halder, **A. S. Majumdar** and B. C. Paul, *Late time cosmology in f(R,G) gravity with exponential interactions*, The European Physical Journal C, 83, 23, 2023
14. Shashank Gupta, Debashis Saha, Zhen-Peng Xu, Adán Cabello, and **A.S. Majumdar**, *Quantum Contextuality Provides Communication Complexity Advantage*, Physical Review Letters, 130, 080802, 2023
15. **Rabin Banerjee**, *Dual description of gauge theories from an iterative Noether approach*, Nuclear Physics B, 981, 115875, 2022
16. Ruchi Pandey, Gesesew R Habtie, Rahul Bandyopadhyay, **Ramkrishna Das**, François Teyssier, Joan Guarro Fló, *Study of 2021 outburst of the recurrent nova RS Ophiuchi: Photoionization and morphokinematic modelling*, Monthly Notices of the Royal Astronomical Society, 515, 4655, 2022
17. Sneh Lata, W P Chen, J C Pandey, Athul Dileep, Zhong-Han Ai, Alisher S Hojaev, Neelam Panwar, Santosh Joshi, **Soumen Mondal**, Siddhartha Biswas, B C Bhatt, *Photometric variable stars in the young open cluster NGC 6823*, Monthly Notices of the Royal Astronomical Society, 520, 1092, 2023
18. Alik Panja, Yan Sun, Wen Ping Chen, and **Soumen Mondal**, *Star and Cluster Formation in the Sh2-112 Filamentary Cloud Complex*, The Astrophysical Journal, 939, 46, 2022
19. Soumen Bera, Tapan K. Sasmal, Dusmanta Patra, and **Soumen Mondal**, *"Winged" Radio Sources from the LOFAR Two-meter Sky Survey First Data Release (LoTSS DR1)*, The Astrophysical Journal, 260, 7 2022
20. Rituparna Mandal, **Sunandan Gangopadhyay**, **Amitabha Lahiri**, *Newtonian cosmology from quantum corrected Newtonian potential*, Physics Letters B, 839, 137807, 2023

21. **Sunandan Gangopadhyay**, Soham Sen and Rituparna Mandal, *Interference and reflection from the event horizon of a quantum corrected black hole*, Europhysics Letters, 141, 49001, 2023
22. Ashmita Das, Soham Sen, and **Sunandan Gangopadhyay**, *Virtual transitions in an atom-mirror system in the presence of two scalar photons*, Physical Review D, 107, 025009, 2023
23. Anish Das, Ashis Saha and **Sunandan Gangopadhyay**, *Shadow of Kottler black hole in the presence of plasma for a co-moving observer*, Classical and Quantum Gravity, 40, 015008, 2023
24. Rituparna Mandal and **Sunandan Gangopadhyay**, *Black hole thermodynamics in asymptotically safe gravity*, General Relativity and Gravitation, 54, 159, 2022
25. Anirban Roy Chowdhury, Ashis Saha, and **Sunandan Gangopadhyay**, *Role of mutual information in the Page curve*, Physical Review D, 106, 086019, 2022
26. Rituparna Mandal, **Sunandan Gangopadhyay** and **Amitabha Lahiri**, *Cosmology with modified continuity equation in asymptotically safe gravity*, The European Physical Journal Plus, 137, 1110, 2022
27. Manjari Dutta, Shreemoyee Ganguly and **Sunandan Gangopadhyay**, *Explicit form of Berry phase for time dependent harmonic oscillators in noncommutative space*, Physica Scripta, 97, 105204, 2022
28. Arnab Mukherjee, **Sunandan Gangopadhyay** and **A. S. Majumdar**, *Unruh quantum Otto engine in the presence of a reflecting boundary*, Journal of High Energy Physics, 2022, 105, 2022
29. 29. Soham Sen, Sukanta Bhattacharyya and **Sunandan Gangopadhyay**, *Path Integral Action for a Resonant Detector of Gravitational Waves in the Generalized Uncertainty Principle Framework*, Universe, 8, 450, 2022
30. Soham Sen, Rituparna Mandal, and **Sunandan Gangopadhyay**, *Near horizon aspects of acceleration radiation of an atom falling into a class of static spherically symmetric black hole geometries*, Physical review D, 106, 025004, 2022
31. Ashis Saha, **Sunandan Gangopadhyay** and Jyoti Prasad Saha, *Mutual information, islands in black holes and the Page curve*, The European Physical Journal C, 82, 476, 2022
32. Soham Sen, Rituparna Mandal, and **Sunandan Gangopadhyay**, *Equivalence principle and HBAR entropy of an atom falling into a quantum corrected black hole*, Physical Review D, 105, 085007, 2022
33. Neeraj Kumar, Soham Sen, and **Sunandan Gangopadhyay**, *Phase transition structure and breaking of universal nature of central charge criticality in a Born-Infeld AdS black hole*, Physical Review D, 106, 026005, 2022
34. Neeraj Kumar, Soham Sen, and **Sunandan Gangopadhyay**, *Breaking of the universal nature of the central charge criticality in AdS black holes in Gauss-Bonnet gravity*, Physical Review D, 107, 046005, 2023
35. Anirban Roy Chowdhury, Ashis Saha and **Sunandan Gangopadhyay**, *Mixed state information theoretic measures in boosted black brane*, Annals of Physics, 452, 169270, 2023
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69. Aishwaryo Ghosh, Soumendu Datta, and **Tanusri Saha-Dasgupta**, *Understanding the Trend in Core-Shell Preferences for Bimetallic Nanoclusters: A Machine Learning Approach*, The Journal of Physical Chemistry C, 126, 6847, 2022

70. Shiladitya Karmakar, Pradip Chakraborty and **Tanusri Saha-Dasgupta**, *Trend in light-induced excited-state spin trapping in Fe(ii)-based spin crossover systems*, Physical Chemistry Chemical Physics, 24, 10201, 2022

71. Shiladitya Karmakar, Rajdeep Biswas, and **Tanusri Saha-Dasgupta**, *Giant Rashba effect and nonlinear anomalous Hall conductivity in a two-dimensional molybdenum-based Janus structure*, Physical Review B, 107, 075403, 2023

72. Achintya Low, Susanta Ghosh, Susmita Changdar, Sayan Routh, Shubham Purwar, and **S. Thirupathaiah**, *Tuning of topological properties in the strongly correlated antiferromagnet Mn_3Sn via Fe doping*, Physical Review B, 106, 144429, 2022

73. Susmita Changdar, Susanta Ghosh, Kritika Vijay, Indrani Kar, Sayan Routh, P. K. Maheshwari, Soumya Ghorai, Soma Banik and **S. Thirupathaiah**, *Nonmagnetic Sn doping effect on the electronic and magnetic properties of antiferromagnetic topological insulator $MnBi_2Te_4$*, Physica B: Condensed Matter, 657, 414799, 2023

74. Suraka Bhattacharjee, **Koushik Mandal** and Supurna Sinha, *Interplay of dissipation and memory in the quantum Langevin dynamics of a spin in a magnetic field*, International Journal of Modern Physics B, 2024, 245005, 2023

75. Banasree Sadhukhan, Raghuveer Chimata, Biplab Sanyal and **Abhijit Mookerjee**, *Magnetization Dynamics in Fe_xCo_{1-x} in Presence of Chemical Disorder*, Magnetochemistry, 9, 44, 2023

76. Yash Wath, M. Hariprasad, Freya Shah & **Shashank Gupta**, *Eavesdropping a quantum key distribution network using sequential quantum unsharp measurement attacks*, The European Physical Journal Plus, 138, 54, 2023

77. Ram Awdhesh Kumar, **Alo Dutta** and T. P. Sinha, *Structural and dielectric properties of microwave dielectric materials $xBa(Zn_{1/3}Ta_{2/3})O_3$ - (1-x) $La(Zn_{1/2}Ti_{1/2})O_3$*, Journal of Electroceramics, 50, 1, 2023

78. Debashish Pal, **Dipanjan Maity**, Ayan Sarkar, Debasis De, Aditya Raj, and Gobinda Gopal Khan, *Multifunctional Ultrathin Amorphous CoFe-Prussian Blue Analogue Catalysts for Efficiently Boosting the Oxygen Evolution Activity of Antimony-Doped TiO_2 Nanorods Photoanode*, ACS Applied Energy Materials, 5, 15000, 2022

79. Himadri Sekhar Tripathi, Riju Karmakar, Tushar K. Bhowmik, Saswata Halder, **Alo Dutta**, T. P. Sinha, *$RCoO_3$ {R=Pr, Nd and Sm} electrode-based for efficient solid-state symmetric supercapacitor*, Solid

State Sciences, 134, 107065, 2022

80. **Anupam Gorai**; Rohan Mandal; **Dipika Mandal**, *Enhanced Electromagnetic Wave Absorption by Bi-Layered Nano-Hollow Spheres*, IEEE Transactions on Magnetics, 58, 2102006, 2022

81. **Ravindra Singh Bisht**, **Sudipta Chatterjee**, Sreyan Raha, Achintya Singha, D. Kabiraj, D. Kanjilal, and A. K. Raychaudhuri, *Disorder-induced crossover of Mott insulator to weak Anderson localized regime in an argon-irradiated $NdNiO_3$ film*, Physical Review B, 105, 205120, 2022

82. Himadri Sekhar Tripathi, **Alo Dutta** and T. P. Sinha, *Tailoring structural and electrochemical properties in Sr^{2+} incorporated nanostructured $BiFeO_3$ for enhanced asymmetric solidstate supercapacitor*, Electrochimica Acta, 421, 140505, 2022

83. Debashish Pal, **Dipanjan Maity**, Ayan Sarkar, Debasish Sarkar, Gobinda Gopal Khan, *Effect of defect-rich Co-CeO_x OER cocatalyst on the photocarrier dynamics and electronic structure of Sb-doped TiO_2 nanorods photoanode*, Journal of Colloid and Interface Science, 620, 209, 2022

Inter-Departmental Publications

1. Debashish Paul, Anirban Paul, Dipanjan Mukherjee, Saroj Saroj, Manorama Ghosal, Suchetan Pal, Dulal Senapati, **Jaydeb Chakrabarti**, **Samir Kumar Pal**, and Tatini Rakshit, *A Mechanoelastic Glimpse on Hyaluronan-Coated Extracellular Vesicles*, The Journal of Physical Chemistry Letters, 13, 8564, 2022

2. Akash Das, **Soumen Mandal**, and **Manik Pradhan**, *Signature of the photonic spin Hall effect in monolayer MoS_2 via weak measurement*, Journal of the Optical Society of America B, 39, 1822, 2022

3. Didhiti Bhattacharya, Shubhrasish Mukherjee, **Atindra Nath Pal**, **Rajib Kumar Mitra**, **Samit Kumar Ray**, *Two-Dimensional $Mo_xW_{1-x}S_2$ Alloys for Nanogenerators Producing Record Piezo-Output and Coupled Photodetectors for Self-Powered UV Sensor*, Advanced Optical Materials, 10, 2200353, 2022

4. Dipanjan Mukherjee, Gulmi Chakraborty, Md. Nur Hasan, Uttam Pal, Priya Singh, Tatini Rakshit, Reem I. Alsantali, **Tanusri Saha Dasgupta**, Saleh A. Ahmed, Ranjan Das, **Samir Kumar Pal**, *Reversible photoswitching of spiropyran in biomolecular interfaces: A combined spectroscopy and computational study*, Journal of Photochemistry and Photobiology A: Chemistry, 430, 113958, 2022

5. Susmita Mondal, Sayan Bayan, Ria Ghosh, Monojit Das, Aniruddha Adhikari, Dipanjan Mukherjee, Asim Kumar Mallick, **Samit Kumar Ray** and **Samir Kumar Pal**, *Functionalized Two-Dimensional Carbon Nitride Nanodots Detect and Reverse Lead Toxicity in the Physiological Milieu*, ACS Applied Materials & Interfaces, 14, 27002, 2022

6. Sudip Garai, A. Ghose-Choudhury and **Partha Guha**, *On a geometric description of time-dependent singular Lagrangians with applications to biological systems*, International Journal of Geometric Methods in Modern Physics, 19, 2250181, 2022

7. Suptish Ghosh, Ayan Mondal, Gouri Tudu, **Sourav Ghosh**, Heramba V. S. R. M. Koppisetti, Harish Reddy Inta, Dipannita Saha, and Venkataramanan Mahalingam, *Efficient Electrochemical Reconstruction of a Cobalt- and Silver-Based Precatalytic Oxalate Framework for Boosting the Alkaline Water Oxidation Performance*, ACS Sustainable Chemistry & Engineering, 10, 7265, 2022

8. **Sourav Ghosh**, Harish Reddy Inta, Mohua Chakraborty, Gouri Tudu, Heramba V. S. R. M. Koppisetti, Khushboo S. Paliwal, Dipannita Saha, and Venkataramanan Mahalingam, *Nanoporous Graphitic Carbon Nitride Nanosheets Decorated with Nickel-Cobalt Oxalate for Battery-Like Supercapacitors*, ACS Applied Nano Materials, 5, 7246, 2022

9. **Sanjoy Choudhury**, Ashish Kr. Luhach, Waleed Alnumay, Buddhadeb Pradhan and Diptendu Sinha Roy, *A neuro evolutionary scheme for improved IoT energy efficiency in smart cities*, Computers and Electrical Engineering, 104(Part B), 108443, 2022

Total number of Journal Publications: 253

Other Publications

Department of Astrophysics and High Energy Physics

1. Soumen Mondal, Ramkrishna Das, Tapas Baug, and Mithilesh Pande - "S. N. Bose Astronomical Observatory: A new initiative in the Eastern part of India", Astronomical Society of India (ASI) Vision Document on the Observing facilities, December 2022

Department of Chemical and Biological Sciences

1. P. Barik and M. Pradhan (2022). All-Optical Detection of Biocompatible Quantum Dots. In: Barik, P., Mondal, S. (eds) Application of Quantum Dots in Biology and Medicine. Springer, Singapore (2022)

Department of Condensed Matter and Materials Physics

1. Chapter One - "Spin dynamics in patterned magnetic multilayers with perpendicular magnetic anisotropy" by Mateusz Zelent, Pawel Gruszecki, Mathieu Moalic, Olav Hellwig, Anjan Barman, Maciej Krawczyk in Book series "Solid State Physics", v.73, p.1-51, 2022
2. N S Das, K K Gogoi, A Chowdhury, A Roy, Investigation of optical and structural properties of synthesized graphene oxide and thermally reduced graphene oxide, Materials Today: Proceedings 76 (2023) 160–165
3. N S Das, N K Das, A Chowdhury, A Roy, Electrical studies of thermally annealed reduced graphene oxide polymer nanocomposites, Materials Today: Proceedings 74 (2023) 329–333
4. Swarnali Hait, Kalyan Mandal, "Enhancement of Curie temperature of gallium ferrite beyond room temperature by the formation of Ga0.8Fe1.2O3-Y3Fe5O12 composite", AIP Adv. 13 (2023). Conference Name and Details: MMM Conference, 31 October- 04 November 2022, Minneapolis, USA
5. Ordering of Fe2+ In Olivine Under Upper Mantle PT Conditions Z Gholami Mahmoodabadi, S Chatterjee, T Saha-Dasgupta AGU Fall Meeting Abstracts 2022, MR22A-0052
6. Effect of Mo doping on the electrical and magnetic properties of antiferromagnetic CrSe, Sayan Routh, Susanta Ghosh, P. K. Maheshwari, P. Singha Deo, S. Thirupathaiah, Materials Today: Proceedings, 65, 342-344 (2022)
7. Single Crystal Growth, Electrical, and Magnetic Properties Studies on Hexagonal CoSe, Shubham Purwar, Sayan Routh, S. Thirupathaiah, Materials Today: Proceedings, 65, 332-334 (2022)
8. Crossover from linear to quadratic magnetoresistance in $NiTe_2$, Indrani Kar and S. Thirupathaiah, Materials Today: Proceedings, 65, 70-73 (2022)

Total number of Other Publications: 10

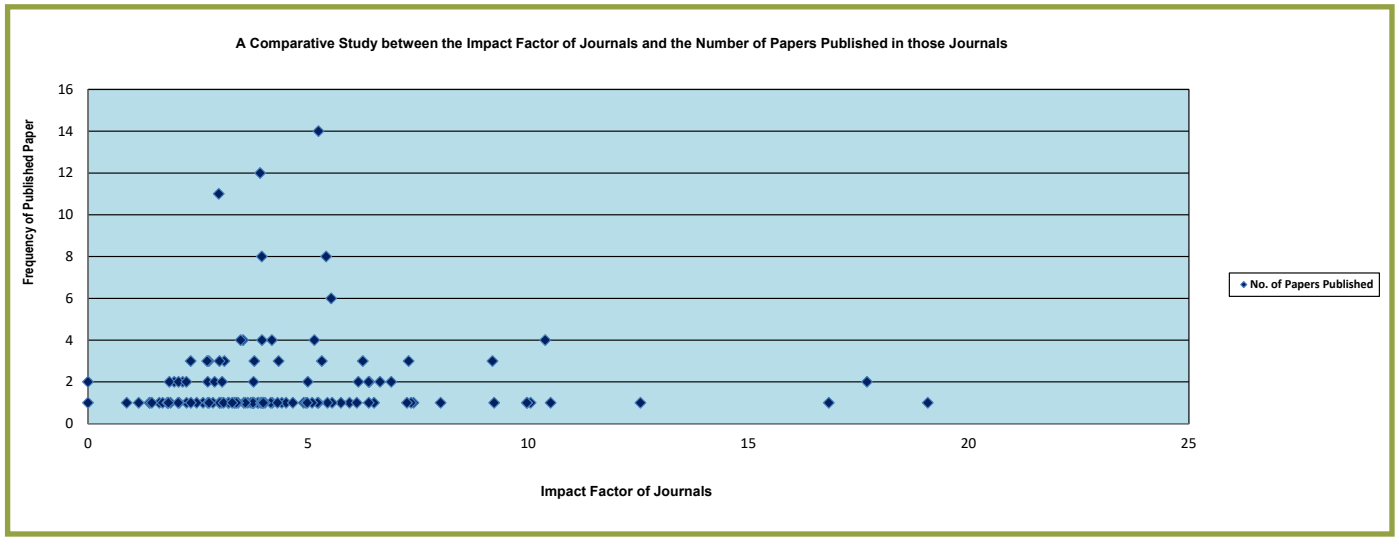
Impact Factor for publications in the Financial Year 2022-23

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
1	ACS Applied Electronic Materials	4.494	2	8.988
2	ACS Applied Energy Materials	6.959	1	6.959
3	ACS Applied Materials & Interfaces	10.383	4	41.532
4	ACS Applied Nano Materials	6.14	2	12.28
5	ACS Physical Chemistry Au	NA	2	NA
6	ACS Sustainable Chemistry & Engineering	9.224	1	9.224
7	Advanced Materials Interfaces	6.389	2	12.778
8	Advanced Optical Materials	10.05	1	10.05
9	Advanced Physics Research	NA	1	NA
10	Advanced Quantum Technologies	5.31	3	15.93
11	Advances in Space Research	2.611	1	2.611
12	Advances in Theoretical & Computational Physics	1.62	1	1.62
13	AIP Advances	1.697	1	1.697
14	Angewandte Chemie	16.823	1	16.823
15	Analytical Chemistry	8.008	1	8.008
16	Annals of Physics	3.036	1	3.036
17	Applied Nanoscience	3.869	1	3.869
18	Applied Physics A	2.983	1	2.983
19	Applied Physics Letters	3.971	1	3.971
20	Applied Surface Science	7.392	1	7.392
21	Applied Surface Science Advances	4.4	1	4.4
22	Archive of Applied Mechanics	2.467	1	2.467
23	Astronomy & Astrophysics	6.24	3	18.72
24	Astrophysical Journal	5.521	6	33.126
25	Batteries	5.938	1	5.938
26	Biochemistry	3.321	1	3.321
27	Biophysical Chemistry	3.628	1	3.628
28	Biopolymers	2.24	1	2.24
29	Biosensors	5.743	1	5.743
30	Biosensors and Bioelectronics	12.545	1	12.545
31	Biotechnology and Applied Biochemistry	2.724	1	2.724
32	Catalysts	4.501	1	4.501
33	Chemical Physics Impact	1.8	1	1.8
34	Chemical Physics Letters	2.719	2	5.438
35	Chemical Science	9.969	1	9.969
36	Chemistry of Materials	10.508	1	10.508

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
37	ChemMedChem	3.54	1	3.54
38	ChemPhysChem	3.52	4	14.08
39	Classical and Quantum Gravity	3.853	1	3.853
40	Communications in Nonlinear Science and Numerical Simulation	4.186	1	4.186
41	Communications Physics	6.497	1	6.497
42	Computational Biology and Chemistry	3.737	1	3.737
43	Computers and Electrical Engineering	4.152	1	4.152
44	Condensed Matter	3.7	1	3.7
45	Current Drug Delivery	3.758	1	3.758
46	ECS Journal of Solid State Science and Technology	2.07	1	2.07
47	Electrochimica Acta	7.336	1	7.336
48	Energy & Fuels	4.654	1	4.654
49	European Physical Journal B	1.398	1	1.398
50	European Physical Journal C	4.994	2	9.988
51	The European Physical Journal Plus	3.758	2	7.516
52	Europhysics Letters	1.958	2	3.916
53	Flexible and Printed Electronics	3.768	1	3.768
54	Frontiers in Chemistry	5.545	1	5.545
55	General Relativity and Gravitation	2.84	1	2.84
56	Infrared Physics & Technology	2.997	1	2.997
57	IEEE Sensors Letters	4.9	1	4.9
58	IEEE Transactions on Magnetics	1.848	2	3.696
59	Inorganic Chemistry	5.436	1	5.436
60	International Journal of Geometric Methods in Modern Physics	1.873	1	1.873
61	International Journal of Modern Physics B	1.404	1	1.404
62	iScience	6.107	1	6.107
63	Journal of Alloys and Compounds	6.371	2	12.742
64	Journal of Applied Physics	2.877	2	5.754
65	Journal of Chemical Physics	4.304	1	4.304
66	Journal of Chemical Sciences	2.15	2	4.3
67	Journal of Colloid and Interface Science	9.965	1	9.965
68	Journal of Cosmology and Astroparticle Physics	7.28	3	21.84
69	Journal of Electroceramics	1.814	1	1.814
70	Journal of Electronic Materials	2.047	1	2.047
71	Journal of High Energy Physics	6.376	1	6.376
72	Journal of Magnetism and Magnetic Materials	3.097	3	9.291
73	Journal of Molecular Liquids	6.633	2	13.266
74	Journal of Molecular Spectroscopy	1.451	1	1.451

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
75	Journal of Nanomedicine	1.15	1	1.15
76	Journal of the Optical Society of America B	2.058	2	4.116
77	Journal of Photochemistry and Photobiology A: Chemistry	5.141	4	20.564
78	Journal of Physical Chemistry B	3.466	4	13.864
79	Journal of Physical Chemistry C	4.177	4	16.708
80	The Journal of Physical Chemistry Letters	6.888	2	13.776
81	Journal of the Physical Society of Japan	1.828	1	1.828
82	Journal of Physics A: Mathematical and Theoretical	2.331	3	6.993
83	Journal of Physics: Condensed Matter	2.745	3	8.235
84	Journal of Statistical Mechanics: Theory and Experiment	2.234	2	4.468
85	Langmuir	4.331	3	12.993
86	Letters in High Energy Physics	0.88	1	0.88
87	Magnetochemistry	3.336	1	3.336
88	Materials	3.748	1	3.748
89	Materials Advances	3.181	1	3.181
90	Materials Letters	3.574	1	3.574
91	Materials Science and Engineering: B	3.407	1	3.407
92	Materials Today Sustainability	7.244	1	7.244
93	Materials Today: Proceedings	3.2	1	3.2
94	Monthly Notices of the Royal Astronomical Society	5.235	14	73.29
95	Monthly Notices of the Royal Astronomical Society: Letters	5.235	1	5.235
96	Nano Energy	19.069	1	19.069
97	Nanotechnology	3.953	4	15.812
98	Nature Communications	17.69	2	35.38
99	New Journal of Chemistry	3.925	1	3.925
100	Nuclear Physics B	3.045	2	6.09
101	Optics Communications	2.335	1	2.335
102	Pediatric Research	3.953	1	3.953
103	Pharmaceuticals	5.215	1	5.215
104	Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences	4.019	1	4.019
105	Physica A: Statistical Mechanics and its Applications	3.778	3	11.334
106	Physica B: Condensed Matter	2.988	3	8.964
107	Physica E	3.369	1	3.369
108	Physica Scripta	3.081	1	3.081
109	Physica Status Solidi (a): applications and materials science	3.277	1	3.277
110	Physical Chemistry Chemical Physics	3.945	8	31.56

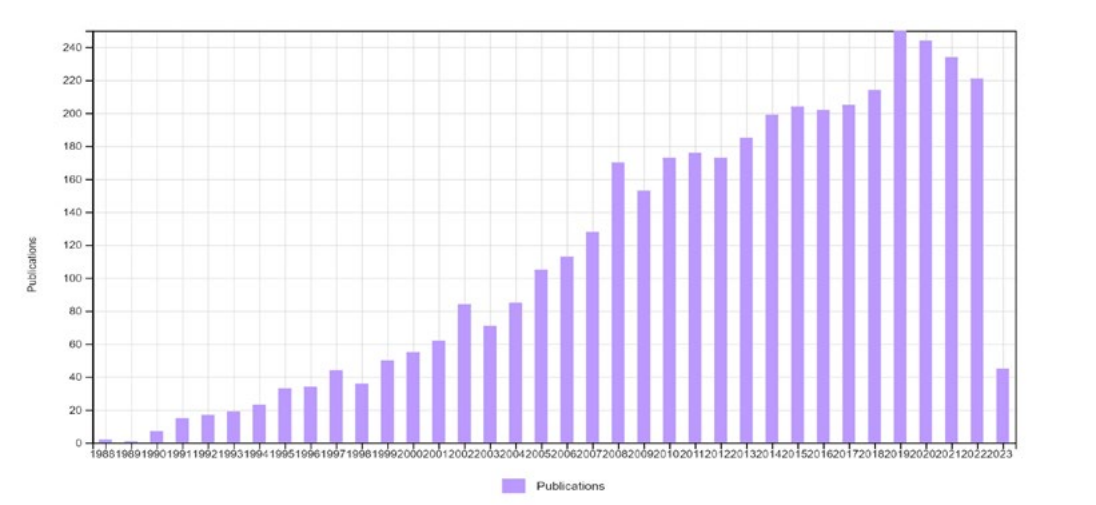
Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
111	Physics of the Dark Universe	5.09	1	5.09
112	Physical Review A	2.971	11	32.681
113	Physical Review B	3.908	12	46.896
114	Physical Review D	5.407	8	43.256
115	Physical Review E	2.707	3	8.121
116	Physical Review Letters	9.185	3	27.555
117	Physical Review Materials	3.98	1	3.98
118	Physics Letters B	4.95	1	4.95
119	Physics of the Earth and Planetary Interiors	2.748	1	2.748
120	Physics of Fluids	4.98	1	4.98
121	Pramana	2.669	2	5.338
122	Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences	3.213	1	3.213
123	Quantum	6.777	1	6.777
124	Quantum Information Processing	1.965	3	5.895
125	Research in Astronomy and Astrophysics	1.889	1	1.889
126	Review of Scientific Instruments	1.843	2	3.686
127	RSC Advances	4.036	2	8.072
128	Scientific Reports (Nature Publishing Group)	4.996	2	9.992
129	SciPost Physics	5.5	2	11
130	Small	15.153	1	15.153
131	Solid State Sciences	3.752	1	3.752
132	Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy	4.831	2	9.662
133	Theory and Applications of Categories	0.545	1	0.545
134	Universe	2.813	1	2.813
	TOTAL	**614.356**	**253**	**1067.684**

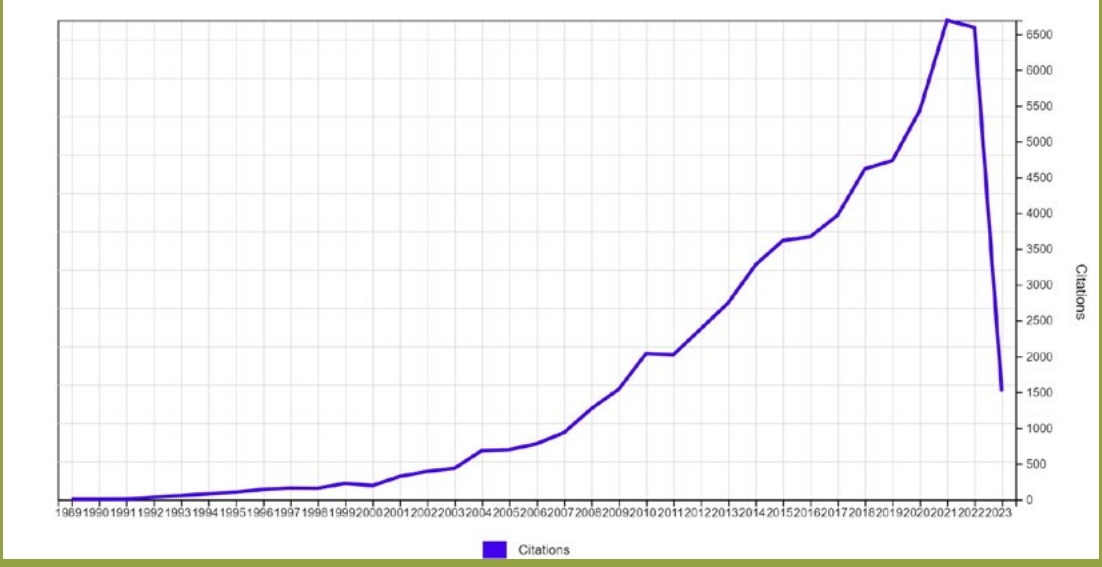


Research publication status

Citation Report (On 18th April, 2023)
Time span = All years. Database =SCI-EXPANDED, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC.

No. of Publications :	4032
Sum of the Times Cited :	61512
Sum of Times Cited without self-citations :	50495
Citing Articles :	40765
Citing Articles without self-citations :	37918





Total no. of Paperspublished	Total no. of Citation received	Citations per paper	Citation per year*	h-index
4032	61512	61512/4032= 15.26	61512 / 36 =1708.67	85

* Year of establishment of the Centre is 1986. Citations received after 1987 to 2023 = 36 years
Source : web of science
Prepared by : Dr. Saumen Adhikari, Librarian – cum – Information Officer


ZOOLOGY

Accounts

Satyendra Nath Bose National Centre for Basic Sciences

Block JD, Sector-III, Salt Lake, Kolkata – 700 106

BUDGET SUMMARY 2022-2023

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2022-2023.

(Figure in Lakhs)

	Actuals 2021-2022	Budget Estimate 2022-2023	Revised Estimate 2022-2023
Plan	4471.74	4598.72	4984.28*

* Sanctioned by DST Plan Rs. 4259.00 released as under:

Plan

Sl no.	Sanction Letter No.	Dated	Amount (Rs. in lakh)
1	AI/SNB/SAL/003/2022/1	21.06.2022	220.00
2	AI/SNB/SAL/003/2022/2	12.08.2022	370.00
3	AI/SNB/SAL/003/2022/3	11.10.2022	438.00
4	AI/SNB/SAL/003/2022/3	30.12.2022	625.00
5	AI/SNB/GEN/003/2022/1	10.06.2022	500.00
6	AI/SNB/GEN/003/2022/2	22.08.2022	370.00
7	AI/SNB/GEN/003/2022/3	14.11.2022	320.00
8	AI/SNB/GEN/003/2022/4	30.12.2022	686.00
9	AI/SNB/CAP/003/2022/1	10.06.2022	200.00
10	AI/SNB/CAP/003/2022/2	22.08.2022	200.00
11	AI/SNB/CAP/003/2022/3	14.11.2022	330.00
	TOTAL (PLAN)		**Rs. 4259.00**

INDEPENDENT AUDITOR'S REPORT

To the Governing Body of Satyendra Nath Bose National Centre for Basic Sciences

Qualified Opinion

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, 2023, 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.

Basis for Qualified Opinion

1. Liability for T.D.S default as per 26AS statement for Financial Year 2022-23 of Rs. 4843.00 has not been provided in the accounts.

   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) As per 26AS statement for the AY (2023-24), Rs. 25,51,438.00 and Rs.29,135/- are refundable against Tax Deducted at Source and Tax Collected at Source respectively, for which the Centre is yet to submit the required income tax return.

b) The Centre has taken up the physical verification of assets through external agency, but the report is yet to be submitted to the Centre. Hence, we cannot comment on the valuation of Fixed Assets taken in books of account as on 31.03.2023

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

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 onthe 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 Roy & Bagchi,
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
M. No. -060694

UDIN: 23060694BGXBYU6642

Place: Kolkata
Date: 31.08.2023

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

BALANCE SHEET AS AT 31ST MARCH 2023

Amount (Rs.)

FUNDS AND LIABILITIES	Schedule	Current Year	Previous Year
Capital / Corpus Fund	1	1348893098.36	1339278916.58
Reserves And Surplus	2	-	
Earmarked/Endowment Funds	3	296187801.93	294625792.61
Secured Loans And Borrowings	4		
Unsecured Loans And Borrowings	5		
Deferred Credit Liabilities	6		
Current Liabilities And Provisions	7	48792269.22	81416704.58
TOTAL		**1693873169.51**	**1715321413.77**
ASSETS			
Fixed Assets	8	866186938.41	706776267.04
Investments-From Earmarked/Endowment Funds	9	192121693.00	194150237.00
Investments - Others	10	479577646.00	578938579.00
Current Assets, Loans, Advances Etc.	11	155986892.10	235456330.73
Miscellaneous Expenditure			
(to the extent not written off or adjusted)			
TOTAL		**1693873169.51**	**1715321413.77**
Significant Accounting Policies	24		
Contingent Liabilities And Notes On Accounts	25		

As Per our report of even date
For Roy & Bagchi
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
Membership no: 060694

Date: 31/08/2023
Place: Kolkata

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2023

Amount (Rs.)

	Schedule	Current Year	Previous Year
INCOME			
Income from Services	12	11265542.15	8199279.95
Grants/Subsidies	13	305423171.00	322300000.00
Fees/Subscriptions(Student Admission & Semester Fees)	14	1545501.00	982504.00
Income from Investments (Income on Investment)	15	24565712.00	
from earmarked/endowment Funds transferred to Funds)			
Income from Technology Transfer & Contract Project	16	0.00	560000.00
Interest Earned on Term Deposits (including in on HBA)	17	15624.00	301532.00
Other Income	18	1074686.00	1760626.28
Increase/(decrease) in stock of finished goods and	19		
works-in-progress			
TOTAL (A)		**343890236.15**	**334103942.23**
EXPENDITURE			
Establishment Expenses	20	165404561.00	140762100.00
Other Administrative Expenses etc.	21	206901765.27	17065139 7.68
Expenditure on Grants, Subsidies etc.	22		
TOTAL (B)		**372306326.27**	**311413497.68**
Balance being excess of Income over Expenditure(A-B)		-28416090.12	22690444.55
Prior period adjustments (Credit)		271564.28	772341.12
Transfer to/from Capital Fund			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO			
CORPUS/CAPITAL FUND		-28144525.84	23462785.67
Significant Accounting Policies	24		
Contingent Liabilities And Notes On Accounts	25		

Date: 31.08.2023

Place: Kolkata

As Per our report of even date

For Roy & Bagchi

Chartered Accountants

FRN: 301053E

(Amit Mitra)

Partner

Membership no:060694

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

RECEIPTS AND PAYMENTS ACCOUNTS For the year ended 31st March 2023

Amount (Rs.)

RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
I. Opening Balances			I. Expenses :		
a) Cash in hand	17877.00	9083.00	a) Establishment Expenses	207101769.00	157510669.00
b) Bank Balances :			b) Administrative Expenses	95282270.08	122699361.60
I. In current accounts(Schd 11A)	114243200.96	82541353.63	c) Maintenance	5318527.00	3619035.00
ii. In deposit accounts			II. Payments made against funds for		
Schedule - 10	596732724.00	519520689.00	various Projects		
Schedule - 11A	1192809.00	22042464.00			
iii. Savings accounts (Schd 11A)	49935060.20	58387229.80	III. Investments and deposits made		
iv. Remittance-in-Transit			a) Out of Earmarked/Endowment	0.00	10000000.00
II. Grants Received			b) CPWD Deposit and NBCC Deposit		
a) From Government of India			c) Bank Gurantee & LC A/C		20849655.00
-For the year	447874865.00	515973268.00	d) Out of Own Fund	258620290.00	125000000.00
-For the previous year					
b) From State Government			IV. Expenditure on Fixed Assets &		
c) From Other sources (details)			Capital Work-in-Progress		
(Grants for capital & revenue exp.			a) Purchase of Fixed Assets	189400272.00	121013634.24
To be shown separately)			b) Expenditure on Capital Work-in-Progress		
			V. Refund of Interest		
III. Interest Received			a) To the Government of India		15206049.00
a) On Bank deposits	5531552.00	7184045.76	b) To the State Government		
			c) To other providers of funds		
IV. Other Income	12730092.00	11502606.28	VI. Finance Charges (Interest)		
V Amount Borrowed			VII. Other Payments	136031669.43	45011470.93
VI. Any other receipts	7847732.88	6274281.46	VIII. Closing Balances		
			a) Cash in hand	4934.00	17877.00
VII. Amount transferred from Current Account/	278892693.00	77212035.00	b) Bank Balances :		
Savings Account to Deposit Account.			I. In current accounts(Schd 11A)	33929134.53	114243200.96
			ii. In deposit accounts		
VIII. Amount transferred from Deposit Account	2522232.00	114955812.00	Schedule - 10	479577646.00	596732724.00
to Savings Account & Currect Account.			Schedule - 11A	0.00	1192809.00
			iii. Savings accounts(Schd.11A)	64387626.00	49935060.20
			iv. Remittance-in-Transit		
	1517520838.04	**1415602867.93**		**1517520838.04**	**1415602867.93**

Per our report of even date
For Roy & Bagchi
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
Membership no: 060694

Date:31.08.2023
Place: Kolkata

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 1 -CAPITAL FUND:

Amount (Rs.)

	Current Year		Previous Year	
Balance as at the beginning of the year	1339278916.58		1198723826.32	
Add : Contributions towards Corpus/ Capital Fund	72999342.00		148500000.00	
Less:Depreciation for the year	35240634.38		31407695.41	
Add : Surplus / Deficit during the year	-28144525.84		23462785.67	
		1348893098.36		1339278916.58
BALANCE AS AT THE YEAR - END		**1348893098.36**		**1339278916.58**

SCHEDULE 2 - RESERVES AND SURPLUS:

	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

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 3 - EARMARKED/ ENDOWMENT FUNDS

Amount (Rs.)

	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	29066319.63	12490817.98	107303424.00	10053382.00	23292849.00	294625792.61	33568199722
b) Additions to the Funds							
I) Donations/grants/ Contributions	0.00	69448452.00	17260569.00	1319150.00	1079847.50	89108018.50	60167776.00
ii) Income from investments made on	618238.00	4387584.00	7276542.00	417286.00	798407.00	13498057.00	14068633.00
account of funds							
iii) Other additions -Provision during							
the year							
TOTAL (a + b)	**29684557.63**	**198745853.98**	**131840535.00**	**11789818.00**	**25171103.50**	**397231868.11**	**409918406.22**
c) Utilisation/Expenditure towards							
objectives of funds							
I) Capital Expenditure							
Fixed Assets	137695.00	8962077.00				9099772.00	42627864.01
Others							
Total							
ii) Revenue Expenditure							
Salaries, Stipend and		29712497.00				29712497.00	33091412.00
allowances etc.							
Rent							
Other Administrative							
expenses							
Other Payments	304835.78	13457023.40	2513519.00	417286.00		16692664.18	29652106.60
iii) Adjustment							
Interest Refunded to DST	3323165.00	141977.00				3465142.00	9921231.00
Unspent Balance Refunded	24878000.00	17195991.00				42073991.00	
TOTAL (c)	**28643695.78**	**69469565.40**	**2513519.00**	**417286.00**	**0.00**	**101044066.18**	**115292613.61**
NET BALANCE AS AT THE YEAR-END (a+b-c)	1040861.85	129276288.58	129327016.00	11372532.00	25171103.50	296187801.93	294625792.61

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 4 - SECURED LOANS AND BORROWINGS:

Amount (Rs.)

	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 (Rs.)

	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:

	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

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 7 - CURRENT LIABILITIES AND PROVISIONS

Amount (Rs.)

	Current Year		Previous Year
A. CURRENT LIABILITIES			
1. Acceptances			
2. Sundry Creditors:			
a) For Capital expenditure	4979152.00		8158201.00
b) Others - Revenue expenditure (including TRC & Project)	9055454.00		14574669.00
3. Othert Liabilities	7955462.88		2704860.88
4. Deposit from Contractors (including Project & TRC)	10644816.50		12301556.00
5. Deposit from Students	2229500.00		2249500.00
6. Deposit from Contractual Employees	1601023.00		1598434.00
7.Provident Fund Account (Payable)	1554375.80		0.00
8.Project Overhead Fund	7783807.53		7319228.43
9.Interest earned on fixed deposit and savings bank (Refundable to DST)	0.00		29551006.76
10.Employees Welfare Fund	129429.00		100000.00
11. EVLP Overhead Fund	2859248.51		2859248.51
TOTAL (A)	**48792269.22**		**81416704.58**
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)	**48792269.22**		**81416704.58**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 8 - FIXED ASSETS

Amount (Rs.)

DESCRIPTION	GROSS BLOCK				DEPRECIATION				NET BLOCK	
	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	Adjus ment 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	449356225.86	5700004.00		455056229.86	80800626.35	7158078.75		87958705.10	367097524.76	368555599.51
b) On Freehold Land										
c) Ownership Flats/Premises										
d) Superstructures on Land not belonging to the entity										
3. PLANT MACHIENRY & EQUIPMENT	55303207.45	122575525.00		675607532.45	460765132.51	20732976.80		481498109.31	194109423.14	92266874.94
4. VEHICLES	1042199.00	0.00		1042199.00	631195.08	85640.84		716835.92	325363.08	411003.92
5. FURNITURE, FIXTURES	4322034.22	7850592.00		51070926.22	37475227.37	1328497.11		38803724.48	12267201.74	5745106.85
6. OFFICE EQUIPMENT	6205896.29	669114.00		6875010.29	5701268.12	172090.09		5873358.21	1001652.08	504628.17
7. COMPUTER & LAN INSTALLATION	96688175.44	49262934.75		145951110.19	77081686.02	5021693.00		82103379.02	63847731.17	19606489.42
8. ELECTRIC INSTALLATIONS	11699040.00	0.00		11699040.00	9474985.71	74165779		10216643.50	1482396.50	2224054.29
9. LIBRARY BOOKS	273040722.11	8593136.00		281633858.11	69586478.05			69586478.05	212047380.06	203454244.06
10. TUBEWELLS & W.SUPPLY								0.00	0.00	-
11. OTHER FIXED ASSETS	84225.55	0.00		84225.55	80014.27			80014.27	4211.28	4211.28
TOTAL OF CURRENT YEAR	1445319480.52	194651305.75	0.00	1639970786.27	741596613.48	35240634.38	0.00	77683724786	863133538.41	703722867.04
PREVIOUS YEAR	1381529652.29	63967993.23	1,78,165.00	1445319480.52	710291516.34	31407695.41	1,02,598.27	741596613.48	703722867.04	703722867.04
B. CAPITAL WORK IN PROGRESS	3053400.00			3053400.00	-	-	-	0.00	3053400.00	3053400.00
TOTAL (A + B)	1448372880.52	194651305.75	0.00	1643024186.27	741596613.48	35240634.38	0.00	77683724786	866186938.41	706776267.04

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS

Amount (Rs)

	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	66247478.00	63540324.00
7. Retirement Benefit Fund Investment	104094692.00	93577032.00
8. Staff Medical Fund Investment	7047708.00	6789112.00
9. Corpus Fund Investment (Project Overhead)	14731815.00	12449624.00
10.TRC Fund Investment	0.00	17794145.00
TOTAL	**192121693.00**	**194150237.00**

SCHEDULE 10 - INVESTMENTS - OTHERS

Amount (Rs)

	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)	323480333.00	487261365.00
Fixed Deposit with Union Bank of India	156097313.00	91677214.00
TOTAL	**479577646.00**	**578938579.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2023

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.

Amount (Rs.)

	Current Year		Previous Year	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares		32868.57		32969.57
2) Cash balances in hand		4934.00		17877.00
3) Bank Balances:				
a) With Scheduled Banks:				
On Current Accoutns:				
Indian Overseas Bank (CA-089302000000220)	2166307.18		82169274.16	
Indian Overseas Bank (CA-089302000000273)	3479505.55		12580128.75	
Union Bank of India (CA-460901010034252)	6824170.95		3327974.42	
HDFC Bank (GEM)(373218248)	12184.00		45340.00	
Reserve Bank of India(TSA)	24776.00	32009943.68		9812717.33
On Deposit Accounts for LC&BG:				
Indian Overseas Bank (CA-089302000000220)	24806691.00		27328923.00	
Indian Overseas Bank (SB-089301000018598 TRC)				
Indian Overseas Bank (CA-089302000000273 PROJECT)		24806691.00	1192809.00	28521732.00
On Savings Accounts:				
Indian Overseas Bank(SB-089301000010662 UNAST)	3770610.60		3668215.00	
Indian Overseas Bank(SB-089301000012029 SYNC.)	840319.96		817571.36	
Indian Overseas Bank(SB-089301000011479 NANO TECH)	595777.66		579676.06	
Union Bank of India (SB-460901110050013)	8046874.97		8046945.77	
Axis Bank (SB-775010100024408)	426984.00		223174.00	
Axis Bank (SB-775010100017860)	1906.00		1850.00	
BOM(1817)	4722041.00			
BOM(3237)	24071569.00			
Indian Overseas Bank-(SB-089302000019902)	20509911.80			
Union Bank of India(SB-460902010097273 TRC)	68242.80		66356.80	
Indian Overseas Bank (SB- 089301000018598 TRC)	1850948.05		16054126.83	
HDFC Bank (SB-6771192)	1401631.01		615794.01	
		66306816.85	35981834.00	66055543.83
5. Remittance - in - Transit				
6. Post Office-Savings Accounts				
TOTAL (A)		**123161254.10**		**192750839.73**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEUDLES FORMING PART OF BALANCE SHEET AS AT 31.03.2020

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.(Contd.)

Amount (Rs.)

	Current Year		Previous Year	
B. LOANS, ADVACNES AND OTHER ASSETS				
1. Loans:				
a) Staff including HBA ,Vehicle &PC Advance(includes Project A/c)		155000.00		146825.00
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	377073.00		305430.00	
d) Contractors & Suppliers	323347.00	1139260.00	5375275.00	6119545.00
3. Income Accrued:				
a) On Investments from Earmarked/Endowment Funds(Including Project & TRC)	20958302.00		24993222.00	
b) On investmetns - Others	8436645.00		8699768.00	
c) Income tax (TDS) Refundable		29394947.00		33692990.00
4.Sundry Debtors - National Research Development Corporation		2030313.00		2657513.00
5. Security Deposit (including Project)		106118.00		88618.00
TOTAL (B)		**32825638.00**		**42705491.00**
TOTAL (A + B)		**155986892.10**		**235456330.73**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

SCHEDULE 12 - INCOME FROM SALES/SERVICES

Amount (Rs.)

	Current Year	Previous Year
1) Income from Sales		
a) Sale of Finished Goods		
b) Sale of Raw Material		
c) Sale of Scraps	484250.00	
2) Income from Services		
a) Guest House Rent	1948300.00	364299.95
b) Hostel Charges (Recovery of HRA)	5670237.00	5717635.00
c) Equipment Utilisation Fees	449000.00	474700.00
d) Hostel Maintenance Fees	1937455.00	1161723.00
e) Project Overhead	431939.40	389449.00
f) Income from BSNL	141107.00	54973.00
g) Seminer Hall Rent	0.00	0.00
h) Dining Hall Rent	0.00	0.00
i) Recovery of Water Charges	0.00	0.00
j) Conference Registration Fee	202000.00	36500.00
k) Profit on Retention of Laptop	1253.75	
TOTAL	**11265542.15**	**8199279.95**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

SCHEDULE 13 - GRANTS/SUBSIDIES

(Irrevocable Grants & Subsidies Received) Amount (Rs.)

	Current Year	Previous Year
1) Central Government	305423171.00	322300000.00
2) State Government(s)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organsations		
6) Others		
TOTAL	**305423171.00**	**322300000.00**

SCHEDULE 14 - FEES/SUBSCRIPTIONS

Amount (Rs.)

	Current Year	Previous Year
1) Student Admission Fee	132501.00	126504.00
2) Annual Fees/Subscriptions		
3) Student Semester Fee	1413000.00	856000.00
4) Consultancy Fees		
5) Others		
TOTAL	**1545501.00**	**982504.00**

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 (Rs.)

	Investment from Earmarked Fund		Investment - Others	
	Current Year	Previous Year	Currnet Year	Previous Year
1) Interest				
a) On Govt. Securities				
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	24066810.00			
b) Interest on SB Accounts	498902.00			
TOTAL	**24565712.00**	**Nil**	**Nil**	**Nil**
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS	**Nil**	**Nil**	**Nil**	**Nil**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK-JD, SECTOR III, SALT LAKE CITY, KOLKATA 700 106

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

SCHEDULE 16 - INCOME FROM TECHNOLOGY TRANSFER & CONTRACT PROJECT

Amount (Rs.)

	Current Year	Previous year
1. Income from Technology Transfer		560000.00
2. Income from Contract Project		
3. Others		
TOTAL	**0.00**	**560000.00**

SCHEDULE 17 - INTEREST EARNED

Amount (Rs.)

	Current Year	Previous year
1) On Term Deposits:		
a) With Scheduled Banks		
b) With Institutions		
c) Others		
2) On Savings Accounts:		
a) With Scheduled Banks		
b) Post Office Savings Accounts		
c) Others		
3) On Loans:		
a) Employees/Staff (Interest on HBA etc.)	15624.00	301532.00
b) Others		
4) Interest on Debtors and Other Receivables		
TOTAL	**15624.00**	**301532.00**

SCHEDULE 18 - OTHER INCOME

Amount (Rs.)

	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	1074686.00	1760626.28
TOTAL	**1074686.00**	**1760626.28**

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SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS

Amount (Rs.)

	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

	Current Year	Previous Year
a) Salaries and Wages	126933421.00	117502728.00
b) Other Allowances and Bonus	0.00	0.00
c) Employer's Contribution to Provident Fund	3152185.00	3534961.00
d) Contribution to Retirement Benefits Fund	16724007.00	10108074.00
e) Staff Welfare Expenses (Medical)	3669973.00	3003569.00
f) Employer's Contribution to NPS	12002345.00	5390774.00
g) Others (LTC, Leave Encashment on LTC, Re-imbursement of Tuition Fees etc.)	2922630.00	1221994.00
TOTAL	**165404561.00**	**140762100.00**

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.

Amount (Rs.)

	Current Year	Previous Year
a) Extended Visitors Programme.(Including Seminars & Workshops)	21635553.30	11466656.00
b) Meeting Expenses	1212737.00	720682.00
c) Library General Expenses	74011.00	120108.00
d) Electricity and Power	34917178.00	35709722.00
e) Laboratory Expenses	12689570.00	9780903.00
f) Insurance	36707.00	30383.00
g) Repairs and Maintenance	66728055.00	50000956.00
h) TPSC Programme	614000.00	0.00
i) Parliamentary Committee Meeting Exps	0.00	0.00
j) Vehicles Hire Charges	1705009.00	1930574.00
k) Postage, Telephone and Communication Charges	985775.00	871883.00
l) Printing and Stationary	1793414.00	1169333.00
m) Travelling and Conveyance Expenses	2443845.00	134250.00
n) Contingency to Faculty	0.00	20000.00
o) Auditors' Remuneration	59000.00	59000.00
p) Bank Charges	211797.45	193899.83
q) Professional Charges (Legal Charges)	20793.00	18896.00
r) Staff Training & Welfare	514136.00	89718.00
s) Patent & Trademark	48451.00	106714.00
t) Integrated Ph.D.	2724857.00	1129831.00
u) Hindi Programme	157206.00	764320.00
v) Advertisement and Publicity	246641.00	199484.00
w) Others	2120552.52	1104977.85
x) Municipal Tax	141388.00	141388.00
z) Contract Services	18606757.00	18161958.00
z1) Stipend (Post BSc. & Post MSc.)	37214332.00	36725761.00
TOTAL	**206901765.27**	**170651397.68**

SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.

Amount (Rs.)

	Current Year	Previous Year
a) Grants given to Institutions/Organisations		
b) Subsidies given to Institutions/Organisations		
TOTAL	**Nil**	**Nil**

SCHEDULE 23 - INTEREST

Amount (Rs.)

	Current Year	Previous Year
a) On Fixed Loans		
b) On Other Loans (including Bank Charges)		
c) others		
TOTAL	**Nil**	**Nil**

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

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.

2. INVENTORY VALUATION

2.1 Stores and Spares (including machinery 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.

4.3 Library Books are accounted for on receipt basis and Journals are accounted for on payment basis.

4.4 Expenditure incurred for purchasing Computer etc. out of Spares & Repair Expenses of Equipment allocation are charged to revenue.

5. DEPRECIATION

5.1 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.

5.2 Depreciation is provided on straight-line method as per rates specified in the Companies Act, 2013.

5.3 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.

5.4 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.

5.5 No depreciation has been provided on Books and Journals for the year since it is not mentioned in the Companies Act, 2013.

5.6 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

6. FOREIGN CURRENCY TRANSACTIONS

6,1 Transactions denominated in foreign currency are accounted at the exchange rate prevailing at the date of transaction.

7. RETIREMENT BENEFITS

7.1 Liability towards gratuity payable on death/ retirement of employees is computed on the assumption that employees are entitled to receive the benefit as at each year end.

7.2 Provision for accumulated leave encashment benefit to the employees is accrued and computed on the assumption that employees are entitled to receive

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2023

the benefit as at each year end.

7.3 Liabilities under above accounts are invested separately in fixed deposit accounts with nationalized bank.

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. 1,81,06,372/- (Previous year Rs.1,31,88,209.00) 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. Nil (Previous year Rs. Nil).

2.2.1 Physical verification of fixed assets has been entrusted to an out side agency and verification is under process, adjustments if any will be given in the accounts on the submission of the Physical Verification Reports.

2.2.2 Capital work-in-progress as on 1st April, 2022 was Rs.30,53,400.00 addition during the year is Rs.Nil -,totaling to Rs.30,53,400.00 an amount of Rs.0.00 has been capitalized, leaving balance of Rs.30,53,400.00 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 :

	Current Year	Previous Year
- Capital Goods	Rs.2,21,25,361/-	Rs.3,66,83,739/-
- Consumables	Rs.53,11,119/-	Rs.8,61,978/-

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.

Kolkata
Dated: 31.08.2023

For Annual Report (2022-23)

PARA-WISE REPLIES TO THE AUDIT OBSERVATIONS

Sl	Audit Observations	Para-wise replies
1	Liability for T.D.S default as per 26AS statement for Financial Year 2022-23 of Rs. 4,843.00 has not been provided in the accounts	The observation is noted for future compliance.
2	As per 26AS statement for the AY(2023-24) , Rs.25,51,438.00 and Rs.29,135.00 are refundable against Tax Deducted at Source and Tax Collected at Sources respectively, for which the Centre is yet to submit the required income tax return	The Centre will submit online Income Tax Return (ITR-7) for the Assessment Year (2023-24) relating to Financial Year(2022-23) based on audited Accounts by the end of September,2023 in order to claim the refund of TDS (Rs. 25,51,438.00) and TCS(Rs.29,135.00).
3	The Centre has taken up the physical verification of assets through external agencies, but the report is yet to be submitted to the Centre. Hence, we can not comment on the valuation of Fixed Assets taken in books of account as on 31.03.2023.	Physical Verification of Fixed Assets will be completed very soon. Report will be submitted in the next spell of Audit.

Satyendra Nath Bose National Centre for Basic Sciences

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