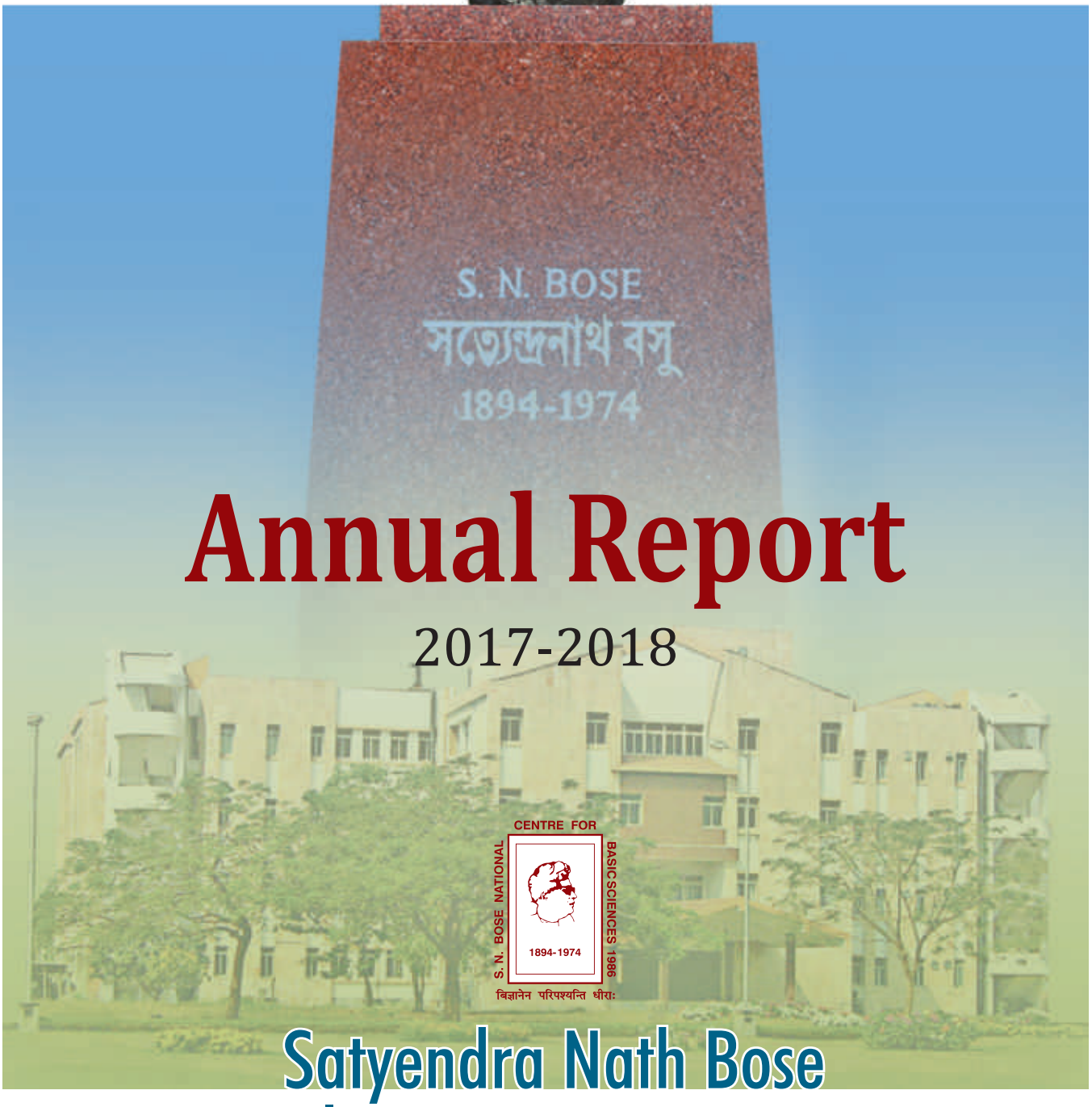
Annual Report 2017–18

2018 BOSE 125 Celebrating 125th Birth Anniversary

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

Satyendra Nath Bose National Centre for Basic Sciences



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Satyendra Nath Bose
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E-mail : saileepress@yahoo.com

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 eighth 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 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 second time the Annual Report is translated and typed in Hindi within the Centre. The Hindi Officer, Sadhana Tiwari has given sincere fatigueless effort to translate the entire Annual Report in Hindi and library staff - 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 is my pleasure to present the Annual Report of the Satyendra Nath Bose National Centre for Basic Sciences for the year 2017-18. The year will go down as the landmark year in the annals of the Centre on the occasion of 125th birth anniversary of Satyendra Nath Bose. The Centre, befittingly chosen to bear the name of the colossal physicist, launched the year long commemoration programme on 1st January, 2018 to pay homage to the legendary scientist. The curtain raiser ceremony was inaugurated by Hon'ble Prime Minister of India, Shri Narendra Modi, through video conferencing in presence of Dr. Harsh Vardhan, Hon'ble Minister, Ministry of Science & Technology, Earth Sciences and Environment, Forests and Climate Change, Government of India; Shri Y. S. Chowdary, Hon'ble Minister of State, Ministry of Science and Technology and Earth Sciences, Government of India, Prof. Ashutosh Sharma, Secretary Department of Science & Technology,Dr. Srikumar Banerjee, Chairman, Governing Body of S. N. Bose Centre and other honourable invitees. The ceremony on 1st January 2018 at the Centre included the release of a special cover on S. N. Bose by the Dept. of posts, the release of a documentary film on Bose, the inauguration of a new Bose Archive & Museum and organizing the first BOSE-125 public and distinguished lectures.

During the last one year the institute scaled new heights in terms of peer recognition and academic achievements. In the last one year there have been 179 publications in referred journals and 29 other types of publications, 17 students were awarded PhD Degree and 21 others submitted their PhD theses. There were 181 PhD students and 23 post-doctoral research students associated with active and productive faculty strength of 32 during 2017-18. I sincerely congratulate all my colleagues for their admirable efforts towards achieving excellence. Beginning 1st January 2018, the Centre has organized several BOSE-125 public, memorial and distinguished lectures and Workshops / Conferences, as reported in the activities of BOSE-125 celebration. The most notable of them was the visit of Nobel laureate Prof. Wolfgang Ketterle to the Centre for delivering the S. N. Bose memorial lecture and a public lecture in the Science City on March 27, 2018 for the College & University students.

Earning extramural research funding has always been one of the primary objectives of the faculty & Scientists, which is evident from the funding of Rs. 3,04,37,606.00 in 2017-18.. The challenging TRC project supported by DST to *establish an application inspired Innovation and Technology Centre is in the midway. Several prototypes have been developed in TRC and efforts are underway for the transfer of some of the technologies*. As per its original mandate, the Centre has taken a leading role on science networking and outreach activities through Theoretical Physics Seminar Circuit (TPSC), EVLP visiting Associates, summer interships, C. K. Majumdar Memorial Summer Workshop and Vidyasagar – Satyendranath Bose National Workshop etc. On the occasion of BOSE-125 celebration, the Centre has further strengthened its outreach programmes in Schools, Colleges and other academic institutes in the national level. The Centre also takes the pride of hosting the 2nd DST conclave attended by the Directors / Heads of the DST autonomous institutes and Professional bodies in presence of the Secretary DST and Dr. Harsh Vardhan, Hon'ble Minister, Ministry of Science & Technology, Earth Sciences during May 2-3, 2017.

My gratitude to the members of the statutory and advisory and internal administrative committees of the Centre for their cooperation and support. Sincere thanks to all the members of the Centre for their profound involvement towards continuous growth of the Centre and the Annual Report Committee for making timely report.

I wish more productive years ahead and hope our endeavour to mandated tasks would lead the Centre to reach a new height in future.

Samit Kumar Ray
Director
S. N. Bose National Centre for Basic Sciences

DEAN
FACULTY

In the year 2017-18, celebrations on account of the 125th birth anniversary of Prof. S. N. Bose were launched. The Centre was involved in several academic activities related to scientific collaborations, hosting national and international conferences, workshops, schools, and organizing outreach programmes, refurbishing of the Bose Archives, etc. Our faculty continued to publish in top quality international journals. In this fiscal year, the total number of publications was 179.

Throughout the year, we organized numerous seminars and distinguished lectures on various topics delivered by scientists ranging from young graduate students to well-established ones. Our ongoing collaborations with various countries like USA, UK, Russia, Germany, Sweden, Japan, etc. 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 at the Centre.

This year two new faculty members have joined in the Departments of TS and CMPMS. Additionally, twelve Post Doctoral Research Associates have joined the Centre. Four of our faculty members were promoted to Senior Professor, two were promoted to Associate Professor, one was promoted to Scientist 'D' and two have superannuated.

The following faculty members received awards/recognitions:

- Prof. Samit K. Ray has been elected as the Fellow of the National Academy of Sciences India, 2017.
- Prof. Priya Mahadevan has been elected as the Member of the Commission on Computational Physics of the International Union of Pure and Applied Physics.
- Prof. Samir Kumar Pal has been awarded the Professor P K Bose Memorial Award, 2016 from the Indian Chemical Society.
- Prof. Ranjit Biswas has been invited as a member of the Editorial Board of 'Journal of Chemical Sciences' from January 2018 to December 2020.
- Dr. Manik Pradhan has been awarded the "Dayawati Rastogi Award" for the best invited lecture in ICSBAM-2017.
- Prof. Anjan Barman has been selected as a Program Committee Member of the 23rd International Colloquium on Magnetic Films and Surfaces (ICMFS-2018), to be held at the University of California, USA.

Asmajumdar

Archan S. Majumdar
Dean (Faculty)

DEAN
ACADEMIC PROGRAMME

We are proud to present the Dean (AP)'s Annual Report on the Academic activities and the Visitors Linkage programme of the Centre during the period April 2017- March 18.

As one of the India's leading academic communities, we go great lengths to bring together the best faculty and most promising students and try our best to provide them the the necessary resources they need to do their best work. The knowledge created here is the great public good we contribute to the Society. It is inspiring to see how many world-changing ideas trace their lineage back to the Yard. These advancements in knowledge bring opportunities to seek solutions.

This report highlights achievements in each of our programme conducted at the Centre i.e, Integrated PhD. Programme & PhD. Programme. In the academic year 2017-18, a total of 31 students joined the PhD Programme including students promoted as JRF from IPhD Programme. Of these, 02 joined Astrophysics & Cosmology, 16 joined Condensed Matter Physics and Material Science, 08 joined Chemical, Biological and Macromolecular Sciences and 05 joined Theoretical Sciences. While 06 students joined I. PhD Programme of the Centre.

The Academic Activities expanded considerably during this time period in different areas of Basic Sciences. Our ongoing commitments towards fostering and promoting the growth of advanced studies in selected branches of basic Sciences drives us to develop Scholars through the discovery, application and communication of knowledge. We work with our vast network of collaborators both within and outside India who help us to prepare young minds so that they can meet the changing needs of the society.

It is my privilege to work with the group of incredibly thoughtful, energetic and inspiring faculty members, teachers, administrative staff and students. The innovations and achievements highlighted in this report – as well as the many other successes not profiled – are the outcome of relentless efforts by countless individuals whose dedication to the program and our students has been unwavering.

COURSES TAUGHT IN 2017-18

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

1st Semester:

- PHY 101, *Classical Dynamics*, Amitabha Lahiri;
- PHY 102, *Mathematical Methods*, Prosenjit Singha Deo & Samir Kumar Paul;
- PHY 103, *Quantum Mechanics I*, M Sanjay Kumar;
- PHY 104, *Computational Methods in Physics I*, Subhrangshu S Manna;
- PHY 191, *Basic Laboratory I*, Samir Kumar Pal & Soumen Mondal.

2nd Semester:

- PHY 201, *Statistical Mechanics*, Sakuntala Chatterjee;
- PHY 202, *Quantum Mechanics II*, M Sanjay Kumar;
- PHY 203, *Electromagnetic Theory*, Sunandan Gangopadhyay;

- PHY 204, *Computational Methods in Physics II*, Jaydeb Chakrabarti;
- PHY 291, *Basic Laboratory II*, Kalyan Mandal & P K Mukhopadhyay.

3rd Semester:

- PHY 301, *Atomic & Molecular Physics*, Anjan Barman & Rajib Kumar Mitra;
- PHY 302, *Condensed Matter Physics*, Priya Mahadevan;
- PHY 303, *Advanced Quantum Mechanics & Applications*, Biswajit Chakraborty & Archan S Majumdar;
- PHY 304, *Project Research II*, Faculty Supervisors;
- PHY 391, *Methods of Experimental Physics*, Kalyan Mandal (Coordinator), Arup K Raychaudhuri, Barnali Ghosh (Saha), Manik Pradhan, Ramkrishna Das & Madhuri Mandal.

4th Semester:

- PHY 401, *Project Research III*, Faculty Supervisors;
- PHY 402, *Seminar Course*, Faculty Experts;
- PHY 403, *Astrophysics & Cosmology*, Sandip K Chakrabarti & Soumen Mondal;
- PHY 406, *Advanced Mathematical Methods*, Partha Guha & Samir Kumar Paul;
- PHY 407, *Advanced Quantum Field Theory*, Rabin Banerjee.

Ph.D. Programme

Course Work Programme

- PHY 501, *Research Methodology*, Ranjit Biswas & Jaivardhan Sinha;
- PHY 502, *Review of the Topical Research*, Faculty Supervisors;
- PHY/CB 591, *Project Research*, Faculty Supervisors;
- CB 527, *Molecular Physics & Spectroscopy*, Manik Pradhan;
- PHY 510, Astrophysics, Ramkrishna Das;
- ●● PHY 604, *Quantum Physics (Application)*, Biswajit Chakraborty & Archan S Majumdar;
- CB 526, *Fundamentals of Biophysics*, Rajib Kumar Mitra;
- ●● PHY 507, *Mathematical Methods*, Partha Guha & Samir Kumar Paul;
- PHY 602, *Advanced Condensed Matter Physics: Electronic Structure & Physics of Materials*, Sugata Mukherjee;
- PHY 604, *Quantum Physics (Application)*, Biswajit Chakraborty.

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

Ph.D. THESIS WORK COMPLETED

1. **Interlinking Fundamental Quantum Concepts with Information Theoretic Resources,** Shiladitya Mal, Supervisor: Archan S Majumdar, in University of Calcutta, in 2017
2. **Cavity Enhanced Absorption Spectroscopy and its Application to Molecular Detection of Diabetes Mellitus,** Chiranjit Ghosh, Supervisor: Manik Pradhan, in University of Calcutta, in July, 2017
3. **Synthesis and Physical Properties of Manganite Nanowires,** Subarna Datta, Supervisor: Barnali Ghosh (Saha), in University of Calcutta, in July, 2017
4. **Integrated Cavity Output Spectroscopy and Its Non-Invasive Applications In Biomedical Diagnosis,** Suman Som, Supervisor: Manik Pradhan, in University of Calcutta, in July, 2017
5. **Some Implications of Gauge Invariant Masses of Vector Bosons,** Ishita Dutta Choudhury, Supervisor: Amitabha Lahiri, in University of Calcutta, in July, 2017
6. **Experimental Study of Spin Waves in Ferromagnetic Thin Films and Nanostructures,** Chandrima Banerjee, Supervisor: Anjan Barman, in Jadavpur University, in July, 2017
7. **First Principles Study On Transition Metal Compounds Using Density Functional Theory,** Kartik Samanta, Supervisor: Tanusri Saha Dasgupta, in University of Calcutta, in July, 2017
8. **Nonequilibrium Features of Voltage Gated Sodium Ion Channe,** Krishnendu Pal, Supervisor: Gautam Gangopadhyay, in University of Calcutta, in July, 2017
9. **Development and application of an optical gas-sensor based on cavity enhanced absorption spectroscopy using diode and quantum cascade lasers,** Abhijit Maity, Supervisor: Manik Pradhan, in University of Calcutta, in July, 2017

10. **Cavity Ring-Down Spectroscopy And Its Application To Biomedical Diagnostics,** Gourab Dutta Banik, Supervisor: Manik Pradhan, in University of Calcutta, in July, 2017
11. **Studying the Effects of Different Cosolutes on Protein Conformational Stability, Hydration Dynamics and Activity,** Nirnay Samanta, Supervisor: Rajib Kumar Mitra, in University of Calcutta, in July, 2017
12. **Spontaneous Evolution of Long-range Correlations in Dynamical Systems,** Biplab Bhattacherjee, Supervisor: Subhrangshu S Manna, in University of Calcutta, in July, 2017
13. **Multi-wavelength Studies on Galactic H II regions,** Somnath Dutta, Supervisor: Soumen Mondal, in University of Calcutta, in July, 2017
14. **Spectroscopic Studies On Nanomaterials For Solar Energy Harvesting Application,** Prasenjit Kar, Supervisor: Samir Kumar Pal, in University of Calcutta, in August, 2017
15. **Investigation of electronic conduction and magnetism in ferromagnetic Gd and ferrimagnetic GdCo alloy nanostructures,** Manotosh Chakravorty, Supervisor: Arup K Raychaudhuri, in University of Calcutta, in September, 2017
16. **Microscopic Model For Spin, Orbital And Charge Ordering In Transition Metal Compounds,** Shishir Kumar Pandey, Supervisor: Priya Mahadevan, in University of Calcutta, in September, 2017
17. **Thermodynamic characterisation of nonequilibrium steady states and study of phase transitions,** Arghya Das, Supervisor: Punyabrata Pradhan, in University of Calcutta, in November, 2017
18. **Additivity Property and Mass Fluctuation in Conserved - Mass Transport Processess,** Sayani Chatterjee, Supervisor: Punyabrata Pradhan, in University of Calcutta, in November, 2017
19. **Role of structure in determining the properties of transition metal / post transition metal compounds,** Sagar Sarkar, Supervisor: Priya Mahadevan, in University of Calcutta, in January, 2018
20. **Exotic Phases in Frustrated Low Dimensional Spin Systems,** Aslam Parvej, Supervisor: Manoranjan Kumar, in University of Calcutta, in January, 2018
21. **Numerical Studies on the Dynamics of Soft Matter Systems,** Suman Dutta, Supervisor: Jaydeb Chakrabarti, in University of Calcutta, in February, 2018

Ph.D. AWARD RECEIVED

1. **Electronic and Structural Properties of Two Dimensional Semiconductors and Oxides,** Ruma Das, Supervisor: Priya Mahadevan, in University of Calcutta, in August 2017
2. **Study On Quantum Properties Of Non-Gaussian States,** Priyanka Chowdhury, Supervisor: Archan S Majumdar, in University of Calcutta, in July, 2017
3. **Manipulating Terahertz Radiation Using Nanostructures,** Debanjan Polley, Supervisors: Rajib Kumar Mitra & Anjan Barman, in University of Calcutta, in July 2017
4. **Topological excitations and spin dynamics in magnetic systems in low dimensions,** Subhajit Sarkar, Supervisors: Ranjan Chaudhury & Samir Kumar Paul, in University of Calcutta, in April, 2017
5. **Heterogeneity and its effects on simple chemical events in molten multi-component systems,** Suman Das, Supervisor: Ranjit Biswas, in Jadavpur University, in May, 2017
6. **Microscopic description of protein-ligand and protein-protein interactions,** Samapan Sikdar, Supervisors: Jaydeb Chakrabarti & Mahua Ghosh, in University of Calcutta, in August, 2017
7. **Structure and Dynamics of Mixed Microemulsions/Reverse Micellar Systems,** Arindam Das, Supervisor: Rajib Kumar Mitra, in University of Calcutta, in April, 2017
8. **Exploration of Biomedically Relevant Spectroscopic Techniques for Potential Clinical Diagnostic and Therapeutic Procedures,** Nabarun Polley, Supervisor: Samir Kumar Pal, in University of Calcutta, in May, 2017
9. **Canonical Transformations and Loop Formulation of SU(N) Lattice Gauge Theory,** Sreeraj T P, Supervisor: Manu Mathur, in University of Calcutta, in August, 2017

10. **Effects of Space Weather on Earth's Ionosphere and Nominal LEO Satellites' Aerodynamic Drag,** Victor U. J. Nwankwo, Supervisor: Sandip K Chakrabarti, in University of Calcutta, in June, 2017
11. **Investigation of opto-electronic phenomena in nanostructured ZnO with electric double layer gate,** Rishi Ram Ghimire, Supervisor: Arup K Raychaudhuri, in University of Calcutta, in January, 2018
12. **Interaction and Dynamics in complex systems,** Kallol Mukherjee, Supervisors: Ranjit Biswas & Anjan Barman, in Jadavpur University, in May, 2017
13. **Study In Noncommutative Geometry Inspired Physics,** Yendrembam Chaoba Devi, Supervisor: Biswajit Chakraborty, in University of Calcutta, in July, 2017
14. **Sources of High Energy Radiation and their Effects on the Very Low Frequency (VLF) Radio Signals,** Asit K. Choudhury, Supervisor: Sandip K Chakrabarti, in Maulana Abul Kalam Azad University of Technology, in November, 2017
15. **Nonrelativistic diffeomorphism invariance and its applications,** Arpita Mitra, Supervisor: Rabin Banerjee & Pradip Mukherjee, Barasat Govt. College, in University of Calcutta, in January, 2018
16. **Study on Conformation and Ultrafast Dynamics in Biomolecular Recognition with Optical Laser Spectroscopy,** Susobhan Choudhury, Supervisor: Samir Kumar Pal, in University of Calcutta, in March, 2018
17. **Some Phenomenological Aspects of Topological Massive Gauge Theories,** Debmalya Mukhopadhyay, Supervisor: Amitabha Lahiri, in University of Calcutta, in March, 2018

POST-DOC PLACEMENT

Ruma Das **-** Assistant Professor, Lalbaba College, Howrah, WB

Priyanka Chowdhury **-** Assistant Professor, Mahishadal Raj College, East Medinipur, WB

Debanjan Polley **-** Postdoctoral Fellow, Stockholm University, Sweden

Subhajit Sarkar **-** Postdoctoral Fellow, IOP, Bhubaneswar

Suman Das **-** PDRA, University of Toronto

Samapan Sikdar **-** PDRA, University of Oklahoma

Arindam Das **-** NPDF (SERB), IISER, Mohali, Punjab

Nabarun Polley **-** Research Associate, University of Potsdam, Potsdam, Germany

Sreeraj T P **-** PDF, Institute of Mathematical Sciences, Chennai

Kallol Mukherjee **-** Postdoc, Ruhr University, Bochum, Germany

Susobhan Choudhury **-** Postdoctoral Researcher, Rudolf-Virchow-Center, University of Wurzburg, Germany

Debmalya Mukhopadhyay **-** Research Associate, VECC, Kolkata

Arpita Mitra **-** ESRF, SNBNCBS

Asit K. Choudhury **-** Senior High School Tescher, Malda, WB

Shiladitya Mal **-** PDRA, HRI, Allahabad

Chiranjit Ghosh **-** Postdoctoral Fellow, University of Waterloo, Canada

Subarna Datta **-** ESRF, SNBNCBS

Suman Som **-** ESRF, SNBNCBS

Chandrima Banerjee **-** ESRF, SNBNCBS

Kartik Samanta **-** Post-doctoral Researcher, Peter Grunberg Institut and Institute for Advanced Simulation, Forschungszentrum Julich GmbH, Germany

Krishnendu Pal **-** ESRF, SNBNCBS

Abhijit Maity **-** Project Scientist C in TRC, SNBNCBS

Gourab Dutta Banik **-** ESRF, SNBNCBS

Nirnay Samanta **-** Research Assistant, Technical University of Braunschweig, Germany

Biplab Bhattacherjee **-** Visiting Postdoctoral Research Scholar, Institute of Physics, Bhubaneswar

Somnath Dutta **-** ESRF, SNBNCBS

Prasenjit Kar **-** Postdoctoral Fellow, IIT, Kanpur

Manotosh Chakravorty **-** High School Teacher, WB

Shishir Kumar Pandey **-** Visiting Scholar, Dept. of Theoretical Condensed Matter Physics, IOP, Bhubaneshwar

Arghya Das - Postdoctoral Fellow, International Centre for Theoretical Sciences, Bangalore

Sayani Chatterjee - Research Asssociate, JNCASR, Bangalore

Sagar Sarkar - Post-doctoral Reaearch Fellow, Indo-Korea Science & Technology Center (IKST), Bangalore

Aslam Parvej - Post-doctoral Researcher, APCTP, Pohang, South Korea

Suman Dutta - CEFIPRA-PDF, Institute of Mathematical Sciences, Chennai

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

SENIOR RESEARCH FELLOW

	Supervisor
2011-2012:	
1. Arindam Das (UGC) ill 28/07/2017	Rajib Kumar Mitra
2. Ishita Dutta Choudhury (SNB) till 24.07.2017	Amitabha Lahiri
3. Kallol Mukherjee (CSIR)	Ranjit Biswas & Anjan Barman
4. Sayani Chatterjee (CSIR)	Punyabrata Pradhan
2012-2013:	
5. Abhijit Maity (INSPIRE)	Manik Pradhan
6. Abhishek Roy (SNB)	Sandip Kumar Chakrabarti
7. Ambalika Biswas (SNB) till 04/04/2017	Amitabha Lahiri
8. Anindita Mondal (SNB)	Ramkrishna Das & Soumen Mondal
9. Arnab Deb (SNB)	Sandip Kumar Chakrabarti
10. Arpita Mitra (SNB)	Rabin Banerjee
11. Aslam Parvej (SNB) till 01/02/2018	Manoranjan Kumar
12. Chandrima Banerjee (CSIR)	Anjan Barman
13. Chiranjit Ghosh (SNB)	Manik Pradhan
14. Gourab Dutta Banik (INSPIRE)	Manik Pradhan
15. Hrishit Banerjee (SNB)	Tanusri Saha Dasgupta & Manoranjan Kumar
16. Karan Savio Fernandes (SNB)	Amitabha Lahiri
17. Kartik Samanta (SNB)	Tanusri Saha Dasgupta
18. Krishnendu Pal (SNB)	Gautam Gangopadhyay
19. Nirnay Samanta (SNB)	Rajib Kumar Mitra
20. Poulami Chakraborty (SNB)	Tanusri Saha Dasgupta
21. Rupali Rakshit (SNB) till 30/04/2017	Kalyan Mandal
22. Sagar Sarkar (CSIR)	Priya Mahadevan
23. Somnath Dutta (SNB)	Soumen Mondal
24. Subarna Datta (SNB)	Barnali Ghosh (Saha)
25. Subrata Dev (SNB)	Sakuntala Chatterjee
26. Suman Som (SNB)	Manik Pradhan
27. Sumanto Chanda (SNB)	Partha Guha
28. Supriyo Ghosh (SNB)	Soumen Mondal
29. Susobhan Choudhury (CSIR) till 03/05/2017	Samir Kumar Pal
2013-2014:	
30. Arindam Ghosh (SNB)	Sandip Kumar Chakrabarti
31. Poonam Kumari (SNB)	Priya Mahadevan
32. Prasenjit Kar (SNB) till 01/03/2018	Samir Kumar Pal
33. Raj Kumar Sadhu (SNB)	Sakuntala Chatterjee
34. Rakesh Das (SNB)	Manoranjan Kumar
35. Ransell Richard Dsouza (SNB)	Sugata Mukherjee & Tanusri Saha Dasgupta
36. Ravindra Singh Bisht (SNB)	Arup Kumar Raychaudhuri
37. Sankar Das (SNB)	Subhra Jana
38. Shaili Sett (SNB)	Arup Kumar Raychaudhuri
39. Souvanik Talukdar (SNB)	Kalyan Mandal
40. Subhadip Chakraborti (SNB)	Punyabrata Pradhan
41. Sutapa Dutta (INSPIRE)	Jaydeb Chakrabarti & Mahua Ghosh

JUNIOR RESEARCH FELLOW

2014-2015:	
42. Anuvab Banerjee (SNB)	Sandip Kumar Chakrabarti
43. Aritra Narayan Bose (SNB)	Biswajit Chakraborty
44. Atanu Baksi(CSIR)	Ranjit Biswas
45. Debasmita Maiti (SNB)	Manoranjan Kumar
46. Ejaj Tarif (SNB)	Ranjit Biswas
47. Indranil Chakraborty (SNB)	Kalyan Mandal
48. Juriti Rajbangshi (SNB)	Ranjit Biswas
49. Priya Singh (SNB)	Samir Kumar Pal

50. Sudipta Pattanayak (SNB)	Shradha Mishra & M. Sanjay Kumar
51. Suraka Bhattacharjee (INSPIRE)	Ranjan Chaudhury
52. Joydeep Chatterjee (CSIR)	Priya Mahadevan
53. Sarowar Hossain (TWAS BOSE)	Pratip Kumar Mukhopadhyay
54. Anulekha De (INSPIRE)	Manik Pradhan
55. Damayanti Bagchi (INSPIRE)	Samir Kumar Pal
56. Debabrata Ghorai(INSPIRE)	Biswajit Chakraborty
57. Dhrimadri Khata (INSPIRE)	Soumen Mondal
58. Keshab Karmakar (INSPIRE)	Kalyan Mandal
59. Mahebub Alam (INSPIRE)	Kalyan Mandal
60. Mithun Pal (INSPIRE)	Manik Pradhan
61. Samrat Ghosh (INSPIRE)	Soumen Mondal
62. Sucheta Mondal (INSPIRE)	Anjan Barman
63. Sandip Saha (RGNF)	Gautam Gangopadhyay
64. Tuhin K Maji (INSPIRE)	Samir Kumar Pal

2015-2016:

65. Kajal Kumbhakar (CSIR)	Ranjit Biswas
66. Jayita Patwari (CSIR)	Samir Kumar Pal
67. Aniruddha Adhikari (SNB)	Ranjit Biswas
68. Probir Kumar Sarkar (RGNF) till 03/08/2017	Samir Kumar Pal
69. Chandan Samanta (SNB) (Saha)	Barnali Ghosh
70. Avisek Maity (SNB) (Saha)	Barnali Ghosh
71. Rahul Bandyopadhyay (SNB)	Ramkrishna Das
72. Alik Panja (SNB)	Soumen Mondal
73. Arnab Sarkar (SNB)	Archan S Majumdar
74. Shounak Datta (INSPIRE)	Archan S Majumdar
75. Dipika Mandal (CSIR)	Kalyan Mandal
76. Subrata Ghosh (CSIR)	Kalyan Mandal
77. Sudip Kumar Saha (INSPIRE)	Manoranjan Kumar
78. Shreya Das (INSPIRE)	Tanusri Saha Dasgupta
79. Bihalan Bhattacharya (INSPIRE) from 09/06/2017	Archan S Majumdar
80. Suchetana Goswami (SNB) from 13/06/2017	Archan S Majumdar

2016-2017:

81. Piklu Santra (UGC)	Sandip Kumar Chakrabarti
82. Prantik Nandi (CSIR)	Sandip Kumar Chakrabarti
83. Sk Imadul Islam (UGC)	Rajib Kumar Mitra
84. Partha Nandi (SNB)	Manu Mathur & Biswajit Chakraborty
85. Subhamita Sengupta (UGC)	Arup Kumar Raychaudhuri
86. Sumanti Patra (SNB)	Priya Mahadevan
87. Jaydeb Das (SNB) till 16/08/2017	Biswajit Chakraborty
88. Sayan Kumar Pal (UGC)	Biswajit Chakraborty
89. Anirban Dinda (UGC) till	Manu Mathur
90. Akash Das (UGC)	Manik Pradhan
91. Saikat Pal (CSIR)	Rajib Kumar Mitra
92. Ikbal Ahmed (INSPIRE)	Manik Pradhan
93. Sasthi Charan Mandal (CSIR)	Manik Pradhan
94. Koushik Mandal (UGC)	Ranjan Chaudhury & Manoranjan Kumar
95. Priyanka Saha (INSPIRE)	Kalyan Mandal
96. Dipanjan Maity (CSIR)	Kalyan Mandal

2017-2018:

97. Arka Chatterjee (INSPIRE)	Samir Kumar Pal
98. Edwine Tendong (TWAS BOSE)	Tanusri Saha Dasgupta
99. Partha Pyne (SNB) from 01/08/2017	Rajib Kumar Mitra
100. Souma Mazumdar(SNB)	Biswajit Chakraborty
101. AnirbanMukherjee (INSPIRE)	Punyabrata Pradhan
102. Shubhadip Moulik	Atindra Nath Pal
103. VishalKumarAggarwal (SNB)	Arup Kumar Raychaudhuri & Manik Pradhan
104. Arundhati Adhikari(SNB)	Jaivardhan Sinha & Anjan Barman
105. Parushottam Maji(SNB)	Arup Kumar Raychaudhuri & Barnali Ghosh(Saha)
106. Didhiti Bhattacharya (SNB)	Samit Kumar Ray & Rajib Kumar Mitra
107. Koustav Dutta(INSPIRE)	Anjan Barman
108. Amrit Kumar Mondal(SNB)	Anjan Barman

109. Sayantan Adak(SNB)	Jaivardhan Sinha & Rajib Kumar Mitra
110. Sk Saniur Rahaman(UGC)	Manoranjan Kumar & M. Sanjay Kumar
111. RituparnaMandal (INSPIRE)	Sunandan Gangopadhyay
112. Abhik Ghosh Moulik (INSPIRE)	Jaydeb Chakrabarti
113. Arpan Bera(CSIR)	Samir Kumar Pal
114. Biswajit Pabi (INSPIRE)	Atindra Nath pal
115. Dhrubajyoti Maji (INSPIRE)	Ranjit Biswas
116. Indrani Kar (INSPIRE)	Thirupathia Setti
117. Jayanta Mondal(INSPIRE)	Ranjit Biswas
118. Rafiqul Alam (INSPIRE)	Atindra Nath Pal
119. Rahul Karmakar(INSPIRE)	Jaydeb Chakrabarti
120. Shuvrasish Mukherjee (INSPIRE)	Samit Kumar Ray & Atindra Nath Pal
121. Siddhartha Biswas (INSPIRE)	Soumen Mondal

PROJECT FELLOWS / ASSISTANTS / TRAINEES

2011-2012:	**Project PI**
122. Shishir Kumar Pandey (PROJECT SRF) till 07/11/2017	Priya Mahadevan
2013-2014:	
123. Suvankar Das (PROJECT Assistant) till 15/01/2018	Amlan Dutta
2014-2015:	
124. Suchetana Goswami (PROJECT JRF) till 12/06/2017	Archan S Majumdar
2015-2016:	
125. Dhiraj Tapader (PROJECT JRF)	Punyabrata Pradhan
2016-2017:	
126. Sangita Dutta (PROJECT Assistant) till 21/01/2018	Soumendu Datta
127. Partha Pyne (PROJECT Assistant) till 31/07/2017	Rajib Kumar Mitra
128. Animesh Halder (PROJECT SRF)	Samir Kumar Pal
129. Bihalan Bhattacharya (PROJECT JRF) till 08/06/2017	Archan S Majumdar
130. Arnab Samanta (PROJECT JRF)	Subhra Jana
2017-18:	
131. Sudipta Chatterjee	Arup Kumar Raychaudhuri & Barnali Ghosh(Saha)
132. Anirban Goswami	Arup Kumar Raychaudhuri & Barnali Ghosh (Saha)

RESEARCH SCHOLARS - INTEGRATED Ph.D. PROGRAMME

SENIOR RESEARCH FELLOW	**Supervisor**
2009–2010:	
133. Biplab Bhattacherjee (SNB) till 06/08/2017	Subhrangshu Sekhar Manna
134. Subhasish Chakrabarty (SNB) till 31/07/2017	Amitabha Lahiri
135. Arghya Das (SNB) till 07/11/2017	Punyabrata Pradhan
2010–2011:	
136. Arpan Krishna Mitra (SNB)	Rabin Banerjee
137. Soumyakanti Bose (SNB)	M. Sanjay Kumar
138. Suman Dutta (SNB) till 31/01/2018	Jaydeb Chakrabarti
2011–2012:	
139. Anita Halder (SNB) Dasgupta	Tanusri Saha
140. Chandreyee Roy (SNB) Manna	Subhrangshu Sekhar
141. Debasish Das Mahanta (INSPIRE)	Rajib Kumar Mitra
142. Shauri Chakrabarty (SNB)	Sakuntala Chatterjee
143. Sumanta Kundu (SNB)	Subhrangshu Sekhar Manna
2013–2014:	
144. Ayan Bhattacharjee (SNB)	Sandip Kumar Chakrabarti
145. Monalisa Singh Roy (SNB)	Manoranjan Kumar
146. Samiran Choudhury (SNB)	Anjan Barman
147. Vibhuti Narayan Rai (SNB)till	Arup Kumar Raychaudhuri
2014–2015:	
148. Amal Garai (SNB)	Punyabrata Pradhan
149. Ankan Pandey (SNB)	Partha Guha
150. Avinash Kumar Chaurasiya (INSPIRE)	Anjan Barman
151. Riddhi Chatterjee (SNB)	Archan S Majumdar

152. Ritam Basu (SNB)	Amitabha Lahiri
153. Sanchi Maithani (INSPIRE)	Manik Pradhan
154. Santanu Mandal (SNB/INSPIRE)	Manik Pradhan

JUNIOR RESEARCH FELLOW

2015–2016:

155. Amit Barh (SNB) till 30/11/2017	Rajib Kumar Mitra
156. Ananda Gopal Maity (SNB)	Archan S Majumdar
157. Arunava Adak (SNB)	Jaydeb Chakrabarti
158. Ruchi Pandey (SNB)	Ramkrishna Das
159. Sourav Sahoo (SNB)	Anjan Barman

2016–2017:

160. Anupam Garain(SNB)	Kalyan Mandal
161. Atul Rathod(SNB/CSIR)	Manu Mathur
162. Shantonu Mukherjee (SNB)	Amitabha Lahiri
163. Shashank Gupta (SNB/CSIR)	Archan S Majumdar
164. Sudip Majumdar (SNB)	Anjan Barman & Rajib Kumar Mitra
165. Surya Narayan Panda(SNB)	Anjan Barman
166. Swarnali Hait(SNB)	Kalyan Mandal

INTEGRATED Ph.D PROGRAMME

2016-2017:

1. Achintya Low
2. Ankur Srivastav
3. Anuj K Dhiman
4. Anwesha Chakraborty
5. Manjari Dutta
6. Megha Dave
7. Raghvendra Pandey
8. Sayan Routh
9. Neeraj Kumar

2017-2018:

10. Harmit Jaysukhlal Joshi
11. Nivedita Pan
12. Parthapratim Mahapatra
13. Riju Pal
14. Samir Rom
15. Shubham Purwar

PART TIME RESEARCH SCHOLARS - Ph.D. PROGRAMME

1. Abhishek Bagchi, Condensed Matter Physics and Material Sciences, under Pratip K. Mukhopadhyay
2. Chaitali Dey, Condensed Matter Physics and Material Sciences, under Kalyan Mandal and Madhuri Mandal
3. Manotosh Chakravorty, Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB
4. Piya Patra, Chemical, Biological & Macro-Molecular Sciences, under Jaydeb Chakrabarti
5. Putul Chakravorty (Malla Chowdhury), Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB
6. Samik Roy Moulik, Condensed Matter Physics & Material Sciences, under Barnali Ghosh (Saha), Current Affiliation: Icon Analytical Equipment Pvt. Ltd., Mumbai
7. Shahnewaz Mondal, Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB
8. Shirsendu Dey, Theoretical Sciences, under Rabin Banerjee, Current Affiliation: Kalyani Govt. Engineering College
9. Soumendra Singh, Chemical, Biological & Macro-Molecular Sciences, under Samir K Pal, Current Affiliation: Bose Institute
10. Soumi Roy Chowdhury, Condensed Matter Physics and Material Sciences, under Ranjan Chaudhury
11. Soumyadipta Pal, Condensed Matter Physics and Material Sciences, under Chhayabrita Biswas / Priya Mahadevan (Co-Supervisor), Current Affiliation: Calcutta Institute of Technology
12. Pratik Tarafdar, Theoretical Sciences, under Amitabha Lahiri
13. Probir Kumar Sarkar, Chemical, Biological & Macro-Molecular Sciences, under Samir K Pal, Current Affiliation: Ananda Mohan College, CU
14. Santanu Pan, Condensed Matter Physics and Material Sciences, under Anjan Barman; Current Affiliation: Netaji Nagar Day College.
15. Kartik Adhikari, Condensed Matter Physics and Material Sciences, under Anjan Barman; Current Affiliation : New Alipore College.

PROJECT RESEARCH

B.Tech. / M. Tech. / M. Sc. Projects

Name	Affiliation	Course of Study	Title of Project	Supervisor/Mentor
Ankur Singh	University of Calcutta	M.Sc.	Spectroscopic analysis of Darjeeling and Nepal Tea sample for their potential dissimilarity	Samir Kumar Pal
Biswajit Sahoo	NISER, Khordha	I. MSc.	Determination of Spin Hall Angle in Ta (5 nm)/ CoFeB (3 nm)/SiO2(2 nm) heterostructure	Anjan Barman
Prerna Baranwal	Birla Institute of Technology and Science, Pilani	B.Tech	Study of Complex Networks	Subhrangshu Sekhar Manna
Chirantan Deb	Visvesvaraya National Institute of Technology, Nagpur	B.Tech	Preparation and Characterization of some FSMA alloys	Pratip Kumar Mukhopadhyay
Darshan Kumar	Visva Bharati University	I. MSc.	Computer Simulation of Soret Colloids	Jaydeb Chakrabarti
Susmita Mondal	University of Calcutta	M.Sc.	Screening of Thalassemia at point-of-care	Samir Kumar Pal
Anagha Kamath	S.V.N.I.T, Surat	M.Sc.	Study on optoelectronic properties of SiNW/ZnO heterojunction for UV-Visible photodetection	Arup Kumar Raychaudhuri
Shaileyee Bhattacharya	Indian Institute of Technology, Roorkee	M.Sc.	Molecular Dynamics Simulations	Jaydeb Chakrabarti
Gokul.P	Amrita Vishwa Vidyapeetham	M.Sc.	Study on annealing effects on Co-Ni-Al FSMA system	Pratip Kumar Mukhopadhyay
Ankit Kargeti	Invertis University, Bareilly	M.Sc.	Synthesis of Ni-Fe-Al alloys and study of their microstructure and FSMA nature	Pratip Kumar Mukhopadhyay
Suchandra Mukherjee	Diamond Harbour Women's University, Sarisha	M.Sc.	Comparative study of magnetorheological fluids prepared with Fe3O4 nanoparticles and nano hollowspheres	Kalyan Mandal
Karabi Chatterjee	Diamond Harbour Women's University, Sarisha	M.Sc.	Study of Cooper Pairing Mechanism Using One and TwoSquare-Well Potential Models and Isotope Exponent from the BCS theory	Ranjan Chaudhury

Educational Visit organised:

VISIT TO RESEARCH FACILITIES AT S N BOSE CENTRE BY STUDENTS AND FACULTY FROM

SL	Date of Visit	Name of the College/Institute
1	14-February 2018	Charuchandra College
2	30-November-2017	Orissa University of Agriculture and Technology (OUAT), Bhubaneswar

Summer Research Project:

SL	Name of the SRP Fellow	Affiliation	Supervisor
1	Kalyan Barman	NIT Rourkela	Punyabrata Pradhan
2	Abhishek Sadhu	IIT Kharagpur	Archan S Majumdar
3	Deep Ghosh	IIT Kharagpur	Rabin Banerjee
4	Smriti Mosel	IIT (ISM) Dhanbad	Kalyan Mandal
5	Akshit Joshi	IIT Delhi	Soumendu Datta
6	Shakil Ahammad Chowdhury	IIT Kanpur	Rajib Kumar Mitra
7	Sinay Simanta Behera	JNU, New Delhi	Manoranjan Kumar
8	Kaushlendra Kumar	IISER-Kolkata	Biswajit Chakraborty
9	Saptorshi Ghosh	IISER-Bhopal	Amlan Dutta
10	Subhasanket Dutta	IIT (ISM) Dhanbad	Subhrangshu Sekhar Manna
11	Rita Majumdar	IIT (ISM) Dhanbad	Jaydeb Chakrabarti
12	Veena Ravindran K	IISER Thiruvananthapuram	Ranjan Chaudhury
13	Arnab Mukherjee	Jadavpur Univ	Soumen Mondal
14	Susmita Mondal	Ballygunge Science College	Samir Kumar Pal
15	Ankit Kargeti	Invertis University	Pratip Kumar Mukhopadhyay
16	Stuti Tamuli	Tezpur University	Anjan Barman

National Science Day – 2018: Student sfrom following colleges participated :

1) Ananda Mohan College
2) Apc Boys Salt Lake
3) Barasat Govt. College
4) Bidhannagar College
5) Diamond Harbour Women's University
6) Dinabandhu Andrews College
7) Gurudas College
8) Hooghly Women's College
9) Lady Brabourne College
10) Maharaja Manindra Chandra College
11) Netaji Nagar Day College
12) Raja Peary Mohan College
13) Rammohan College
14) Salk Lake Bidhannagar Govt. (BD) School
15) Scottish Church College
16) Serampore College
17) Techno India
18) Vidyasagar College For Women

Biswajit Chakraborty
Dean, Academic Programme

CELEBRATION OF 125TH BIRTH ANNIVERSARY OF PROF. SATYENDRA NATH BOSE

The year 2018 is significant to S N Bose National Centre for Basic Sciences for the 125th Birth Anniversary of Professor Satyenda Nath Bose. To celebrate the special occasion, a series of activities have been taken throughout the year to pay homage to the legendary scientist.

Various academic, awareness and cultural programmes were scheduled on the 1st day of January 2018, the 125th Birth Anniversary of Prof. S N Bose. The special day started with a colourful procession with tabloids and banners organized jointly by S N Bose Center and Bangiya Bijnan Parishad in Kolkata. Hundreds of students and research scholars marched past holding Bose's banner high. The curtain raiser ceremony was inaugurated by Hon'ble Prime Minister of India, Shri Narendra Modi, through video conferencing. Dr. Harsh Vardhan, Hon'ble Minister, Ministry of Science & Technology, Earth Sciences and Environment, forests and Climate Change, Government of India; Shri Y. S. Chowdary, Hon'ble Minister of State, Ministry of Science and Technology and Earth Sciences, DST, Government of India, and other honourable delegates,

Inauguration of Curtain Raiser Ceremony by Hon'ble Prime Minister Shri Narendra Modi, through video conferencing

students and staff members of the Centre were present in the ceremony. Trees were planted in the campus by eminent personalities. A special cover on S. N. Bose was released by the Department of Posts, West Bengal Circle. To add to these celebrations , the Centre had designed a special logo to mark this cherished anniversary and decided to use it in all the forthcoming events of the Centre in 2018. "An Iconic Genius", a documentary on the life and works of Bose – produced by the Centre – was premiered on this special occasion. The creation of a Bose Archive and Museum was inaugurated by Dr. Harsh Vardhan. The first BOSE-125 Distinguished Lecture was delivered by Professor Ajay K. Sood, President, INSA, Professor of Department of Physics at IISC, Bangalore on the topic "Nature Inspired Physics: Flocking and Bacterial Heat Engine". The first Bose 125 Public Lecture was delivered by Professor C. N. R. Rao, National Research Professor, Linus Pauling Research Professor and Honorary President, JNCASR, Bangalore on the topic "Photochemical, Thermochemical and Electrochemical splitting of water" at Meghnad Saha Auditorium of Saha Institute of Nuclear Physics, Salt Lake, Kolkata. The lecture was followed by a musical programme performed by Debashis Raychowdhury and Rohini Raychowdhury. A good number of

Address by Dr. Harsh Vardhan, Hon'ble Minister

A road show in Kolkata on 1st January, S N Bose's Birthday

delegates, students and renowned personalities graced the Bose 125 inaugural events on 1st January 2018 and made the occasion memorable .

With an ambitious plan spread over the anniversary year, the Centre set sail on the 1st of January, with a cluster of events – such as conferences, lectures and outreach programmes during the first quarter, which are included in the Annual Report (2017-18).

Dignitaries in front of tableau

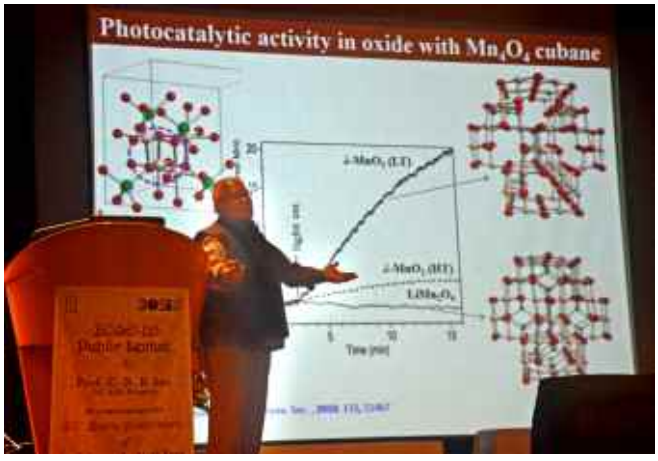
BOSE-125 Public Lectures

The Centre organized the second BOSE - 125 : Public Lecture by Professor Wolfgang Ketterle, MIT, USA and 2001 Nobel Laureate in Physics on 27th March, 2018 at Science City, Kolkata. The topic of the lecture was "Cooling close to absolute zero temperature : a recipe for discoveries". The lecture was accompanied with several experimental demonstrations at low temperatures.

While celebrating National Science Day on 28th February, 2018, Centre organized the third BOSE-125 Public Lecture by Prof. Bruce Tsurutani, Principal Scientist, Jet Propulsion Laboratory, California Institute of Technology, NASA, USA, on the topic "From the Sun: Solar Flares, Auroras, Magnetic Allen Radiation Belts". An inter-institute quiz on scientific topics was also organized among students. The programme was held at Rabindra Okakura Bhavan, Salt Lake, Kolkata.

BOSE-125 Distinguished Lectures

The second BOSE-125 Distinguished Lecture was delivered by Monica Olvera de la Cruz, Lawyer Taylor Professor of Materials Science and Engineering, Northwestern University, USA on the topic "Theoretical models to determine the thermodynamics, statistics and dynamics of macromolecules in complex environment including many-component solutions of heterogeneous synthetic and biological molecules and molecular electrolytes" at the Centre on 3rd January, 2018.



Public Lecture by Prof. C. N. R. Rao

The third BOSE-125 Distinguished Lecture was delivered by Professor Charles H. Bennett, Fellow of IBM Research Division, New York, USA and American Physical Society, USA on the topic " Forging the Culture of Quantum Information science" at the Centre on 2nd February 2018.

The fourth BOSE -125 Distinguished Lecture was delivered by Prof. Bruce Tsurutani, Jet Propulsion Laboratory, California Institute of Technology, NASA, USA on the topic “Space Weather : Plasma Physics from the Sun to the Earth's Atmosphere” at the Centre on 26th February, 2018

The fifth BOSE-125 Distinguished Lecture was delivered by Prof. Ramamoorthy Ramesh, Department of Materials Science and Engineering & Department of Physics, University of California, on the topic "Emergent Chirality & Phase Coexistance in Polar Vortices formed in Oxide Superlattices" at the Centre on 6th March, 2018.

Distinguished Lecture by Prof. Charles H. Bennett

The sixth BOSE-125 Distinguished Lecture was delivered by Prof. Bala Iyer, ICTS-TIFR, Bangalore, on the topic "The Rapid Leap from Gravitational Wave Detection to Multi-Messanger Astronomy" on 9th March 2018.

BOSE-125 Memorial Lectures

a) 23rd S N BOSE Memorial Lecture was delivered by Professor Wolfgang Ketterle, MIT, USA and 2001 Nobel Laureate in Physics on 26th March, 2018 on the topic "New forms of matter with ultracold atoms : supersolid, superradiance, and polar molecules" at the Centre.

b) 13th C. K. Majumdar Memorial Lecture was organized at the Centre on 23rd February, 2018. The lecture was delivered by Professor T V Ramakrishnan on the topic "Bose, Bosons, & Bose Condensation".

BOSE-125 National Science Day Celebration

National Science Day was celebrated on 28th February, 2018. Prof. Bruce Tsurutani, Principal Scientist, Jet Propulsion Laboratory, California Institute of Technology, NASA, USA, delivered a Public Lecture on the topic "Scientific issues for the development of the Nation" and another Popular Scientific Lecture on the topic Allen Radiation Belts".

Popular Scientific Lecture by Prof. Bruce Tsurutani

BOSE-125 Conference/Seminar/Workshop

An International conference on "current trends in materials science and engineering" (CTMSE 2018) jointly organized by Institute of Engineering & Management and S. N. Bose National Centre for Basic Sciences held during 19-20 January at the premises of S. N. Bose Centre

An International Symposium on "New Frontiers in Quantum Correlations (ISNFQC18)" was organized at the Centre during 29th January – 2nd February, 2018.

A Conference on 'Emergent Phenomena in Classical and Quantum Systems (EPCQS18)' had been organized at the Center during 26 - 28th February, 2018.

An International Workshop jointly organized with the Third World Academy of Sciences (TWAS) on Bose-Einstein Condensation and Related Phenomena (IWBECRP) was held at S N Bose Centre, Kolkata during 26-28th March, 2018.

BOSE-125 Bose Fest 2018

BOSE FEST 2018 --The Annual Science Celebration & First Alumni Day of the Center on 8-9-10 February 2018 with great enthusiasm. The programmes consisted of paper/poster presentations by the students. Many of the ex-students were invited through email and web announcement to attend the Alumni Day planned on the occasion of 125th Birth Anniversary Celebration of S N Bose and many of them cordially responded to and attended the programme in spite of their own work schedule. The Bose Fest 2018 was ended with a cultural programme.

Bose-125 Outreach Lecture

BOSE-125 Outreach Programmes

S N Bose National Centre for Basic Sciences participated in the 'Bigyan-O-Prajukti Mela 2018' held during 11-14 January, 2018 at Hedua Park, Kolkata, organized by Paschim Banga Vigyan Mancha.

As an outreach programme by 'Theoretical Physics Seminar Circuit' of the Centre, 9th Vidyasagar-Satyendra Nath Bose National Workshop held during 17 - 19 January, 2018 at Vidyasagar University, Midnapore.

Prof. Samit Kumar Ray, Director of the Centre delivered the 71st Foundation Day Lecture of Bangiya Bijnan Parishad, Kolkata, on 25th January, 2018 in vernacular language. The Bangiya Bijnan Parishad was established by Prof. Satyendra Nath Bose.

Bose-125 Outreach Lecture

Prof. Samir K. Pal, department of Chemical, Biological and Macro Molecular Sciences from S. N. Bose Centre, delivered a popular talk entitled "Scientific detection of Honesty in Tea" at 56th INSPIRE Science Camp organised by Jagadis Bose National Science Talent Search, Kolkata in association with the Department of Science And Technology, Govt.of India during March 26th - 30th 2018 at JB Centre of Excellence for Student-scientists, Kolkata.

A One-day Symposium on Relativity and Quantum Mechanics was organized as an outreach program by S. N.Bose National Centre for Basic Sciences, Kolkata in collaboration with Department of Physics, Karimganj College, Assam on March 21, 2018,. A large numbers of students and teachers attended the Symposium. Prof. Biswajit Chakraborty, Dept of Theoretical Sciences, S N Bose National Centre for Basic Sciences was the resource person and delivered a lecture.

A One-day Symposium on Recent Trends in Physical Sciences was organized as an outreach program organized by S. N. Bose National Centre for Basic Sciences, Kolkata in collaboration with Department of Physics, Assam University, Silchar on March 19, 2018. About 165 students and 07 number of institutions attended the Symposium.

A One-day Conference on "Recent Trends in Physical Sciences" was arranged at the Vinoba Bhave University, Hazaribagh on 19th March, 2018 as a part of the "Outreach Program" of the S. N. National Centre for Basic Sciences. More than 200 students attended the conference. Dr. Archan S. Majumdar, Senior Professor & Dean (Faculty) SNBNCBS, explained the scientific contribution and legacy of Prof. S.N. Bose to the participants. A short film on the life and work of Prof. S. N. Bose was screened.

Dr. Ramkrishna Das, Assistant Professor, Department of Astrophysics and Cosmology from S.N. Bose Centre, delivered popular level lecture on Life and Works of Acharya Satyendranath Bose in a one-day seminar at Suri Vidyasagar College on 17th March 2018. This seminar was organised in association with Bangiya Bigan Parisad as a part of organizing 100 lecture series in different schools and colleges across the state to commemorate the 125th Birth Anniversary of Prof. Satyendra Nath Bose. About 135 students and 25 faculty members attended the seminar.

A One day symposium was organized by S. N. Bose National Centre for Basic Sciences, Kolkata in collaboration with Department of Physics, Tripura University, Tripura on 16th March 2018. Total 117 participants from 4 institutes attended the symposium.

A Conference was organized by the Department of Astrophysics and Cosmology of S. N. Bose Centre on Recent Advancements in Astrophysics and Space Science, at Sidho Kanho Birsha University, Purulia, West Bengal, on 5th March 2018. About 150 students and teachers participated the conference.

Special Publication on Celebration of 125th Birth Anniversary of Bose

S N Bose National Centre published a special issue of its Newsletter (Vol.7, Issue 1) on various events regarding celebration of the 125th Birth Anniversary of Prof. Satyendra Nath Bose.

Public Lecture by Prof. W. Ketterle, Nobel Laureate

EXTENDED VISITORS & LINKAGE PROGRAMME

CELEBRATING 125TH BIRTH ANNIVERSARY OF PROF. S.N. BOSE

"BOSE 125" : Public Lectures

Date	Seminar at	Speaker & Affiliation	Title
01.01.2018	**Auditorium, SINP**	**Prof. C. N. R. Rao** Jawaharlal Nehru Centre for Advanced Scientific Research	Photochemical, Thermochemical and Electrochemical splitting of water
28.2.2018	**Rabindra Okakura Bhaban, Saltlake**	**Prof. Bruce T. Tsurutani** Jet Propulsion Laboratory, California Institute of Technology	From the Sun: Solar Flares, Auroras, Magnetic Storms and the Van Allen Radiation Belts
27.3.2018	**Mini Theater Science City, Kolkata**	**Prof. Wolfgang Ketterle** John D. MacArthur Professor of Physics, Director, MIT-Harvard Center for Ultracold Atoms, USA, Associate Director, Research	Cooling Close to Absolute Zero Temperature : a Recipe for Discoveries

"BOSE 125" : Memorial Lectures

Date	Seminar Type	Speaker & Affiliation	Title
23.02.2018	**13th C. K. Majumdar Memorial Lecture**	**Prof. T. V. Ramakrishnan** Dept. of Physics, IISc. Bangalore Dpet. of Physics, Banaras Hindu University	Bose, Bosons & Bose Condensation
26.03.2018	**23rd S. N. Bose Memorial Lecture**	**Prof. Wolfgang Ketterle** John D. MacArthur Professor of Physics, Director, MIT-Harvard Center for Ultracold Atoms, USA, Associate Director, Research	New forms of matter with ultracold atoms : supersolid, superradiance, and polar molecules

"BOSE 125" : Distinguished Lectures

Date	Seminar Type	Speaker & Affiliation	Title
01.01.2018	**BOSE-125 Distinguished Lecture**	**Prof. A. K. Sood, FRS** President INSA, IISc. Bangalore	Nature Inspired Physics: Flocking and Bacterial Heat Engine
03.01.2018	,,	**Prof. Monica Olvera de la Cruz** Lawyer Taylor Professor, Northwestern University	Controlling Nanoparticle Assembly

02.02.2018	,,	**Prof. Charles H. Bennett** Fellow, IBM Research Division, USA	Forging the culture of quantum information science
26.02.2018	,,	**Prof. Bruce T. Tsurutani** Jet Propulsion Laboratory, California Institute of Technology	Space Weather - Plasma Physics from the Sun to the Earth's Atmosphere
06.03.2018	,,	**Prof. R. Ramesh** Dept. of Material Science and Engineering & Dept. of Physics, University of California, Berkeley, Materials Science Division, LBN Laboratory, Berkeley	Emergent Chirality & Phase Coexistance in Polar Vortices formed in Oxide Superlattices
09.03.2018	,,	**Prof. Bala Iyer** ICTS – TIFR, Bangalore	The Rapid Leap from Gravitational Wave Detection to Multi-Messanger Astronomy

Distinguished Lecture Series on "The Topological Phase in Proximity Induced Superconductors" by Prof Krishnendu Sengupta, Professor, IACS, Kolkata

Title: "Majorana Fermions in Condensed Matter" ,Date: 25.04.2017
Title : Topological Phases And Phase Transition of Matter-I, Date: 11.05.2017
Title : Topological Phases And Phase Transition of Matter-II, Date: 09.06.2017

SEMINAR AND COLLOQUIA PROGRAMME

Institute Seminar/ BOSE Colloquium

Date	Speaker & Affiliation	Title
17.04.2017/ Institute Seminar	**Prof. Ashok K Ganguli** Institute of Nanoscience & Technology, Mohali, Punjab and Department of Chemistry, IIT, New Delhi	***Design of Advanced Materials***
26.05.2017/ Institute Seminar	**Prof. Sharmila M. Mukhopadhyay** Professor of Mechanical & Materials Engineering and Director, Center for Nanoscale Multifunctional Materials, Wright State University, Dayton Ohio and Jefferson Science Fellow at Economic Bureau, Commercial and Business Affairs,Intellectual Property Enforcement	***Emerging Materials for Next Generation Manufacturing***
08.06.2017/ Institute Seminar	**Dr. C. Subramaniam** Department of ChemistryIndian Institute of Technology Bombay	***Thermally-driven nanoparticle assemblies as high-performing surface-enhanced-Raman-scattering substrates***
07.08.2017/ Institute Seminar	**Prof. N. Mukunda** Centre for High Energy Physics, IISc, Bangalore and Honorary Professor at IISER, Thiruvananthapuram	***Pancharatnam, Bargmann and Berry phases - a retrospective***
24.8.2017/ Institute Seminar	**Prof. Shaibal K Sarkar** Department of Energy Science and Engineering, Indian Institute of Technology Bombay	***Photoluminescence intermittency in micron-size hybrid lead halide perovskites***

28.8.2017/ Institute Seminar	**Prof. Sibasish Ghosh** Institute of Mathematical Sciences, Chennai	***Implications of Coupling in Quantum Thermodynamic Machines***
14.12.2017/ Bose Colloquium	**Prof. Prashant V. Kamat** Departments of Chemistry & Biochemistry and Chemical & Biomolecular Engineering and Radiation Laboratory, University of Notre Dame	***Lead Halide Perovskites for Next Generation Photovoltaics***
14.12.2017/ Bose Colloquium	**Prof. David B. Mitzi** Department of Mechanical Engineering and Materials Science and Department of Chemistry, Duke University	***Halide Perovskites: Structural Diversity and Opportunities for Semiconductor Design /Fabrication***
15.12.2017/ Bose Colloquium	**Prof. Dimitrie Culcer** School of Physics and Australian Research Council Centre of Excellence in Future Low-Energy Electronics Technologies, UNSW Node, The University of New South Wales, Sydney, Australia	***Quantum kinetic theory of magneto-transport in topological materials***
24.11.2017/ SpecialColloquium 3.11.2017/ Institute Seminar	**Prof. Kanjaksha Ghosh** Surat Raktadan Kendra & Research Centre **Prof. Kinkini Dasgupta Misra** IT and Gender and Technology Communication DivisionVigyan Prasar	***A holistic view of death*** ***Communication engagement to proliferate Science and Technology to wider target audience***
14.11.2017/ Institute Seminar	**Prof. Kartik Ghosh** Physics and Materials ScienceMissouri State	***Nanoscale Investigation of Multiferroic Domain***
Switching	Universityand Sabbatical Visitor, SNBNCBS	***in Ferromagnetic / Ferroelectric Hetero-structures using Scanning Probe Microscopy***
01.12.2017/ Institute Seminar	**Dr. Sobhan Sen** Spectroscopy LaboratorySchool of Physical SciencesJawaharlal Nehru University, New Delhi	***Dynamics of Water and Ions around DNA: What's so special about them?***
20.12.2017 /Institute Seminar	**Prof. Florin Diacu** Yale-NUS CollegeNational University of Singapore	***The classical n-body problem in the context of curved space***
22.12.2017/ Institute Seminar	**Prof. Pradeep R. Varadwaj** School of Engineering,The University of Tokyo	***Halogen in Materials Design: Revealing the Nature of Halogen-Centered Non-Covalent Interactions in the Polymorphic Transformations of Methylammonium Lead Trihalide Perovskites***

19.1.2018/ Institute Seminar	**Dr. Swadhin K. Mandal** IISER Kolkata	***Mimicking Transition Metals: Lesson from Other Discipline***
02.02.2018/ Bose Colloquium	**Dr. Amitava Pramanik** Unilever R&D Bangalore	***Basic Science to Technology Development – Connecting the Dots***
06.02.2018/ Institute Seminar	**Dr. Shimonishi Takashi** Assistant Professor, Tohoku University	***Astrochemistry at low metallicity***
10.2.2018/ Special Colloquium	**Sandeep Dutta** www.EyeoftheWild.com	***Making of a wild life Photographer***
23.02.2018/ Bose Colloquium	**Professor Debashish Chowdhury** Dept. of Physics, Indian Institute of Technology, Kanpur	***Nano-machine: bear on a mountainous landscape or frog in a lily pond?***
19.04.2018/ Special Colloquium	**Dr. Yashawant Dev Panwar** Head PFC, Patent Facilitating Centre (PFC)Technology Information Forecasting and Assessment Council (TIFAC), New Delhi	***Intellectual Property Rights Eco System in India and their Management in Government R&D Institutes***

VISITOR, ASSOCIATES AND STUDENTS PROGRAMME

Associates and Short Term Visitors

Name of the Visitor	Affiliation	Period of stay		Host Faculty/ Department
		Date From	Date to	
Dr. Joseph A M Paddison (Short term Visitor)	*Academic And research Staff of Quantum Matter group,University of Cambridge, UK*	16.82017	20.8.2017	*Dr. Manoranjan Kumar/ CMPMS*
Dr. Shraddha Mishra (Associate)	Assistant Professor, IIT BHU	15.5.2017	16.9.2017	*Dr. Punyabrata Pradhan/TS*
Dr. Sekhar Bhattacharya (Associate)	Senior Research Scientist. SSN Research Centre,TN	29.5.2017	30.6.2017	*Dr. Barnali Ghosh /CMPMS*
Dr. Sujit Sarkar (Associate)	Poornaprajna Institute of Scientific Research, Bangalore	14.4.2017 12.8.2016	23.4.2017 26.8.2017	*Dr. Manoranjan Kumar/ CMPMS*
Dr. Arka Chaudhuri *(Associate)*	Haldia Institute of Technology, West Bengal	20.06.2017	29.07.2017	*Prof. Kalyan Mandal CMPMS*
Dr. Pradip Mukherjee *(Associate)*	Professor, Barasat Govt. College, W.B	9.5.2017	30.5.2017	*Prof. Rabin Banerjee/ TS*
Mr. Jayprakash Singh Junior Research Fellow (Short Term Visitor)	JRF, IIT BHU	22.5.2017	5.6.2017	*Dr. Manoranjan Kumar /CMPMS*

Mr. Sougata Mallick Senior Research Scholar *(Short Term Visitor)*	SRF, Laboratory for Nanomagnetism and Magnetic Materials (LNMM) School of Physical Sciences (SPS)NISER, Bhubaneswar P.O. - Bhimpur-Padanpur, via - Jatni	02.07.2017	15.07.2017	*Prof. Anjan Barman/ CMPMS*
Dr. Rabaya Basori	DST INSPIRE Faculty, School of Nano Science , IITKgp	01.05.2017	12.05.2017	*Prof. A.K. Raychaudhuri/ CMPMS*
Professor Florin Diacu (Short Term Visitor)	Yale-NUS CollegeNational University of Singapore	15.12.2017	20.12.2017	*Prof. Partha Guha/TS*
Prof. M.P Das (Short Term Visitor)	Research School of Physics and Engineering,The Australian National University, Canberra	19.11.2017	23.11.2017	*Dr. Ranjan Choudhury/ CMPMS*
Prof. Banibrata Mukhopadhyay (Short Term Visitor)	Associate Professor., IISc. Bangalore	26.12.2017	29.12.2017	*Prof. Biswajit Chakraborty/ TS*
Dr. Urbashi Satpathi (Short Term Visitor)	PDRA, RRI,Bangalore	3.10.2017	12.10.2017	*Prof. P.Singha Deo/CMPMS*
Dr. Rupali Rakshit (Short Term Visitor)	NPDF,IISER ,Bhopal	1.10.2017	22.10.2017	*Prof. Kalyan Mondal/ CMPMS*
Dr. Sujit Sarkar (*Associate*)	Poornaprajna Institute of Scientific Research, Bangalore	05.11.2017	12.11.2017	Dr. Manoranjan Kumar/ CMPMS
Dr. Pradip Mukherjee *(Associate)*	Professor, Barasat Govt. College, W.B	3.10.2017	27.10.2017	*Prof. Rabin Banerjee/ TS*
Dr. Rabaya Basori (Associate)	DST INSPIRE Faculty, School of Nano Science , IITKgp	05.10.2017	20.10.2017	*Prof. A.K. Raychaudhuri /CMPMS*

ADVANCED POST-DOCTORAL MANPOWER PROGRAMME

Advanced Postdoctoral Manpower Programme (APMP)

Sl. No.	Name	Status	Mentor / Department
1	Amna Ali	PDRA-II	Prof. Archan S. Majumdar / Astrophysics & Cosmology
2	Aurab Chakraborty	PDRA-III	Prof. Tanusri Saha-Dasgupta / Condensed Matter Physics and Material Sciences
3	C Jebarathinam	PDRA-I	Prof. Archan S. Majumdar / Astrophysics & Cosmology

4	Chaitrali Sengupta	PDRA-I	Dr. Rajib Kr. Mitra / Chemical, Biological & Macro Molecular Sciences
5	Dayasindhu Dey	PDRA-I	Dr. Manoranjan Kumar / Condensed Matter Physics and Material Sciences
6	Deepika Kumari	PDRA-I	Prof. Partha Guha / Theoretical Sciences
7	Dipak Kumar Das	PDRA-II	Prof. Anjan Barman / Condensed Matter Physics and Material Sciences
8	Indrani Banerjee	PDRA-I	Prof. Sandip Kr. Chakrabarti / Astrophysics & Cosmology
9	Kumar Abhinav	PDRA-I	Prof. Partha Guha / Theoretical Sciences
10	Mausumi Ray	PDRA-III	Prof. Jaydeb Chakrabarti / Chemical, Biological & Macro Molecular Sciences
11	Prasanta Kundu	PDRA-I	Prof. Gautam Gangopadhyay / Chemical, Biological & Macro-Molecular Sciences
12	Ravikant Verma	PDRA-I	Prof. Biswajit Chakraborty / Theoretical Sciences
13	Sayantani Das	PDRA-I	Prof. Kalyan Mandal / Condensed Matter Physics and Material Sciences
14	Shamik Chakrabarti	PDRA-I	Prof. Tanusri Saha-Dasgupta / Condensed Matter Physics and Material Sciences
15	Srabantika Ghose	PDRA-I	Prof. Kalyan Mandal / Condensed Matter Physics and Material Sciences
16	Suman Chakraborty	PDRA-I	Prof. Sandip Kr. Chakrabarti / Astrophysics & Cosmology
17	Vinodh Kumar Shanmugam	PDRA-I	Prof. Pratip Kr. Mukhopadhyay / Condensed Matter Physics and Material Sciences

Sl. No.	Name	Status	Mentor / Department
1	Ankita Ghatak	NPDF	Dr. Barnali Ghosh (Saha) / Condensed Matter Physics and Material Sciences
2	Jashashree Ray	NPDF	Prof. Arup Kumar Raychaudhuri / Condensed Matter Physics and Material Sciences
3	Samyadeb Bhattacharya	NPDF	Prof. Archan S. Majumdar / Astrophysics & Cosmology
4	Shubhashis Rana	NPDF	Dr. Punyabrata Pradhan / Theoretical Sciences
5	Sumona Sinha	NPDF	Prof. Anjan Barman / Condensed Matter Physics and Material Sciences
6	Tanushree Dutta	NPDF	Prof. Samir Kumar Pal / Chemical, Biological & Macro-Molecular Sciences

Conferences, Workshops and Extension Programme (CWEP)

workshops/seminars/discussion meetings held during the period are as below:

(1) C.K. Majumdar Memorial Summer Workshop in Physics

The C.K. Majumdar Memorial Summer Workshop in Physics–2017 was organized jointly by Indian Association of Physics Teachers (Regional Council 15) [IAPT RC 15] and S.N. Bose National Centre for Basic Sciences (SNBNCBS), Kolkata during May 23 to June 02, 2017. The purpose of this summer workshop was to give exposure to different fields of research (both theoretical and experimental) to a group of outgoing final year B.Sc students of physics from the universities of West Bengal and other states of India.

(2) Young Investigator Meet on Quantum Condensed Matter Theory

A two days meeting on Young Investigator Meet on Quantum Condensed Matter Theory was organized at the Centre during October 26 to October 27, 2017. The idea of this meeting was to bring together all the young faculty (below 45 years), postdoctoral fellow and students working in the area of Quantum Condensed Matter Theory. The main focus of the research were, Quantum phase transition, Application of Quantum theory in modeling of real material, Exotic phase and transport properties in low dimension, Many body localisation.

(3) Emerging Trends in the Physics of Surfaces, Interfaces and Nanostructures

A two-day meeting on Emerging Trends in the Physics of Surfaces, Interfaces and Nanostructures was organized during November 24 to November 25, 2017. This meeting was hosted jointly by Indian Association for the Cultivation of Sciences (IACS), Kolkata and S.N. Bose National Centre for Basic Sciences (SNBNCBS) because of the commonality of interest in this field in these two institutes. The aim of this meeting was to bring some of the eminent scientists working in this area in India, to discuss and share knowledge on the latest developments in this field with young researchers and students. The subjects and scientific problems discussed are surface physics, low dimensional structures, surface characterization, epitaxial growth, laser and plasma induced surface engineering, growth of nanostructures, theory of surface and interfaces, ion beam modification, surface spectroscopy etc.

(4) HyPe-2017 (A Discussion Meeting on Hybrid Perovskites)

A discussion meeting on hybrid perovskites (HyPe) which is an emerging area in photovoltaics where recently it has been shown that efficiencies comparable with the existing semiconductor technologies have been achieved in a short time was held during December 14 to December 15, 2017. The purpose of this meeting was to bring together experts on this topic, primarily within the country, working in various aspects of these materials.

(5) International Conference on Current Trends in Materials Science and Engineering (CTMSE 2018)

An international conference on Current Trends in Materials Science and Engineering was jointly organized by the Institute of Engineering & Management (IEM), Kolkata and S.N. Bose National Centre for Basic Sciences (SNBNCBS) during January 19 to January 20, 2018. This was an interdisciplinary forum on all aspects of materials science and engineering, quantum phenomenon and related topics.

(6) International Symposium on New Frontiers in Quantum Correlations (ISNFQC 18)

An international symposium on New Frontiers in Quantum Correlations was organized during January 29 to February 02, 2018. In order to take stock of the major advances in several theoretical and experimental aspects of quantum correlations, this international symposium was organized. Some of the topical themes of this international symposium was, Quantum nonlocality and its applications, Quantum coherence, Experimental manifestations of quantum entanglement, Quantum thermodynamics, Quantum statistics and bosonic channels. Keynote lecture was delivered by Prof. Charles H. Bennett, IBM Fellow, USA.

(7) Conference on Emergent Phenomena in Classical and Quantum Systems (EPCQS 18)

A conference on Emergent Phenomena in Classical and Quantum Systems was organized during February 26 to February 28, 2018. Some of the subjects and scientific problems discussed in this conference are, Fluctuation, relaxation and transport in classical/quantum systems, Nonequilibrium dynamics in systems (classical/quantum) driven far from equilibrium, Thermalization and equilibration in quantum systems, Phase transitions, structure and pattern formation in nonequilibrium, Other exotic phenomena in classical/quantum systems.

(8) International Workshop on Bose-Einstein Condensation and Related Phenomena (IWBECRP) jointly organized by 'The World Academy of Sciences' (TWAS) and SNBNCBS

An international workshop on Bose-Einstein Condensation and Related Phenomena was organized during March 26 to March 28, 2018. The purpose of this workshop was to bring together eminent scientists, young researchers and students who have been working in various aspects of the above mentioned research areas. Some of the subjects and scientific problems discussed in this workshop are, Bose-Einstein Condensation in atomic and molecular gases, Bardeen-Cooper-Schrieffer (BCS) pairing to BEC crossover in superconductors and superfluids, Physics of cold atoms and condensation of interacting bose gas, Feshbach resonance and spectroscopic techniques. The keynote lecture was delivered by Wolfgang Ketterle, 2001 Nobel Laureate in Physics.

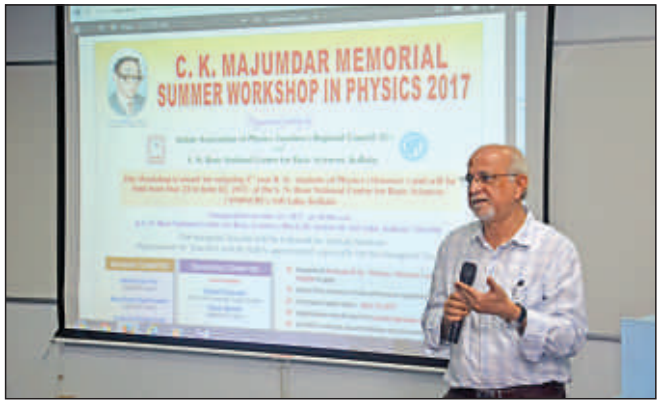
Nibedita Konar | Debashish Bhattacharjee | Rupam Porel

CTMSE 2018

IWBECRP

EPCQS 18

HyPe-2017



C K Majumdar Memorial Summer Workshop 2017

ISNFQC 18

CTMSE 2018

IWBECRP

DEPARTMENT OF SCIENCE AND TECHNOLOGY (DST) CONCLAVE 2017

S N Bose National Centre for Basic Sciences hosted the DST Conclave 2017 during 2-3 May, 2017 in Kolkata. Honorable Union Minister of Science and Technology and Earth Sciences, Dr. Harsh Vardhan, Secretary DST, Prof. Asutosh Sarma, Directors of autonomous DST Institutes, Professional bodies and Heads of various division of DST participated in the conclave. The achievements of the Autonomous Bodies and various Research and Development (R&D) promotional programmes of DST were presented in the Conclave.

On May 2, 2017, the inaugural session started with the welcome of the delegates by the Director of S N Bose National Centre for Basic Sciences. He expressed happiness over S. N. Bose Centre getting the opportunity for organizing this flagship event of DST. Introductory speech was delivered by Prof. Ashutosh Sharma, Secretary, DST covering an overview of DST's activities, which emphasized the nodal and coordinating role that the Department played in laying down science and technology policies and promoting R&D activities in the country. The report of 'DST Conclave 2015' and 'Compendium of Technologies Developed by Autonomous Institutions of DST' were released by Dr. Harsh Bardhan, the Hon'ble Union Minister of Science and Technology and Earth Sciences. Heads of the autonomous R &D institutes of DST, Professional bodies and Presidents of Academies presented the highlights of the achievements and visions of their respective institutes. The session continued on May 3rd 2017.

All participating institutes also presented posters reflecting their major objectives and activities. Dr. Harsh Bardhan, Hon'ble Union Minister of Science and Technology and Earth Sciences expressed his satisfaction on the achievements of the DST in pursuing R&D activities on national missions such as Make in India, Swachh Bharat, Swastha Bharat, Digital India, Skill Development etc. Honorable Union Minister and Secretary, DST also addressed a press conference during the meeting. In the valedictory session, a brain storming discussion and interactions among participants were held..

The Honorable Union Minister, Dr. Harsh Vardhan inaugurated a state-of-the-art Clean Room with Nanofabrication facilities in the SN Bose Centre on the concluding day.

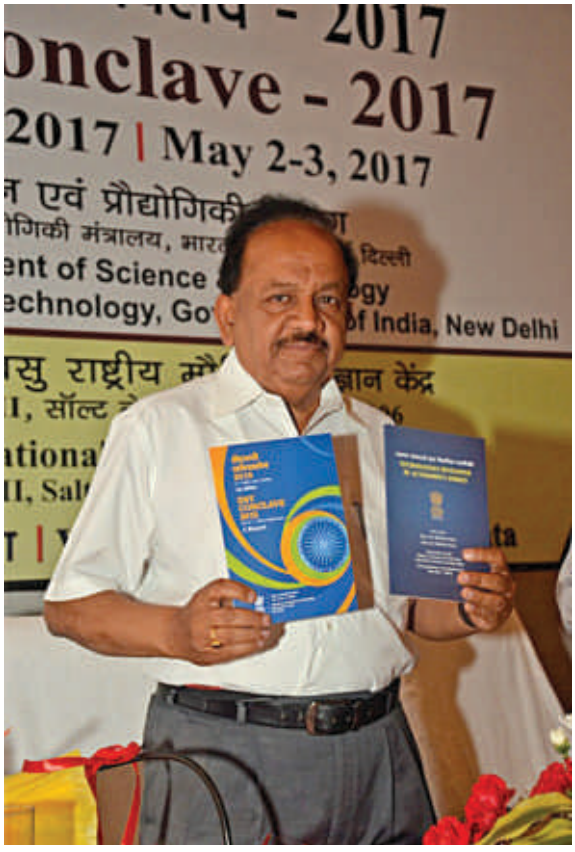
Dr. Harsh Vardhan, Honorable Union Minister was greeted by the Director, S N Bose Centre in the Conclave.

Professor Ashutosh Sharma,Secretary, DST was welcomed by the Director, S N Bose Centre in the Conclave.

Participants of DST Conclave 2017

Group Photo : DST Conclave 2017 during 2-3 May

Inauguration of clean room



The Hon'ble Union Minister for Science and Technology and Earth Sciences, Dr. Harsh Vardhan released 'Report of DST Conclave 2015' and 'Compendium of Technologies Developed by Autonomous Institutions of DST'

The Hon'ble Union Minister for Science and Technology and Earth Sciences, Dr. Harsh Vardhan interacted with the press and media persons regarding research and activities of DST institutes.

THEORETICAL PHYSICS SEMINAR CIRCUIT

Academic visits

Sl No	Seminar Date	Speaker	Affiliation	Duration of Visit	Title of the Talk
1.	19-07-2017	Dr. Rajeev Singh	Ramanujan Fellow, Department of Physics, IIT-BHU	July 19-23, 2017	Many-body localization and its signatures in quantum quenches
2.	13-09-2017	Dr. Arijit Saha	Reader-F, Institute of Physics (IOP), Bhubaneswar	September 11-15, 2017	Cooper pair splitting in a graphene based beam splitter geometry
3	05-02-2018	Mr. Tridev Mishra	PhD Scholar, Birla Institute of Technology & Science (BITS), Pilani, Rajasthan	February 4-10, 2018	Some studies on modifications of low dimensional systems under the application of periodic driving

Advanced Research Workshop

- 2,00,000 INR TPSC grant released to Vidyasagar University for organizing the 9th Vidyasagar-Satyendranath Bose National Workshop on "Science of Materials: Challenges and Prospects (SMCP 2018)" during 17th to 19th January 2018 at Vidyasagar University Campus, Midnapore. The total number of participants was 183.
- 2,00,000 INR TPSC Grant released to Savitribai Phule Pune University for organizing the "International Conference on Recent Advances in Condensed Matter Physics and Complex System" during 30th October to 1st November 2017 at the Department of Physics, Savitribai Phule Pune University, Pune.

Topical Research School

- 1,00,000 INR TPSC Grant released to Scottish Church College for organizing a workshop on "Recent Advances in Research of Statistical Physics: A School for Undergraduate Students" in collaboration with Satyendra Nath Bose National Centre for Basic Sciences, Saha Institute of Nuclear Physics and Physics Alumni Association, Scottish Church College during 25th to 28th July 2017 at the Department of Physics, Scottish Church College, Kolkata.

Participants of ICRACMPCS, Pune

Details of the speakers from the different Institute/Centre /university who visited the TPSC Centres across India

Speaker	Affiliation	TPSC Centre Visited
Prof. P Pradeep Kumar	S. P. Pune University	Indian Institute of Technology, Roorkee
Dr. Hans-Juergen Wollersheim	IIT Ropar	
Dr. Lalit Mohan Joshi	Indian Institute of Geomagnetism, Mumbai	
Dr .Vijay Pal Singh	University of Hamburg, Germany	
Dr. Hum Chand	Aryabhatta Research Institute of Observational Sciences (ARIES)	
Dr. Sushil K. Sharma	Jagiellonian University, Krakow, Poland	
Dr. V. L Narayanan	NARL, Gardanki	
Dr. B. Sangeetha	CICECO-Aveiro Institute of materials, University of Aveiro	
Prof. K. G. Arun	Chennai Mathematical Institute, Chennai	Cochin University of Science and Technology
Dr. E. Prasad	Central University of Kerala, Kasaragod	
Prof. P. M. G. Nambissan	Saha Institute of Nuclear Physics, kolkata	
Prof. Sitabra Sinha	IMSC., Chennai	
Prof. Indranil Mazumdar	TIFR, Mumbai	
Dr. Sayantan Choudhury	TIFR, Mumbai	Institute of Physics, Bhubaneswar
Dr. Soumya C	University of Hyderabad	
Dr. Poonam Mehta	JNU, New Delhi	
Dr. Reetanjali Maharana	Hebrew University, Israel	
Dr. Abhishek Mahapatra	Ohiostate University	
Dr. Suratha Das	IIT, Kharagpur	
Dr. Moon Moon Devi	Tezpur University	
Mr. Ankit Budhraja	IISER, Bhopal	
Soumyabrata Chatterjee	Institute of Physics, Bhubaneswar	Indian Institute of Technology, Kanpur
Krishnamohan Parattu	IIT, Madras	
Mehul Malik	IQOQI, Vienna	
Arijit Saha	Institute of Physics, Bhubaneswar	
Tridev Mishra	Birla Institute of Technology and Science, Pilani	
Dr. S. Sabarathinam	University of Delhi	Bharathidasan University, Tiruchirappalli
Dr. R. Sahadevan	University of Madras	
Ms. Sangita Bera	Presidency University	
Prof. S. Lakshmivarahan	University of Oklahoma, USA	
Dr. K. Suresh	Anjaliammal Mahalingam Engineering College, Thanjavur	
Prof. Syamal Kumar Dana	Jadavpur University	

Sakuntala Chatterjee

Sakuntala Chatterjee
Convener, Theoretical Physics Seminar Circuit

9th Vidyasagar-Satyendranath Bose National Workshop on "Science of Materials: Challenges and Prospects (SMCP 2018)

SMCP 2018 at Vidyasagar University

ICRACMPCS at Pune University

Workshop on "Recent Advances in Research of Statistical Physics: A School for Undergraduate Students" at Department of Physics, Scottish Church College, Kolkata

REGISTRAR

Report on Administrative Matters

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 2017-2018 successful. Staff comprising of strength of approximately 19 in permanent, 12 in temporary and 41 in contractual category as on 31st March 2018, have functioned effectively 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 has been made possible due to the professional services provided by the various service agencies working closely with the administrative sections of the Centre. The administrative employees of the Centre have been encouraged to attend various training programmes and workshops all through the year so that their administrative and technical abilities are enhanced. The Centre has maintained a close communication with the Department of Science and Technology and some other ministries and have replied to their various enquiries and requirements. The Centre has successfully replied to Audit Queries, Parliamentary Questions and disseminated various factual information to the Ministry. The Hindi Cell of the Centre has been functioning effectively since April 2008 and substantial work has been undertaken regarding implementation of the Official Language Act.

No cases related to vigilance have been reported during the period of 2017-2018. The Centre has also adhered to the norms of the Right to Information Act and so far has received twenty five (25) cases under the said Act in the last financial year all of which has been successfully disposed off.

As part of Vigilance Awareness Week 2017 during 30th October 2017 to 4th November 2017, the Centre organised an Essay Competition (Topic: "My Vision-Corruption Free India"). 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. Sudipta Das, Office Assistant.
- 2nd Prize – Mr. Saikat Paul, Junior Research Fellow.
- 3rd Prize – Mr. Gurudas Ghosh – Technical Assistant (Library).

The Centre celebrated the birth anniversary of Sardar Vallabhbhai Patel as "Rashtriya Ekta Diwas (National Unity Day) on 31st October 2017 through pledge ceremony. The Centre took Cleanliness Oath/Pledge followed by in-house hindi drama on the occasion of "Swachhta Hee Seva" on 25th September 2017 and also celebrated 'Swachhta Pakhwada' from 1st November 2017 to 15th November 2017. The Centre also organised an interactive yoga session for its staff and students on the occasion of the International Yoga Day on 21st June 2017.

The Centre played host to the DST Conclave – 2017 held on 2-3 May 2017 at Hotel Hyatt Regency, Kolkata in which the Directors of the various Autonomous Institutes under DST participated along with various officials of DST. The meeting was inaugurated by Dr. Harsh Vardhan, Hon'ble Minister, Ministry of Science & Technology, Earth Sciences and Environment, Forests and Climate Change, Government of India and Prof. Ashutosh Sharma, Secretary to the Government of India, DST. The administration lent a strong support in organising the Conclave in an efficient and professional manner.

This year, the Centre is celebrating 125th Birth Anniversary of Prof. Satyendra Nath Bose with great zeal and fervour through number of lectures (in the name of BOSE-125 Distinguished lecture series), Public Lectures given by distinguished speakers, Outreach Programmes within West Bengal in different Schools and Colleges in coordination with Bangiya Bijnan Parishad and outside Bengal as well, etc.

- The celebrations were initiated on 1st January 2018 with garlanding the bust of Prof. S.N.Bose followed by Tree plantation by Distinguished Guests. Prior to this a colourful procession was jointly organised by the Centre and Bangiya Bijnan Parishad in which a tabloid was taken out on behalf of the Centre and the students and faculty members participated with full enthusiasm followed by a Curtain Raising Ceremony and Address by Hon'ble Prime Minister of India, Shri Narendra Modi through Video Conferencing mode. A number of dignitaries, members of the media, many academicians and staff and students of the Centre attended the session.
- On the same day, the Centre released a Special Cover on Prof. Bose taken out by the Department of Posts inaugurated by Ms. Arundhaty Ghosh, Chief Postmaster General, West Bengal Circle, Kolkata and followed by addresses of i) Prof. Ashutosh Sharma, Secretary to the Government of India, DST ii) Guest of Honor – Shri Y.S. Chowdary, Hon'ble Minister of State, Ministry of Science & Technology and Earth Sciences, Government of India iii) Chief Guest – Dr. Harsh Vardhan , Hon'ble Minister, Ministry of Science & Technology, Earth Sciences and Environment, Forests and Climate Change, Government of India. The dignitaries were felicitated on the dais by Prof. Samit K. Ray, Director, S.N.Bose National Centre for Basic Sciences and the session ended with vote of thanks by Ms. Shohini Majumder, Registrar, S.N.Bose National Centre for Basic Sciences.
- Prof. Partho Ghose, INSA Senior Scientist delivered lecture on "Reminiscences of Bose" and Prof. Ajay K. Sood, President, INSA, IISC, Bangalore delivered Bose-125 Distinguished Lecture on "Nature Inspired Physics: Flocking and Bacterial Heat Engine".
- A documentary film titled "An Iconic Genius - Life and Works of Bose" directed by the Satyajit Ray Film Institute and produced by the Centre was screened on the occasion.
- In the evening at Meghnad Saha Auditorium, SINP, Kolkata, the Centre organised a Public Lecture by Prof. C.N.R. Rao, FRS National Research Professor, Linus Pauling Research Professor and Honorary President of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore to celebrate 125th Birth Anniversary of Prof. S.N.Bose. The evening was summed up with a Musical Program – Rabindrasangeet by Shri Debashis Raychowdhury and Smt Rohini Raychowdhury and Esraj by Smt Sewli Basu.
- It is also worth mentioning that the Centre has entered into an Agreement with the NRLC, Lucknow for preservation of Prof. Bose's artefacts (handed over to the Centre by his family members) and NCSM, Kolkata for setting up a 'Bose Archive' in the Centre's Premises. The new location of the Bose Archive and Museum was inaugurated by the Hon'ble Minister for Science and Technology on 1st January 2018 and it is expected that the Archive will be ready in a year's time.

Meetings of the Statutory Committees of the Centre :

(i) The 54th & 55th Governing Body (GB) meetings of the Centre were held on 13.09.2017 and 12.01.2018 respectively.

(ii) The 35th Finance Committee (FC) meeting of the Centre was held on 12.09.2017.

(iii) The Building Committee meeting of the Centre was held on 02.11.2017 [02/17].

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 (in case of permanent staff members) and to the students 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, Homeopath and Ayurvedic 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 tie ups under CGHS 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 etc who provide cash less indoor hospitalisation facility. Outdoor treatments are also available as per CGHS rates.

The Centre has Crèche facilities (Kishlay) for children of staff and students of the Centre. 'Kishlay' provides a nurtured environment where the child can build a foundation for continued learning. 'Kishlay' also provides a family – friendly workplace for its employees.

The Centre houses a modern Guest House by the name of 'Bhagirathi' comprising of 57 air conditioned rooms (including Single Bed, Double Bed & Transit rooms), 5 air conditioned suites and a fully AC Seminar cum Dining Hall and Kitchen with modern facilities and Seminar room. 'Bhagirathi' also has an equipped Doctor's chamber and two Air Conditioned office rooms. The Centre has two hostels by the name 'Radhachura' and 'Krishnachura' and an Essential Staff Quarter (Subarnarekha) which provides hostel accommodation to approximately 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 also provides accommodation to Post Doctoral Fellows, on request. The newly constructed Integrated Hostel Building and Transit Quarter (by the name 'Basundhara') is being moderately put into use through its dining hall facilities and housing of summer students.

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 as well on hiring basis.

For recreational facilities 'Muktangan' has been successfully organising various creative activities within the Centre in activities such as Performing Arts, Literary Arts, Visual Arts, Sports Activities and Social Outreach. 'Muktangan' organised several programmes under its aegis during the year 2017-18.

The Centre also successfully organised a number of conferences during this period, namely CTMSE-2018, EPCQS18-2018, ISNFQC-2018, IWBECRP-2018, where the administration provided a strong support.

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. Samit Kumar Ray, Director for his valuable guidance and advice on administrative matters.

Shohini Majumder
Registrar

HINDI (RAJBHASHA) IMPLEMENTATION IN THE CENTRE

The Centre paid emphasis on implementation of the Official Language in the year 2017-18. 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 are circulated in Hindi also. Many of the internal notings and signing in the Attendance Register is done in Hindi. The Centre has its official website in Hindi and some of the important policy documents of the Centre have been translated in Hindi and have been uploaded in the Centre's website. The Centre has also carried out some correspondences in Hindi with the ministry and other organisations and is regularly submitting the online quarterly progress report on Hindi. 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.

Miscellaneous jobs like calendar, greetings cards and banners for different Seminars etc. are done in bi-lingual format.

The year also saw Hindi Diwas being celebrated in great zeal, in the month of September with 'Hindi Pakhwada' from 01.09.2017 to 14.09.2017. The Pakhwada commenced with Hindi Extempore. The Pakhwada ended on 14th September 2017 in the presence of Dr. Rajshree Shukla, Professor, Hindi Department, Calcutta University, Shri. R.N.Saroj, Dy. Director, Hindi Teaching Scheme, Dept. of OL, MHA, Govt. of India and Shri. Vipati, Hindi Teacher, Hindi Teaching Scheme, Dept. of OL, MHA, Govt. of India.

The hindi pakhwada was celebrated through screening of Hindi Film 'ANGUR', staging of an in house Cultural programme by staff members 'LAPTOP BABA', Hindi play 'BAAP BADA NA BHAIYYA SABSE BADA RUPAIYYA' performed by 'Ognam' group and a Hindi Quiz programme. The Centre organised a Hindi Essay Competition on the occasion as well. The topics were (i) Prof. Satyendra Nath Bose ki Vigyan me Yogdan (ii) Sarkari daftaro mein Rajbhasha Hindi ki Sthithi (iii) Nari Sashiktikaran. The essay competition carried a cash award of Rs.6,000/- (1st prize), Rs.4,000/- (2nd prize) and Rs.3,000/- (3rd prize). The winners were:

- 1st Prize - Ms. Ananya Sarkar, Technical Assistant (Library).
- 2nd Prize – Mr. Amit Ray, Technical Assistant (Library).
- 3rd Prize – Ms. Urmi Chakrabarty, Technical Assistant.

For the first time, a "Hindi Essay Writing Competition" was organised in the Centre on 13th July 2017 for students of Classes IX & X in which total 25 students of 5 different schools-Kendriya Vidyalaya No. 1, Kendriya Vidyalaya No. 2, Salt Lake, Hariyana Vidya Mandir, APJ School and Bhartiya Vidya Bhawan participated with lot of interest.

The Centre organised quarterly 'Hindi Workshops' on (i) 23.06.2017 where Shri Nirmal Dubey, Research Officer (Implementation) & Office Head, Regional Implementation Office (East Region), Kolkata, Official Language Department, Ministry of Home Affairs spoke on "Official Language – related constitutional provisions, policies, rules, and its implementation in offices" ; ii) 19.08.2017 where Smt. Purnima Bagh, Assistant Manager (Rajbhasha Officer), Regional Office, Kolkata-I, Indian Overseas Bank spoke on "Format of letter writing and notation" ; iii) 08.12.2017

where Shri Bhaskaranand Jha, Assistant Director (Official Language), Variable Energy Cyclotron Centre, Department of Atomic Energy, Government of India spoke on "Implementation of Language Policies in Scientific Institutions" ; iv) 23.03.2018 where Mrs. Manju Sirin, Assistant Director & Office President, Hindi Shikshan Yojana, Department of Official Language, Home Ministry , Government of India & Shri Vipati ji, Hindi Adhyapak, Hindi Shiksha Yojana, Official Language Department, Home Ministry spoke on "Drafting different forms of correspondence and writing".

Shohini Majumder

Registrar

Inauguration of Hindi Pakhwada 2017

Hindi Divas 2017

Essay writing competition for school students

Hindi Workshop

COMMITTEES

Governing Body

Dr. Srikumar Banerjee Homi Bhabha Chair Professor Department of Atomic Energy Bhabha Atomic Research Centre	Chairman
Prof. Ashutosh Sharma Secretary Department of Science & Technology Government of India, New Delhi	Member
Prof. Archana Bhattacharyya Emeritus Scientist Former Director, IIG, Mumbai	Member
Prof. Sudha Bhattacharya Professor School of Environmental Sciences JNU, New Delhi	Member
Prof. Debashish Chowdhury Professor Dept. of Physics IIT, Kanpur	Member
Prof. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Siddhartha Roy Director Bose Institute	Member
Prof. Santanu Bhattacharya Director Indian Association for Cultivation of Science Kolkata	Member
Shri J.B. Mohapatra Joint Secretary & Finance Advisor Department of Science & Technology Government of India, New Delhi	Member
Chief Secretary, Government of West Bengal Kolkata	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Non-Member Secretary

Finance Committee

Prof. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Dr. Praveen Chaddah Former Director UGC-DAE Consortium for Scientific Research Indore	Member
Shri. J.B.Mohapatra Joint Secretary & Financial Adviser Department of Science & Technology New Delhi	Member
Prof. Biswajit Mahanty Dean, Planning & Coordination & Professor Department of Industrial and System Engineering 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. 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 Senior Professor, Bose Institute, Kolkata	Member
Prof. S.M.Yusuf Scientific Officer (H+), BARC, Mumbai	Member
Prof. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Archan S Majumdar Dean (Faculty) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Biswajit Chakraborty 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. Saumen Mondal Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Dr. M. Sanjay Kumar Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Kalyan Mandal Head, Department of Condensed Matter Physics and Material Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Jaydeb Chakrabarti Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee

Building Committee

Prof. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Retd. Engineer of CPWD (Not below the rank of Superintending Engineer)	Member
Mr. Chirantan Debdas Superintending Engineer (Electrical) Indian Institute of Chemical Biology (CSIR) 4, Raja S.C.Mullick Road Kolkata – 700 032	Member
Prof. Sriman Kumar Bhattacharyya Deputy Director and professor Civil Engineering Indian Institute of technology Kharagpur A-193, IIT Campus Kharagpur 721 302 (WB)	Member
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member-Secretary
Mr. Sujit Kr. Dasgupta Superintending Engineer S. N. Bose National Centre for Basic Sciences Kolkata	Special Invitee
Mr. Apurba Kanti Sarkar Deputy Registrar (Finance) S. N. Bose National Centre for Basic Sciences Kolkata	Special Invitee

Consultative Advisory Committee

Prof. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Prof. Archan S Majumdar Dean (Faculty) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Biswajit Chakraborty Dean (Academic Programme) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Dr. M. Sanjay Kumar Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Dr. Saumen Mondal Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Jaydeb Chakrabarti Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Kalyan Mandal 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. Apurba Kanti Sarkar 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. Samit Kumar Ray Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Ms. Shohini Majumder Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member-Secretary
Prof. Manu Mathur Professor S. N. Bose National Centre for Basic Sciences Kolkata	Member
Mr. Apurba Kanti Sarkar Deputy Registrar (Finance) 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
Mr. Debashish Bhattacharjee Deputy Registrar (Administration) S. N. Bose National Centre for Basic Sciences Kolkata	Member
Ms. Sadhana Tiwari Hindi Officer S. N. Bose National Centre for Basic Sciences, Kolkata	Member

ACADEMIC MEMBERS

Faculty Members

1	Samit Kumar Ray	Senior Professor & Director
2	Amitabha Lahiri	Senior Professor, TS
3	Anjan Barman	Senior Professor, CMPMS & Associate Dean (Faculty)
4	Archan S. Majumdar	Senior Professor, A&C & Dean (Faculty)
5	Atindra Nath Pal (from 27.12.2017)	Assistant Professor, CMPMS
6	Barnali Ghosh (Saha)	Scientist-E (Technical Cell), CMPMS
7	Biswajit Chakraborty	Professor, TS & Dean (AP)
8	Gautam Gangopadhyay	Professor, CBMS
9	Jaydeb Chakrabarti	Professor & HOD, CBMS
10	Kalyan Mandal	Senior Professor & HOD, CMPMS
11	Manik Pradhan	Associate Professor, CBMS
12	Manoranjan Kumar	Associate Professor, CMPMS
13	Manu Mathur	Professor, TS
14	M. Sanjay Kumar	Associate Professor & HOD, TS
15	Partha Guha	Professor, TS
16	Pratip Kr. Mukhopadhyay	Senior Professor, CMPMS
17	Priya Mahadevan	Senior Professor, CMPMS & Associate Dean (AP)
18	Prosenjit Singha Deo	Professor, CMPMS
19	Punyabrata Pradhan	Associate Professor, TS
20	Rabin Banerjee (*Superannuated on 31.10.2017*)	Senior Professor, TS
21	Rajib Kumar Mitra	Associate Professor, CBMS
22	Ramkrishna Das	Assistant Professor, A&C
23	Ranjan Chaudhury	Professor, CMPMS
24	Ranjit Biswas	Professor, CBMS
25	Sakuntala Chatterjee	Associate Professor, TS
26	Samir K. Pal	Senior Professor, CBMS
27	Sandip K. Chakrabarti	Senior Professor, A&C
28	Sanjoy Choudhury	Scientist-D (Computer Services Cell)
29	Soumen Mondal	Associate Professor & HOD, A&C
30	Subhrangshu Sekhar Manna(*Superannuated on 31.01.2018*)	Senior Professor, TS
31	Sunandan Gangopadhyay (from 12.12.2017)	Assistant Professor, TS
32	Tanusri Saha Dasgupta *(On lien to IACS)*	Senior Professor, CMPMS

Distinguished Professor (Emeritus)

1	Arup Kumar Raychaudhuri	CMPMS

Emeritus Professors

1	Rabin Banerjee (from 01.11.2017)	TS
2	Subhrangshu Sekhar Manna (from 01.02.2018)	TS
3	Subodh Kumar Sharma	TS

Academic Visitor		
1	Abhijit Mookerjee	CMPMS
Honorary Fellow		
1	Samir Kumar Paul	TS
2	Sugata Mukherjee	CMPMS
Scientist-D		
1	Bhushan Omprakash Awasarmol (till 01.07.2017)	TUECMS
2	Biswaroop Mukherjee (till 14.11.2017)	TUECMS
3	Jaivardhan Sinha (till 30.04.2017)	IUENDT
4	Shreemoyee Ganguly (till 15.05.2017)	TUECMS
DST Inspire Faculty		
1	Amlan Dutta (till 15.01.2018)	CMPMS
2	Soumendu Datta	CMPMS
3	Subhra Jana	CBMS
Ramanujan Fellow		
1	Jaivardhan Sinha (from 01.05.2017 to 28.03.2018)	CMPMS
Sabbatical Visitor		
1	Kartik Ghosh (from 04.09.2017 to 18.01.2018)	CMPMS
Visiting Faculty		
1	Madhuri Mandal	CMPMS
Young Scientist		
1	Alo Dutta	CMPMS
Post Doctoral Research Associates		
1	Amna Ali (till 15.04.2017)	A&C
2	Aurab Chakraborty (from 24.07.2017)	CMPMS
3	C Jebarathinam (from 14.07.2017)	A&C
4	Chaitrali Sengupta (from 01.08.2017)	CBMS
5	Dayasindhu Dey (till 22.02.2018)	CMPMS
6	Deepika Kumari (from 01.08.2017)	TS
7	Dipak Kumar Das (from 17.07.2017)	CMPMS
8	Indrani Banerjee (till 28.06.2017)	A&C
9	Kumar Abhinav (till 31.08.2017)	TS
10	Mausumi Ray (from 20.02.2018)	CBMS
11	Prasanta Kundu (from 20.02.2018)	CBMS
12	Ravikant Verma (till 28.02.2018)	TS
13	Sayantani Das (from 18.07.2017 to 09.11.2017)	CMPMS
14	Shamik Chakrabarti	CMPMS
15	Srabantika Ghose (from 15.02.2018)	CMPMS
16	Suman Chakraborty (from 19.02.2018)	A&C
17	Vinodh Kumar Shanmugam (from 10.04.2017)	CMPMS
National Post Doctoral Fellow		
1	Ankita Ghatak	CMPMS
2	Jashashree Ray	CMPMS
3	Samyadeb Bhattacharya (from 30.10.2017)	A&C
4	Shubhashis Rana	TS
5	Sumona Sinha	CMPMS
6	Tanushree Dutta	CBMS

A&C : Department of Astrophysics & Cosmology
CBMS : Department of Chemical, Biological & Macro-Molecular Sciences
CMPMS : Department of Condensed Matter Physics and Material Sciences
TS : Department of Theoretical Sciences
TUECMS : Thematic Unit of Excellence on Computational Materials Science
TUENDT : Thematic Unit of Excellence on Nanodevice Technology
UNANST : Unit for Nanoscience and Technology

ADMINISTRATIVE AND TECHNICAL STAFF MEMBERS

Shohini Majumder	Registrar
Gautam Gangopadhyay	Vigilance Officer
Saumen Adhikari	Central Public Information Officer

Other Members

Apurba Kanti Sarkar	Deputy Registrar (Finance)
Nibedita Konar	Deputy Registrar (Academic)
Debashish Bhattacharjee	Deputy Registrar (Administration)
Saumen Adhikari	Librarian cum Information Officer
Sivaji Chatterjee	Campus Engineer cum Estate Officer *[12.10.2017 – 19.03.2018]*
Sukanta Mukherjee	Sr. Assistant Registrar (Projects)
Santosh Kumar Singh	Assistant Registrar (Purchase)
Sirsendu Ghosh	Programme Coordinating Officer
Achyut Saha	Personal Assistant to Director
Jaydeep Kar	Programme Assistant
Prosenjit Talukdar	Programme Assistant
Shiba Prasad Nayak	Pump Operator
Bijoy Kumar Pramanik	Junior Assistant (Guest House)
Bhupati Naskar	Library Stack Assistant
Sushanta Kumar Biswas	Driver
Pradip Kumar Bose	Tradesman 'A'
Partha Mitra	Attendant
Ratan Acharya	Attendant
Swapan Ghosh	Attendant

PERSONNEL WITH TEMPORARY STATUS

Biman Roy	Attendant (Administration)
Dulal Chatterjee	Attendant (Maintenance)
Somnath Roy	Attendant (Accounts)
Sudhanshu Chakraborty	Attendant (Technical Cell)
Sukamal Das	Attendant (Central Registry)
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

Sunish Kumar Deb	Advisor (Liaison)
Sujit Kr. Dasgupta	Superintending Engineer
Ayan Deb	Assistant Engineer (Electrical)
Sutapa Basu	PS to Registrar
Sadhana Tiwari	Hindi Officer
Abhijit Ghosh	Junior Computer Engineer
Sagar Samrat De	Junior Computer Engineer
Somasree Mal	Junior Computer Engineer *[joined on12.04.2017]*
Deblina Mukherjee	Junior Computer Engineer *[joined on 10.04.2017]*
Amit Roy	Technical Assistant (Library)
Gurudas Ghosh	Technical Assistant (Library)
Ananya Sarkar	Technical Assistant (Library)
Shakti Nath Das	Technical Assistant
Surajit Mukherjee	Technical Assistant *[till 11.06.2017]*

Urmi Chakraborty	Technical Assistant
Amit Kumar Chanda	Technical Assistant
Joy Bandopadhyay	Technical Assistant
Dipayan Banerjee	Technical Assistant *[joined on 04.09.2017]*
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
Swarup Dutta	Office Assistant
Moumita Banik	Office Assistant
Suvendu Dutta	Office Assistant
Siddhartha Chatterjee	Office Assistant
Sonali Sen	Office Assistant
Sudipta Das	Office Assistant
Lina Mukherjee	Jr. Office Assistant
Debasish Mitra	Telephone Operator
Amit Kumar Ghosh	Mechanic
Sani Amed Ali Molla	Technician (AC & Refrigeration)
Arvind Paswan	Driver *[till 05.07.2017]*
Gobinda Das	Driver *[till 05.07.2017]*
Kalyani Ghosh	Caretaker (Creche)
Suranjan Deb	Telephone Technician
Harishikesh Nandi	Glass Blower (Part-time)

MEDICAL CELL (CONSULTANT PHYSICIAN)

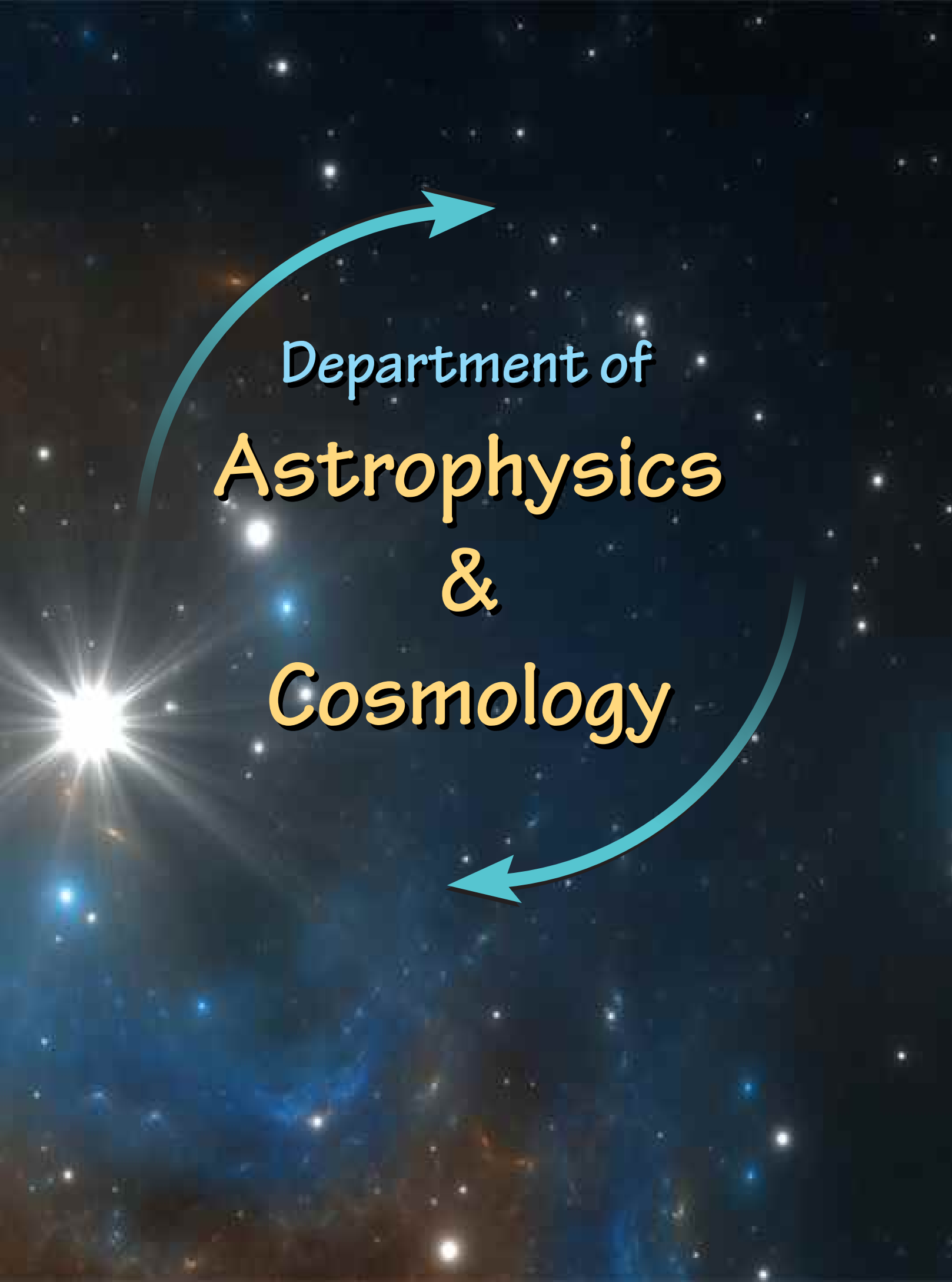
Dr. Swapan Kumar Bhattacharyya	Authorised Medical Officer
Dr. Sarbani Bhattacharya	Medical Officer
Dr. Tridib Kumar Sarkar	Doctor of Homeopathy
Dr. Gopal Chandra Sengupta	Doctor of Ayurvedic

Staff members of SNBNCBS

Staff members of Academic Section, SNBNCBS

Staff members of Administrative Section, SNBNCBS

Staff members of Purchase Section, SNBNCBS


Department of
Astrophysics
&
Cosmology

Department of Astrophysics & Cosmology

Soumen Mondal

Department profile indicators

Table_A : Manpower and resources		
Number of faculties	04	
Number of Post -doctoral research associate (centre + project)	03	
Number of Ph.D students	26	
Number of other project staff	0	
Number of summer students	03	
Projects (ongoing)	02	
Table B: Research Activities indicators		
Number of research papers in Journals	30	
Number of Book-chapters/books	0	
Number of other publications	02	
Number of Ph.D students graduated (submitted + degree awarded)	05	
Number of M.Tech/M.Sc projects	11	
Table C: Academic activities and likeage		
Number of courses taught by faculties	08	
Number of Visitors (non -associates)	03	
Number of associates	0	
Number of Seminars organized	24	
Number of Conference/Symposia/Advanced Schools organized	04	
Number of talks delivered by members of department in conferences/Symposia	National	15
	International	06

Most important research highlights

- Understanding of exact cause of hysteresis in black hole accretion disk light curve.
- Observational signatures of unusual outgoing longwave radiation (OLR) and atmospheric gravity waves (AGW) as precursory effects of earthquakes.
- From studying of the abundances of certain amines in the interstellar medium, it was noticed that increase the possibility of producing pre-biotic molecules during the collapse.
- Proposal for a viable scenario of the emergent universe with wormholes in massive gravity.
- Derivation of new bipartite qutrit local realist inequalities and the robustness of their quantum mechanical violation.
- Demonstration of preservation of quantum coherence under Lorentz boost for narrow uncertainty wave packets.
- Derivation of tighter Einstein-Podolsky-Rosen steering inequality based on the sum steering relation.
- Formulation of a tighter steering criterion using the Robertson-Schrodinger uncertainty relation.
- Proposal of a measure of EPR steering in the context of extremal boxes.
- Proposal for determination of genuine tripartite nonlocality using the Mermin inequality.
- Photo-ionization modeling of the recurrent Nova RS Ophiucus.
- Novae comprehensive grid model using Photo-ionization code Cloudy and observational studies of planetary nebulae.
- Photometric variable stars of young pre-main sequence stars in the Galactic star-forming regions.
- Optical/Near-Infrared spectroscopic characterization of a new Oxygen-rich Mira.
- Understanding of variability properties in very low mass stars and brown dwarfs.
- Building of Astronomical Observing facilities at Panchet hill, Purulia, West Bengal is planned.

Summary of research activities

- In black hole astrophysics, we found the exact reason of hysteresis seen in outbursting sources. We showed that it takes a very long time to destroy a Keplerian disk around a black hole as compared to the time taken to build it up. We also found that around a neutron star the disk structure remains the same as that around a black hole, but a normal boundary layer has to be added on the hard surface. While fitting the data we found that viscosities required to enable state transition are similar for all the black hole candidates.
- In Astrochemistry, we extended our early work to study the abundances of certain amines in the interstellar medium. This increases the possibility of producing pre-biotic molecules during the collapse.
- In ionospheric research, we found that definite quantitative ionospheric changes occur just before earthquakes. In balloon born studies we have been able to show how the cosmic rays are anti-correlated with solar activity.
- In cosmology, emergent universe (EU) scenarios describe the evolution of a static Einstein universe in the infinite past whereby certain problems associated with the big-bang singularity can be circumvented. By investigating the very early universe in the presence of gravitational instanton solutions, we show how a static Einstein universe emerges, leading to a cosmologically viable EU scenario in the framework of massive gravity [B. C. Paul and A. S. Majumdar, Class. Quant. Grav. 35, 065001 (2018)].
- In quantum information and foundations, Bell-type local realist inequalities are developed for demonstrating quantum nonlocality of bipartite entangled qutrit states by generalizing Wigner's argument that was originally formulated for the bipartite qubit singlet state. It is first shown that such generalized Wigner inequalities (GWI) are violated by quantum mechanics (QM) for both the bipartite qutrit isotropic and singlet states using trichotomic observable [D. Das, S. Datta, S. Goswami, A. S. Majumdar, D. Home, Phys. Lett. A 381, 3396 (2017)] .
- The effect of relativistic boosts on single particle Gaussian wave packets is investigated. Using various formulations of coherence it is shown that in general, the coherence decays with the increase of the momentum of the state, as well as the boost applied to it. Our result is exemplified quantitatively for practically realizable neutron

wave functions [R. Chatterjee, A. S. Majumdar, Phys. Rev. A 96, 052301 (2017)].

- The problem of determining the presence of genuine tripartite entanglement through the violation of Mermin inequality are investigated here. Here we show that Mermin inequality suffices as a genuine entanglement witness if at least two of the local marginal distributions are not completely random, provided the local Hilbert space dimension of at least one of the subsystems is 2. [S. S. Bhattacharya, B. Paul, A. Roy, A. Mukherjee, C. Jebaratnam, M. Banik, Phys. Rev. A 95, 042130 (2017)].
- Einstein-Podolsky-Rosen steering is a form of quantum nonlocality which is weaker than Bell nonlocality, but stronger than entanglement. Here we present a method to check Einstein-Podolsky-Rosen steering in the scenario and propose a measure of steerability called steering cost [D. Das, S. Datta, C. Jebaratnam, A. S. Majumdar, Phys. Rev. A 97, 022110 (2018)].
- We investigate quantum steering by non-Gaussian entangled states. Here, we derive a tighter steering criterion using the Robertson-Schrodinger uncertainty relation. We show that our steering condition is able to detect steerability of several classes of non-Gaussian states such as the photon squeezed vacuum state and the NOON state [S. Sasmal, T. Pramanik, D. Home, A. S. Majumdar, Phys. Lett. A 382, 27 (2018); A. G. Maity, S. Datta, A. S. Majumdar, Phys. Rev. A 96, 052326 (2017)] .
- In Novae observational studies, the photoionization modeling of the recurrent Nova RS Ophiucus (during the 2006 outburst and quiescence period) is presented. The best-fit model parameters are compatible with a hot white dwarf source with black body temperature of 5.5 - 5.8 $\times$ 105 K and roughly constant a luminosity of 6 - 8 $\times$ 1036 ergs $s-1$ and the ejecta is significantly enhanced, relative to solar, in helium, nitrogen, neon, iron, and argon [Mondal, A. et al. 2018, MNRAS, 474, 4211]. A comprehensive grid model of Novae atmospheres is constructed using the basic parameters spanning over the probable parameter space appropriate for novae, This provides a tool to derive the values of other parameters for a particular nova, by matching the observed values with the calculated ones [Mondal, A. et al., MNRAS (under review), 2018].
- In planetary nebulae, the observed optical/near-infrared spectra have been analyzed and modeled to estimate physical parameters of few Pnes.
- In observational studies of evolved giants, we first confirm a newly discovered Mira variable MASTER-Net Optical Transient J212444.87+321738.3 toward the Cygnus constellation. From long-term optical/near-infrared (NIR) photometric and spectroscopic observations, we estimate a variability period of 465 ± 30 days and the wavelength-dependent amplitudes of the observed light curves range from $\Delta I \sim 4$ mag to $\Delta K \sim 1.5$ mag. Interestingly, a phase lag of ~60 days between optical and NIR light curves is also seen, as in other Miras. Our optical/NIR spectra show molecular features of TiO, VO, CO, and strong water bands that are a typical signature of oxygen-rich Mira [Ghosh et al. 2018, The Astronomical Journal, 155].
- In observational studies of stellar variability, photometric variability is a ubiquitous characteristic of young stars in star-forming regions. The variation in observed flux is proposed to be due mainly to the rotational modulation of hot/cool spots on the young star's surface, yielding rotation period ranges from hours to 15 days. From time series photometry of young clusters NGC 2282 and Cyg OB7, we identified and characterized the variability of pre-main-sequence (PMS) stars [Dutta, S., et al. 2018, MNRAS, 476; Dutta, S. et al. 2018, MNRAS (under review)].
- The photometric variability studies of an L3.5 brown dwarf 2MASS J00361617+1821104 (2M0036+18) in the field and of four young brown dwarfs in the star-forming region IC 348 are studied here. From muti-epoch observations, we found significant periodic variability in 2M0036+18 with a period of 2.66 $\pm$ 0.55 hours on one occasion while it seemed to be non-variable on three other occasions. An evolving dust cloud might cause such a scenario. Among the four young brown dwarfs of IC 348 in the spectral range M7.25 - M8, one brown dwarf 2MASS J03443921+3208138 shows significant variability [Mondal, S. et al. 2018, BLRSS, 87]

Soumen Mondal

Head, Department of Astrophysics and Cosmology

Archan Subhra Majumdar

Senior Professor & Dean (Faculty)
Astrophysics & Cosmology
archan@bose.res.in

Archan S. Majumdar is a theoretical physicist working in the dual fields of (i) gravitation and cosmology, and (ii) quantum information and foundations.

Supervision of Research / Students

Ph.D. Students

1. Subhadipa Das, Study of bipartite and multipartite quantum nonlocality, Thesis submitted
2. Sovik Roy, Study on entanglement and its utility in information processing, Thesis submitted
3. Shiladitya Mal, Interlinking fundamnental quantum features to information theoretic resources, Thesis submitted
4. Suchetana Goswami, Weak measurements and quantum steering, Ongoing
5. Shounak Datta, Applications of uncertainty relations on information theoretic resources, Ongoing
6. Riddhi Chatterjee, Relativistic quantum entanglement, Ongoing
7. Arnab Sarkar, Cosmological probes with gravitational waves, Ongoing
8. Ananda Gopal Maity, Quantum information theory, Ongoing
9. Sourav Karar, Quantum information theory, Ongoing
10. Shasank Gupta, Quantum information theory, Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Abhiskek Sadu, IIT Kharagpur, Introduction to quantum information, Completed
2. Manjari Datta, SNBNCBS, Introduction to general theory of relativity and cosmology, Completed
3. Saurav Karar, SNBNCBS, An introductory review of quantum heat engines, Completed
4. Ananda Gopal Maity, SNBNCBS, Uncertainty relations and some applications, Completed
5. Bihalan Bhattacharya, SNBNCBS, Self testing of any pure entangled state in the EPR steering scenario, Completed
6. Megha Dave, SNBNCBS, An introduction to quantum information theory, Completed
7. Raghvender, SNBNCBS, Introduction to cosmology, Completed
8. Sayan Routh, SNBNCBS, Fundamental aspects of quantum theory and quantum information, Completed

Post Doctoral Research Scientist/s

1. C. Jebaratnam
2. Samyadeb Bhattacharya (NPDF)

Teaching activities at the Centre

1. 2nd Semester, Summer project research, (PHY 292), IPhD, 1
2. 3rd Semester, Advanced quantum mechanics and applications (PHY 303), IPhD, 8, shared with Biswajit Chakraborty
3. 3rd Semester, Project Research II, (PHY 304), IPhD, 2
4. 5th Semester, Project Research Part I, (PHY 591), PhD, 3

Publications in Journals

1. D. Das, S. Datta, S. Goswami, A. S. Majumdar, D. Home, *Bipartite qutrit local realist inequalities and the robustness of their quantum mechanical violation*, Phys. Lett. A, 381, 3396 (2017)

2. R. Chatterjee, A. S. Majumdar, *Preservation of quantum coherence under Lorentz boost for narrow uncertainty wave packets*, Phys. Rev. A, 96, 052301 (2017)
3. A. G. Maity, S. Datta, A. S. Majumdar, *Tighter Einstein-Podolsky-Rosen steering inequality based on the sum-uncertainty relation*, Phys. Rev. A, 96, 052326 (2017)
4. S. Sasmal, T. Pramanik, D. Home, A. S. Majumdar, *A tighter steering criterion using the Robertson-Schrodinger uncertainty relation*, Phys. Lett. A, 382, 27 (2018)
5. B. C. Paul and A. S. Majumdar, *Emergent universe with wormholes in massive gravity*, Class. Quant. Grav. 35, 065001 (2018)
6. D. Das, S. Datta, C. Jebaratnam, A. S. Majumdar, *Cost of Einstein-Podolsky-Rosen steering in the context of extremal boxes*, Phys. Rev. A, 97, 022110 (2018)

Independent publications of student/s

1. S. S. Bhattacharya, B. Paul, A. Roy, A. Mukherjee, C. Jebaratnam, M. Banik, *Improvement in device-independent witnessing of genuine tripartite entanglement by local marginals*, Phys. Rev. A, 95, 042130 (2017)
2. S. S. Bhattacharya, A. Mukherjee, A. Roy, B. Paul, K. Mukherjee, I. Chakraborty, C. Jebaratnam, N. Ganguly, *Absolute non-violation of a three-setting steering inequality by two-qubit states*, Quant. Inf. Process., 17, 3 (2018)

Lectures Delivered

1. "Backreaction and the future evolution of an accelerating universe", *Hot topics in Cosmology -SW11,* Cargese, France, May 2017.
2. "Sharing of nonlocality", *International Workshop on Quantum Contextuality,* (Organized by Purdue University), Prague, Czech Republic, June 2017.
3. "Sharing of nonlocal correlations", *International Conference on Quantum Foundations",* NIT Patna, December 2017.
4. "The accelerating universe: challenges in theory and observations", *Invited Colloquium* at IIT Guwahati, February 2018.
5. "Dark energy amd the future evolution of a accelerating universe", *Recent trends in frontier research in physics,* at Jadavpur University, March 2018.
6. "Sequential sharing of nonlocal correlations", *National Symposium on recent trends in applied mathematics,* at Calcutta University, March 2018.

Membership of Committees

Internal Committee

Faculty Search Committee; Works Committee; Bose-125 PMC; TRC LMC

Sponsored Projects

1. Fundamental Aspects of Quantum Theory and Quantum Information, DST SERB, up to June 2017

Conference / Symposia / Workshops / Seminars etc. organized

1. International Symposium on New Frontiers in Quantum Correlations, 29th January – 2nd February, 2018, SNBNCBS, Convener

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. With Bose Institute, Sl. No. 1 & 4
2. With North Bengal University, Sl. No. 5
3. With ISI Kolkata and Calcutta University, Sl. No. 1 & 2 in "Independent publications of student/s"

Member of Editorial Board

1. Journal of Quantum Information Science (Scientific Research Publishing Inc., Irvine CA, USA)

Participation in Science Outreach program

- Recent developments in Astrophysics & Cosmology, at SKBU Purulia, WB, March 2018
- Recent trends in Physical Sciences, at VBU Hazaribagh, Jharkhand, March 2018

Societal impact of Research

- My research in basic science attempts to address fundamental questions regarding the physical world. It hence fulfills one of the most crucial needs for advance of cultured society, i.e., pure knowledge creation that has been recognized as important since the beginning of human civilization.
- Progress in basic science is the key attractor for young minds into subsequent applied science research.
- All technology development of the future is based upon and motivated by current advance in basic science.

Significant research output / development during last one year

General research areas and problems worked on

(A) Gravitation & Cosmology: dark energy from various perspectives

(B) Quantum Information & Foundations: entanglement, nonlocality and uncertainty relations

Interesting results obtained

Bell-type local realist inequalities are developed for demonstrating quantum nonlocality of bipartite entangled qutrit states by generalizing Wigner's argument that was originally formulated for the bipartite qubit singlet state. This treatment is based upon assuming existence of the overall joint probability distributions in the underlying stochastic hidden variable space for the measurement outcomes pertaining to the relevant trichotomic observables, satisfying the locality condition and yielding the measurable marginal probabilities. It is first shown that such generalized Wigner inequalities (GWI) (which do not reduce to Bell-CHSH inequalities by clubbing any two outcomes) are violated by quantum mechanics (QM) for both the bipartite qutrit isotropic and singlet states using trichotomic observables defined by six-port beam splitter (three input and three output ports) as well as by the spin-1 component observables, thereby revealing the nonlocality of these states. The efficacy of GWI is then probed in these cases by comparing the QM violation of GWI with that obtained for the other type of local realist inequality (known as the CGLMP inequality) that has been suggested for probing nonlocality of entangled bipartite qutrits. This comparison is done by incorporating white noise in the isotropic and singlet qutrit states.

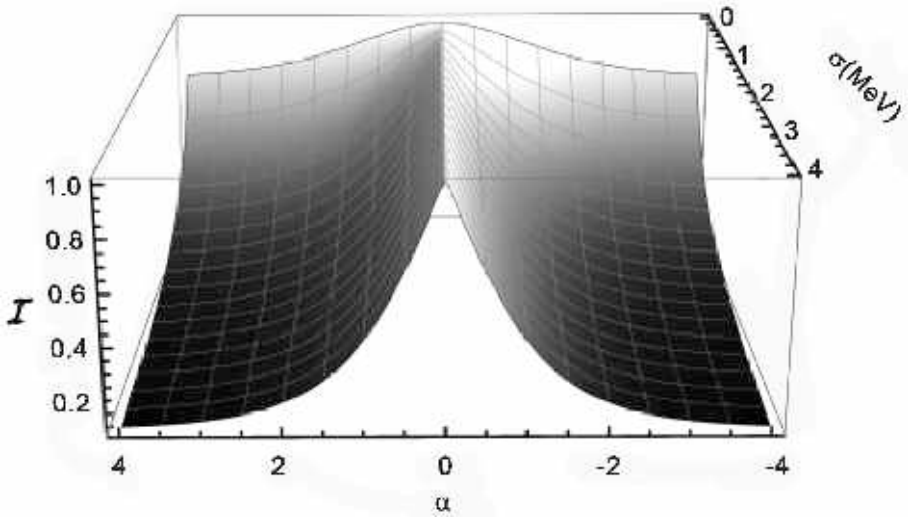
We consider the effect of relativistic boosts on single particle Gaussian wave packets. The coherence of the wave function as measured by the boosted observer is studied as a function of the momentum and the boost parameter. Using various formulations of coherence it is shown that in general the coherence decays with the increase of the momentum of the state, as well as the boost applied to it. Employing a basis-independent formulation, we show however, that coherence may be preserved even for large boosts applied on narrow uncertainty wave packets. Our result is exemplified quantitatively for practically realizable neutron wave functions.

We consider the uncertainty bound on the sum of variances of two incompatible observables in order to derive a corresponding steering inequality. Our steering criterion when applied to discrete variables yields the optimum steering range for two qubit Werner states in the two measurement and two outcome scenario. We further employ the derived steering relation for several classes of continuous variable systems. We show that non-Gaussian entangled states such as the photon subtracted squeezed vacuum state and the two-dimensional harmonic oscillator state furnish greater violation of the sum steering relation compared to the Reid criterion as well as the entropic steering criterion. The sum steering inequality provides a tighter steering condition to reveal the steerability of continuous variable states.

We consider quantum steering by non-Gausssian entangled states. The Reid steering criterion based on the Heisenberg uncertainty relation fails to detect steerability for many categories of such states. Here, we derive a tighter steering criterion using the Robertson-Schrodinger uncertainty relation. We show that our steering condition is able to detect steerability of several classes of non-Gaussian states such as entangled eigenstates of the two-dimensional harmonic oscillator, the photon squeezed vacuum state and the NOON state.

Emergent universe (EU) scenarios describe the evolution of a static Einstein universe in the infinite past whereby certain problems associated with the big-bang singularity can be circumvented. A flat universe

composed of interacting fluids with a non-linear equation of state within the EU scenario leads to a viable cosmological model accommodating the presently observed accelerating era, as well. In the present work we focus on the origin of such a EU scenario. By investigating the very early universe in the presence of gravitational instanton solutions, we show how a static Einstein universe emerges, leading to a cosmologically viable EU scenario in the framework of massive gravity. Our analysis leads to certain constraints on the model parameters for the feasibility of such a scenario.



Einstein-Podolsky-Rosen steering is a form of quantum nonlocality which is weaker than Bell nonlocality, but stronger than entanglement. Here we present a method to check Einstein-Podolsky-Rosen steering in the scenario where the steering party performs two black-box measurements and the trusted party performs projective qubit measurements corresponding to two arbitrary mutually unbiased bases. This method is based on decomposing the measurement correlations in terms of extremal boxes of the steering scenario. In this context, we propose a measure of steerability called steering cost. We show that our steering cost is a convex steering monotone. We illustrate our method to check steerability with two families of measurement correlations and find out their steering cost.

We consider the problem of determining the presence of genuine tripartite entanglement through the violation of Mermin inequality. Although the violation of Mermin inequality cannot certify the presence of genuine nonlocality, it can certify the presence of genuine tripartite entanglement whenever the violation is strictly greater than $2\sqrt{2}$. Here we show that Mermin inequality suffices as a genuine entanglement witness even when its value is $2\sqrt{2}$ if at least two of the local marginal distributions are not completely random, provided the local Hilbert space dimension of at least one of the subsystems is 2. Thus local marginals suffice as a semi-device-independent genuine entanglement witness. This is intriguing in a sense, as the local properties of a composite system can help to identify its global property. Furthermore, analyzing another quantity constructed from Mermin polynomials, we show that the genuine entanglement certification task for the correlations with Mermin inequality violation equal to $2\sqrt{2}$ can actually be made fully device independent.

Proposed research activities for the coming year

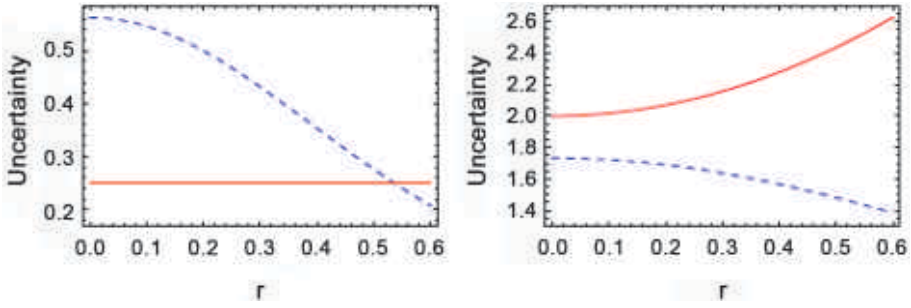
We will consider the effect of the expanding universe on the gravitational wave amplitude obtained from distant binary sources. The expression for the asymptotic gravitational wave amplitude will be calculated in terms of the rest energy density of the source taking into account the background expansion. We will show that the amplitude acquires a non-trivial dependence on the Hubble parameter that could lead to significant corrections on the estimated parameters of high red-shift binaries. We will consider several examples including a recently observed binary system and evaluate the effect of such corrections on the gravitational wave amplitude due to the expansion of the universe.

We will investigate the effect of backreaction due to inhomogeneities on the evolution of the present Universe by considering the Universe to be partitioned into multiple domains within the Buchert framework. We will consider various different partitioning of the Universe and perform a comparative analysis for the separate cases on the behaviour of the acceleration and backreaction of the Universe. The dynamics will be explored in the analogous FLRW cosmology. We will use observational data from Type Ia Supernovae, Baryon Acoustic Oscillations, and Cosmic Microwave Background to constrain the parameters of the model

for a viable cosmology, providing the corresponding likelihood contours.

Recently, the quantumness of local correlations arising from separable states in the context of a Bell scenario have been studied and linked with superlocality. Here we will investigate the quantumness of unsteerable correlations in the context of a given steering scenario. Generalizing the concept of superlocality, we will define as super-correlation, the requirement for a larger dimension of the preshared randomness to simulate the correlations than that of the quantum states that generate them. Since unsteerable states form a subset of Bell local states, it is an interesting question whether certain unsteerable states can be super-correlated. Here, we will address this question. This will provide a generalized approach to quantify the quantumness of unsteerable correlations in convex operational theories.

We will consider the problem of 1-sided device-independent self-testing of any pure entangled two-qubit state based on steering inequalities which certify the presence of quantum steering. In particular, we will show that in the steering scenario involving 2 parties, 2 measurement settings per party, and 2 outcomes per measurement setting, the maximal violation of a fine-grained steering inequality can be used to witness certain extremal steerable correlations, which certify all pure two-qubit entangled states. We will demonstrate that the violation of the analogous CHSH inequality of steering or nonvanishing value of a quantity constructed using a correlation function called mutual predictability, together with the maximal violation of the fine-grained steering inequality can be used to self-test any pure entangled two-qubit state in a 1-sided device-independent way.



Ramkrishna Das

Assistant Professor
Astrophysics & Cosmology
ramkrishna.das@bose.res.in

Dr. Ramkrishna Das received his Ph. D. degree from Physical Research Laboratory, Ahmedabad, India in 2010. He is an observational astronomer. He is presently working on observational studies of variable stars and establishment of observational facility of the centre.

Supervision of Research / Students

Ph.D. Students

1. Anindita Mondal (jointly with Dr S Mondal), Multi wavelength studies of Novae, Ongoing
2. Dhrimadri Khata (jointly with Dr S Mondal), Understanding Physical properties of M-Dwarfs, Ongoing
3. Rahul Bandyopadhyaya, Multi wavelength studies of Planetary Nebulae, Ongoing
4. Ruchi Pandey, Study of dust formation (tentative), Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Megha Dave, SNBNCBS, *Stellar Evolution,* Completed
2. Megha Dave, SNBNCBS, Analysis of Spitzer Data, Completed
3. Saikat Sadhukhan, IIT Madras, Ongoing

Teaching activities at the Centre

1. 3rd Sem (July – Dec, 2016), PHY 391: Advanced Experimental Physics (Astronomy), IPhD, 08 students
2. 5th Sem (July – Dec, 2017), PHY 510: Astrophysics, PhD, 1 student

Publications in Journals

1. A. Mondal, G. C. Anupama, U. S. Kamath, **R. Das**, G. Selvakumar, S. Mondal, *Optical spectroscopy of the recurrent nova RS Ophiuchi – from the outburst of 2006 to quiescence*, MNRAS, **474**, 4211 (2018)
2. S. Ghosh, S. Mondal, R. Das, D. P. K. Banerjee, N. Ashok, F. J. Hambsch, S. Dutta, *Phase-dependent photometric and spectroscopic characterization of the MASTER-Net Optical Transient J212444.87+321738.3: An Oxygen-rich Mira*, AJ, 155, 216 (2018)
3. S. Dutta, S. Mondal, S. Joshi, J. Jose, R. Das, S. Ghosh, *Optical Photometric Variable Stars towards the Galactic H II region NGC 2282*, MNRAS, 476, 2813 (2018)

Other Publications

1. S. Dutta, S. Mondal, J. Jose, R. Das, Stellar Population and Star Formation History of the Distant Galactic H II regions NGC 2282 and Sh2-149, ASP Conf. Series, 2017, 510, 85

Lectures Delivered

1. "Interpretation of Observed Data Observational Astronomy", IERCOO, Sitapur, Paschim Medinipur, WB, November 2017, 1
2. "Celebration of 125th Birth Anniversary of SN Bose", Sidho Kanho Birsa University, Purulia, March 2018, 1
3. "Observing the sky: tools and techniques", Sidho Kanho Birsa University, Purulia, March 2018, 1
4. "Observing the Universe", Siuri Vidyasagar College, Birbhum, March 2018, 1

Academic Visits

National

1. Astronomical Observations, IIA, Bangalore, March, August, October (2017), April 2018

Membership of Committees

Internal Committee

Committee to facilitate and initiate the process of land acquisition and construction activities at the proposed site for setting up of astronomical observatory and installation of telescope; Reservation Cell for SCs, STs, Persons With Disabilities and Other Backward Classes; Conference, Workshops and Extension Program; Seminar and Colloquia Program

Awards / Recognitions

1. Adjunct faculty in Indian Centre for Space Physics
2. Reviewer in 'Research in Astronomy and Astrophysics'

Conference / Symposia / Workshops / Seminars etc. organized

1. One day seminar on scope of astronomy with small telescope, 6 November 2017, Ionospheric and Earthquake Research Centre & Optical Observatory (IERCOO), Pashchim Medinipur, West Bengal, Joint Convener
2. Conference on Recent Advances in Space Science, 6 March 2018, Sidho Kanho Birsa University, Purulia, Co-Convenor
3. Bose Fest 2018, 8-10 February 2018, SNBNCBS, Joint Convenor

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl. No. 2 and 3

National

Sl. No. 1

International

Sl. No. 2

Participation in Science Outreach program

- Arranged 'Sky Watching Program' for participants of C K Majumdar Memorial Summer Workshop, 2018
- Conference on Recent Advances in Space Science, 6 March 2018, Sidho Kanho Birsa University, Purulia (to commemorate 125th Birth Anniversary of Prof S N Bose)
- Seminar on Life and Work of Prof S N Bose, Siuri Vidyasagar College, Birbhum, 17 March 2018 (to commemorate 125th Birth Anniversary of Prof S N Bose)

Societal impact of Research

Astronomical objects have no direct impact on us, but the fruits of scientific and technological development in astronomy, have become essential to our daily life, with applications such as personal computers, communication satellites, nuclear energy, mobile phones, gps, solar panels etc. Now, with progresses of our understanding, for example, the discovery that the basic elements that we find in stars, are the same elements that make up our bodies has further deepened the connection between us and the cosmos. Though astronomers have made significant progress in understanding the astronomical events, there are still many unanswered questions in astronomy like "How life began on earth?". Answers of these questions are related to the chemistry in space which depends on evolution of stars. Thus knowledge of stellar phenomena will help to find answers of fundamental questions.

Significant research output / development during last one year

General research areas and problems worked on

- Observational studies of novae and variable stars.
- Planetary Nebulae.
- Modeling of observed spectra.
- Telescope project of S N Bose Centre

Interesting results obtained

In the previous year different kinds of astronomical objects viz. novae, planetary nebulae, star forming regions, late type stars etc. have been observed using the national facilities, e.g., 2m Himalaya Chandra Telescope, 1.3m Devashtal Fast Optics Telescope etc. Part of the observed data has been analyzed,

interpreted, modeled where applicable, and results have been published.

One of the important works we completed is photoionization modeling of the recurrent RS Ophiucus (during the 2006 outburst and quiescenec period). The best-fit model parameters are compatible with a hot white dwarf source with black body temperature of 5.5 - 5.8 $\times$ 10^5 K and roughly constant a luminosity of 6 - 8 $\times$ 10^{36} ergs s^{-1} and the ejecta is significantly enhanced, relative to solar, in helium, nitrogen, neon, iron and argon (for details please see Mondal et al. 2018, MNRAS, 474, 4211).

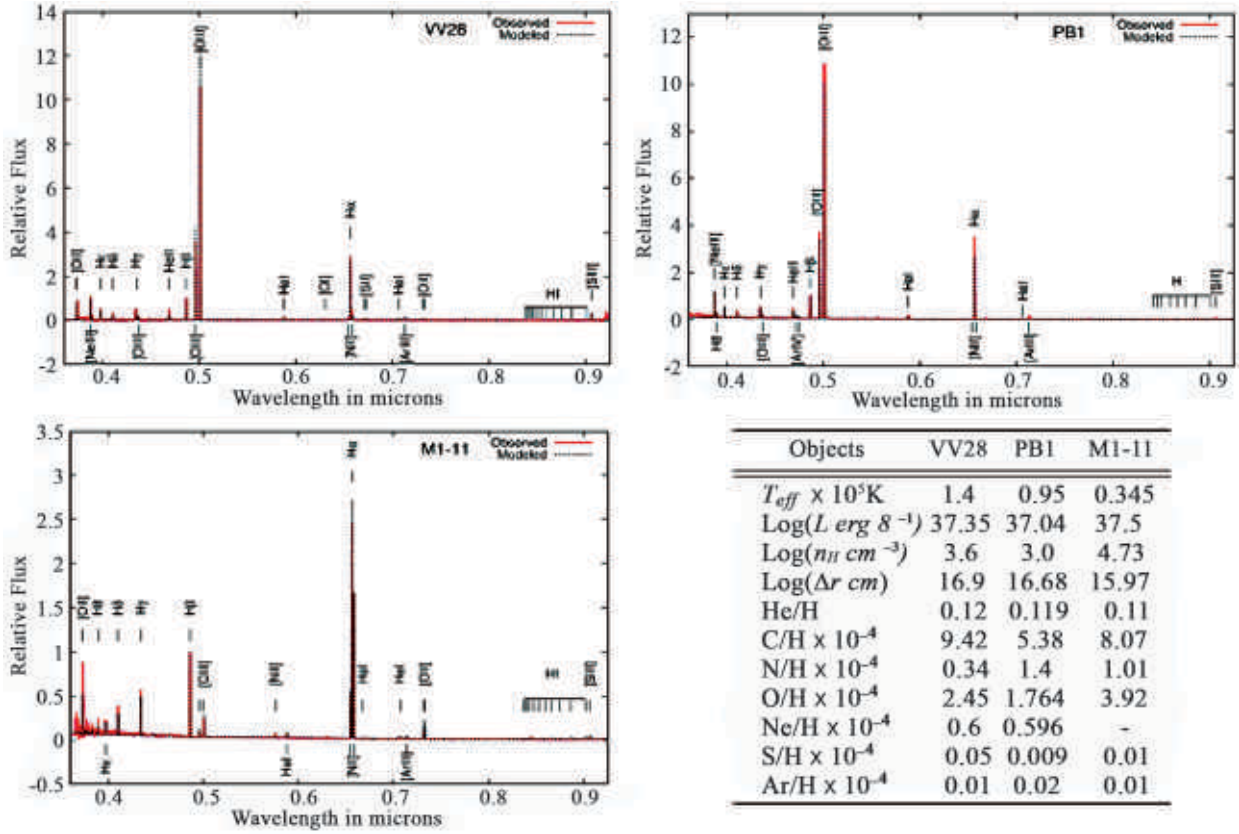
We have also completed calculation of novae grid model where we have constructed a comprehensive grid of model atmospheres using the basic parameters spanning over the probable parameter space appropriate for novae, This provides a tool to derive the values of other parameters for a particular nova, by matching the observed values with the calculated ones (paper to be submitted soon).

We have are also observed several planetary nebulae (VV28, PB1, M1-11 etc) which have not been studied in details earlier. We have analyzed and modeled few of observed spectra and estimated physical parameters (please see Figure).

Proposed research activities for the coming year

We hope to complete analysis and interpretation of remaining observed data. We plan to observe and study more astronomical objects using the national facilities. In addition, we wish to investigate several problems like understanding the chemical composition, geometry (morphology) and velocity (kinematics) of the material in ejecta of novae, dust formation process in novae, multi wavelength studies of planetary nebulae, evolution of recurrent novae in quiescence phase etc.

We are also working to establish observational facility at Panchet hill (we have recently received stage-II approval for land). As a part of the program we have established a roll-off roof observatory and we are also installing telescopes there.



Objects	VV28	PB1	M1-11
T_{eff} x 10^5K	1.4	0.95	0.345
Log(L erg s^{-1})	37.35	37.04	37.5
Log(n_H cm^{-3})	3.6	3.0	4.73
Log(Δr cm)	16.9	16.68	15.97
He/H	0.12	0.119	0.11
C/H x 10^{-4}	9.42	5.38	8.07
N/H x 10^{-4}	0.34	1.4	1.01
O/H x 10^{-4}	2.45	1.764	3.92
Ne/H x 10^{-4}	0.6	0.596	-
S/H x 10^{-4}	0.05	0.009	0.01
Ar/H x 10^{-4}	0.01	0.02	0.01

Figure : Results of Cloudy modeling of planetary nebulae. Observed spectra in red (solid line) and the modeled spectra in black (dashed line) are shown for PNe VV28 (top left), Pb1 (top right) and M1-11 (bottom left). Prominent emission lines have been marked. Model parameters are shown in tabular form (bottom right). Model Results : Central Star parameters: effective temperature, T_{eff} and luminosity, L; Nebular parameters: hydrogen density, n_H, nebular shell-thickness, Δr and elemental abundances relative to hydrogen.

Sandip Kumar Chakrabarti

Senior Professor
Astrophysics and Cosmology
chakraba@bose.res.in

Prof. Sandip Kumar Chakrabarti received PhD Degree from University of Chicago (1981) and became a Tolman Fellow at Caltech (1985-1987). He worked as a Senior Research Fellow at NASA Goddard (1994-1995). His research Interest includes accretion/outflows around black holes, ionospheric sciences, Astrochemistry and balloon borne near space experiments.

Supervision of Research / Students

Ph.D. Students

1. Ayan Bhattacharyya, Two component advective flow solution for nutron stars, ongoing
2. Anubhav Banerjee, Spectral and temporal properties of several black hole candidates, ongoing
3. Arindam Ghosh, Sizes of Accretion disks in low and high mass X-ray binaries, ongoing
4. Abhishek Roy, Numerical simulation of outbursts in black hole candidates, ongoing
5. Arnab Deb, Properties of magnetic flux in accretion and winds around black holes, ongoing
6. Prantik Nandi, Comptonization in a realistic electron cloud around a black hole, ongoing
7. Piklu Santra, Two component flows around compact stars, ongoing
8. Arka Chatterjee, Images of black hole accretion disks and outflows, completed

Post Doctoral Research Scientist/s

1. Suman Chakraborty

Teaching activities at the Centre

1. 4th Semester, PHY403, IphD, 7 students, Dr. S. Mondal

Publications in Journals

1. Milan Sil, Prasanta Gorai, Ankan Das, Bratati Bhat, Emmanuel E. Etim, **Sandip K. Chakrabarti**, *Chemical Modeling for Predicting the Abundances of certain Aldimines and Amines in Hot Cores*, ApJ, **853**, 139 (2018)
2. Suman Chakraborty, Sudipta Sasmal, **Sandip K. Chakrabarti**, Arnab Bhattacharya, *Observational signatures of unusual outgoing longwave radiation (OLR) and atmospheric gravity waves (AGW) as precursory effects of May 2015 Nepal earthquakes*, J. of Geodynamics, **113**, 43 (2018)
3. Abhishek Roy, **Sandip K. Chakrabarti**, *Hydrodynamic simulations of accretion flows with time-varying viscosity*, MNRAS, **472**, 4689 (2017)
4. Arka Chatterjee, **Sandip K. Chakrabarti**, Himadri Ghosh, *Temporal evolution of photon energy emitted from two-component advective flows: origin of time lag*, MNRAS, **472**, 1842 (2017)
5. Ayan Bhattacharjee, **Sandip K. Chakrabarti**, *Monte Carlo simulations of thermal comptonization process in a two-component advective flow around a neutron star*, MNRAS, **472**, 1361 (2017)
6. Arnab Deb, Kinsuk Giri, **Sandip K. Chakrabarti**, *Dynamics of magnetic flux tubes in an advective flow around a black hole*, MNRAS, **472**, 1259 (2017)
7. Jinho Kim, Sudip K. Garain, Dinshaw S. Balsara, **Sandip K. Chakrabarti**, *General relativistic numerical simulation of sub-Keplerian transonic accretion flows on to black holes: Schwarzschild space-time*, MNRAS, **472**, 542 (2017)

8. Dipak Debnath, Arghajit Jana, **Sandip K. Chakrabarti**, Debjit Chatterjee, Santanu Mondal, *Accretion Flow Properties of Swift J1753.5-0127 during Its 2005 Outburst*, ApJ, **850**, 92 (2017)
9. Arghajit Jana, **Sandip K. Chakrabarti**, Dipak Debnath, *Properties of X-Ray Flux of Jets during the 2005 Outburst of Swift J1753.5-0127 Using the TCAF Solution*, ApJ, **850**, 91 (2017)
10. Santanu Mondal, **Sandip K. Chakrabarti**, Shreeram Nagarkoti, Patricia Arévalo, *Possible Range of Viscosity Parameters to Trigger Black Hole Candidates to Exhibit Different States of Outbursts*, ApJ, **850**, 47 (2017)
11. Suman Chakraborty, Sudipta Sasmal, Tamal Basak, Soujan Ghosh, Sourav Palit, **Sandip K. Chakrabarti**, Suman Ray, *Numerical modeling of possible lower ionospheric anomalies associated with Nepal earthquake in May, 2015*, AdSpR, **60**, 1787 (2017)
12. Ritabrata Sarkar, **Sandip K. Chakrabarti**, Partha Sarathi Pal, Debashis Bhowmick, Arnab Bhattacharya, *Measurement of secondary cosmic ray intensity at Regener-Pfotzer height using low-cost weather balloons and its correlation with solar activity*, AdSpR, **60**, 991 (2017)
13. Sudipta Sasmal, Tamal Basak, Suman Chakraborty, Sourav Palit, **Sandip K. Chakrabarti**, *Modeling of temporal variation of very low frequency radio waves over long paths as observed from Indian Antarctic stations*, Journal of Geophysical Research: Space Physics, **122**, 7698 (2017)
14. S. Pal, Y. Hobara, **S. K. Chakrabarti**, P. W. Schnoor, *Effects of the major sudden stratospheric warming event of 2009 on the subionospheric very low frequency/low frequency radio signals*, Journal of Geophysical Research: Space Physics, **122**, 7555 (2017)
15. Surya K. Maji, **Sandip K. Chakrabarti**, Dipak Sanki, Sujay Pal, *Topside ionospheric effects of the annular solar eclipse of 15th January 2010 as observed by DEMETER satellite*, JASTP, **159**, 1 (2017)
16. **Sandip K. Chakrabarti**, Ritabrata Sarkar, Debashis Bhowmick, Arnab Bhattacharya, *Study of high energy phenomena from near space using low-cost meteorological balloons*, Experimental Astronomy, **43**, 311 (2017)
17. Ayan Bhattacharjee, Indrani Banerjee, Anuvab Banerjee, Dipak Debnath, **Sandip K. Chakrabarti**, *The 2004 outburst of BHC H1743-322: analysis of spectral and timing properties using the TCAF solution*, MNRAS, **466**, 1372 (2017)
18. Prasanta Gorai, Ankan Das, Liton Majumdar, **Sandip Kumar Chakrabarti**, Bhalamurugan Sivaraman, Eric Herbst, *The Possibility of Forming Propargyl Alcohol in the Interstellar Medium*, Molecular Astrophysics, **6**, 36 (2017)

Other Publications

1. **Sandip K. Chakrabarti**, Study of accretion processes around black holes becomes 'Science': Tell tale observational signatures of two component advective flows, in Proceedings of 14th Marcel Grossman Meeting, Eds. M. Bianchi, R.T. Jantzen, R. Ruffini, World Scientific (Singapore) 369-384

Lectures Delivered

1. Evolution of Life since big bang and the origin of life, University of Gour Banga, Malda, July, 2017, S. Chandrasekhar Memorial Lecture
2. Transonic Flows Around Black Holes, Univ. Of Notre Dame, USA, August, 2017, Five Departmental Lectures
3. Synthesis of Biomolecules in Interstellar Medium, Walter E. Washington Convention Center, Washington, DC, USA at the 254th ACS meeting, August, 2017, A contributed Talk
4. High Energy Astronomy with meteorological balloons, Convention Centre Jeju Island, S. Korea, September, 2017, A Contributed Talk
5. Food Habits of Black Holes, National Students' Space Challenge meeting at IIT Kharagpur, Sept. 2017, A guest lecture
6. Chemical Evolution of the Universe since Big Bang and the Origin of Life, Heritage Institute of

Technology, Kolkata and St. Pauls College, Kolkata, Feb. 2018; CORASS conference, S.K.B. University, Purulia, Mar. 2018; Invited Science Day Talk

7. Invited review talk on Numerical Simulation of Accreting Matters Around black holes at the Applied Mathematics Department Seminar of Calcutta University (February, 2018)

Academic Visits

International

1. Visited University of Notre Dame, USA for fourteen days, from August 6th to August 19th, 2017

Membership of Committees

External Committee

General Secretary of the Governing Body, Indian Centre for Space Physics; Main Organizer of COSPAR Commission E1.4 at Caltech, Pasadena; Deputy Organizer of COSPAR Commisions C0.3, F3.5 and PSB.1; International Organizing Committee Member of 15th Marcel Grossman Conference, Rome and Organizer of Black Hole Session

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

International

Sl. No. 7 & 14

Participation in Science Outreach program

- Organized a joint SNBNCBS and S.K. B. University Conference in March, 2018
- Presented Science day lectures at two colleges (Heritage Institute of Technology and St. Paul's College) in February, 2018
- Presented a Guest lecture at the "National Students' space Challenge' at IIT, Kharagpur

Significant research output / development during last one year

General research areas and problems worked on

In black hole astrophysics we found the exact reason of hysteresis seen in outbursting sources. We showed that it takes a very long time to destroy a Keplerian disk around a black hole as compared to the time taken to build it up. We also found that around a neutron star the disk structure remains the same as that around a black hole, but a normal boundary layer has to be added on the hard surface. While fitting the data we found that viscosities required to enable state transition are similar for all the black hole candidates. We found that definite quantitative ionospheric changes occur just before earthquakes. In Astrochemistry, we extended our early work to study the abundances of certain amines in interstellar medium. This increases the possibility of producing pre-biotic molecules during collapse. In balloon borne studies we have been able to show how the cosmic rays are anti-correlated with solar activity.

Interesting results obtained

1. Obtaining the cause of hysteresis in black hole accretion disk light curve
2. Obtaining a sure proof that ionospheric changes occur before the earthquakes
3. It was possible to produce significant pre-biotic molecules in interstellar medium.

Proposed research activities for the coming year

1. We shall complete the spectral fit with our accretion disk model around a neutron star.
2. We shall also show that Cyg X-1 indeed has a smaller accretion disk than the disks around black holes in low mass X-ray binaries.
3. We shall use Chakrabarti-Titarchuk solution to Active Galaxies and Ultra-luminous X-ray sources to obtain the mass of the black holes.

Soumen Mondal

Associate Professor and HOD
Astrophysics and Cosmology
soumen.mondal@bose.res.in

Dr. Soumen Mondal received his Ph.D. degree from Physical Research Laboratory (PRL), Ahemdabad in 2004. He has post doctoral research experience at PRL for a year, and then at National Central University, Taiwan under International Taiwanese-American Occultation Survey (TAOS) program for about two and half years. He joined Aryabhatta Research Institute for Observational Sciences (ARIES), Nainital as a Scientist in 2007 and worked for four years, and then moved to S N Bose National Centre for Basics Sciences in 2011 as an Assistant Professor.

Supervision of Research / Students

Ph.D. Students

1. Somnath Dutta (5th yr.) - "Multi-wavelength studies on Galactic H II regions" – Thesis submitted to CU on July 2017
2. Supriyo Ghosh (5th yr.) - "Study of cool and evolved stars" - expected to submit Thesis to by September 2018
3. Anindita Mondal (5th year, jointly RK Das) - "Multi-wavelength studies of Novae",expected to submit Thesis to CU by September 2018
4. Samrat Ghosh (3rd yr.)- "A search for Photometric Variability inYoung/Old Brown Dwarfs" - Thesis ongoing
5. Dhrimadri Khata (3rd yr. jointly with RK Das)) - "Understanding Physical Properties of M-Dwarfs" - Thesis ongoing
6. Alik Panja (2nd yr.) - "Multi-wavelength studies on Galactic star-forming regions" - Thesis ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Arnab Mukherjee– M.Sc(Physics) – Jadavpur University - 2017 Summer project

Teaching activities at the Centre

1. PHY-403 – Astrophysics and Astronomy Elective part (4th Sem) with Prof. S. K. Chakrabarti
2. PHY-191 – Basic Laboratory 1 optics part with Prof. Samir Kr. Pal

Publications in Journals

1. Supriyo Ghosh, Soumen Mondal, Ramkrishna Das, D. P. K. Banerjee, N. M. Ashok, Franz-Josef Hambsch Somanth Dutta, Phase-dependent photometric and spectroscopic characterization of the MASTER-Net Optical Transient J212444.87+321738.3: an oxygen-rich Mira, The Astronomical Journal, 155 (5), 216 (2018)
2. Somnath Dutta, Soumen Mondal, Santosh Joshi, Jessy Jose, Ramkrishna Das, and Supriyo Ghosh, Optical Photometric Variable Stars towards the Galactic H II region NGC 2282, Monthly Notices of the Royal Astronomical Society, 476 (2), p.2813-2824 (2018)
3. Anindita Mondal, G. C. Anupama, U. S. Kamath, Ramkrishna Das, G. Selvakumar, Soumen Mondal, Optical spectroscopy of the recurrent nova RS Ophiuchi - from the outburst of 2006 to quiescence, Monthly Notices of the Royal Astronomical Society, 474 (3), p.4211-4224 (2018)
4. Soumen Mondal, Samrat Ghosh, Dhrimadri Khata, Santosh Joshi and Ramkrishna Das, Understanding of variability properties in very low mass stars and Brown dwarfs, Bulletin of Ligue Royal Society of Sciences, 87, pp. 242-252 (2018)

Other Publications

1. Dutta, S.; Mondal, S.; Jose, J.; Das, R. K. - "Stellar population and star formation histories of distant Galactic H II regions NGC 2282 and Sh2-149 complex", 2017, ASP Conf. Series. 510, 85

Lectures Delivered

1. Conference talk on "Understanding of the atmospheric properties and binarity in very low-mass stars, brown dwarfs and exo-planets" at TMT: Beyond First Light, held at Infosys Campus, Mysore during 7 -9 Nov 2017
2. Invited talk on "Star Formation in the Milky Way" at C. K. M memorial Summer Workshop in Physics, held at SNBNCBS, 23 May – 2 June 2017
3. Invited talk "Physical processes in Star and Planet formation" at National Seminar on Nonlinear Processes in Physical & Biological Systems held at Jadavpur University, 16 March 2018

Membership of Committees

Internal Committee

Board of Studies (BoS); Students' Curriculum & Research Evaluation Committee (SCREC) ; Member in Project and Patent cell; Member in Library Committee; Land-acquisition committee for the Astronomical Observatory, Advisory committee member of Computer cell; LMC of TRC, member Secretary

Sponsored Projects

1. One of Activity Leader (PI) in Technical Research Centre (TRC) project of DST from Jan 2016-2020

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Dr. Ramkriskna Das (Sl. No. 1-4)

National

Profs. D. P. K. Banerjee and N. M. Ashok , Physical Research Laboratory (Sl. No. 1) ; Dr. Santosh Joshi, ARIES (Sl. No. 2, 4); Dr. Jessy Jose, IISER-Tripati; Prof. G. C. Anupama, IIA (Sl. No. 3); Dr. U. K. Kamath, IIA(Sl. No. 3)

International

Dr. Franz-Josef Hambsch, American Association of Variable Star Observers (AAVSO), Cambridge, USA (Sl. No. 1)

Participation in Science Outreach program

- "Sky watching program with our roof-top telescope" on National Science Days (Feb., 2018)
- Sky watching program with our roof-top telescope during C K. Mazumder Memorial Summer Workshop (May/June, 2017)
- Gave a talk at C. K. M. Memorial Summer workshop in Physics, held at SNBNCBS, June 2017

Societal impact of Research

- Human resource development through training of Ph.D. students for National needs in educational sectors
- Advanced manpower generation for National/ International mega projects (like TMT, LIGO etc.)
- Under TRC project "Analysis of Adulteration in Milk using NIR instrumentation" - benefit to Food sector and Food security

Significant research output / development during last one year

General research areas and problems worked on

- Extra-solar planets, Brown dwarfs, and low-mass stars in star-forming regions
- M-Giants and Mira variables
- Small solar system objects
- Astronomical Instrumentation

Interesting results obtained

1. Optical photometric variable stars towards the Galactic H II region NGC 2282

Photometric variability is a ubiquitous characteristic of young stars. The variation in observed flux is proposed to be due mainly to the rotational modulation of hot/cool spots on the young star's surface, yielding

rotation period ranges from hours to 15 days. Using 2m Hanle and 1.3m Devasthal telescope we conducted time series photometry of a young (2–5 Myr) cluster NGC 2282 to identify and understand the variability of pre-main-sequence (PMS) stars. From the light curves of 1627 stars, we identified 62 new photometric variable candidates. Their association with the region was established from Halpha emission and infrared (IR) excess. Out of 62 variables, 41 are periodic variables, with a rotation rate ranging from 0.2–7 d. The period distribution exhibits a median period at ~1 d, as in many young clusters (e.g. NGC 2264,ONC, etc.), but it follows a unimodal distribution, unlike others that have bimodality, with slow rotators peaking at ~ 6–8 d (Somnath Dutta et al. 2018).

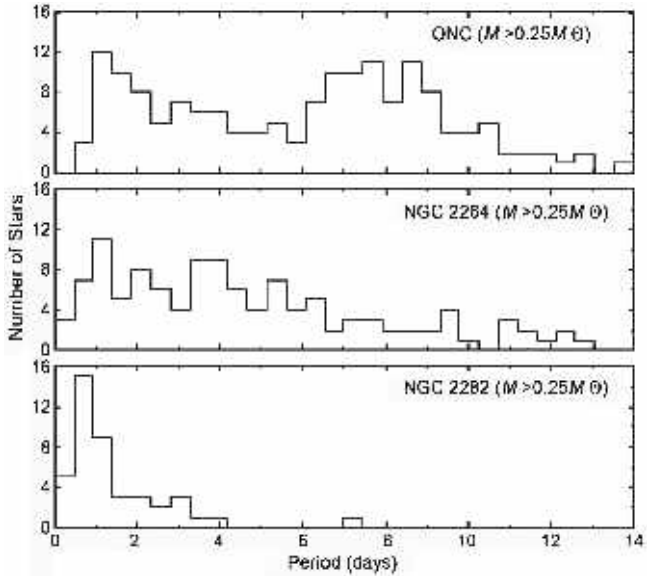


Fig.1: The distribution of periods in NGC 2282 is compared with that of the young clusters ONC and NGC 2264. A bimodal period distribution is seen in ONC and NGC 2264, while the distribution for NGC 2282 is unimodal.

2. Phase-dependent Photometric and Spectroscopic Characterization of the MASTER-Net Optical Transient J212444.87+321738.3: An Oxygen-rich Mira

Mira-type variables are in the Asymptotic giant branch (AGB) phase, which is the last stage of stellar evolution before they turn into planetary nebulae. Miras are long-period (100–1000 days) pulsating variables with a large visible amplitude of more than 2.5 mag. These giants have initial masses ≈ 0.8–8 M_{Sun} (low to intermediate main-sequence mass) and are generally surrounded by circumstellar matter from huge mass-loss rates of $\sim 10^{-8}$–10^{-4} Me yr^{-1}. We describe the time-dependent properties of a new spectroscopically confirmed Mira variable, which was discovered in 2013 as MASTER-Net Optical Transient J212444.87+321738.3 toward the Cygnus constellation. We have performed long-term optical/near-infrared (NIR) photometric and spectroscopic observations to characterize the object. From the optical/NIR light curves, we estimate a variability period of 465 ± 30 days. The wavelength-dependent amplitudes of the observed light curves range from $\Delta I \sim 4$ mag to $\Delta K \sim 1.5$ mag. The (J – K) color index varies from 1.78 to 2.62 mag over phases. Interestingly, a phase lag of ~60 days between optical and NIR light curves is also seen, as in other Miras. Our optical/NIR spectra show molecular features of TiO, VO, CO, and strong water bands that are a typical

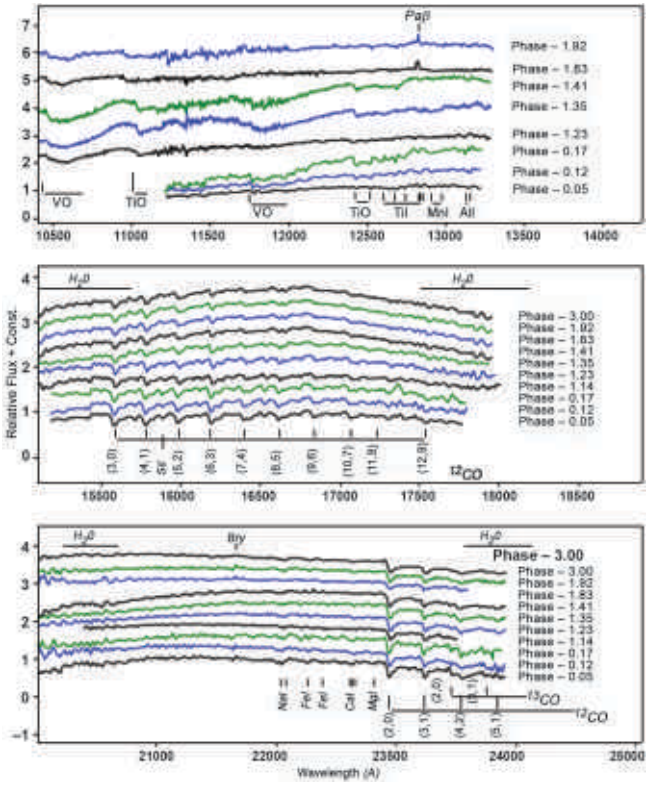


Figure 2: The NIR JHK-band spectra in the wavelength range 1.02 – 2.39 μm at eight different phases of the Mira are shown here in the first, second, and third panels,respectively. The first three NIR spectra from the bottom (phase ~0.05, 0.12, 0.17) are taken with the NICMOS-3 instrument on 1.2 m Mt.Abu telescope, and rest are observed with TIRSPEC instrument on 2.0 m HCT. In the J-band, molecular bands like TiO, VO, and a few atomic lines are present in the spectra. The Paβ emission line appears at two phases (1.83 and 1.92).

signature of oxygen-rich Mira. We rule out S- or C-type as ZrO bands at 1.03 and 1.06 μm and C2 band at 1.77 μm are absent. We estimate the effective temperature of the object from the Spectral Energy Distribution, and distance and luminosity from standard Period–Luminosity relations. The optical/NIR spectra display time-dependent atomic and molecular features (e.g., TiO, Na I, Ca I, H2O, CO), as commonly observed in Miras. Such spectroscopic observations are useful for studying pulsation variability in Miras (Supriyo Ghosh et al. 2018).

3. Understanding of variability properties in very low mass stars and brown dwarfs

The term "very low mass star" (VLMs) refers to a main sequence star with a spectral type from mid-K to late-M and a mass from about 0.6 M_{Sun} down to the brown dwarf limit of 0.075 M_{Sun} . The metallicities of VLMs in the solar neighborhood span up to ± 0.5–1.0 dex around the solar value. However, the metallicity in these dwarfs shows a wide-range from metal-rich in the galactic disk and open clusters (e.g. Pleiades, Hyades, Ophiuchus, Persei) to metal-poor dwarfs of the galactic halo and globular clusters (Allard et al. 1997). Brown dwarfs (BDs) are sub-stellar objects with a mass below 0.075 M_{Sun} and a spectral type L, T, or Y. They don't have enough mass to fuse the hydrogen inside the core. They burn deuterium instead, as the threshold energy for deuterium fusion is lower compared to the one of hydrogen fusion. The photometric variability studies of a L3.5 brown dwarf 2MASS J00361617+1821104 (2M0036+18) in the field and of four young brown dwarfs in the star-forming region IC 348 are studied here. From muti-epoch observations, we found significant periodic variability in 2M0036+18 with a period of 2.66 ± 0.55 hours on one occasion while it seemed to be non-variable on three other occasions. An evolving dust cloud might cause such a scenario. Among four young brown dwarfs of IC 348 in the spectral range M7.25 - M8, one brown dwarf 2MASS J03443921+3208138 shows significant variability.

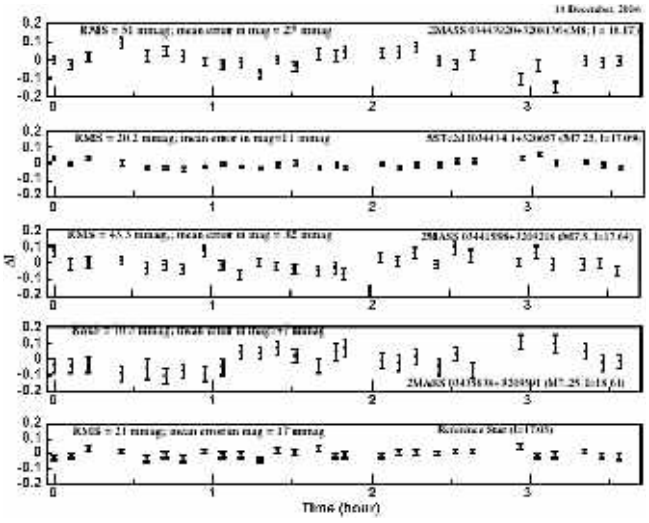


Figure 3: The I-band light curves of four young BDs in IC 348 (four top panels) and of a referencestar of similar brightness on the CCD frames (bottom panel) as observed on 18 December 2016.

Proposed research activities for the coming year

1. S. N. Bose Centre Telescope project at Panchet Hill

At S. N. Bose Centre, recently we have initiated to establish the World-class Astronomical observing facility at Panchet hill. This project envisages establishing initially a small one-meter-class relatively wide-field telescope, which will be first in the eastern part of the country. Recently, we got the approval for 2 hectares land at Panchet hill-top, Purulia (about 220 km from the Centre) for this Astronomical Observatory site from the Forest department of Govt. Of India and state Govt. Of West Bengal, and processes of hand-over the land to the Centre is on-going. Scientific motivations for our telescope program encompass forefront problems in Astronomy and Astrophysics ranging from Extra-solar planets to Black-hole astrophysics.

2. On-going long-term Scientific programs

(i). Spectrophotometric studies of late M-type stars (dwarfs and giants) and Miras

Spectrophotometric studies of low-to-intermediate mass stars represent vital test of theoretical models of stellar evolution, structure, and atmospheres. In stellar evolution. The low-to-intermediate main-sequence stars evolve to red giant branch (RGB) through Asymptotic Giant Branch (AGB) before planetary nebulae. Optical/Near-IR spectrophotometric studies of these RGB/AGB objects are undertaken to understand their atmospheres and pulsation. Furthermore, studies of M dwarfs have been recognized as promising targets in the search for small extra-solar planets.

(ii) Multi-wavelength studies of Galactic star-forming regions

Galactic star-forming regions provide us crucial information about star-formation process, stellar evolution and stellar structure etc. Multi-wavelength studies of such regions provide census of Young Stellar Objects, their fundamental parameters e.g., masses, ages, effective temperatures, circumstellar disks around them (if any) etc. We are studying of these regions in optical, near infrared (near-IR) and mid infrared (mid-IR) wavelengths from ground and space-based national/international facilities..

(iii) Photometric variability studies and characterization of very-low mass (VLM) stars and brown dwarfs

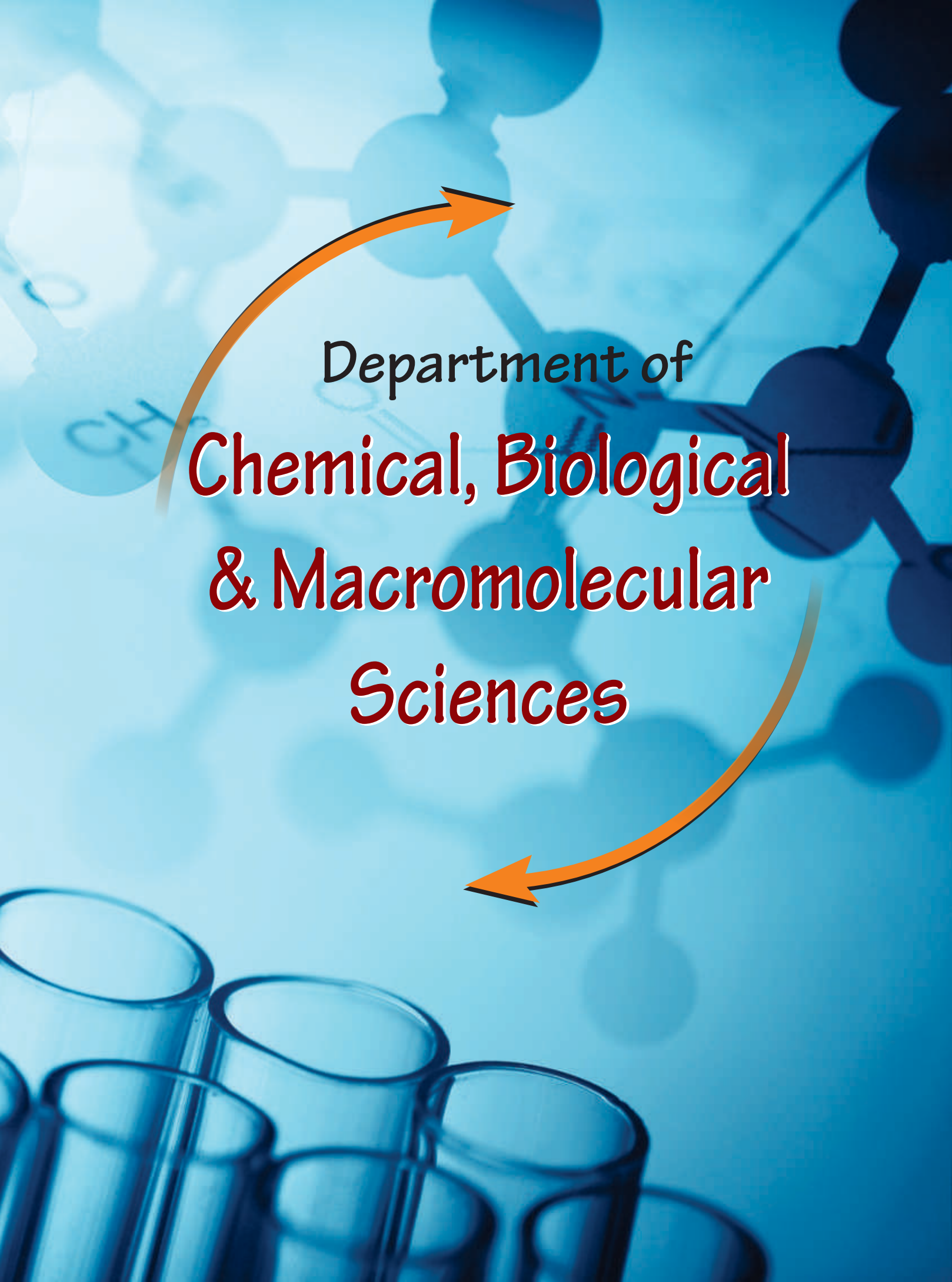
To provide comprehensive observations and in-depth study of the physical properties of Very Low Mass (VLM) objects and brown dwarfs in galactic field as well as in young star-forming regions, we have started an observational program using the National telescope facilities.

3. Astronomical Instrumentation

With our expertise in the Optical/IR instrument design and development, we are working to establish an Astronomical Instrumentation Laboratory at the Centre for building the state-of-art backend instruments for the telescopes. We have planned one fibre-fed low-intermediate resolution spectrograph for our own telescope and other national facility telescope as a visitor instrument.

4. Establishing roll-off roof observatory

Recently, we have built a roll-off roof observatory at roof-top of the Centre to house the 8 inch Meade telescope and 14 inch Robotic telescope. The 8 inch telescope are used to train the students, e. g., IPhD students, project students and public outreach programs. The 14 inch telescope are used for scientific observations of bright objects and future seeing measurement at the new Panchet site.


Department of
Chemical, Biological
& Macromolecular
Sciences

Department of Chemical, Biological & Macro-Molecular Sciences

Jaydeb Chakrabarti

Department profile indicators

Table A : Manpower and resources		
Number of faculty members	07	
Number of Post -doctoral research associate (centre + project)	03	
Number of Ph.D students	42	
Number of other project staff	01	
Number of summer students	03	
Projects (ongoing)	17	
Table B: Research Activities indicators		
Number of research papers in Journals	39	
Number of Book-chapters/books	01	
Number of other publications	06	
Number of Ph.D students graduated (submitted + degree awarded)	11	
Number of M.Tech/M.Sc projects	00	
Table C: Academic activities and likeage		
Number of courses taught by faculty members	07	
Number of Visitors (non -associates)	Nil	
Number of associates	Nil	
Number of Seminars organized	11	
Number of Conference/Symposia/Advanced Schools organized	02	
Number of talks delivered by members of department in conferences/Symposia	National	18
	International	06

Most important research highlights

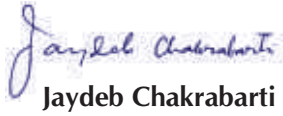
- Prof. Ranjit Biswas and his coworkers decoded the frictional coupling to molecular relaxations in deep eutectics, and their differences in the parent systems
- Prof. Jaydeb Chakrabarti and coworkers established microscopic mechanism of specificity of anion binding to functional proteins by using conformational switching (PP, MG, RB and JC, Proteins, 85, 2179-2190, 2017)
- Prof. Gautam Gangopadhyay and coworkers carried out biophysical characterization of dynamic hysteresis of a voltage gated sodium ion channel (KP, BD and GG, J.Theo. Biol. (2017)415:113-124)
- Dr. Subhra Jana and coworkers synthesized hybrid nano-composites for solar light induced enhanced photo-catalytic activity and removal of toxic contaminants from waste-water (S.D., A.S. and S.J. ACS Sustainable Chemistry & Engineering, 5, 9086-9094, 2017; A.S., S.D. and S.J. Chemistry Select, 3, 2467–2473, 2018)
- Dr. Rajib Kumar Mitra and his group established the key role of hydrophobicity to determine the effect of complex ionic salts on protein hydration and explored the microstructure and collective dynamics of the membrane interfacial hydration shell in zwitterionic and negatively charged phospholipid membrane bilayers using terahertz time-domain spectroscopy
- Prof. Samir Kumar Pal and his coworkers focused on technology development which includes AJO technologies transfer to NRDC for potential commercialization, and authentication of Darjeeling tea. They also investigated the science of NIR light harvesting and developed material for Cancer theranostics
- Dr. Manik Pradhan and his group developed a prototype breath analyzer that can selectively diagnose stomach infection and ulcer disease by measuring some unique panel of molecular species in human exhaled breath

Summary of research activities

- Prof. Ranjit Biswas and his group work for an integrated understanding of chemical events in complex systems. They completed three major projects last year: (1) Molecular dynamics on Reorientational dynamics of the constituent ions in a room temperature ionic liquid (RTIL), 1-Butyl-3-Methylimidazolium Hexafluorophosphate ([BMIM][PF6]). Jump and waiting time distributions of the ions depict power-law dependences, suggesting temporally heterogeneous dynamics for the medium. (2) Experimental investigations on temperature dependent dynamics of a polyethylene glycol based non-ionic deep eutectic solvent (DES). This non-ionic DES possesses a nanosecond relaxation component similar to that in ionic acetamide DESs along with fractional viscosity dependence for rotation. (3) Computer simulations ondeep eutectics made of acetamide (CH_3CONH_2) and lithium salts (LiX) reveal that amide-amide H-bond interaction decreases significantly upon the addition of electrolyte, and the interactions of Li^+ and X^- (X^- being No^-_3, Br^- and ClO^-_4) with CH_3CONH_2 lead to heterogeneous solution structures with clusters stable up to a few nanoseconds.
- Prof. Jaydeb Chakrabati's group primarily focuses on statistical mechanics of soft condensed matter and bio-molecular systems through both fully atomistic and model based studies. During last year his group developed microscopic understanding based on thermodynamics of conformational changes to formation of protein complexes in host-pathogen interaction, allosteric ligand binding in proteins and anion specificity of binding motifs in functional proteins. They also carried out comprehensive studies on dynamical features of Coulomb particles in a trap with both regular and irregular geometries to show that the confinement modifies the liquid state density fluctuations. Sutapa Datta from this group got foreign travel award.
- Prof. Gautam Gangopadhyay and his group are working in the broad area of Chemical Physics, including statistical mechanical modeling of kinetics of reaction network, ion-channels. During

last year, they did a series of works on sodium ion channel. This year we have dynamically characterized inactivation path in voltage-gated Na+ ion channel by non-equilibrium response spectroscopy. In the similar context we have estimated then non-equilibrium response of a voltage gated sodium ion channel and biophysical characterization of dynamic hysteresis.

- Dr. Subhra Jana's laboratory focuses on synthesis of nano-particle for various applications. During last year a novel solution chemistry route was developed for the synthesis of nano-scale hierarchical flower-like MnO_2 over the surface of clay nano-tubes. By tuning the reaction conditions, δ-MnO_2 flowery nanostructures comprised of assemblies of many wrinkled and intersected nano-sheets were synthesized. Their photo-catalytic activity was investigated towards the degradation of organic pollutants under renewable and never-ending solar energy. The underlying mechanism demonstrates the formation of reactive oxygen species that facilitate the degradation of contaminants, without the need of any supplementary oxygen sources. Dr. Jana received SERB Women Excellence Award, 2017.
- Dr. Rajib Kumar Mitra and his laboratory focuses on terahertz spectroscopy, time resolved fluorescence spectroscopy to understand hydration dynamics, Protein folding, and Self-assembled systems. This group has developed during last year a home-built optical rectification (OR) based THz radiation facility using ZnTe crystals. This group has also developed one-color and two-color optical pump-probe set up. Combining the THz time domain and optical pump-probe spectroscopy our group is presently investigating the highly debated notion of "hydrophobic hydration" in various liquid mixtures and self-assembled systems.
- Prof. Samir Kumar Pal and his group are active in various fields. The activities of his group in the last year were manifold: (1) Experimental Biophysics: The studies range from molecular recognition of small ligands/drugs by biological macromolecules to complicated protein-DNA, protein-protein complexation. (2) Experimental nano-physics and bio-nano interface: Selective attachment of inorganic semiconductor/metal nanoparticles to medicinally important organic molecules is the key feature of the nano-conjugates, which leads synthesis of nanomedicines. (3) Experimental biomimetics: preparing various drug delivery vehicles. (4) Biomedical instrumentation: low cost spectroscopic gadgets for the biomedical/ environmental usage. Prof. Pal is recipient of Professor P. K. Bose Memorial Award 2016 (Indian Chemical Society) awarded in 2017.
- The thrust area of Dr. Manik Pradhan's laboratory is Laser Spectroscopy and Biomedical Science. They have developed during last year a mid-infrared detection strategy with 1f-normalized 2f-wavelength modulation spectroscopy (WMS-2f/1f) technique using a continuous wave (CW) external-cavity quantum cascade laser (EC-QCL) operating between 7.5 and 8 μm. A high-resolution Cavity Ring-down Spectroscopy (CRDS) technique using an EC-QCL was developed for direct monitoring of methane isotopes in air. They have experimentally shown that the catalytic activity of urease exhibits a unique isotope-specific response where the $^{12}CO_2$ isotope is strongly preferred over the $^{13}CO_2$ isotope during its catalytic activation. Dr. Pradhan got "WIDF-Innovation Award" by World India Diabetes Foundation (WIDF), USA (2017) and "Dayawati Rastogi Award" for the Best Invited Lecture in "ICSBAM", India (2017).



Jaydeb Chakrabarti
Head, Department of Chemical, Biological and Macromolecular Sciences

Gautam Gangopadhyay

PROFESSOR
CBMS
gautam@bose.res.in

Professor Gautam Gangopadhyay is working here in the broad area of Chemical Physics. It includes statistical mechanical modelling of reaction kinetics for example, in reaction network, ion-channels. They are working on nonlinear dynamical characterization of ion channels and drug binding. They are also interested in quantum nonadiabatic molecular properties theoretically through conduction and spectroscopic tools.

Supervision of Research / Students

Ph.D. Students

1. Krishnendu Pal, Theoretical studies on Sodium ion Channel, Ongoing (thesis submitted)
2. Sandip Saha, Nonlinear dynamical studies on Isochronous oscillators in Chemistry and Biology, Ongoing (2015-)

Other Publications

1. S Saha and G Gangopadhyay, Dynamical response of the limit cycle due to parametric excitation, Proc. Of "Complex Dynamical Systems and Applications" at the Indian Institute of Technology, Guwahati, Dec 4-6, 2017
2. A Karmakar and G Ganagopadhyay, Molecular conductance through pyridine system, Procedings of IACS-CESSD-2018, Feb 22-25, 2018

Lectures Delivered

1. "Complex Dynamical Systems and Applications" at the Indian Institute of Technology, Guwahati,India during Dec 4-6, 2017.
2. Nonequilibrium thermodynamics on some relevance to enzyme catalysis: One-day Physical Chemistry Seminar at IACS: 27th Oct'2017

Academic Visits

National

1. IIIT Guwahati, CDSA, Dec 4-6, 2017

Membership of Committees

External Committee

Theoretical Chemistry Symposium-2016, member of National Advisory Committee

Internal Committee

Member Patent and Project Cell

Fellow / Member of Professional Body

1. Life Member of IACS, IPS

Participation in Science Outreach program

Participated in the Discussion meeting of Physical Chemists at IACS, Nov-Dec' 2017

Societal impact of Research

Discussed with members, Indian Association of Physics Teachers (IAPT Regional Council 15)

Significant research output / development during last one year

General research areas and problems worked on

We have done a series of works on sodium ion channel. This year we have dynamically characterized inactivation path in voltage-gated

Na+ ion channel by non-equilibrium response spectroscopy. In the similar context we have estimated then nonequilibrium response of a voltage gated sodium ion channel and biophysical characterization of dynamic hysteresis

We had studied the dynamical response of the limit cycle due to parametric excitation and vibrational resonance. We have found the condition of Isochronicity and limit cycle oscillation in several biochemical systems

Interesting results obtained

We have introduced a method of estimating the work done associated with the dynamic memory due to a cycle of oscillating voltage. We have quantitatively characterised the loop area of ionic current which gives information about the work done to sustain the dynamic memory only for ion conduction, while the loop area of total entropy production rate gives the estimate of work done for overall gating dynamics. The maximum dynamic memory of Na-channel not only depends on the requency and amplitude but it also depends sensitively on themean of the oscillating voltage and here we have shown how the system optimize the dynamic memory itself in the biophysical range of field parameters. The relation between the average ionic current with increasing frequency corresponds to the nature of the average dissipative work done at steady state.

Proposed research activities for the coming year

1. Large Deviation theory and its impact on enzyme catalysis and kinetic proof reading
2. Consumption in Coupled Neurons and the effect due to Drug Blocking of Sodium and Potassium Channels. Microscopic study of the Effect of single Sodium And Potassium Blockers on Action Potential Using Gillespie Simulation of Modified Hodgkin-Huxley Model

Any other matter

Continuing as Vigilance Officer of the Centre from Nov'2014

Joydeb Chakrabarti

Professor
CBMS
jaydeb@bose.res.in

Professor Jaydeb Chakrabarti works in the area of soft matter physics. He did his PhD from IISc, Bangalore in 1995. And Post –doctoral research at FOM, AMOLF, Amsterdam, The Netherlands and TUE, Eindhoven, The Netherlads.

Supervision of Research / Students

Ph.D. Students

1. Suman Dutta on "Numerical studies on soft matter systems under external drive", submitted to CU.
2. Sutapa Dutta (ongoing, jointly with M. Ghosh) "Microscopic insight to Protein functions", registered at Calcutta University
3. Piya Patra (jointly with R. Banerjee, WBUT), "Electrostatic interactions in biomolecular functions", External student registered at WBUT
4. Arunava Adak (ongoing)
5. Abhik GhoshMoulik (ongoing)
6. Rahul Karmakar (ongoing)
7. Edwine Tendong (ongoing, jointly with T. Saha-Dasgupta)

Post Doctoral Research Scientist/s

1. Mausumi Roy

Teaching activities at the Centre

1. Statistical mechanics, PHY201, spring 2017

Publications in Journals

1. M. Mandal, M. Ghosh and **J. Chakrabarti**, *Molecular dynamics simulations on interaction between bacterial proteins: Implication on pathogenic activities*, Proteins: Struc., Func. And Bio-inform., **86**, 370 (2018)
2. L. Maganti, M. Ghosh and **J. Chakrabarti**, *Allostery in Orai1 binding to Calmodulin revealed from conformational thermodynamics*, J. Biomolecular Structure and Dynamics, (2018) https://doi.org/10.1080/07391102.2018.1430617
3. Lakshmi Maganti, Mahua Ghosh and **J. Chakrabarti**, *Molecular dynamics studies on conformational thermodynamics of Orai1–calmodulin complex*, J. Biomolecular Structure and Dynamics, (2017) https://doi.org/10.1080/07391102.2017.1388289
4. B. Ash, **J. Chakrabarti** and A. Ghosal, *Static and dynamic properties of two-dimensional Coulomb clusters*, Phys. Rev. E, **96**, 042105 (2017)
5. Piya Patra, Mahua Ghosh, Raja Banerjee and **Jaydeb Chakrabarti**, *Anion induced conformational preference of CαNN motif residues in functional proteins*, Proteins: Struc., Func. And Bio-inform., **85**, 2179 (2017)

Lectures Delivered

1. Anomalous dynamics of metal ions in presence of protein surface, AMOLF, Amsterdam, 2017
2. Heterogeneous dynamical response in a driven colloid, Institute of Theoretical Phsics-II, Heinrich Heinz University, Duesseldorf, 2017
3. Conformational thermodynamics in a bio-molecular complex, Structural Biology-2017, Zurich, 2017
4. Lecture to postgraduate students on Brownian Dynamics of colloidal suspension, Basanti Devi College, 2017
5. Model for aggregation of misfolded proteins, ISPC meeting, Bangalore, 2018
6. Anomalous ion dynamics in presence of proteins, CTMSE, IEM, Kolkata-2018

Membership of Committees

External Committee

Ph D committee, Dept of physics, Presidency University

Internal Committee

Head of the Department, CBMS

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl. No. 3

National

Sl. No. 2

Participation in Science Outreach program

Lecture to postgraduate students on Brownian Dynamics of colloidal suspension, Basanti Devi College, 2017

Societal impact of Research

Training manpower:

- Basic course on Statistical Mechanics at post-graduate level in Post-BSc curriculum
- PhD thesis submission by Samapan Sikdar
- Lectures for undergraduate students to create awareness on research

Significant research output / development during last one year

General research areas and problems worked on

Statistical mechanics of soft matter and bio-molecular systems

Interesting results obtained

1. Functional ligand binding of proteins via allosteric regulation: Here we the microscopic mechanism of calmodulin-binding to Orai1 that regulates Ca^{2+}-dependent inactivation process in eukaryotic cells. We compute conformational thermodynamic changes from histograms of dihedral angles over simulated trajectories of calmodulin and its complexes with Orai1. Our analysis shows that Orai1binds to both C-terminal and N-terminal domains of CaM, indicating 1:2 stoichiometry. However, Orai1 binding to N-terminal domain of calmodulin is less stable than that to the C-terminal domain, as in experiments. The binding residues are primarily hydrophobic. Moreover, we predict that the polar residue T44 destabilized and disordered via backbone fluctuations in N-terminal domain is allosterically regulated by the binding of Orai1 to the C-terminal domain.

2. Anion specificity by functional proteins: Among different ligand binding motifs, anion binding $C^{\alpha}NN$ motif consisting of peptide backbone atoms of three consecutive residues are observed to be important for recognition of free anions, like sulphate or bi-phosphate and participate in different key functions. Here we study the interaction of sulphate and bi-phosphate with $C^{\alpha}NN$ motif present in different proteins. Instead of total protein, a peptide fragment has been studied keeping $C^{\alpha}NN$ motif flanked in between other residues. We use classical force field based Molecular Dynamics Simulations to understand the stability of this motif. Our data indicate fluctuations in conformational preferences of the motif residues in absence of the anion. The anion gives stability to one of these conformations. However, the anion induced conformational preferences are highly sequence dependent and specific to the type of anion. In particular the polar residues are more favourable compared to the other residues for recognising the anion.

3. Dynamics of confined systems: The dynamical responses of Coulomb-interacting particles in nano-clusters are analyzed at different temperatures characterizing their solid- and liquid-like behavior. Depending on the trap-symmetry, both the spatial and temporal correlations undergo slow, stretched exponential relaxations at long times, arising from spatially correlated motion in string-like paths. Our results indicate that the distinction between the 'solid' and 'liquid' is soft: While particles in a 'solid' flow producing dynamic heterogeneities, motion in 'liquid' yields unusually long tail in the distribution of particle-displacements. A phenomenological model captures much of the subtleties of our numerical simulations.

Proposed research activities for the coming year

- Conformational stability of therapeutic protein complexes
- Coarse-grained description of bio-molecular processes involving disordered and mis-folded proteins

Manik Pradhan

Associate Professor
CBMS
manik.pradhan@bose.res.in

Having been awarded a prestigious Dorothy Hodgkin Postgraduate Fellowship, Dr. Pradhan received his PhD from the University of Bristol, England (2008). He did his postdoctoral works at University of Cambridge, England (2008-2010) and Stanford University, USA (2010-2011). He also worked as a Visiting Research Assistant (2004-2005) at the Institute of Atomic and Molecular Sciences (IAMS), Academia Sinica, Taiwan. He is currently leading many multi-disciplinary research projects as a Principal Investigator (PI) as well as a Co-PI. He is also one of the Activity Leaders of the Technical Research Centre (TRC) at S. N. Bose Centre.

Supervision of Research / Students

Ph.D. Students

1. Gourab Dutta Banik (Thesis submitted)
2. Abhijit Maity (Thesis submitted)
3. Suman Som (Thesis submitted)
4. Chiranjit Ghosh (Thesis submitted)
5. Mithun Pal
6. Sanchi Maithani
7. Akash Das
8. Ikbal Ahmed

Teaching activities at the Centre

1. CB 527 (Molecular Physics and Spectroscopy)
2. PHY 391 (METHODS OF EXPERIMENTAL PHYSICS) (shared)

Publications in Journals

1. S. Maithani, S. Mandal, A. Maity, M. Pal and **M. Pradhan,** *High-resolution spectral analysis of ammonia near 6.2 μm using a cw EC-QCL coupled with cavity ring-down spectroscopy,* Analyst, 143, 2109 (2018)
2. G. D. Banik, S. Som, A. Maity and **M. Pradhan**, *Cavity ring-down spectroscopy measurements of l-type doubling of hot bands in Δ vibrational states of OCS near 5.2 μm*, Journal of Physics Communications, **2**, 045014 (2018)
3. A. Maity, M. Pal, S. Maithani, G. D. Banik and **M. Pradhan**, *Wavelength modulation spectroscopy coupled with an EC-QCL operating between 7.5and 8 μm*, Laser Physics Letters, **15**, 045701 (2018)
4. G. D. Banik, A. Maity, S. Som, M. Pal and **M. Pradhan**, *An external-cavity quantum cascade laser operating near 5.2 μm combined with cavity ring-down spectroscopy for multi-component chemical sensing,* Laser Physics, 28, 045701 (2018)
5. C. Ghosh, S. Mandal, M. Pal and **M. Pradhan**, *New strategy for in vitro determination of carbonic anhydrase activity from analysis of oxygen-18 isotopes of CO_2,* Analytical Chemistry, **90**, 1384-1387 **(2018)**
6. S. Som, G. D. Banik, A. Maity, S. Chaudhuri and **M. Pradhan**, *Exhaled nitric oxide as a potential marker for detecting non-ulcer dyspepsia and peptic ulcer disease,* Journal of Breath Research, **12**, 026005 (2018)

7. S. Mandal, P. Mukhopadhyay, C. Ghosh, M. Pal, G.D. Banik, S. Chaudhuri, T. Chatterjee, S. Ghosh and **M. Pradhan**, *Isotope-specific breath analysis to track the end-stage renal disease during hemodialysis,* Journal of Breath Research, **12**, 036019 (2018)
8. A. Maity, M. Pal, G. D. Banik, S. Maithani and **M. Pradhan**, *Cavity ring-down spectroscopy using an EC-QCL operating at 7.5 μm for direct monitoring of methane isotopes in air,* Laser Physics Letters, 14, 115701 (2017)
9. S. Maithani, M. Pal, A. Maity and **M. Pradhan**, *Isotope selective activation: a new insight into the catalytic activity of urease,* RSC Advances, **7**, 31372 (2017)
10. C. Ghosh, S. Mandal,M. Pal, P. Mukhopadhyay, S. Ghosh and **M. Pradhan**, *^{13}C isotopic abundances in natural nutrients: a newly formulated test meal for non-invasive diagnosis of type 2 diabetes,* Journal of breath Research, **11**, 026005 (2017)

Other Publications

1. "Detection of isotopic $^{12}CH_4$ and $^{13}CH_4$ using cavity ring-down spectroscopy coupled with an external-cavity quantum cascade laser": M. Pal, A. Maity, S. Maithani, and **M. Pradhan**, Mid-Infrared Coherent Sources (MICS), MT3C.1 (Proceedings) (2018)
2. "Applications of high-resolution cavity ring-down spectroscopy for non-invasive medical diagnostics": **M. Pradhan**. Asian Journal of Physics, 26, 291-298 **(2017)**

Lectures Delivered

1. Spectroscopy and Dynamics of Molecules and Clusters, SDMC-2018: Dooars, India
2. 2nd International Diabetes Summit-2018: Pune, India
3. World Congress on Biotechnology and Biological Studies, WCBBS 2017: New Delhi, India
4. 16th International Symposium on Diabetes: 2017: Mumbai, India
5. International Conference on Spectroscopy of Biomolecules and Advanced Materials, ICSBAM 2017: Kerala, India

Academic Visits

National

1. Visit to NCL Venture Fractal Programme, Pune

Patent/s submitted / granted

1. "Advancement in methodology and system to control isotopic fractionations in carbon containing gases"; File No: 201731017087; Country: India
2. "A System for monitoring hemodialysis efficacy of a subject"; File No: 201731042502; Country: India
3. "A Gas-sensing system for selective detection of (Nitric Oxide) NO gas and a method for fabricating the same"; File No: 201731038036; Country: India

Awards / Recognitions

1. "Dayawati Rastogi Award" for the Best Invited Lecture in "ICSBAM-2017", India

Fellow / Member of Professional Body

1. Research Society for the Study of Diabetes in India (RSSDI)

Sponsored Projects

1. Ministry of Earth Sciences (MoES): 2013-2017

   Title: "Development of a mid-IR Cavity Ring-down Spectrometer for High-Precision Real-Time Continuous Monitoring of Multiple Trace Gases and Stable Isotopic Species in the Atmosphere"
2. RSSDI (Research Society for the study of Diabetes in India):2015-2017

   Title: "Non-invasive detection of diabetes mellitus from breath analysis using cavity enhanced absorption spectroscopy"
3. Department of Science and Technology (DST), Government of India: 2015-2018

   Title: "New-frontiers in quantitative mid-IR high-resolution cavity ring-down spectroscopy using

quantum cascade laser"

4. Department of Science and Technology (DST), Government of India: 2017-2020

   Title: "Understanding of growth of vertically aligned nanowires or nanotubes of binary oxides and physics of isotopic fractionation of gases by them"

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

Sl. No. 6, 7 and 10

Member of Editorial Board

1. Scientific Reports (Nature Publishing Group)
2. World Journal of Gastroenterology

Societal impact of Research

- Using a high-resolution ring-down spectroscopy technique we have shown that exhaled nitric oxide could be used as a potential non-invasive marker for selective and accurate detection of peptic ulcer disease (PUD) and non-ulcer dyspepsia (NUD) without any endoscopy based biopsy tests.
- We have developed a new strategy exploiting the isotope-specific breath analysis method to track the end-stage renal disease (ESDR) in CKD patients during hemodialysis without any invasive blood tests.
- We have formulated a new test meal utilizing ^{13}C-enriched isotopic abundance in natural nutrients for non-invasive diagnosis of type 2 diabetes, thus devoiding of any synthetically manufactured commercial ^{13}C-enriched glucose.

Significant research output / development during last one year

General research areas and problems worked on

- Cavity Ring-Down Spectroscopy
- Quantum Cascade Laser & Applied Spectroscopy
- High-Resolution Gas-phase Molecular Spectroscopy
- Trace Gas Detection and Isotope Ratios Measurements
- Chemical Analysis of Human Exhaled Breath
- Applied Optics and Optical Properties of Nanomaterials
- Surface Plasmon Resonance & Evanescent Wave

Interesting results obtained

(A) Wavelength Modulation Spectroscopy (WMS) technique using Quantum Cascade Laser (QCL)

We have developed a mid-infrared detection strategy with 1*f*-normalized 2*f*-wavelength modulation spectroscopy (WMS-2*f*/1*f*) using a continuous wave (CW) external-cavity quantum cascade laser (EC-QCL) operating between 7.5 and 8 μm.

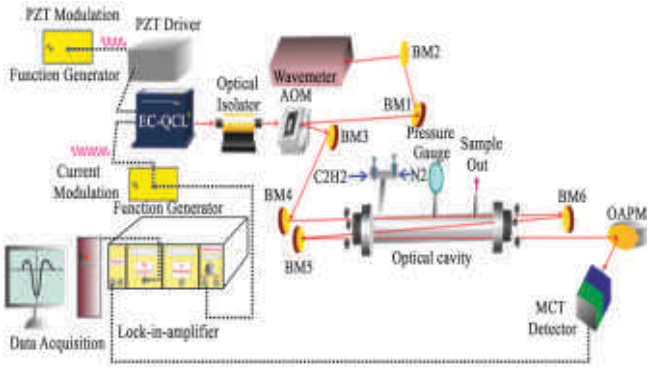


Fig. The quantum cascade laser based WMS technique developed in my laboratory

The detailed performance of the WMS-2*f*/1*f* detection method was evaluated by making rotationally resolved measurements in the $(\nu_4+\nu_5)$ combination band of acetylene (C_2H_2) at 1311.7600 cm^{-1}. A noise-limited detection limit of three parts per billion (ppb) with an integration time of 110□s was achieved for C_2H_2 detection. The present high-resolution CW-EC-QCL system coupled with the WMS-2*f*/1*f* strategy was further validated with an extended range of C_2H_2 concentration of 0.1–1000 ppm, which shows excellent promise for real-life practical sensing applications.

(B) Cavity Ring-down Spectroscopy (CRDS) using an EC-QCL operating at 7.5 μm for direct monitoring of methane isotopes in air:

We have developed a mid-infrared continuous-wave

(*cw*) cavity ring-down spectroscopy (CRDS) technique coupled with an external-cavity (EC) mode-hop-free quantum cascade laser (QCL) operating at 7.5 μm. We validated the EC-QCL based high-resolution *cw*-CRDS system by measuring $^{12}CH_4$ and $^{13}CH_4$ isotopes of methane (CH_4) which served as a benchmark molecule. The direct, quantitative and selective measurements of ^{12}C and ^{13}C isotopes of CH_4 in ambient air as well as in

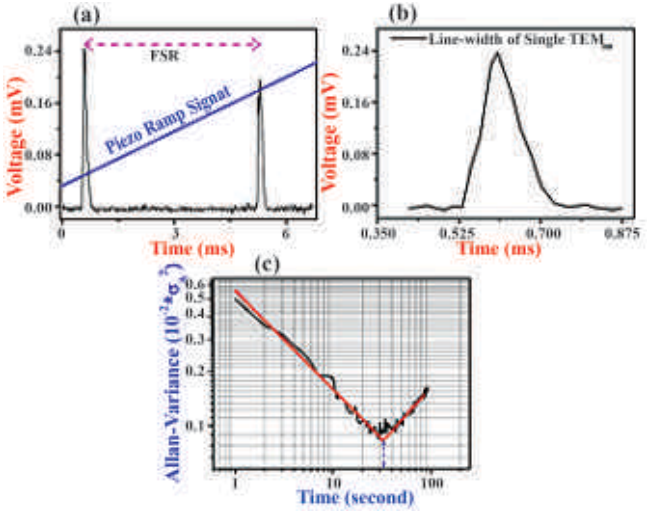


Fig. (a) Laser-cavity resonances during cavity mirror oscillation over one free-spectral-range (FSR), (b) a zoom-in of single resonance, and (c) an Allan-variance plot of empty cavity ring-down time (τ_0).

human breath samples in the levels of parts per billion by volume were made by probing one of the strongest

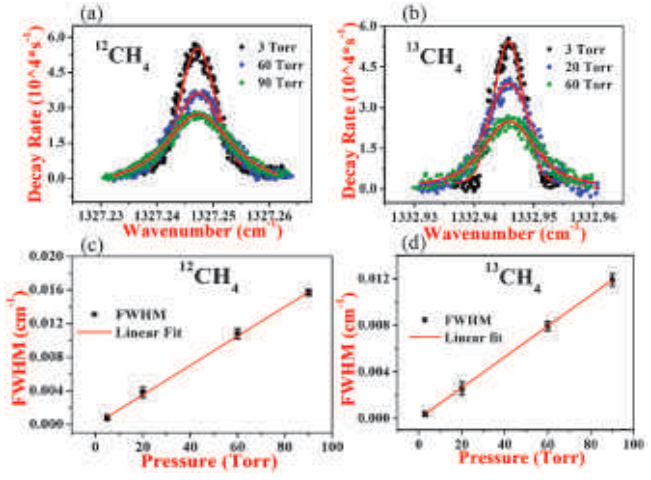


Fig. (a) and (b) Variation of absorption spectra of ^{12}C and ^{13}C isotopes of CH_4 respectively at different cavity pressures, (c) and (d) a linear regression plot between FWHM of absorption spectra and cavity pressures for ^{12}C and ^{13}C isotopes of CH_4 respectively.

fundamental vibrational transitions of CH_4 arising from the asymmetric bending (ν_4 band) vibrations of the bonds centred at ~1327.244 cm^{-1} and ~1332.946 cm^{-1}, respectively. The current high-resolution *cw*-CRDS system could be further exploited to harness the full advantage of the spectral region covering 7.5–8 μm to monitor several other trace molecular species along with their isotopic compositions.

(C) Isotope selective activation: a new insight into the catalytic activity of urease:

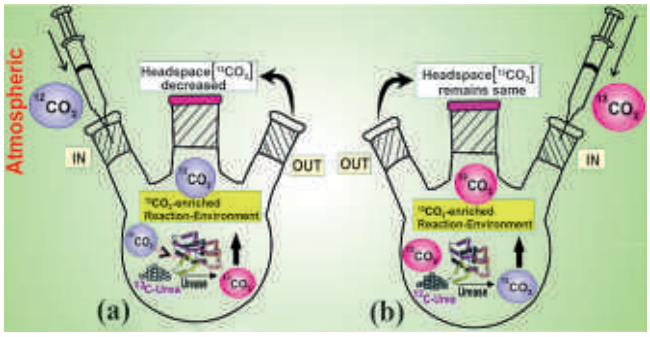


Fig. A scheme showing the isotope-specific catalytic reaction of urease enzyme

We have experimentally shown that the catalytic activity of urease exhibits a unique isotope-specific response where the $^{12}CO_2$ isotope is strongly preferred over the $^{13}CO_2$ isotope during its catalytic activation. Moreover, this isotope-selective activation depends on different isotopic fractionations (^{12}C:^{13}C) of the reaction-environment as well as the substrate urea (^{13}C-urea and ^{12}C-urea), where the $^{12}CO_2$ isotope in the reaction medium essentially facilitates the hydrolysis of ^{13}C-enriched urea. This deepens our understanding of the isotope-specific urease activation and its potential role in hydrolytic reaction.

Our findings thus may offer novel opportunities for a better fundamental understanding of isotope-specificity in chemical reactions involving metalloenzymes.

(D) ^{13}C isotopic abundance in natural nutrients: a newly formulated test meal for non-invasive diagnosis of type 2 diabetes:

A new method to replace commercially prepared ^{13}C-labelled glucose with naturally available ^{13}C-enriched substrates could result in promotion of the clinical

applicability of the isotopic breath test for detection of type 2 diabetes (T2D). Variation of the carbon-13 isotope in human breath depends on the ^{13}C enrichment in the diet taken by subjects. Here, we formulated a new test meal comprising naturally available ^{13}C-enriched foods and subsequently administered it to non-diabetic control (NDC) subjects and those with T2D.

We found that the new test meal-derived ^{13}C enrichment of breath CO_2 was significantly lower in T2D compared with NDC. Furthermore, from our observations T2D exhibited higher isotopic enrichment of oxygen-18 (^{18}O) in breath CO_2 compared with NDC following ingestion of the new meal. We determined the optimal diagnostic cut-off values of ^{13}C (i.e. $\delta\ ^{13}C‰ = 7.5‰$) and ^{18}O (i.e. $\delta\ ^{18}O‰ = 3.5‰$) isotopes in breath CO_2 for precise classification of T2D and NDC.

Our new method involving the administration of naturally ^{13}C-abundant nutrients showed a typical diagnostic sensitivity and specificity of about 95%, suggesting a valid and potentially robust global method devoid of any synthetically manufactured commercial ^{13}C-enriched glucose which thus may serve as an alternative diagnostic tool for routine clinical applications.

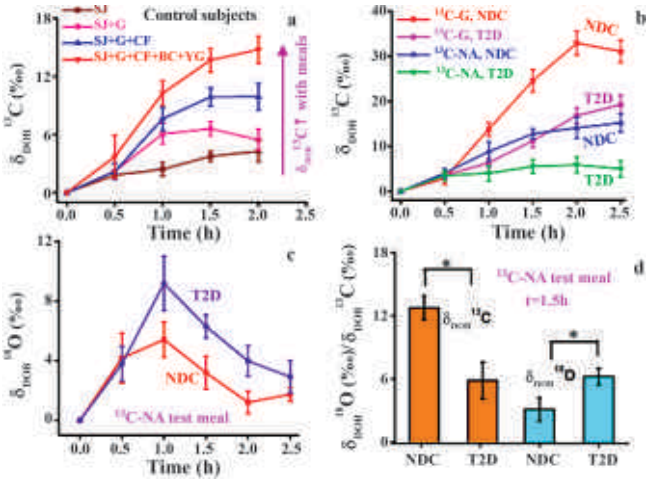


Fig. (a), (b) The excretion kinetic pattern of $\delta_{DOB}{}^{13}C(‰)$. (c) The $\delta_{DOB}{}^{13}C$ (‰) in NDC and T2D after administration of the natural abundance (NA) test meal . (d) A comparative representation of $\delta_{DOB}{}^{13}C$ (‰) and $\delta_{DOB}{}^{13}C$ (‰) at 1.5 h after the test meal load. SJ, sugarcane juice; G, glucose, CF, cornflakes; BC, baby corn; YG, yogurt. *$p < 0.05$.

(E) Exhaled nitric oxide as a potential marker for detecting non-ulcer dyspepsia and peptic ulcer disease

Nitric oxide (NO) plays a key role in the development of peptic ulcer disease (PUD). Conversely, the gastric pathogen *Helicobacter pylori* colonizes the human stomach and contributes to the development of non-ulcer dyspepsia (NUD) and PUD. However, the underlying relation between molecular NO in exhaled breath and *H. pylori*-associated NUD and PUD remains largely unknown. Here, we found that the excretion kinetics of NO profiles in exhaled breath are altered markedly in *H. pylori*-infected NUD and PUD subjects. In our observations, PUD led to considerably higher enrichments of NO in exhaled breath compared to NUD, thus revealing a potential link between exhaled NO and ulcer and non-ulcer complications.

Our findings therefore suggest that molecular NO in

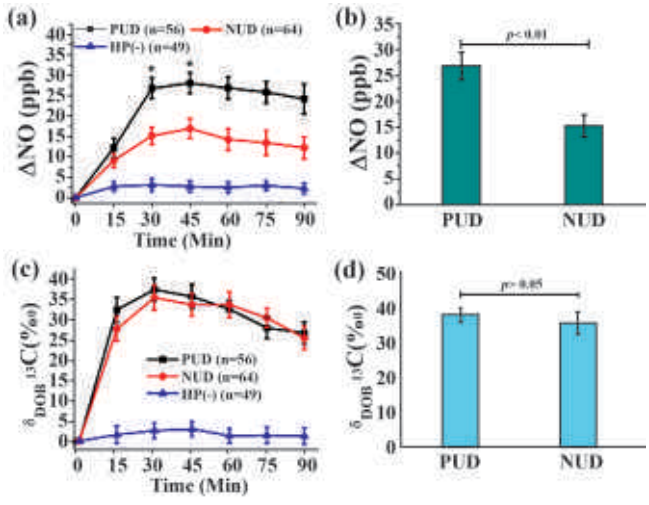


Fig. Assessment of excretion kinetics of both ΔNO (ppb) and $\delta_{DOB}{}^{13}C$ (‰) values in exhaled breath associated with *H. pylori*-infected PUD, NUD and negative individuals in response to ^{13}C-enriched urea. (a) The excretion kinetics ΔNO illustrate the significant enrichment of the ΔNO value for both PUD and NUD subjects compared to *H. pylori*-negative subjects and thus produces (b) a marked statistical difference ($p < 0.01$) between PUD and NUD subjects at 30 min. (c) The excretion dynamics of $\delta_{DOB}{}^{13}C$ (‰) values for PUD, NUD and *H. pylori*-negative subjects up to 90 min, revealing the (d) statistically insignificant difference ($p > 0.05$) of $\delta_{DOB}{}^{13}C$ (‰) values between PUD and NUD subjects at 30 min. * $p < 0.05$.

exhaled breath could be used as a potential biomarker for non-invasive diagnosis and selective differentiation of NUD from PUD. Our observations also highlight that alterations of NO in the gastric environment can play an important role in the pathogenesis of peptic ulcers and thus may provide a new strategy for precise evolution of the actual disease state without the need for endoscopic biopsy, even after the eradication of *H. pylori* infection.

Proposed research activities for the coming year

1. We are currently working on fundamental understanding of high-resolution molecular spectroscopy of some large VOCs in mid-IR spectral fingerprint region.

2. We plan to develop few prototype breath analyzers for non-invasive detection of bacterial infection in human stomach.

3. We have also stared on working on optical properties of nanomaterials such as transition metal dichalcogenides.

Rajib Kumar Mitra

Associate Professor
CBMS
rajib@bose.res.in

Dr. Rajib Kumar Mitra carried out Ph.D. work at Indian Statistical Institute, Kolkata (Ph.D. degree awarded by Jadavpur University in 2005). He joined S.N. Bose National Centre for Basic Sciences as a Post Doctoral fellow in 2006, selected as a Bose Fellow in 2007. He worked as a BOYSCAST Fellow at Ruhr University, Germany during 2009-2010. He joined the centre as an Assistant Professor in August, 2010 and promoted to Associate Professor in January, 2015.

Supervision of Research / Students

Ph.D. Students

1. Arindam Das, "Structure and Dynamics of Mixed Microemulsions/Reverse Micellar Systems", Ph.D. degree awarded in April, 2017
2. Debanjan Polley, "Manipulating THz Radiation Using Nanostructures", Ph.D. degree awarded in July, 2017
3. Nirnay Samanta, "Studying the Effects of Different Cosolutes on Protein Conformational Stability, Hydration Dynamics and Activity", submitted Ph.D. thesis in July, 2017
4. Debasish Das Mahanta, "Investigation of the Collective H-bonded network and Hydration Dynamics around Electrolytes and Bio-molecules", expected to submit Ph.D. thesis in July, 2018
5. Sk. Imadul Islam, working since July, 2016 on "Studies on ultrafast dynamics and spectroscopic investigations on fluorescent probes in bimolecular and biomimetic recognition"
6. Saikat Pal, working since January, 2017
7. Partha Pyne, working since August, 2017
8. Didhiti Bhattacharyya, working since August, 2017
9. Sayantan Adak, working since August, 2017

Post Doctoral Research Scientist/s

1. Chaitrali Sengupta

Teaching activities at the Centre

1. 3rd Semester (Aug-Dec 2017), PHY 301: Atomic and Molecular Physics (Post B.Sc. course), jointly with Prof. Anjan Barman
2. Jan-July 2018: Post-M.Sc. CB 526: Fundamental of Biophysics

Publications in Journals

1. D. K. Das, D. Das Mahanta and **R. K. Mitra**, *Nonmonotonic Hydration Behavior of Bovine Serum Albumin in Alcohol/ Water Binary Mixtures: A THz Spectroscopic Investigation*, *ChemPhysChem*, **18**, 749–754 (2017)
2. K. Neeraj, S. Choudhury, D. Polley, R. Achrya, J. Sinha, A. Barman and **R. K. Mitra**, *Efficient Terahertz Anti-Reflection Properties of Metallic Anti-Dot Structures*, Opt. Lett., **42**, 1764-1767 (2017)
3. D. Das Mahanta, N. Samanta and **R. K. Mitra**, *Decisive Role of Hydrophobicity on the Effect of Alkylammonium Chlorides on Protein Stability: A Terahertz Spectroscopic Finding*, J. Phys. Chem. B, **121**, 7777-7785 (2017)
4. A. De, S. Mondal, C. Banerjee, A. K. Chaurasiya, R. Mandal, Y. Otani, **R. K. Mitra** and A. Barman, *Investigation of magnetization dynamics in 2D $Ni_{80}Fe_{20}$ diatomic nanodot arrays*, J. Phys. D: Appl. Phys., **50**, 385002 (2017)

Lectures Delivered

1. "Modification of water structure in presence of hydrophobic solutes: A spectroscopic investigation", 16th June, 2017, PC Colloquia Lecture, Ruhr University, Bochum, Germany
2. "THz application in Biology and Chemistry", 28th June, 2017, See The Light, Menlo Systems, Munich, Germany
3. "Hydration Dynamics Around Hydrophobic Solutes: A Terahertz Spectroscopic Investigation", UFS 2017, 2nd to 4th Nov'2017, Central University Hyderabad
4. "Water in biology: from spectroscopic perspective", RTPS 2018, Vinoba Bhave University, Hazaribagh, 19th March, 2018

Academic Visits

National

1. CCMB, Hyderabad, November, 2017

International

1. Ruhr University, Bochum, June, 2017

Membership of Committees

Internal Committee

Admission Committee; Students' Curriculum & Research Evaluation (SCREC) Committee; Visitor, Associates and Students' Programme (VASP) Committee; Warden of the Students' Hostel

Sponsored Projects

1. "Real Time Structure and Solvation Dynamics of Proteins during Folding/Unfolding in Crowded Environment", SERB (DST), July 2014 - June 2017

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

1. 2 (Sl. No. 2 and 4)

Participation in Science Outreach program

Delivered a lecture as a part of the Science Outreach Program at the Vinoba Bhabe University, Jharkhand in March, 2017

Societal impact of Research

- Understanding of the nature of various biophysical processes which provides with a knowledgebase that is a prerequisite for real life biomedical and pharmaceutical applications
- Fabrication of various materials which are suitable for THz opticoelectronics (e.g. polarizer, band width filters, anti reflection coating etc.)
- Training of students

Significant research output / development during last one year

General research areas and problems worked on

Terahertz Spectroscopy, Time resolved pump-probe spectroscopy, Hydration dynamics, Biophysics, Protein folding, Self-assembled systems (micelles, reverse micelles, lamellae, vesicles etc.), Nanomaterials

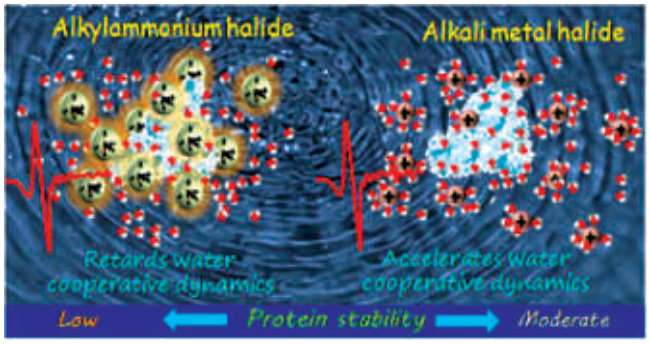
Interesting results obtained

1. Our group has developed home-built optical rectification (OR) based THz radiation facility using ZnTe crystals.

2. Our group has also developed one-color and two-color optical pump-probe set up. Combining the THz time domain and optical pump-probe spectroscopy our group is presently investigating the highly debated notion of "hydrophobic hydration" in various liquid mixtures and self-assembled systems.

3. Our recent study has explored the microstructure and collective dynamics of the membrane interfacial hydration shell in zwitterionic and negatively charged phospholipid membrane bilayers using terahertz time-domain spectroscopy.

4. We have investigated the ultrafast (subpicosecond to picosecond) collective hydrogen bond dynamics of water in the extended hydration layers in a series of alkylammonium chloride salts using THz time domain spectroscopic (TTDS) technique (We found the THz absorption coefficient (α) of the salt solutions systematically vary with the salt type. We obtain the hydrogen bond relaxation dynamics by fitting the frequency dependent dielectric constants in a multiple Debye dielectric relaxation model. We found these salts to transform from being a water "structure breaker" to "structure maker" with increasing carbon content. We also investigate their effect on a model protein and found a systematic trend toward disrupting the protein secondary structure. The associated changes in the protein hydration in the presence of these salts have also been investigated using TTDS.



5. Our studies on two-photon absorption (TPA) process in rhodamine based dyes on the thermal denaturation of a model serum protein strongly affirm the suitability of TPA process in protein imaging and as an alternative marker to tracking its conformational transformations using NIR radiation. We also have extended our TPA measurements towards micellar systems.

6. We have studied the effect of ethylene glycol (EG) and PEGs of different chain lengths (M_n 400 and 4000) on the enzyme efficiency of hen egg white lysozyme (HEWL) on Micrococcus lysodeikticus (*M. Lys.*) cell. We found that the enzyme activity increases at low osmolyte concentrations (~2%) beyond which it decreases. The maximum in the enzyme efficiency has been explained on the basis of an optimization between excluded volume effect and soft interaction among the protein and the cosolutes.

Proposed research activities for the coming year

1. We plan to couple this facility with an optical pump and probe it with THz. That will provide us with the time-resolved optical pump – THz probe measurements of some light sensitive chemicals and proteins.

2. We would continue our study to understanding how molecular crowders 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. This study will include both experimental as well as simulation measurements.

3. We would continue our study on the improvement and fabrication of various THz optical components (e.g. polarizers, band pass filters, anti reflection coatings etc.).

4. We would collaborate with industries regarding application of THz spectroscopy in pharmaceutical and biomedical applications.

Ranjit Biswas

Professor
CBMS
ranjit@bose.res.in

Research involves theory, simulations and experiments; strives for developing molecular level understanding of relaxation processes in condensed phases.

Supervision of Research / Students

Ph.D. Students

1. Ejaj Tarif, Experimental studies of deep eutectics and other complex systems (on going)
2. Kajal Kumbhakar, Spectroscopic investigation of polymer electrolytes, electrolyte solutions, and media near critical solution temperatures (on going)
3. Atanu Bakshi, Theoretical and simulation studies of confined systems, and other complex reaction media (on going)
4. Juriti Rajbangshi, Computer simulations of Coulomb fluids and ionic deep eutectics (on going)
5. Dhrubajyoti Maji, Computational investigations of dielectric relaxations and related polarization relaxation in deep eutectics (on going)
6. Jayanta Mondal, Experimental investigation of room temperature melts, and other related systems (on going)

Teaching activities at the Centre

1. Aug-Dec 2017, Research Methodology, PHY 501 (~ 30)

Publications in Journals

1. Suman Das, Biswaroop Mukherjee and Ranjit Biswas, *Orientational Dynamics in a room temperature Ionic Liquid: Are Angular Jumps Predominant?*, Journal Chemical Physics, 148, 193839 (2018)

Lectures Delivered

1. Invited Talk at the national conference in memory of Mihir Chowdhury at the IACS on 24 February, 2018 entitled "Dielectric Relaxation in Deep Eutectics: Measurements and Simulations"

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl. No. 1

Member of Editorial Board

1. Journal of Chemical Science

Societal impact of Research

- Trying to develop a low-cost hand-held kit (under the TRC project) for visual detection of adulteration in milk

Significant research output / development during last one year

General research areas and problems worked on

Our research has helped in decoding the frictional coupling to molecular relaxations in deep eutectics, and their differences in the parent systems.

Interesting results obtained

Reorientational dynamics of the constituent ions in a room temperature ionic liquid (RTIL), 1-Butyl-3-Methylimidazolium Hexafluorophosphate ([BMIM][PF6]), is explored via molecular

dynamics simulations, and several features of orientation dynamics summarized. The anion, [PF6]-, not only exhibits higher propensity to orientation jumps than the cation, [BMIM]+, but also access wider jump angle distribution and larger peak-angle. Jump and waiting time distributions for both the ions depict power-law dependences, suggesting temporally heterogeneous dynamics for the medium. This heterogeneity feature is further highlighted by the finding that the simulated first rank ( ) and second rank ( ) average reorientational correlation times reflect a severe break-down of the Debye's law for orientational diffusion in an isotropic homogeneous medium. Average simulated jump trajectories reveal a strong rotation-translation coupling and indicate relatively larger changes in spatial and angular arrangements for the anion during an orientation jump.

Temperature dependent dynamics of a polyethylene glycol based non-ionic deep eutectic solvent (DES) has been investigated via both dielectric relaxation spectroscopic (DRS), and time-resolved fluorescence (TRF) Stokes shift and anisotropy measurements. DRS measurements have been performed within the frequency window, $0.2 \leq \nu/\mathrm{GHz} \leq 50$. Interestingly, the estimated static dielectric constant ( ) for this DES is considerably large, even higher than the value of polar solvents like, dimethyl formamide and acetonitrile. Measured DR spectra require four relaxation processes, spread over sub-10 ps to nanosecond time regime, to adequately describe the detected DR dynamics of this DES. Surprisingly, this non-ionic DES possesses a nanosecond relaxation component similar to that in ionic acetamide DESs. Both DR and dynamic fluorescence anisotropy data reveal substantial fractional viscosity dependence for solute rotation in this DES.

Extensive computer simulations with deep eutectics made of acetamide (CH_3CONH_2) and lithium salts (LiX) have been performed at 303 K and 350 K to identify the solution-phase microstructures in these media and investigate the anion dependence of the size and lifetime distributions of these microstructures. In addition, we explore how the added electrolyte interferes with the natural hydrogen bonded (H-bonded) network structure of liquid acetamide. For this purpose several radial distribution functions have been analysed and visualised. The results reveal that amide-amide H-bond interaction decreases significantly upon the addition of electrolyte, and the interactions of Li^+ and X^- (X^- being NO^-_3, Br^- and ClO^-_4) with lead to heterogeneous solution structures. Furthermore, we have obtained the cluster size and lifetime distributions in order to estimate the size of local microstructures and their stability. Both these distributions are analysed by separating the contributions arising from (a) $CH_3CONH_2 - CH_3CONH_2$, (b) $Li^+ - CH_3CONH_2$ and (c) $Li^+ - X^-$ interactions. The size distribution of $Li^+ - X^-$ clusters is found to be different from those for the other two. Also, the lifetime distributions show a pronounced anion dependence and suggest cluster stability time up to a few nanoseconds.

Proposed research activities for the coming year

We would like to carry out further research in the following sub-areas:

(i) More simulation and experimental investigations of deep eutectics

(ii) Polymer electrolytes

(iii) Complex condensed systems

Samir Kumar Pal

Senior Professor
CBMS
skpal@bose.res.in

Group of Professor Samir Kumar Pal is involved in the investigation of key ultrafast time scales, which are recognized to be very relevant and important in the field experimental nanoscience-technology, Biophysics and Biomedical instrumentation. They have more than 230 research papers published in various international peer-reviewed journals, 22 patent applications, 10 extramural research funding and 5 book chapters resulting more than 9444 citations, 50 h-index, 163 i10 index, to describe their activities concisely.

Supervision of Research / Students

Ph.D. Students

1. Nabarun Polley, "Exploration of Biomedically Relevant Spectroscopic Techniques for Potential Clinical Diagnostic and Therapeutic Procedures", University of Calcutta (Completed 2017)
2. Susobhan Chaudhury, "Study on Conformation and Ultrafast Dynamics in Biomolecular Recognition with Optical Laser Spectroscopy", University of Calcutta (Completed 2018)
3. Prasenjit Kar, "Spectroscopic Studies on Nanomaterials for Solar Energy Harvesting Application", University of Calcutta (Submitted) (2017)
4. Damayanti Bagchi, "Spectroscopic and Microscopic Studies on Nanohybrids of Inorganic Metal-oxides with Medicinally Important Organic Ligands", University of Calcutta (Ongoing)
5. Priya Singh, "Spectroscopic Studies on Structure, Function and Dynamics of Biological Macromolecules in Physiologically Relevant and Engineered Environments", University of Calcutta (Ongoing)
6. Probir Sarkar, "Spectroscopic Studies on Molecules and Nanomaterials for Potential Applications in Medical Diagnosis and Environmental Pollution Monitoring", University of Calcutta (Ongoing)
7. Tuhin Maji, "Combined experimental and computational investigation on optical and catalytic properties of functionalized metal oxides", University of Calcutta (Ongoing)
8. Aniruddha Adhikari, "Studies on Therapeutic Potential of Various Nanomaterials and Ethnobotanical Ingredients in Preclinical Disease Model", University of Calcutta (Ongoing)
9. Jayita Patwari, "Photophysical Studies on Light Harvesting Nanomaterials for Improved Solar Energy Conversion", University of Calcutta (Ongoing)
10. Soumendra Singh, "Development of Spectroscopic Techniques for Potential Environmental and Biomedical Applications", University of Calcutta (Ongoing)
11. Arka Chatterjee, "Studies on Light Harvesting Mechanism at Near Infrared Region of Solar Radiation for Potential Application in Photovoltaics and Photocatalysis", Jadavpur University (Ongoing)
12. Arpan Bera, "Spectroscopic Studies on Functional Nanohybrids and their Potential Biological Application", University of Calcutta (Ongoing)

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Ankur Singh, "Spectroscopic Detection of Tea Quality", University of Calcutta (2017)
2. Susmita Mondal, "Screening Thalassemia at Point of Care", University of Calcutta (2017)

Post Doctoral Research Scientist/s

1. Tanushree Dutta

Teaching activities at the Centre

1. Biological Physics PHY 405 Shared with Dr. R. K. Mitra
2. Biophysics CB 526

Publications in Journals

1. H. Ghadi, J. Patwari, P. Murkute, D. Das, P.K. Singh, S. Dubey, M. Bhatt, A. Chatterjee, A. Balgarkashi, **S. K. Pal** and S. Chakrabarti, *Optimizing dot-in-a-well infrared detector architecture for achieving high optical and device efficiency corroborated with theoretically simulated model*, J. Alloys and Compounds, **751**, 337 (2018)
2. P. Kar, T. K. Maji, P. K. Sarkar, P. Lemmens and **S. K. Pal**, *Development of a Photo-Catalytic Converter for Potential Use in the Detoxification of Cr(VI) Metal in Water from Natural Resources*, J. Mat. Chem. A, **6**, 3674 (2018)
3. J. Patwari, A. Chatterjee, S. Sardar, P. Lemmens and **S. K. Pal**, *Ultrafast Dynamics in Co-sensitized Photocatalysts under Visible and NIR Light Irradiation*, Phys. Chem. Chem. Phys., **20**, 10418 (2018)
4. P. K. Sarkar, A. Halder, A. Adhikari, N. Polley, S. Darbar, P. Lemmens and **S. K. Pal,** *DNA-based Fiber Optic Sensor for Direct In-vivo Measurement of Oxidative Stress*, Sensors & Actuators B: Chemical, **255**, 2194 (2018)
5. P. Singh, S. Choudhury, S. Kulanthaivel, D. Bagchi, I Banerjee, S. A. Ahmed, and **S. K. Pal**, *Photo-triggered Destabilization of Nanoscopic Vehicles by Dihydroindolizine for Enhanced Anticancer Drug Delivery in Cervical Carcinoma*, Colloids and Surfaces B: Biointerfaces, **162**, 202 (2018)
6. A. Halder, P. K. Sarkar, P. Pal, S. Chakrabarti, P. Chakrabarti, D. Bhattacharyya, R. Chakraborty and **S. K. Pal**, *Digital Camera-Based Spectrometry for the Development of Point-of-Care Anemia Detection on Ultra-low Volume Whole Blood Sample*, IEEE Sensors Journal, **17**, 7149 (2017)
7. J. Patwari, S. Sardar, B. Liu, P. Lemmens and **S. K. Pal**, *Three-in-One Approach Towards Efficient Organic Dye-Sensitized Solar Cells: aggregation suppression, Panchromatic Absorption and Resonance Energy Transfer*, Beilstein J. Nanotechnology, **8**, 1705 (2017)
8. P. K. Sarkar, A. Halder, N. Polley and **S. K. Pal**, *Development of Highly Selective and Efficient Prototype Sensor for Potential Application in Environmental Mercury Pollution Monitoring*, Water, Air, & Soil Pollution, **228**, 314 (2017)
9. P. Kar, T. K. Maji, J. Patwari and **S. K. Pal,** *Can A Light Harvesting Material be Always Common in Photocatalytic and Photovoltaic Applications?*, Materials Chemistry and Physics, **200**, 70 (2017)
10. A. Mazumder, S. Batabyal, M. Mondal, T. Mondol, S. Choudhury, R. Ghosh, T. Chatterjee, D. Bhattacharyya, **S. K. Pal** and S. Roy, *Specific DNA Sequences Allosterically Enhance Protein-Protein Interaction in a Transcription Factor through Modulation of Protein Dynamics: Implications for Specificity of Gene Regulation*, Phys. Chem. Chem. Phys., **19**, 14781 (2017)
11. R. Nandi, S. Mishra, T. K. Maji, K. Manna, P. Kara, S. Banerjee, S. Dutta, S. K Sharma, P. Lemmens, K. Das Saha and **S. K. Pal**, *A Novel Nanohybrid for Cancer Theranostics: Folate Sensitized Fe_2O_3 Nanoparticles for Colorectal Cancer Diagnosis and Photodynamic Therapy*, J. Mat. Chem. B, **5**, 3927 (2017)

Other Publications

1. T. K. Maji, **S. K. Pal** and D. Karmakar, Hole-doping and contact induced spin-polarization in Weyl semimetal TaAs, AIP Conference Proceedings, **1942**, 130053 (2018)
2. T. K. Maji, **S. K. Pal** and D. Karmakar, Doping induced carrier and band-gap modulation in bulk versus nano for topological insulators: A test case of Stibnite, AIP Conference Proceedings, **1942**, 090029 (2018)

Books / Book Chapter / Monographs Published / Edited

1. "Impact of a Nobel Prize on the Far Side of the Earth" in the book "Reminiscences of Ahmed Zewail: Photons, Electrons and What Else?"

World Scientific edited by A. Douhal, J.S. Baskin and D. Zhong

Lectures Delivered

1. Invited speaker at the 2nd Regional Science & Technology Congress (Southern Region) in collaboration with the Department of Higher Education, Science and Technology & Biotechnology, Govt. of West Bengal. Held during 14th - 15th December, 2017 at University of Kalyani
2. Invited speaker at National Seminar on Recent Developments in Chemical Sciences (RDCS – 2018) Lecture Schedule at Indira Gandhi National Tribal University (IGNTU) Department of Chemistry. Held during February 23-24th 2018
3. P.K. Bose Memorial award lecture at 54th ANNUAL CONVENTION OF CHEMISTS, 2017 held in Surat Gujrat during 23-25th December 2017
4. Plenary speaker at National Conference on Emerging Materials (NCEM-2018) at Department of Chemistry, Assam University, Silchar during March 20-22, 2018
5. Key note speaker and Guest of honour at UGC sponsored National Level Seminar on RECENT TRENDS in BASIC SCIENCE RESEARCHES, held on and from 21st September, 2017 to 23rd September, 2017 in Department of Physics Srikishan Sarda College, Hailakandi, Assam
6. Invited speaker at all India Homoeopathic Post Graduate Seminar, 2018 (In technical collaboration with CCRH, Ministry of AYUSH, Govt. of India.) during 16th &17th February, 2018
7. Invited speaker at International Workshop on Advanced Hybrid Separation Techniques in Industrial Wastewater management during December 8-9, 2017 at Chemical Technology Department, Jadavpur University
8. Invited speaker at refresher Course on "Recent Advances in Chemistry" Department of Chemistry, Jadavpur University (January 02-24, 2018)
9. Invited speaker at the International seminar entitled 'Frontier's in Biological Sciences' organized by postgraduate department of Microbiology, St. Xavier's University on 30th January, 2018
10. Invited Speaker at 1st workshop on "Indigenization of Strategic Technologies: Government, Stakeholder and Think tank's perspectives (IST:GST)" on the 25th-26th of November 2017 at VMCC, IIT Bombay
11. Invited Speaker National Conference on Environment and health to be organized at JECRC University, Jaipur, Rajasthan during Nov 17-18, 2017
12. Invited Speaker in a special seminar at West Bengal State University (WBSU) Barasat on 13th June 2017
13. Invited Speaker in a special seminar of Nanomet at Technical University of Braunsweig, Germany on 7th June 2017
14. Invited speaker in national level conference in the areas of Electronic Structure, Spectroscopy and Dynamics organized at IACS during February 22-25, 2018
15. Invited speaker at Workshop on Advanced Materials for Energy" on 16th March 2018 at IACS
16. Invited speaker in a Refresher Programme in Physics with special emphasis on Nano and Biotechnology at IIT(ISM) Dhanbad on 25th May to 14th June 2017

Academic Visits

International

1. Collaborative Research Technical University of Braunsweig, Germany May-June 2017

Membership of Committees

Internal Committee

Chairman Pest Control

Patent/s submitted / granted

Granted on 2018

1. A method and system for non-invasive quantitative estimation of Hemoglobin in

human blood, Indian Pat. 466/KOL/2009

Submitted

1. (Cu)PP-TiO_2 -based photo-catalytic converter of toxic metal ions in water including Cr (VI), Indian Pat. Appl. (2017), TEMP/E-1/27957/2017-KOL
2. Dual Action Zinc Nano-fertilizer Cum Nano-pesticide and its Customized Sustainable Release in Agricultural Soils For Higher Crop Productivity, Indian Pat. Appl. (2017), TEMP/E-1/27924/2017- KOL
3. A Low Cost Test Kit for High Throughput Detection of Thalassemia, Indian Pat. Appl. (2017), TEMP/E-1/27904/2017-KOL
4. Digital Camera Based Spectrometric System for Point-of-care Analysis of Ultra-low Volume Whole Blood Sample, Indian Pat. Appl. (2017), TEMP/E-1/29882 2017-KOL
5. Dna-based Fiber Optic Sensor for Direct In-vivo Measurement of Oxidative Stress, Indian Pat. Appl. (2017), TEMP/E-1/29886/2017-KOL

Awards / Recognitions

1. Professor P. K. Bose Memorial Award 2016 (Indian Chemical Society) awarded in 2017

Sponsored Projects

1. Title: *"Science and application of organic ligand-transition metal oxide hybrids as new functional materials"* (Award No. 2013/37P/73/BRNS) Board of Research in Nuclear sciences (BRNS), Department of Atomic Energy (DAE), Completed on 2017
2. Title: *"In(Ga)As/GaAs Quantum Dot Solar Cells"* (Award No. DST/TMC/SERI/FR/117) Department of Science and Technology (DST), Approved on 2015, Completed
3. Title: *"Development and Optimization of a Non-contact Optical Device for Online-Monitoring of Neonatal and Maternal Jaundice"* Indian Council of Medical Research (ICMR), Approved on 2017, Completed
4. Title: *"Nanogels: Biophysical Characterization and Potential Biomedical Applications in Drug Delivery"* Department of Biotechnology (DBT), Approved in 2015, Completed
5. Title: *"Exploration of key photoinduced dynamics in inorganic nanohybrids for enhanced biological activities"* (Award No. EMR/2016/004698), Agency: Department of Science and Technology (DST), Approved on 2017, Continuing
6. Title: *"Development of low cost, easy to use instrument for quick validation of Geographical Indication, Darjeeling Tea"* (Award No. 17(404)/2016/6000), Agency: National Tea Research Foundation (NTRF), Approved on 2017, Completed

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

Sl. No. 1,6,10

International

Sl. No. 2-5, 7, 11

Member of Editorial Board

1. EPJ Techniques and Instrumentation (Springer), J. Materials Nanoscience

Participation in Science Outreach program

- Speaker at postgraduate department of Microbiology, St. Xavier's University on 16th August 2017.
- Speaker at Ananda Mohan College on 28th November 2017.
- Speaker at Jagadis Bose National Science Talent Search (JBNSTS) for Senior Students on 29th April 2017
- Speaker at Jagadis Bose National Science Talent Search (JBNSTS) for Junior Students on 4th May 2017
- Speaker at Jagadis Bose National Science Talent Search (JBNSTS) for Senior Students on 29th March 2018

Societal impact of Research

- We have developed a technology which would detect maternal and neonatal jaundice and anemia in a noncontact and non-invasive way. The prototype is under use in NRS hospital on a trial.
- We have developed an instrument (DetecTea) for the quantitative determination of Tea quality.
- We have also developed a minimally invasive low cost digital camera-based instrument for the detection of Anemia

Significant research output / development during last one year

General research areas and problems worked on

Ultrafast Spectroscopy of Molecules and Nanomaterials, Solar Devices, Environmental Monitoring, Food Security, Biomedical Instrumentation, Spectroscopic Techniques and Instrumentation

Interesting results obtained

In S.N. Bose National centre our research activities are mainly in the field of experimental Biological Physics, Bio-Nano Interface, Biomimetics and biomedical instrumentation. Our activities and future direction are briefly mentioned in the following section.

Research in the field of Experimental Biophysics: Our research activities in the field of experimental Biophysics, are interdisciplinary in nature that applies the theories and methods of physics. The studies included under the umbrella of biophysics range from molecular recognition of small ligands/drugs by biological macromolecules to complicated protein-DNA, Protein-Protein complexation.

Research in the field of Experimental Nano-physics and Bio-nano Interface: The interface between the biological sciences and nanoscience constitutes one of the most interesting and technologically promising frontiers in modern science. Our group is involved in the synthesis of various bio-nano conjugates. Selective attachment of inorganic semiconductor/metal nanoparticles to medicinally important organic molecules is the key feature of the nano-conjugates, which leads synthesis of nanomedicines .

Research in the field of Experimental Biomimetics: Our activities in the area of biomimetic systems, which are very useful to understand the complex biomolecular systems and works excellent as templates for the synthesis of nano-materials are also evident from our publications. The systems are also used to prepare various drug delivery vehicles.

Research in the field of Biomedical Instrumentation: Finally, our heartiest effort to bring the frontier research to common people in our society in terms of lost cost spectroscopic gadgets for the biomedical/ environmental usage are obvious from our publications in allied science journals and patents.

Proposed research activities for the coming year

1. Plan on Experimental Biophysics: Understanding of the ultrafast biomolecular processes (with nanosecond resolution) including early event of molecular recognition and structural events in proteins and DNA by using microfluidic/nanofluidic techniques attached to our existing picosecond/femtosecond facility will be one of focus areas of my group. Our preliminary works in this direction already reflects some promise for our future activities.

2. Plan on Bio-nano Interface: Non-invasive control of biological function by using magnetic field to the nanomagnets encapsulated in biological macromolecules would be our aim in near future. Exploration of the photo-processes in various nanomaterials including Mn_3O_4 for the better nanomedicinal application would also be our aim in our future studies.

3. Plan on Biomimetics Studies: Understanding the complex biomolecular reaction in chemically controllable environments of physiologically relevance will be the future activities. Synthesis of various drug delivery vehicles by solution routes for the biological application will also be our future works.

4. Plan on Biomedical Instrumentation Studies: Bringing science to the reach of common people in the form of noninvasive diagnostic technology is the motivation.

Subhra Jana

DST Inspire Faculty
CBMS
subhra.jana@bose.res.in

Subhra Jana is currently working as a DST INSPIRE faculty at S. N. Bose National Centre for Basic Sciences. She did her postdoctoral research work from Pennsylvania State University, University Park and Ph.D. from Indian Institute of Technology Kharagpur. Her multi-disciplinary research involves solution phase synthesis and potential application of alloys, intermetallics and hybrid nanocomposites. Her work was recognized by SERB Women Excellence Award and Young Associate of Indian Academy of Sciences, Bangalore.

Supervision of Research / Students

Ph.D. Students

1. Sankar Das: Synthesis of Inorganic-Organic Hybrid Nanocomposites for Environmental Application (Ongoing)
2. Arnab Samanta: Solution Phase Synthesis and Catalytic Application of Alloys and Intermetallics (Ongoing)

Publications in Journals

1. S. Das, A. Samanta and **S. Jana**, *Light-Assisted Synthesis of Hierarchical Flower-Like MnO_2 Nanocomposites with Solar Light Induced Enhanced Photocatalytic Activity*, ACS Sustainable Chemistry & Engineering, **5**, 9086 – 9094 (2017)
2. A. Samanta, S. Das and **S. Jana**, *Exploring β-FeOOH Nanorods as an Efficient Adsorbent for Arsenic and Organic Dyes*, ChemistrySelect, **3**, 2467– 2473 (2018)

Books / Book Chapter / Monographs Published / Edited

1. A. Modak and **S. Jana**, Advances in Porous Adsorbents for CO_2 Capture and Storage, 2018. ISBN: 978-953-51-5675-8; InTechOpen. (Invited Book Chapter)

Lectures Delivered

1. Invited Talk at National Conference on Graphene and Functional Materials (NCGFM-2018), February 23 – 24, 2018 held at CSIR-Central Mechanical Engineering Research Institute
2. Chairperson at International Conference on Current Trends in Materials Science and Engineering (CTMSE 2018), January 19-20, 2018 held at S N Bose Centre
3. Invited Talk at Recent Advances in Functional Inorganic & Nanomaterials Chemistry (RAFINC- 2017), November 11, 2017 held at IIT Kharagpur
4. 83rd Annual Meeting of Indian Academy of Sciences, Bangalore, November 3-5, 2017 held at NEHU, Shillong

Membership of Committees

External Committee

Editorial Board Member of Scientific Reports from 2015 onward

Internal Committee

Seminar In-charge of CBMS Department; Member of Interview Committees; Member of Technical Committee of Technical Research Centre Project, SNBNCBS

Patent/s submitted / granted

1. Title: A Clay Based Nano Confined Reactor, Inventors: Sankar Das and Subhra Jana (Filed, India)

2. Title: A Method for the Synthesis of Flower-like δ-MnO_2 Nanocomposites with Enhanced Photocatalytic Activity, Inventors: Sankar Das, Arnab Samanta and Subhra Jana (Filed, India)

Awards / Recognitions

1. SERB Women Excellence Award, 2017-2020
2. Secured **Excellent Grade** (<10%) from DST, India during comprehensive evaluation of INSPIRE Faculties in 2017
3. Young Associate of Indian Academy of Sciences, Bangalore, 2015-2018

Fellow / Member of Professional Body

1. Life Member of Chemical Research Society of India (CRSI)
2. Life Member of Materials Research Society of India (MRSI)

Sponsored Projects

1. SERB Women Excellence Research Grant, DST, India, from 2017-2020 (PI)
2. Extramural Research Grant funded by Nano Mission, DST, India from 2016- 2019 (PI)
3. Technical Research Centre (TRC) funded by DST, India from 2016-2020. (One of the Activity Leaders, PIs)
4. INSPIRE Research Grant funded by DST, India from 2012- 2018

Member of Editorial Board

1. Editorial Board Member of Scientific Reports

Participation in Science Outreach program

Participated in the "Exhibition on Science & Technology Innovations" by Scientific Ministries and Departments of Govt. of India, held in the Parliament House Annexe, New Delhi from July 28 - August 11, 2017

Societal impact of Research

Swachh Bharat

Significant research output / development during last one year

General research areas and problems worked on

Experimental Materials Chemistry

- Hierarchical Flower-Like MnO_2 Nanocomposites with Solar Light Induced Enhanced Photocatalytic Activity
- Synthesis of Hybrid Nanocomposites for Use as Efficient Carbon Dioxide Capture Materials
- Solution Phase Conversion of Nanoscale Metals into Intermetallics: Efficient Catalysts for Chemoselective Organic Transformations

Interesting results obtained

1. A novel solution chemistry route has been developed for the synthesis of nanoscale hierarchical flower-like MnO_2 through a light-assisted decomposition of a manganese precursor over the surface of a clay nanotube (Figure 1). By tuning the reaction conditions, we have successfully synthesized δ-MnO_2 flowery nanostructures and subsequently studied their photocatalytic activity for the degradation of organic dyes under natural sunlight irradiations. Microscopic analysis demonstrates that δ-MnO_2 nanoflowers comprise of assemblies of many wrinkled and intersected nanosheets. The photocatalytic activity of the HNTs/δ-MnO_2 NCs has been investigated

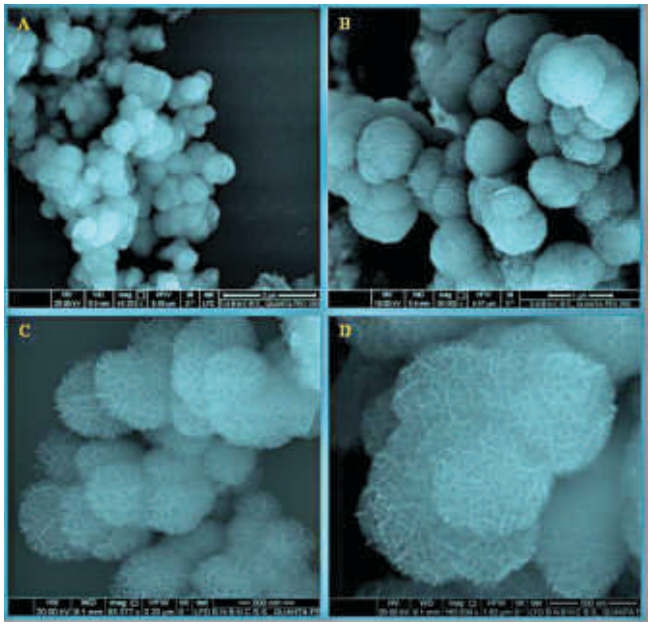


Figure 1. FESEM images of HNTs/MnO_2 nanocomposites at different magnifications, demonstrating hierarchical flower-like MnO_2 nanostructures were grown over the outer surfaces of halloysite clays (HNTs).

towards the degradation of organic dyes in presence of renewable and never-ending solar energy. Methylene blue (MB) and eosin yellow (EY) were chosen as model contaminants to study their catalytic efficacy.

The crystallographic phase dependent photocatalytic activity of MnO_2 nanocomposites has also been carried out towards the photodegradation of dyes, indicating δ-MnO_2 nanostructures possess higher catalytic efficiency compared to α-MnO_2. The underlying mechanism demonstrates the formation of reactive oxygen species, which in turn facilitate the degradation of dyes and also substantiate that there is no need of any supplementary oxygen sources during photodegradation. Thus the present work points to a low-temperature environmentfriendly approach for the synthesis of hierarchical flowerlike δ-MnO_2 nanostructures, which may be considered to be an alternative heterogeneous photocatalyst for the degradation of organic pollutants under natural sunlight irradiations. Thus, these new insights will shed light in the practical applications of heterogeneous catalysts for environmental remediation through wastewater treatment in a greener approach.

2. Exploring a light-assisted solution chemistry route, we have demonstrated the synthesis of iron oxide nanorods in a large scale from an iron precursor under alkaline condition for the adsorption of toxic metals and organic contaminants from waste-water. β-FeOOH nanorods demonstrate an excellent binding capacity for As(III), As(V), and organic dyes, which are toxic and cause severe effect to the mankind if present in the drinking water beyond the permissible limit (Figure 2). As(III) and As(V) sorption isotherms are look-alike and indicate similar surface site densities on β-FeOOH NRs and the sorption of both As(III) and As(V) over the NRs is more favourable at low pH. However beyond pH 3, As(III) has higher affinity towards NRs than that of As(V). The asprepared β-FeOOH nanorods exhibit a monolayer molecular adsorption for As(III), As(V), and organic dyes and their adsorption follows pseudo-second-order kinetic model. The exceptional adsorption capacity of β-FeOOH nanorods, accompanied by the convenient synthetic approach, represents an alternative and environmentally friendly approach to develop adsorbents for the extraction of toxic metals as well as organic dyes. Additionally, the novelty of this work lies in the synthesis of monodispersed nanorods without the use of any shape directing material as well as exceptional adsorption efficacy of β-FeOOH NRs. Thus, these new insights will shed light in the societal needs of an adsorbent for cleaning-up of both industrial effluents and ground water in a greener approach, which in turn will protect the environment and human being from several toxic effects.

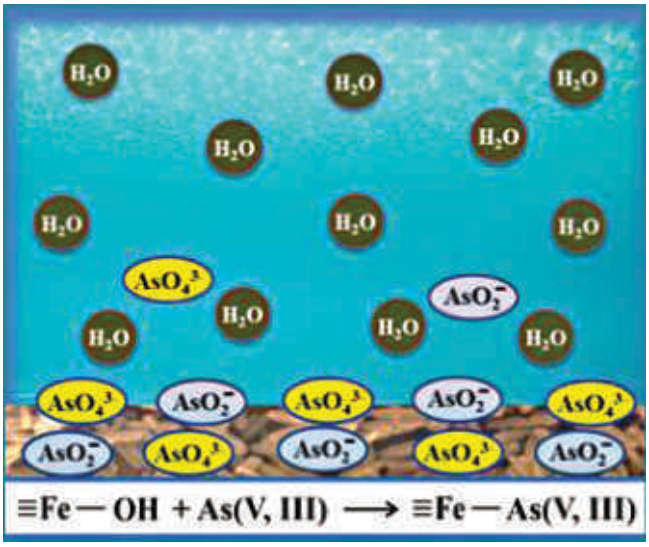


Figure 2. Adsorption of As(III) and As(V) over the surface of β-FeOOH nanorods.

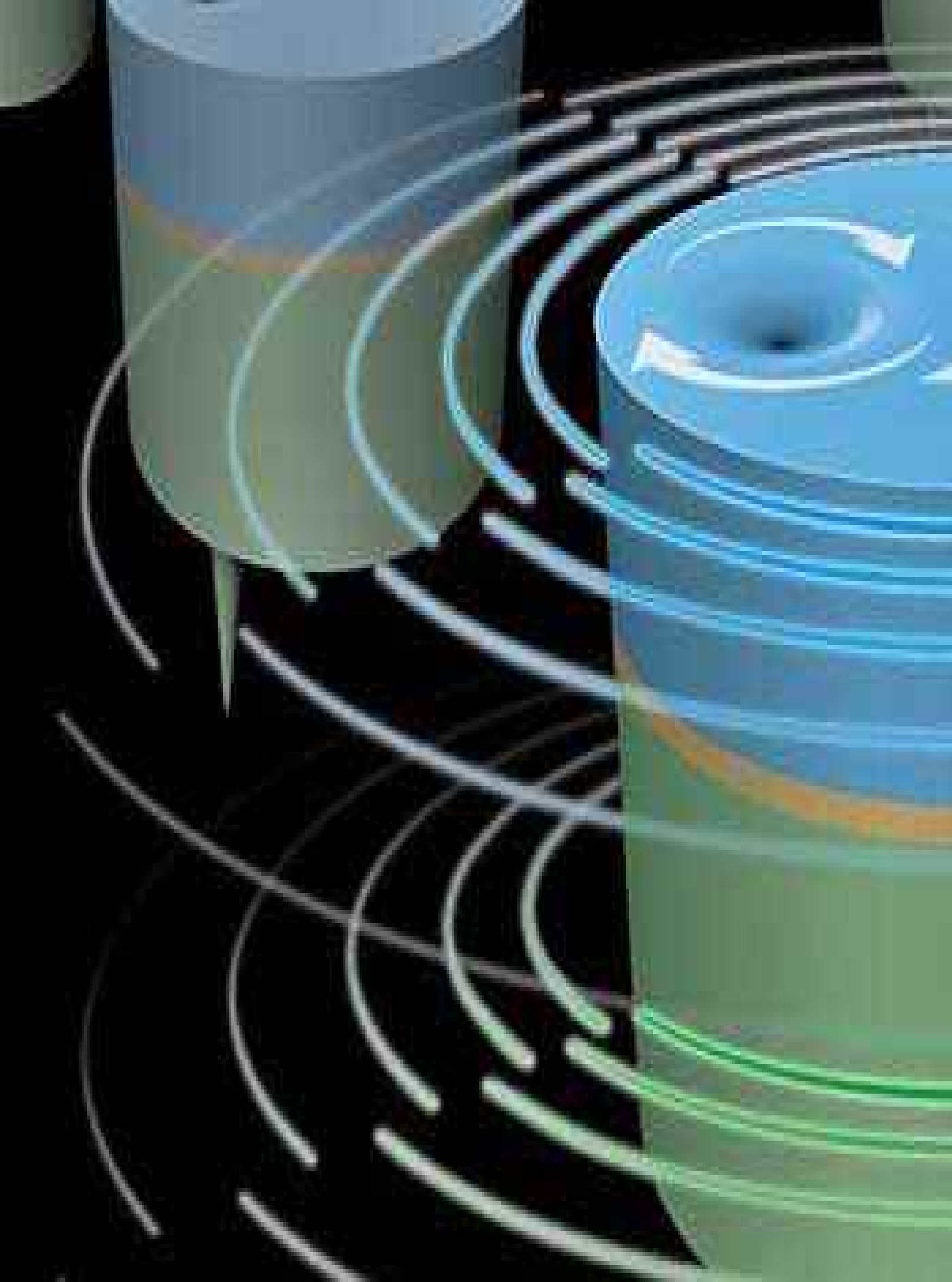
Proposed research activities for the coming year

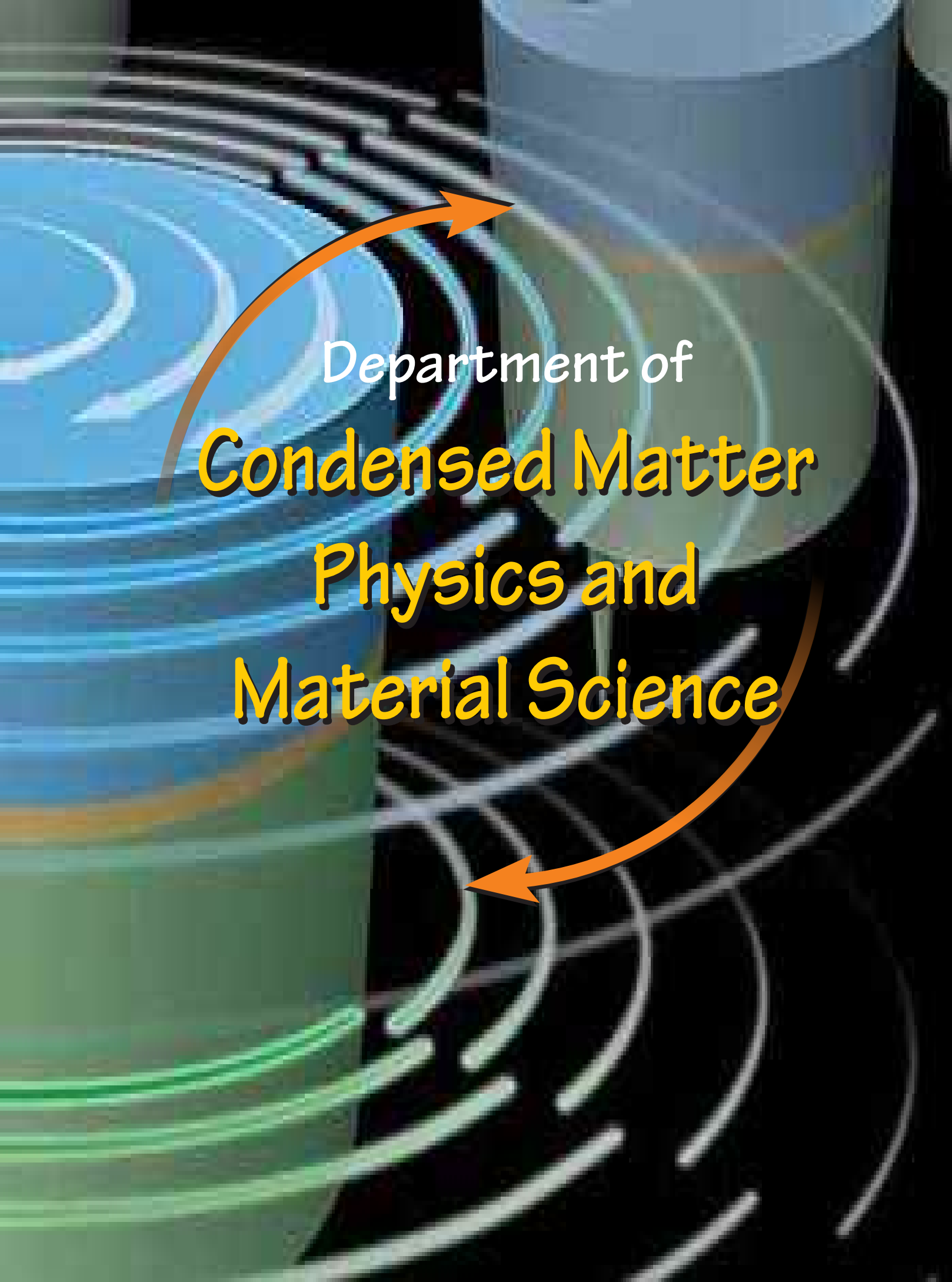
Proposed research plan has been summarized below:

- Fabrication of inorganic-organic hybrid nanocomposites using solution chemistry route for environmental remediation
- Size- and shape-tunable alloys and Intermetallics
- Application as catalysts for several chemical and photochemical reactions

Any other matter

Reviewer of several journals of ACS, RSC, Elsevier and Wiley




Department of
Condensed Matter
Physics and
Material Science

Department of Condensed Matter Physics and Material Sciences

Kalyan Mandal

Department profile indicators

Table A : Manpower and resources	
Number of faculties	11
Number of Post -doctoral research associate (centre + project)	10
Number of Ph.D students	63
Number of other project staff	03
Number of summer students	06
Projects (ongoing)	19
Table B: Research Activities indicators	
Number of research papers in Journals	82
Number of Book-chapters/books	02
Number of other publications	19
Number of Ph.D students graduated (submitted + degree awarded)	Submitted = 7 Awarded = 3
Number of M.Tech/M.Sc projects	13
Table C: Academic activities and likeage	
Number of courses taught by faculties	07
Number of Visitors (non -associates)	10
Number of associates	02
Number of Seminars organized	08
Number of Conference/Symposia/Advanced Schools organized	06
Number of talks delivered by members of department in conferences/Symposia	National 10 International 10

Most important research highlights

- An all optical detection method of spin hall angle in W/CoFeB/SiO_2 heterostructures (Physical Review B, 96, 054414 (2017)).
- A new strategy of using ligand-free attachment of Au nanoparticles on the surface of a ZnO nanowire to make high-performance broadband photodetectors was invented (Nanotechnology, 28, 295703 (2017)).
- Size dependent magnetic phases diagram in manganites evaluated using neutron diffraction (J. Phys. D: Appl. Phys., 50, 425003 (2017)).
- A route to reduce the relative cooling power in $Ni_{45.5}Co_2Mn_{37.5}Sn_{15}$ magnetocaloric materials was examined (Journal of Alloys and Compounds, 712, 714-719 (2017)).
- Multipolar phases in frustrated spin-1/2 and spin-1 chains determined (Physical Review B, 96, 054413 (2017)).
- Showed for the first time that quantum confinement could lead to an enhanced ferromagnetic temperature in dilute magnetic semiconductors (Physical Review B 96, 014430 (2017)).
- Direct band gap transition in Sn doped Ge islands (Nanotechnology, 28, 295201 (2017)).
- Computer predictions on Rh-based double perovskites with unusual magnetic properties was carried out (npj Quantum Materials, 3, 17 (2018)).

Summary of research activities

The research activities of the department have focussed on functional materials in which magnetism as well as magnetization dynamics, nanomagnetism, models for magnetic order, determining phase diagrams and nanomagnetism feature prominently. Additional focus areas include mesoscopic physics, the study of nanomaterials and the physics of correlated oxides.

Key highlights of the groups in the department working on various aspects of magnetism are summarised below. The development of advanced spintronics devices hinges on the efficient generation and utilization of pure spin current. Spin Hall effect is an efficient method of generation of pure spin current and the conversion efficiency is determined by spin Hall angle (SHA). A. Barman and coworkers have achieved a giant SHA in beta-tungsten (-W) thin films in Sub/W(t)/$Co_{20}Fe_{60}B_{20}$(3 nm)/SiO_2(2nm) heterostructures with variable W thickness. Considering nanostructured fulms of Gd, the group of A.K.Raychaudhuri have proposed Bose–Einstein condensation (BEC) of magnons over an extended size range than found earlier. A softening of the spin wave stiffness parameter D at BEC has been used to probe the transition. Continuing on the topic of magnetism in low-dimensional systems, B. Ghosh and coworkers have used neutron difffraction to examine the modification in the magnetic order as well as its correlation to the structural properties in nanowires of La0.5Sr0.5MnO3.

Examining one of the most popular models for frustrated magnetism, the J_1-J_2 spin-chain model with nearest-neighbor J_1 and next-nearest-neighbor antiferromagnetic J_2 interaction, the group of M. Kumar show the existence of higher order $p>4$ multipolar phase near the critical point $(J_2/J_1)c=-0.25$. The group of P. Mahadevan consider a multiband Hubbard model to describe the electronic structure of the dilute magnetic semiconductors with Coulomb interactions included on the transition metal site and show that quantum confinement effects could enhance the Curie temperature from that observed in the bulk. The group of R. Chaudhury have examined the generalized spin stiffness constant as a function of doping at one dimension. They find that it shows very distinct behaviour for the contributions from the hopping term and the exchange term. Detailed analysis show that the former is very similar to that due to a ferromagnet-like coupling and the latter resembles an anti-ferromagnet-like response. T. Saha-Dasgupta and co-workers have used a combination of evolutionary algorithm, density functional theory, and statistical-mechanical tools to predict the structural, electronic and magnetic properties of yet-to-be synthesized Rh based double perovskite compounds.

On an applied side, heusler alloys exhibiting inverse magnetocaloric properties across their structural transition have been studied by K.Mandal's group. They show that Si substitution in place of Sn is found to be effective in reducing the average hysteresis loss in $Ni_{48}Co_{1.5}Mn_{35}Sn_{15.5-x}Si_x$ (x = 1, 2, 4) alloys. The group of P.K.Mukhopadhyay have found a photon induced micro actuation effect in a set of ferromagnetic shape memory alloys.

Examining mesoscopic systems, the group of P. Singha Deo have made advances in the determination of the density of states beyond currently used methods which involve impurity averaging. The group S.K. Ray have been exploring the properties of islands of $Ge_{1-x}Sn_x$ grown on Si and found that they could achieve a direct band gap.

Kalyan Mandal
Head, Department of Condensed Matter
Physics and Material Sciences

Alo Dutta

Young Scientist of DST Fast Track Project
CMPMS
alo_dutta@yahoo.com;
alo.dutta@bose.res.in

Dr. Alo Dutta have been associated with the design and synthesis of advanced materials with novel electronic properties. The structural, electrical, magnetic, vibrational and optical properties of these materials have been investigated by various experimental techniques. For physical understanding of these properties, density functional theory with generalized gradient approximation has been explored.

Publications in Journals

1. R.A. Kumar, **Alo Dutta**, P.K. Mukhopadhyay and T.P. Sinha, *Antiferromagnetic behaviour and dielectric relaxation of xBa_2FeNbO_6-(1-x)$LaFeO_3$ [x = 0.1, 0.3, 0.5]*, Journal of Alloys and Compounds, **730**, pp. 201-207 (2018)
2. **Alo Dutta**, S.K. Singh, V.R.K. Murthy, P.K. Mukhopadhyay and T.P. Sinha, *Crystal structure, Raman spectroscopy and microwave dielectric properties of $xBa_3MgNb_2O_9$–(1-x)Ba_2InNbO_6 [x=0.4, 0.6, 0.8]*, Materials Research Bulletin, **100**, pp. 178-183 (2018)
3. A.P Sakhya, D.P. Rai, Md. S. Sheikh, M. Mukherjee, **Alo Dutta** and T.P. Sinha, *Origin of the optical anisotropy and the electronic structure of Ru-based double perovskite oxides: DFT and XPS studies*, Royal Society of Chemistry Advances, **7**, pp. 43531- 43539 (2017)
4. Md. S. Sheikh, S. Chanda, A. Dey P. Sakhya, P. Sadhukhan, **Alo Dutta**, S. Das and T.P. Sinha, *Dielectric relaxation and Ac conductivity of perovskites $CH_3NH_3PbX_3$ (X = Br, I)*, Ferroelectrics, **514**, pp. 146-157 (2017)
5. Md. S. Sheikh, D. Ghosh, **Alo Dutta**, S. Bhattacharyya and T.P. Sinha, *Lead free double perovskite oxides Ln_2NiMnO_6 (Ln = La, Eu, Dy, Lu), a new promising material for photovoltaic application*, Materials Science and Engineering B, **226**, pp. 10-17 (2017)
6. S. Halder, **Alo Dutta** and T.P. Sinha, *Time–temperature superposition in the grain and grain boundary response regime of A_2HoRuO_6 (A = Ba, Sr, Ca) double perovskite ceramics: a conductivity spectroscopic analysis*, Royal Society of Chemistry Advances, **7**, pp. 43812- 43825 (2017)
7. Md. S. Sheikh, A.P. Sakhya, **Alo Dutta** and T.P. Sinha, *Light induced charge transport in La_2NiMnO_6 based Schottky diode*, Journal of Alloys and Compounds, **727**, pp. 238-245 (2017)
8. Md. S. Sheikh, A.P. Sakhya, **Alo Dutta** and T.P. Sinha, *Dielectric relaxation of $CH_3NH_3PbI_3$ thin film*, Thin Solid Films, **638**, pp. 277-281 (2017)
9. Md. S. Sheikh, A.P. Sakhya, P. Sadhukhan, **Alo Dutta**, P.P. Ray and T.P. Sinha, *Investigation of light induced charge transport properties in Dy_2NiMnO_6 perovskite based Schottky diode*, Ferroelectrics, **518**, pp. 204-211 (2017)

Other Publications

1. Md. S. Sheikh, S. Chanda, **Alo Dutta**, S. Das and T.P. Sinha, Schottky diode like behaviour in Ag/Dy_2NiMnO_6/FTO device, Materials Today: Proceedings, 5, pp. 9839–9845 (2018)

Sponsored Projects

1. "Microwave dielectric properties and collective vibrational modes of double perovskite oxides", DST Fast Track Project for Young Scientist, Period (3 years: From 2nd February 2015

to 1st February 2018 and extension from 2nd February 2018 to 1st August 2018)

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. 7 (Sl. No. 3-9)

Societal Impact of Research

- Due to the high dielectric constant and quality factor in microwave region, $xBa_3MgNb_2O_9$–(1-x)-Ba_2InNbO_6 [x = 0.4, 0.6, 0.8] can be used as resonators and filters for wireless communications.
- The light induced charge transport study suggests that Dy_2NiMnO_6 can be a promising material in fabrication of an efficient light sensing Schottky diode as well as other electronic devices including thin film solar cell.
- The photovoltaic performance and the simplicity of large scale fabrication of Ln_2NiMnO_6 (Ln = La, Eu, Dy, Lu) solar cells may open a new avenue to develop cheap and eco-friendly solar cells for mass production.

Significant research output / development during last one year

General research areas and problems worked on

1. Synthesize of perovskite oxides by solid state and sol-gel processes
2. Study of vibrational and structural properties by Raman and X-ray diffraction
3. Investigation of magnetic, electrical, dielectric (microwave and radio frequency) and optical properties of synthesized materials
4. Study of electronic structure using density functional theory and X-ray photoemission spectroscopy

Interesting results obtained

1) Crystal structure, Raman spectroscopy and microwave dielectric properties of $xBa_3MgNb_2O_9$–(1-x)Ba_2InNbO_6 [x = 0.4, 0.6, 0.8]

The structural parameter dependence of microwave dielectric properties of $xBa_3MgNb_2O_9$–(1-x)Ba_2InNbO_6 [x = 0.4, 0.6, 0.8] is investigated. The Raman shift of the stretching mode ν_1 (BO_6) and the ionic polarizability of the cations strongly influenced the dielectric constant (ε_r) whereas the value of the quality factor Q_f depends upon the width of ν_1 (BO_6) mode. The temperature coefficient of resonant frequency (τ_f) increases with the increase of the octahedral-distortion in the crystal structure.

2) Lead free double perovskite oxides Ln_2NiMnO_6 (Ln = La, Eu, Dy, Lu), a new promising material for photovoltaic application

Inorganic lead free double perovskite oxides Ln_2NiMnO_6 (Ln = La, Eu, Dy and Lu) with a variation of band gap from 1.08 to 1.19 eV have been synthesized for the photovoltaic application. These materials show very long carrier life-time (~ 0.1 ms), very close to that of the silicon solar cell and much higher than that of halide perovskites (~ low μs range). In spite of being room temperature ferroic, these materials show robust photovoltaic performance, higher than the ferroic $Pb(Zr,Ti)O_3$, $BiFeO_3$ and $KBiFe_2O_5$ solar cells. The obtained photovoltaic performance and the simplicity of large scale fabrication of Ln_2NiMnO_6 solar cells may open a new avenue to develop cheap and eco-friendly solar cells for mass production.

3) Antiferromagnetic behaviour and dielectric relaxation of xBa_2FeNbO-(1-x)$LaFeO_3$ [x = 0.1, 0.3, 0.5]

The magnetic and dielectric properties of xBa_2FeNbO_6-(1-x)$LaFeO_3$ [x = 0.1, 0.3, 0.5] have been investigated. The effect of lattice distortion on the magnetic and dielectric properties has been discussed. The temperature dependent magnetization study reveals anti-ferromagnetic behaviour. The M-H curve indicates the canting of Fe^{3+} spins in these materials like $LaFeO_3$. The dielectric relaxation of the materials is analyzed within impedance and electric modulus mechanisms. The increasing value of conductivity with the increase of BFN content in the material can be correlated with the increase of the B-O-B bond angle which results in the increase of the interaction between O-2p and Fe-3d/Nb-4d states. It has been observed that the doping of BFN in LFO has improved the magnetic and dielectric

properties.

4) Origin of the optical anisotropy and the electronic structure of Ru-based double perovskite oxides: DFT and XPS studies

Experimental and theoretical studies of electronic structure of Pr_2LiRuO_6 (PLR), Nd_2LiRuO_6 (NLR) and Sm_2LiRuO_6 (SLR) are reported. The linear optical properties have been investigated using density functional theory calculations. The calculations show that SLR has a relatively large birefringence ($\sim$ 0.06) compared to others, which is important for mid-infrared nonlinear optical applications. We propose that O 2p to Ru 4d transition is primarily responsible for the optical activity in these materials while the origin of the optical anisotropy results from asymmetrically oriented Ru–O bonds in the RuO_6 octahedra of the unit cell. The evolution of Ru 3d core-level signals obtained from X-ray photoemission spectroscopy measurements provide confirmation of a dynamic increment in the electron correlations as we move from PLR and NLR to SLR.

Proposed research activities for the coming year

Synthesize of thin film of the prepared perovskite oxide by PLD. The electrical, magnetic, optical properties of these films will be studied. Microwave dielectric properties of some complex perovskite oxides will be studied. Photocatalytic properties of the synthesized materials will be investigated. The density functional theory will be used to study the electronic structure and optical properties of the synthesized materials.

Anjan Barman

Senior Professor
CMPMS
abarman@bose.res.in

Professor Barman obtained Ph.D. from IACS (Jadavpur University) in 1999. He worked as Postdoctoral Fellow in Europe and USA between 1999 and 2006, and as Assistant Professor at University of South Carolina, USA and IIT Delhi between 2006 and 2009. He joined SNBNCBS in 2009. He works in ultrafast magnetization dynamics, nanomagnetism and spin-orbitronics. He has published more than 150 journal papers, several book chapters and a monograph from Springer.

Supervision of Research / Students

Ph.D. Students

1. Chandrima Banerjee, Experimental Study of Spin Waves in Magnetic Thin Films and Nanostructures, Completed
2. Samiran Choudhury, Spin Waves in Two-Dimensional Magnonic Crystals, Ongoing
3. Sucheta Mondal, Spin Dynamics and Spin Hall Effect in Metallic Thin Films and Nanostructures, Ongoing
4. Anulekha De, Spectroscopic Studies of Metallic Nano and Microstructures, Ongoing (jointly with Rajib K. Mitra)
5. Avinash Kumar Chaurasiya, Brillouin Light Scattering Studies of Interfacial Dzyaloshinskii-Moriya Interaction, Ongoing
6. Sourav Sahoo, Spin Dynamics in 3D Magnonic crystal and 2D Spin Ice Systems, Ongoing
7. Suryanarayan Panda, Interface Dominated Magnetization Dynamics, Ongoing
8. Sudip Majumdar, Ferromagnetic Resonance of Magnonic Crystals, Ongoing (jointly with Rajib K. Mitra)
9. Koustuv Dutta, Time-resolved Spin Dynamics of Ferromagnetic Nanostructures, Ongoing
10. Amrit Kumar Mondal, Brillouin Light Scattering of Spin Waves in Magnonic Crystals, Ongoing
11. Arundhati Adhikari, Spin Dynamics and Spin Transport in Ferromagnetic/Nonmagnetic Heterostructures, Ongoing (jointly with Jaivardhan Sinha)
12. Santanu Pan, Ultrafast Spin Dynamics in Ferromagnetic Thin Films, Ongoing (part time student)
13. Kartik Adhikari | Ferromagnetic Resonance of Patterned Magnetic Nanostructures | Ongoing (part time student)

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Anuj Kumar Dhiman**,** SNBNCBS (IPhD student), Investigation of spin-wave dynamics in permalloy ($Ni_{80}Fe_{20}$) thin film with diamond dot lattice (**project 1**, completed); Microwave power dependent spin-wave dynamics in diamond shaped permalloy ($Ni_{80}Fe_{20}$) nanodot lattice (**project 2**; completed); Modulation of spin-wave dynamics by varying bias field orientation in nanoscale ferromagnetic dot array (**project 3**, completed)
2. Biswajit Sahoo, NISER, Bhubneswar, Determination of Spin Hall Angle (SHA) in Ta (3 nm)/CoFeB (3 nm) bilayer system, Completed
3. Stuti Tamuli, Tezpur University, Study of static magnetic properties in Co/Pd multilayer system, Completed

Post Doctoral Research Scientist/s

1. Jaivardhan Sinha, Ramanujan Fellow.
2. Sumona Sinha, NPDF
3. Dipak Kumar Das, PDRA-II

Teaching activities at the Centre

1. PHY301: Atomic and Molecular Physics, IPhD, No. of students: 08, Co-Teacher: Dr. Rajib Kumar Mitra
2. PHY292: Summer Project Research I, IPhD, No. of Students: 03
3. PHY304: Project Research, IPhD, No. of students: 01
4. PHY401: Project Research III, IPhD, No. of students: 01

Publications in Journals

1. K. Mukherjee, E. Tarif, **A. Barman** and R. Biswas, *Dynamics of a PEG Based Non-Ionic Deep Eutectic Solvent: Temperature Dependence*, Fluid Phase Equilibria, **448,** 22 (2017)
2. S. Pan, T. Seki, K. Takanashi, and **A. Barman**, *Role of the Cr Buffer Layer in the Thickness-dependent Ultrafast Magnetization Dynamics of $Co_2Fe_{0.4}Mn_{0.6}Si$ Heusler Alloy Thin Films*, Physical Review Applied, **7,** 064012 (2017)
3. S. Pan, J. W. Klos, S. Mieszczak, **A. Barman** and M. Krawczyk, *Spin waves in periodic antidot waveguide of complex base*, J. Phys. D: Appl. Phys., **50,** 275003 (2017)
4. C. Banerjee, P. Gruszecki, J. W. Klos, O. Hellwig, M. Krawczyk, and **A. Barman,** *Magnonic band structure in a Co/Pd stripe domain system investigated by Brillouin light scattering and micromagnetic simulations*, *Physical Review B*, **96,** 024421 (2017)
5. C. Banerjee, S. Chowdhury, J. Sinha and **A. Barman,** *Pseudo-One-Dimensional Magnonic Crystals for High-Frequency Nanoscale Devices*, Physical Review Applied, **8**, 014036 (2017)
6. A. De, S. Mondal, C. Banerjee, A. K. Chaurasiya, R. Mandal, Y. Otani, R. K. Mitra and **A. Barman,** *Investigation of Magnetization Dynamics in 2D $Ni_{80}Fe_{20}$ Diatomic Nanodot Arrays*, *J. Phys. D: Appl. Phys.*, **50**, 385002 **(2017)**
7. S. Mondal, S. Chowdhury, N. Jha, A. Ganguly, J. Sinha and **A. Barman**, *All-Optical Detection of the Spin Hall Angle in $W/CoFeB/SiO_2$ Heterostructures with Varying Thickness of the Tungsten Layer*, *Physical Review B*, **96**, 054414 (2017)
8. S. Sinha, S. Pan, J. Sinha and **A. Barman,** *Extrinsic Spin-Orbit Coupling-Induced Large Modulation of Gilbert Damping Coefficient in CoFeB Thin Film on the Graphene Stack with Different Defect Density*, *J. Phys. Chem. C*, **121**, 17442 (2017)
9. S. Choudhury, S. Barman, Y. Otani, and **A. Barman**, *Efficient Modulation of Spin Waves in Two-Dimensional Octagonal Magnonic Crystal*, ACS Nano, **11,** 8814 (2017)
10. N. Porwal, S. Mondal, S. Choudhury, A. De, J. Sinha, **A. Barman** and P. K. Datta, *All optical detection of picosecond spin-wave dynamics in two-dimensional annular antidot lattice*, J. Phys. D: Appl. Phys., ***51,*** *055004* (2018)
11. A. De, S. Mondal, S. Sahoo, S. Barman, Y. Otani, R. K. Mitra and **A. Barman**, *Field controlled ultrafast magnetization dynamics in two-dimensional nanoscale ferromagnetic antidot arrays*, Beilstein Journal of Nanotechnology, **9**, 1123 (2018)
12. S. Mondal, S. Barman, S. Choudhury, Y. Otani and **A. Barman,** *Influence of Anisotropic Dipolar Interaction on the Spin Dynamics of $Ni_{80}Fe_{20}$ Nanodot Arrays Arranged in Honeycomb and Octagonal Lattices*, Journal of Magnetism and Magnetic Materials, **458**, 95 (2018)
13. A. K. Chaurasiya, S. Choudhury, J. Sinha and **A. Barman,** *Dependence of interfacial Dzyaloshinskii-Moriya interaction on layer thicknesses in Ta/Co-Fe-B/TaO_x heterostructures from Brillouin light scattering*, *Physical Review Applied*, **9,** 014008 (2018)

Books / Book Chapter / Monographs Published / Edited

1. **Anjan Barman** and Jaivardhan Sinha, Spin Dynamics and Damping in Ferromagnetic Thin Films and Nanostructures *(Monograph)*, 2018, Springer; doi: 10.1007/978-3-319-66296-1, e-book ISBN: 978-3-319-66296-1, softcover ISBN: 978-3-319-66295-4, Series ISSN: 2192-1091

Lectures Delivered

1. Ultrafast Spin Dynamics in Ferromagnetic Thin Films and Nanostructures for Applications in Spintronics and Magnonics, A. Barman, Department of Physics Colloquium, IIT Kanpur, 16 Mar., 2018
2. Investigation of Ultrafast Spin Dynamics in Nanomagnets Towards Application in Nanoscale Magnonics, A. Barman, Indo-US Workshop on Recent Advances in Magnetism and Spintronics, IIT Bombay, 5-6 Feb., 2018
3. Ultrafast Spin Dynamics in Magnetic Bilayers, Multilayers and Heterostructures, A. Barman, Indo-US Discussion Meeting on Surfaces and Interfaces, Saha Institute of Nuclear Physics, 2-4 Jan., 2018
4. Ultrafast Spin Dynamics in Ferromagnetic Thin Films, Heterostructures and Nanostructures, A. Barman, ISIF 2017 Conference, New Delhi, 10-13 Dec., 2017
5. Interface Controlled Spin Dynamics in Ferromagnet/Nonmagnet Bilayers, Multilayers and Heterostructures, A. Barman, 9th IACS-APCTP Joint Conference on Novel Quantum Phases in Oxide Materials and Low Dimensional Systems, Vedic Village, Kolkata, 27-29 Nov., 2017
6. Ultrafast Spin Dynamics in Artificially Structured Ferromagnetic Thin Films for Applications in Spintronics and Magnonics, A. Barman, Physics Department Seminar, Presidency University, 11 Oct. 2017
7. Magnetization Dynamics: from Theory to Experiment, A. Barman, Enrichment Lecture in C. K. Majumdar Memorial Workshop in Physics, 2017 by Indian Physics Association, S. N. Bose Centre, Kolkata, May 23 – June 02, 2017

Membership of Committees

External Committee

Member of Executive Committee of MRSI- Kolkata Chapter; Member of Faculty Selection Committee of Jadavpur University; Expert for PhD Thesis Examination Committee at IIT Delhi and IISc Bangalore

Internal Committee

Associate Dean (Faculty); Member of Admission Committee; Member of Works Committee; Member of Faculty Search Committee; Member of Technical Cell Advisory Committee; Invitee of Consultative Advisory Committee; Convener of the *Advanced Spectro-Microscopy Unit* at the S. N. Bose Centre

Awards / Recognitions

1. Invited as Visiting Scientist to RIKEN Centre for Emergent Matter Science, Japan

Fellow / Member of Professional Body

1. Member of American Physical Society
2. Member of IEEE
3. Life Member of MRSI

Sponsored Projects

1. Nanoscale Modifications and Active Control of Magnonic Crystals for On-Chip Microwave Communication, DST under India-Poland Collaborative Research Project, 2015-18
2. Advanced Spectro-Microscopy for Novel Materials, S. N. Bose National Centre for Basic Sciences, 2012-17

Conference / Symposia / Workshops / Seminars etc. organized

1. Current Trends in Materials Science and Engineering (CTMSE-2018), 19-20 Jan, 2018, S. N. Bose National Centre for Basic Sciences, Kolkata, Joint Organizer
2. 9th IACS-APCTP Joint Conference on Novel Quantum Phases in Oxide Materials and Low Dimensional Systems, 27-29 Nov., 2017, Vedic Village, Kolkata, Joint Organizer
3. Emerging Trends in the Physics of Surfaces, Interfaces and Nanostructures (ETSPIN-2017), 24-25 Nov., 2017, IACS and SNBNCBS, Kolkata, Joint Organizer

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

1. Sl. No.1

National

1. Sl. No. 10

International

Sl. No. 2, 3, 6, 9, 11, 12

Member of Editorial Board

1. Scientific Reports

Societal impact of Research

- Initiated new and emerging research fields such as magnonics and spin-orbitronics for enabling India to compete at the international level
- Developed novel research facilities such as Time-resolved Magneto-optical Kerr Effect Microscopy, Micro-focused Brillouin Light Scattering and spin-torque FMR for the first time in India for the experimental studies of magnonics and spintronics
- Played advisory role to several young scientists in India for developing the above research fields and facilities
- Generated knowledge base for applications in magnetic data storage, memory, logic and communication devices
- Trained Masters and PhD students and Postdoctoral scientists for the development of future science and technology in India

Significant research output / development during last one year

General research areas and problems worked on

Ultrafast Spin Dynamics; Ultrafast Demagnetization, Magnetization Precession; Spin Waves; Gilbert Damping; Lithographically Patterned Magnetic Nanostructures; Magnonic Crystal; GHz Frequency Magnonic Filter; Magnetic Vortex Transistor and Logic; Magnetic Thin Films, Multilayers and Heterostructures; Spin Hall Effect; Interfacial Dzyaloshinskii-Moriya Interaction; Skyrmions; Heusler Alloy Thin Films; Nanomaterials for THz Applications; Dielectric Relaxation Spectroscopy

Interesting results obtained

a. All-Optical Detection of the Giant Spin Hall Angle in W/CoFeB/SiO_2 Heterostructures: The development of advanced spintronics devices hinges on the efficient generation and utilization of pure spin current. Spin Hall effect is an efficient method of generation of pure spin current and the conversion efficiency is determined by spin Hall angle (SHA). We have achieved a giant SHA in beta-tungsten (β-W) thin films in $Sub/W(t)/Co_{20}Fe_{60}B_{20}(3\ nm)/SiO_2(2nm)$

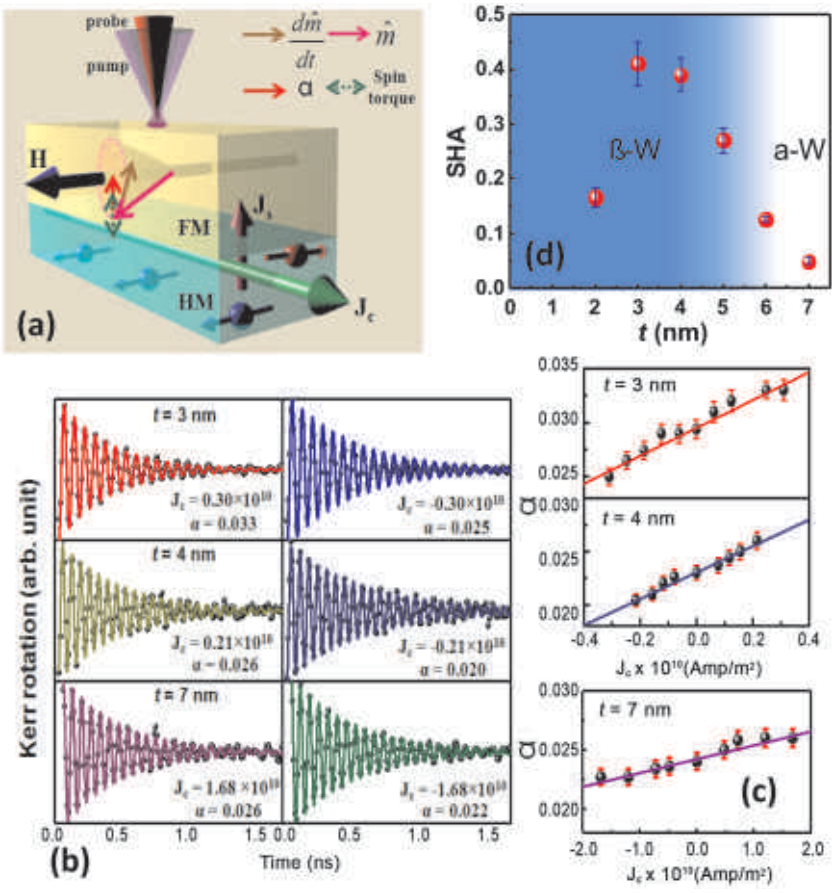


Fig. 1. (a) Schematic of all-optical measurement technique of spin Hall angle. (b) Time-resolved magnetization dynamics of W/CoFeB heterostructures with varying W thickness at opposite charge currents. (c) Modulation of Gilbert damping with charge current density. (d) Spin Hall angle (spin current to charge current ratio) as a function of W thickness. The transition of β-W to α-W phase is shown in the figure.

heterostructures with variable W thickness. A non-monotonic variation of SHA with W layer thickness is observed with a maximum of about 0.4 at about 3 nm, followed by a sudden reduction to a very low value at 6 nm (**Fig. 1**). This variation of SHA with W-thickness correlates well with the thickness-dependent structural phase transition and resistivity variation of W above the spin diffusion length of W, while below this length the interfacial electronic effect at W/CoFeB influences the estimation of SHA.

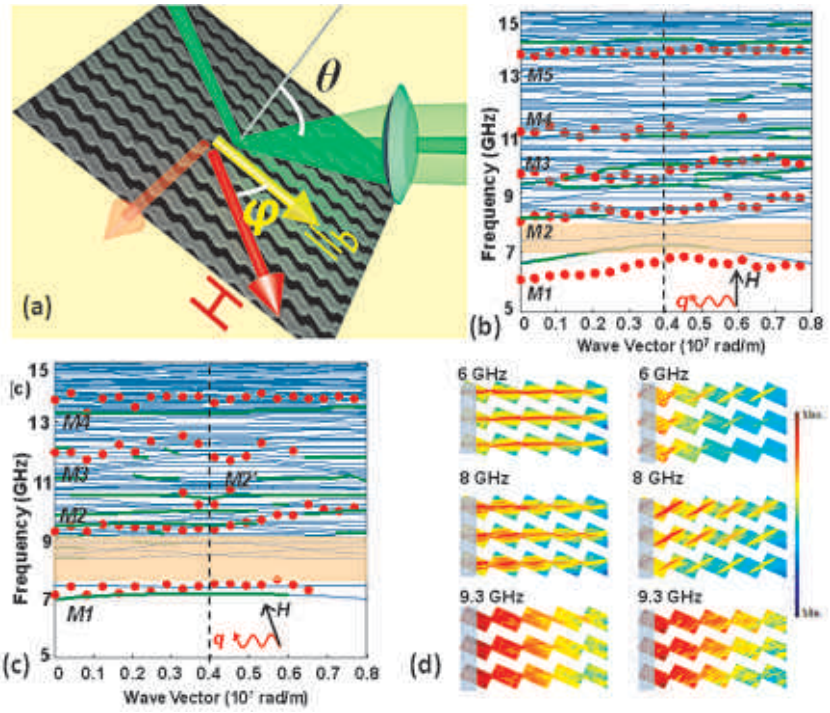


Fig. 2. (a) A schematic of the pseudo one-dimensional magnonic crystal with BLS measurement geometry. Magnon dispersion with wavevector for bias field applied at (b) 90° and (c) 70°. (d) Spin-wave propagation characteristics for line excitation at various monochromatic frequencies showing GHz frequency filer properties.

b. Layer Thickness Dependence of Interfacial Dzyaloshinskii-Moriya interaction in Ta/Co-Fe-B/TaO_x heterostructures: We have explored the ferromagnetic and heavy metal layer thickness dependence of interfacial Dzyaloshinskii-Moriya interaction (iDMI) in Ta/$Co_{20}Fe_{60}B_{20}$/TaO_x heterostructures by measuring non-reciprocity in spin-wave frequency using Brillouin light scattering (BLS) technique. Linear scaling behaviour of iDMI with inverse of CoFeB thicknesses suggests its purely interfacial origin, whereas we observe a weak dependence of Ta thickness on the strength of iDMI. Importantly, the observed value of iDMI constant is reasonably large by a factor of three compared to annealed Ta/CoFeB/MgO heterosturctures. We propose that the observation of large iDMI is likely due to the absence of boron diffusion towards Ta/CoFeB interface as the heterostructures are as-deposited. Our detailed investigation opens up a route to design thin film heterostructures with tailored iDMI constant for controlling skyrmion based magnetic memory devices.

c. Development of a Novel Pseudo One-Dimensional Magnonic Crystal and Tunability of its Bandgap: We introduced an array of asymmetric sawtooth shaped width modulated nanoscale ferromagnetic waveguides forming a pseudo one-dimensional magnonic crystal. The frequency dispersion of collective modes, measured by Brillouin light scattering technique, is compared with the band diagram obtained by numerically solving the eigenvalue problem derived from the linearized Landau-Lifshitz magnetic torque equation. We found that the magnonic band-gap width, position, and the slope of dispersion curves are controllable by changing the angle between the spin-wave propagation channel and the magnetic field (Fig. 2). The calculated profiles of the dynamic magnetization reveal that the corrugation at the lateral boundary of the waveguide effectively engineers the edge modes, which forms the basis of the interactive control in magnonic circuits. The results represent a prospective direction towards managing the internal field distribution as well as the dispersion properties, which find potential applications in dynamic spin-wave filters and magnonic waveguides in the gigahertz frequency range.

d. Development of a Magnonic Quasicrystal: Efficient tunability of magnonic spectra is demonstrated in two-dimensional ferromagnetic octagonal antidot lattices which can be considered as quasi-periodic magnonic crystals due to the presence of broken translational symmetry. A rich variation in the spin-wave spectra is observed with the variation of inter-antidot separation

as well as the strength and orientation of the bias magnetic field. A broad band of spin-wave modes are observed for the denser array which finally converges to two spin-wave modes for the sparsest one. The most intense spin wave frequency shows an eight-fold anisotropy with a superposition of weak four- and two-fold anisotropy which arises due to the angular variation of the magnetostatic field distribution at different regions of the octagonal lattice. The observations are important for the tunable and anisotropic propagation of spin waves in magnonic crystal based devices.

e. Giant Modulation of Gilbert Damping in Graphene/CoFeB Bilayer: We report a large tunability of Gilbert damping by varying the underlayer of CoFeB thin film from few-layer-graphene (FLG) to graphite layer. We measured the ultrafast magnetization dynamics of CoFeB, FLG/CoFeB and graphite/CoFeB by using time-resolved magneto-optical Kerr effect (TR-MOKE) magnetometry. While the magnetization precession frequency remained independent on the underlayer, a very large variation (~ 200%) in the value of the Gilbert damping coefficient α is observed from FLG/CoFeB ($\alpha \sim 0.035 \pm 0.002$) to graphite/CoFeB ($\alpha \sim 0.008 \pm 0.001$). This large variation of the damping coefficient is understood in terms of the extrinsic spin-orbit interaction of FLG and graphite films, which is very large in FLG due to the presence of large amount of surface defects in it. A faster demagnetization time and fast relaxation time (τ_1) were noted for graphite/CoFeB bilayer system than that of FLG/CoFeB. In general, we infer that interfacial spin physics is primarily governed by the growth of CoFeB layer, from our bilayer systems. This finding suggests a new direction towards the control of precessional magnetization dynamics leading towards the applications in miniaturized high-speed magnetic devices.

f. Achievement of Extremely Small Gilbert Damping in CFAS Heusler Alloy Thin Film by Cr Buffer Layer: The epitaxial growth of $Co_2Fe_{0.4}Mn_{0.6}Si$ (CFMS) Heusler alloy on MgO with high crystal orientation requires the use of buffer layer. The utilization of Cr buffer layer in a controlled manner without hampering the intrinsic CFMS properties remains a challenge. Here, we have epitaxially grown the CFMS films on Cr buffered MgO substrate and investigated the thickness (t)-dependent variation in structural ordering, and its impact on magnetic Gilbert damping and magnetic anisotropy. We observed a regular improvement in the crystal structure with increasing t, which caused similar increasing trend in saturation magnetization and magneto-crystalline anisotropy (MCA). Interestingly, we achieved a very low t-independent value of Gilbert damping parameter (α) of ~ 0.0045 because of unaltered atomic site ordering which indicates different origin of MCA and α in this system. Notably, α also remains nearly independent of frequency (f) for lower thickness regime in these CFMS films. The observation of t-independent and f-independent value of α strongly suggests the suitability of thinner CFMS film for device applications in broadband frequency regime.

g. Magnonic band structure in a Co/Pd stripe domain system: An Energy Efficient Dynamic Magnonic Crystal: By combining Brillouin Light Scattering and micromagnetic simulations we studied the spin-wave dynamics of a Co/Pd thin film multilayer, features a stripe domain structure at remanence. The periodic up and down domains are separated by cork-screw type domain walls. The existence of these domains causes a scattering of the otherwise bulk and surface spin-wave modes, which form mode families, similar to a one dimensional magnonic crystal. The dispersion relation and mode profiles of spin waves are measured for transferred wave vector parallel and perpendicular to the domain axis.

h: Development of new types of two dimensional magnonic crystals: We have developed novel magnonic crystals in the form of diatomic dot lattices and annular antidot lattices. Distinct spin-wave mode frequencies and anisotropy in spin-wave modes are observed, which are tunable by strength and orientation of external bias magnetic field. The spin-wave mode profiles revealed various quantized modes, some of which are identified as interacting modes.

Proposed research activities for the coming year

a. Ultrafast Spin Dynamics in 3D Magnetic nanostructures: Three-dimensional magnetic nanostructures are now attracting intense interest due to their potential as ultrahigh density future magnetic storage devices. We will study ultrafast magnetization

dynamics of a complex three-dimensional magnetic nanostructure. Arrays of magnetic tetrapod structures will be fabricated using the combination of two-photon lithography (TPL) and electrodeposition. All-optical time-resolved magneto-optical Kerr microscopy will be exploited to probe the spin-wave modes from such structure. 3D micromagnetic simulations will be used to understand the nature of these modes.

b. Tailoring of Spin-Wave Modes by Bias Magnetic Field in ferromagnetic Nano-cross Structure: Ferromagnetic nano-cross structures revealed interesting spin-wave dynamics. By subtle variation of the azimuthal angle () of the in-plane bias magnetic field the we will study the variation spin configuration and the ensuring spin-wave dynamics, including mode softening, mode splitting, mode crossover and mode merging. Numerically simulated spin-wave spectra and phase profiles will reveal the nature of various spin-wave modes and the origin of above variation of the dynamics with bias-field angle.

c. A Unified Approach Towards Laser Controlled Ultrafast Magnetization Dynamics in Ferromagnetic Thin Film: Laser induced modulation of the magnetization dynamics occurring over various time-scales will be unified in ferromagnetic thin film excited by amplified femtosecond laser pulses. The correlation between demagnetization and relaxation times will be investigated with the aid of three-temperature model considering the temperatures of electron, spin and lattice. We will study the variation of precession frequency and Gilbert damping with pump fluence and correlate it with the ratio of electronic temperature to Curie temperature within very short time scale. The changes in the local magnetic properties due to accumulation and dissipation of thermal energy within the probed volume will be described by the evolution of temporal chirp parameter in a comprehensive manner.

d. Interfacial Dzyaloshinskii-Moriya Interaction in Single Layer Graphene/ Ferromagnet Heterostructures: Graphene/Ferromagnet interface is unusual and can be testbed of a number of interesting phenomena. We will explore the interfacial Dzyaloshinskii-Moriya interaction (DMI) in Graphene/ferromagnet/Oxide heterostructures. Here, extrinsic spin-orbit interaction due to defects and spin polarized band with Rashba spin-orbit coupling may lead to DMI effect. This will be correlated with interfacial spin-mixing conductance.

e. Controlled Co-excitation of Direct and Indirect Ultrafast Demagnetization in Co/Pd Multilayers: We will investigate the ultrafast demagnetization dynamics in a magnetic multilayer with high PMA to unveil a new way of understanding the basic underlying mechanisms. A systematic in-depth investigation will be done to understand if the process of ultrafast magnetization quenching occurs via the direct excitation induced conventional spin-flip scattering contribution and an indirect excitation via a diffusive heat(spin) current transport. We will exploit the concept of direct scaling of skin depth with excitation wavelength for probing the indirect excitation.

f. All-optical study of Spin Pumping in heavy metal/ferromagnet bilayers: We will study the spin pumping mechanism from ferromagnet (FM) layer to an adjacent nonmagnetic heavy metal (HM) layer. The angular momentum transfer from the precessional magnetization of the FM layer to the nonmagnetic layer through the interface will be studied by the variation of Gilbert damping with the FM and HM layer thickness. Additional effects like two-magnon scattering, interfacial hybridization etc. will also be explored. The spin memory loss and interface transparency parameters will be extracted from the experimental data. Finally a thin conducting spacer layer will be introduced between the FM and HM layer to isolate the spin pumping phenomenal from other interface effects.

Arup Kumar Raychaudhuri

Distinguished Professor Emeritus
CMPMS
arup@bose.res.in

Professor Arup Kumar Raychaudhuri did his M.Sc. from IIT, Kanpur. He obtained his Ph.D. from Cornell University. He joined the Centre in 2004 (Director 2006-2014), worked at Max Planck Institute, Stuttgart as Humboldt Fellow, Indian Institute of Science, Bangalore as Professor and National Physical Laboratory, New Delhi as Director. His research interests cover broad canvas of condensed matter physics and materials science.

Supervision of Research / Students

Ph.D. Students

1. Ravindra Singh Bisht, "Investigation of metal-insulator transition in 3d and 5d transition Metal Oxides", Ongoing
2. Shaili Seth, "Investigation of transport properties in Germanium Nanowires", Ongoing
3. Subhamita Sengupta, "Physical Properties of interface of Ferroelectric and Ferromagnetic films", Ongoing
4. Vishal Kumar Garg, "Physical investigations on Ge nanowires and devices", Ongoing
5. Parushottam Majhi, "Interface based applications of functional Oxides", Ongoing - Shared with Dr.Barnali Ghosh
6. Manotosh Chakravorty, "Investigation of electronic conduction and magnetism in ferromagnetic Gd and ferrimagnetic GdCo alloy nanostructures", Submitted

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Anagha Kamath, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, M.S thesis - A Study on optoelectronic properties of p-SiNW/n-ZnO heterojunction for photodetection application, Ongoing

Post Doctoral Research Scientist/s

1. Jashasree Ray NPDF

Teaching activities at the Centre

1. 3rd semester, PH 391 Methods of Experimental Physics, IPHD Year 2, 7 students, Dr. Barnali Ghosh, Dr.Kalyan Mandal and others

Publications in Journals

1. Soumendu Datta, **A. K. Raychaudhuri** and Tanusri Saha-Dasgupta, *First principles study of bimetallic $Ni_{13-n}Ag_n$ nano-clusters (n = 0–13): Structural, mixing, electronic, and magnetic properties*, The Journal of Chemical Physics, **146**, 164301 (2017)
2. Manotosh Chakravorty, **A K Raychaudhuri**, Tapati Sarkar and Mikael Svante Andersson, *Proposed Bose–Einstein condensation of magnons in nanostructured films of Gd at low temperature and its manifestations in electrical resistivity and magnetoresistance*, J. Phys.: Condens. Matter, **29**, 255701 (2017)
3. Rishi Ram Ghimire, Rajib Nath, Rajesh Kr Neogy and **A K Raychaudhuri**, *Ligand-free attachment of plasmonic Au nanoparticles on ZnO nanowire to make a high-performance broadband photodetector using a laser-based method*, Nanotechnology, **28**, 295703 (2017)
4. Manotosh Chakravorty and **A. K. Raychaudhuri**, *Domain wall motion in a nanoconstriction of Gd*, Appl. Phys. Lett., **111**, 143105 (2017)

5. Rabaya Basori and **A. K. Raychaudhuri**, *Floating Back-Gate Field Effect Transistor Fabricated Using a Single Nanowire of Charge Transfer Complex as a Channel*, J. Phys. Chem. C, **122**, 1054 – 1060 (2018)
6. Subhamita Sengupta, Ankita Ghatak , Shaili Sett, Monjoy Sreemany, Sandip Bysakh, Barnali Ghosh and **A K Raychaudhuri**, *Restoration of perovskite phase in the top layer of thin BTO film by plasma treatment and annealing*, J. Phys. D: Appl. Phys, **51**, 085304 (2018)

Other Publications

1. Shaili Sett, Meneka Banik, Rabibrata Mukherjee, and **A. K. Raychaudhuri**, "Fabrication of large array of uniform metal nanostructures by use of soft sphere lithography and plasma etching", AIP Conference Proceedings (2017) 1832, 050066

Lectures Delivered

1. The joy of Small Things, Solapur University, Solapur, January 2018 -1
2. Ultrahigh responsivity near- infrared photo detectors based on single semiconductor nanowire, International Meeting On Advanced Nanomaterials and Nanotechnology, Singapore, November 2017 -1
3. Novel green synthesis of Gold and Silver nanocolloids and structured nanofluids and enhanced thermal transport in them, Nanochemistry 2017, Atlanta,Georgia November , 2017 -1
4. Detecting Radiation: Our tribute to Acharya , RTCMP 2017, Bose Institute, October 2017 -1
5. Enhancement of Functional Properties of ZnO through electric double layer gate dielectric as well as surface functionalization, Conference on Advanced Functional Materials, Los Angeles, August 2017-1
6. Perspectives and Certain Emerging Aspects in Instrumentation for Materials Science, Techniques & Instrumentation in Materials Research (TIMR) UGC-DAE CSR Indore August, 2017-1

Membership of Committees

External Committee

Member of Board, National Science and Engineering Research Board; Chairman, Scientific Advisory Committee, UGC-DAE Consortium for research; Member, Governing Body and Governing Council, UGC-DAE Consortium for research; Chairman, Programme Advisory Committee on Physics, International Division, Department of Science and technology; Member Faculty, Selection Committees at IISER's and IIT's

Internal Committee

Member Secretary – National Advisory Committee TRC project; Member - Local Management committee of TMC

Patent/s submitted / granted

1. Flexible Thin Film Transitor Using Electric Double Layer as Gate Dielctric and a Method of Fabricating Thereof, 201731015268, Submitted
2. A technique to regenerate ferroelectric phase by surface and subsurface engineering of $BaTiO_3$ thin films, 201731036353, Submitted
3. A Gas-sensing system for selective detection of (Nitric Oxide) NO gas and a method for fabricating the same, 201731038036, Submitted
4. A STABLE NANOSIZED SILVER COLLOID AND ITS PROCESS OF PREPARATION THEREOF, 288554, Granted

Fellow / Member of Professional Body

1. Fellow, Indian National Science Academy
2. Fellow, Indian Academic of Sciences
3. Fellow, National Academy of Sciences.
4. Fellow, Asia Pacific Academy of Materials.
5. Fellow, West Bengal academy of Science and Technology.
6. Fellow, Metrology Society of India
7. Life Member Materials Research Society of India
8. Life Member Indian Physics Association

9. Life member Indian Association of Physics Teachers.
10. Member American Physical Society

Sponsored Projects

1. J.C Bose Fellowship, SERB, June 2006- February 2020,
2. An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide films, SERB, March 2017-March 2020
3. Technical Research Centre at SNBNCBS, DST, January 2016-December 2020

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl. No. 1 and 6

National

Sl. No. 5 and 6

International

Sl. No. 2

Societal impact of Research

- Development of low cost hand held calorimeter
- Development of high sensitivity gas senor for breath analysis for non-invasive disease detection

Significant research output / development during last one year

General research areas and problems worked on

- Broad areas: Nanomaterials, and Nanolithography,. Physics of correlated oxides
- Specific problems investigated in 2017-18, include Bose–Einstein condensation of magnons in nanostructured films of Gd, Current induced domain wall motion in nanoconstriction in Gd, Broad band photo response in plasmonic nanoparticle functionalized ZnO nanowires, High performance single nanowire FET

Interesting results obtained

We observed of a DC-current driven magnetic domain wall (DW) motion in an artificially created nanoconstriction (size < 300 nm) in a microstrip of 4f ferromagnet Gd (film thickness, 40 nm), where beyond a critical current density, a sharp reduction in the resistance is observed which gives the DW resistance RW. This is similar to that seen in nanoconstrictions made in conventional 3d ferromagnets such as Ni and its alloys. The effect is most prominent at 100K or below and becomes smaller as the temperature increases, and it vanishes as $T \rightarrow TC$. The value of RW was used in conjunction with the measured anisotropic magnetoresistance to find the domain wall thickness (d) and the anisotropy energy (E_A) of the Gd film. The observation of this phenomenon in 4f metal Gd, which is distinct from itinerant conventional 3d transition metals, extends the phenomena to rare-earth ferromagnets. A low ferromagnetic transition temperature of Gd also allows us to study the phenomena and the evolution of d and E_A as a function of temperature.

We made observation of a proposed Bose–Einstein condensation (BEC) of magnons in a temperature range of around 15–20 K in nanostructured films of Gd with grain sizes that are much larger than the size range where superparamagentism is expected. The observation was carried out using magnetic as well as high precision resistivity and magnetoresistance (MR) measurements performed to low temperatures. We observe that the experimental observations depend crucially on one parameter, namely softening of the spin wave stiffness parameter *D* at BEC and the resistivity as well as MR can be related quantitatively to magnetic measurements through the temperature variation of the constant *D* in the vicinity of the transition. This paper establishes that the BEC reported before in nanocrystalline Gd can be extended to a somewhat larger size range.

We invented a new strategy for ligand-free attachment of plasmonic Au nanoparticles on the surface of a ZnO nanowire to make high-performance broadband photodetectors using a pulsed laser ablation technique in a liquid medium. The photoresponse of the ZnO-based photodetector is enhanced and the photodetection limit is broadened from UV to visible, which can be controlled by varying the concentration of Au nanoparticles attached to the ZnO surface. This

Au nanoparticle concentration can be tuned by varying the number of laser pulses used in the ablation process. We found that the responsivity of the detector is 10 mAW – 1 for $\lambda \sim 525$ nm and increases to as much as 0.4 A W–1 for $\lambda \leq 400$ nm for the maximum Au concentration. The enhanced responsivity was found to be linked to increased absorption over a broad spectral range arising from direct and indirect plasmonic processes due to Au nanoparticle attachment, and the enhanced absorption also leads to a large increment in photocurrent generation. We also found that the attachment of Au nanoparticles makes the relaxation of the photocurrent (persistence) considerably faster in both the UV and visible regions of the spectrum and that the persistence directly depends on the concentration of Au nanoparticles attached to the ZnO nanowire. This single-step pulsed laser ablation-based nanoparticle attachment process can be further used to make other plasmonic nanoparticle-decorated nanowire devices.

Metal – organic charge transfer complex (MOCT) material have good application potentials. We observed a high carrier mobility in MOCT material Cu:tetracyanoquinodimethane (Cu:TCNQ) single nanowire (NW). A novel floating backgate field effect transistors is fabricated using Cu:TCNQ single NW of diameter ranging from ~ 50 to 100 nm and length ~ 1.0 – 2.0 μm as channel material. Floating gate is made of conducting Si (c-Si) electrically isolated from the environment by thermally grown SiO_2 (100 nm thickness) all around it, which is an easy and inexpensive approach to reduce leakage current and improve the device performance. The devices can exhibit on/off current ratio of ~ $10^2 - 10^4$ at room temperature. Mobility of the NW channel as measured in different single NW devices is ~4.3 × 10^2 to 1.2 × 104 cm^2 V – 1 s – 1 which is the best reported mobility in such molecular materials. The observed high mobility has been proposed to arise from $\pi - \pi$ stacking of the molecular orbitals of donor – acceptor type CT materials and good crystallinity and also small device size that reduces carrier scattering.

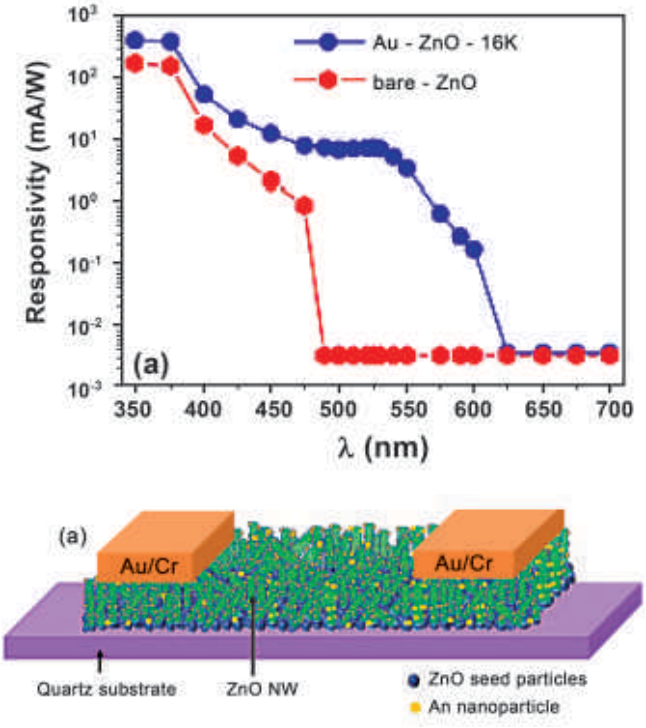


Fig. Broad Band photo response in a Au decorated ZnO Nanowire device

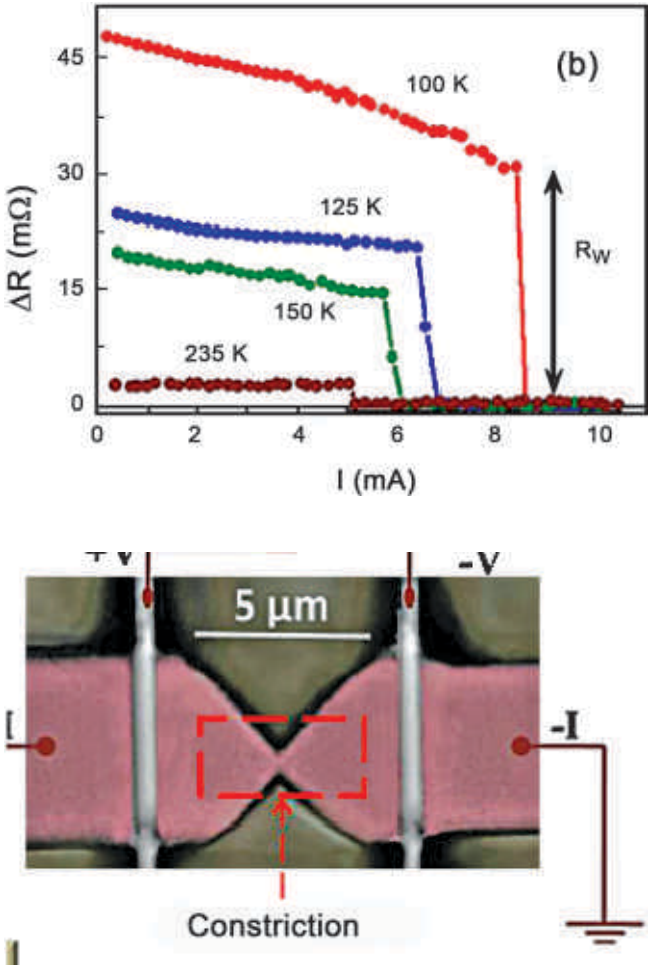


Fig. Current driven domain wall motion in a nanoconstriction in

Gd microwire

Proposed research activities for the coming year

Investigation of metal-insulator transition in correlated oxide like rare-earth Nickelates. In particular we will investigate whether it is possible to achieve continuous transition from weakly localized regime to strong localization regime in systems like Mott insulators that show first order transition. The investigation on the the metal insulator transition in correlated oxide films will be done using such tools as low temperature transport and magneto-transport measurements down to 0.3K, 1/f noise spectroscopy , Scanning Tunneling Microscopy as well as impedance spectroscopy.

Investigate large broad- band photo-response (300nm-1100nm) in single nanowire photo-detectors made using vapor phase grown Ge nanowires. In particular investigation will be done to probe the role of surface oxides and surface states in enabling such large photo-response.

Investigation of basic thermodynamic properties of oxide free Ge nanowires will be investigated using temperature dependent Raman scattering studies.

Interface of ferroelectric (FE) and ferromagnetic (FM) materials will be investigated by growing epitaxial films of $SrRuO_3$ (a FM material below 160K) and $La_{0.7}Sr_{0.3}MnO_3$ (a FM material below 300k) on $BaTiO_3$ (a Ferroelectric material below 350K). It is expected that such an interface will show electric as well magnetic field dependent interfacial barrier height.

Investigation of structural instabilities and related non-linear transport will be studied in one-dimensional charge transfer complex nanowires using a combination of temperature dependent non-linear transport properties, Raman Spectroscopy and Synchrotron X-Ray based structural studies.

Work on oxygen ion implanted Ge to make Ge on Insulator wafers for device fabrications will be initiated. Use of PZT film to make functional devices will also be investigated.

Atindra Nath Pal

Assistant Professor
CMPMS
atin@bose.res.in

Dr. Atindra Nath Pal is an experimental condensed matter physicist, joined recently and in the process of developing his laboratory.

Supervision of Research / Students

Ph.D. Students

1. Shubhadip Moulick, Title of work: Charge and spin transport in hybrid two dimensional nanodevices, Status: ongoing
2. Biswajit Pabi, Title of work: An Investigation Of Mechanical tunability in Two Dimensional Materials to Molecules, Status: ongoing
3. Rafiqul Alam, Title of work: An investigation of topological effects and spin dependent phenomena in layered two dimensional materials, Status: ongoing
4. Shubhrasish Mukherjee (Jointly with Prof. S. K. Ray), Title of work: An investigation of electronic and optical properties in 2D semiconductors and their heterostructures, Status: ongoing

Publications in Journals

1. Atindra Nath Pal, Tal Klein, Ayelet Vilan, and Oren Tal, Electronic conduction during the formation stages of a single-molecule junction, Beilstein J. Nanotechnol., 9, 1471–1477 (2018)

Lectures Delivered

1. Invited talk at RTCMP-2018, IACS, Kolkata, Title: Extreme intramolecular spin filtering through a single molecular junction

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

International

Dr. Oren Tal, Weizmann Institute of Science, Israel (Sl. No. 1)

Significant research output / development during last one year

General research areas and problems worked on

Spin transport through single molecular junction using shot noise measurements

Interesting results obtained

Our recent work include studying the electronic transport properties of premature junction configurations before the realization of a single-molecule bridge based on vanadocene molecules and silver electrodes. With the aid of conductance measurements, inelastic electron spectroscopy and shot noise analysis, we identify the formation of a single-molecule junction in parallel to a single-atom junction and examine the interplay between these two conductance pathways. Furthermore, the role of this structure in the formation of single-molecule junctions is studied. Our findings reveal the conductance and structural properties of premature molecular junction configurations and uncover the different scenarios in which a single-molecule junction is formed. Future control over such processes may pave the way for directed formation of preferred junction structures.

Proposed research activities for the coming year

Currently I am in the process of developing my new laboratory. Our research mainly focuses on studies of the mechanisms of charge transport, spin transport nano-scale down to single atom. Proposed research:

1. Creating Hybrid 2D electronic devices using 2D materials and molecules.
2. Understanding charge/spin/heat transport in single molecule using mechanical break junction.
3. Developing transport and noise measurement set up to understand various physical phenomena.

Barnali Ghosh (Saha)

Scientist- E (Technical Cell)
CMPMS
barnali@bose.res.in

Dr. Barnali Ghosh (Saha) received her Ph.D. from University of Kalyani. She did her postdoctoral work at IISC Bangalore, and then joined at Satyendra Nath Bose National Centre for Basic Sciences in 2004 as a visiting Faculty Fellow and also as a scientist under Women Scientist Scheme (DST sponsored). On February, 2011, she has joined as Research Scientist (Scientist-D) at Satyendra Nath Bose National Centre for Basic Sciences. Now she is working as Scientist-E, since August 2013 at this centre. She is also associated with Technical Research Centre Project as one of the Activity leader and PI. Her research interest is Physics of Complex oxide systems and in nano materials.

Supervision of Research / Students

Ph.D. Students

1. Subarna Datta, "Synthesis And Physical Properties Of Manganite Nanowires", Submitted July 2017
2. Samik Roy Moulik, "Synthesis and study of physical properties of binary oxide thin films and nanostructures and devices", Ongoing (External)
3. Avisek Maity, "Synthesis, Characterization, Physical Property Studies & Applications of Perovskite Halide", Ongoing
4. Chandan Samanta, "Synthesis, Physical Properties And Applications Of Metal Oxide Semiconductor Nanostructures And Thin Films", Ongoing
5. Parushottam Majhi, "Interface based applications of functional Oxides" - Shared with Prof. A.K. Raychaudhuri, Ongoing

Post Doctoral Research Scientist/s

1. Ankita Ghatak (National Post Doctoral Fellow, SERB)

Teaching activities at the Centre

1. PHY391, "Methods of experimental physics", Third Semester Course", shared with Prof. A. K. Raychaudhuri

Publications in Journals

1. Subarna Datta, S D Kaushik, V Siruguri, Amit Kumar, S M Yusuf and **Barnali Ghosh**, *Size induced magnetic phases in half doped manganite nanowires of $La_{0.5}Sr_{0.5}MnO_3$: a neutron diffraction study*, J. Phys. D: Appl. Phys., **50**, 425003 (2017)
2. Subhamita Sengupta, Ankita Ghatak, Shaili Sett, Monjoy Sreemany, Sandip Bysakh, **Barnali Ghosh**, Arup Raychaudhuri, *Restoration of Perovskite Phase in the Top Layer of Thin BTO Film by Plasma Treatment and Annealing*, J. Phys. D: Appl. Phys., **51**, 085304 (2018)
3. Sudipta Goswami, Dipten Bhattacharya, Chandan K. Ghosh, **Barnali Ghosh**, S. D. Kaushik, Vasudeva Siruguri, and PSR Krishna, *Nonmonotonic particle-size-dependence of magnetoelectric coupling in strained nanosized particles of $BiFeO_3$*, Scientific Reports, **8**, 3728 (2018)

Lectures Delivered

1. "Modification of ground state property on size reduction to 1D" 11th International Conference on Advanced Materials & Processing, September 7-8 2017, Edinburgh, Scotland, Invited Speaker, one
2. "Nanostructured materials and their Characterization by Transmission Electron Microscopy and Energy Filtered Imaging, Solapur University", Solapur, Jan 2, 2018, Invited Speaker, one

3. Investigation of Surface & Interface controlled growth of nanostructured material using Electron Microscopy based techniques" National Conference on Science and Technology of Special Steels and Nanomaterials (STSSN) Feb 17- 18, 2018, B.I.T. Sindri in association with RDCIS, SAIL,Ranchi, Invited speaker, one

Membership of Committees

Internal Committee

Various thesis committee; purchase committee; various committees related to Technical cell; Convenor, In-charge Technical Cell

Patent/s submitted / granted

1. Flexible thin film transistor using eletrcic double layer as gate dielectric and a method of fabrication thereof; Inventors: Rishi Ram Ghimire, Chandan Samanta, Barnali Ghosh, Arup Kumar Raychaudhuri; Patent no: 201731015268, Filed on 29/04/2017, Published on 09/6/2017
2. Advancement in methodology and system to control isotopic Fractionations in Carbon containing gases; Inventors: Samik Roy Moulik, Abhijit Maity, Mithun Pal, Manik Pradhan, Barnali Ghosh; Patent no: 201731017087, Filed on 16/05/2017, Published on 16/06/17
3. A technique to regenerate ferroelectric phase by surface and subsurface engineering of BaTiO3 thin films; Inventors: Ankita Ghatak, Shubhamita Sengupta, Shaili Sett, A.K. Raychaudhuri, Barnali Ghosh; Patent No: 201731036353, Filed on 12/10/2017
4. A Gas-sensing system for selective detection of (Nitric Oxide) NO gas and a method for fabricating the same; Inventors: Sanchi Maithani, Abhijit Maity, Chandan Samanta, Kaustuv Das, Barnali Ghosh, Manik Pradhan, Arup Kumar Raychaudhuri; Patent no: 201731038036, Filed on 26/10/2017, Published on 10/11/2017
5. A paper based ammonia gas selective sensor with electrical read out and a method for manufacturing the same; Inventors: Avisek Maity, Arup Kumar Raychaudhuri and Barnali Ghosh; Patent no: 201831001993, Filed on 17/01/2018, Published on 16/02/2018

Fellow / Member of Professional Body

1. Life member Indian Physics Association,
2. Life member Indian Association for the Cultivation of Science

Sponsored Projects

1. Understanding of Growth of Vertically aligned Nanowires or nanotubes of binary oxides and Physics of isotopic fractionation of gases by them, DST-SERB, 2017-2019, PI
2. An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide films SERB,DST, 24/03/2017 to 23/03/2020, (CO-PI)
3. Technical Research Centre, DST, 01/01/2016 to 31/ 12/2020, PI
4. Development of a mid-IR Cavity Ring-Down Spectrometer for High-Precision Real-Time Continuous Monitoring of Multiple Trace Gases and Stable Isotopic Species in the Atmosphere, MoES, Government of India, (Co-PI)

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl no. 2

National

Sl. No. 1 & 3

Member of Editorial Board

Referee of journals:

1. Journal of Material Science and Engineering B
2. Journal of Applied Physics
3. Solid State Communications
4. Journal of Alloys and Compounds
5. Journal of Physics and Chemistry of Solids
6. Journal of Materials

Participation in Science Outreach program

- Hon'ble Union Minister for Science and Technology and Earth Science, Dr. Harsha Vardhan visited the Nano –Lithograpy and nano fabrication facility, Funded by Nano Mission: UNANST, established on year 2011 and has been dedicated to nation by the Hon'ble Minister in the gracious presence of DST, Secretory, Prof Ashutosh Sharma on 7th May 2017
- 30 number of participants in C. K. Majumdar Memorial Summer Workshop (during 23May-02 June, 2017, at S. N. Bose Centre had visited and performed hands on experiments on X-ray diffraction, Scanning Electron Microscope, VSM and Atomic Force microscope laboratories for 4days, during 29 May-01 June, 2017. They have performed experiments successfully
- Odisha University of Agriculture and Technology Bhubaneswar visited on X-ray diffraction, Scanning Electron Microscope, VSM and Atomic Force microscope laboratories on 30.11.2017
- Department of Physics of Charuchandra College visited the Laboratories of X-ray diffraction, Scanning Electron Microscope, VSM and Atomic Force microscope, pulsed laser deposition unit .Fifty (50) students attended. They have visited on 14.02.2018

Societal impact of Research

Main area:

- Environment and related issues
- Health Care Sector
- Food storage

"Visual color change based ammonia gas sensor for stand -alone use":

- Hazards Gas detection in an open atmosphere down to 10ppm level/based on ammonia gas sensing, patent filed).
- The technology developed is to be used for Ammonia gas detection without any other peripherals like a pH paper.

"Prototype is ready for use which can sense ammonia $<$10ppm level by visual effect (just by colour change)"

Significant research output / development during last one year

General research areas and problems worked on

Areas of Research:

Part A: Technology development based research

- Environment related issue: Making of sensor for Hazardous gas detection
- Health Care Sector: Technology development for making device for detection of disease.

Part B: Basic Research

- Development of Hazards Gas Detection Sensor based devices
- Physical Property study on Single nanowire based devices
- Growth to Physical Properties on thin film transistors (TFT)
- Study of Complex and binary Oxides: Synthesis & Crystallographic structure and Microstructure
- Synchrotron and Neutron Diffraction study on complex and binary oxides

Interesting results obtained

The nature of work has two distinct regions:

a) Academic nature: Research activities along with five Ph.D students under CMPMS department and Technology Research Centre (TRC)

b) Administrative nature: Handling central equipment facilities under Technical Cell as Scientist I/C of the cell, I have to be actively involved in the instrumental facility management and equipment installation. (Ref. "Any Other matter" section below)

a) Academic work:

Part A: Technology development based Research

1) Hazardas Gas like Ammonia detection down to $<$10ppm level from atmosphere based on visual colour change without any other peripherals

a) Test system developed for proof of concept (Patent filed)

b) PROTOTYPE is ready for early detection of hazardous gas like ammonia by using the sensor VISUALLY just by colour change

"The idea is wire the wrist band (*Ammo-watch*), which is the ammonia sensor when one is working in the hazardous environment".

Part B: Basic Research

1) Fabrication of amorphous Indium Gallium Zinc Oxide thin film transistor on flexible substrate using a polymer electrolyte as gate dielectric:

We have fabricated a flexible thin film transistor (TFT) with relevant high performances indices using polymer electrolyte as gate dielectric and amorphous Indium Gallium Zinc Oxide (a-$InGaZn_2O_5$) as a channel on polyimide Kapton® tape. Low temperature (≈ 100°-120° C) prepared amorphous Indium Gallium Zinc Oxide (a-IGZO) showed n- channel device characteristic and operated in enhancement mode with high saturation mobility of 42 cm^2/Vs, good ON/OFF ratio of ~10^5, low threshold voltage of ~ 0.7 V and low sub-threshold swing of ~ 175mV/decade. The improvements of the performance indices arise due to influence high value of specific gate capacitance of polymer electrolyte. The gate bias stress test of the flexible TFT showed the stable electrical characteristics.

a) The proof of Concept has been established and an a patent has been filed 201731015268, Filed on 29/04/2017, published on: 09/6/2017 (mentioned in Serial no 8 in details)

b) Paper has been accepted in IEE, ED in the year 2018

2) Fast response paper based visual color change gas sensor for efficient ammonia detection at room temperature:

We show that a cheap rapid paper sensor (working at room temperature) can be made using perovskite halide $CH_3NH_3PbI_3$ (MAPI) to detect presence of the toxic ammonia gas by just colour change, where the black coloured MAPI film (on the paper) changes to yellow color in presence of a very low concentration of NH_3 gas. The sensor can detect presence of NH_3 gas in open or closed atmosphere down to around 10ppm with a response time of nearly 10 sec which decreases to few seconds when the concentration exceeds 20 ppm. The easy to fabricate sensor paper being a visual sensor does not need any other extra equipment for its operation. The sensor is not sensitive to moisture with RH upto 90% and does not also respond to gases like Methane (CH_4), Nitrous Oxide (N_2O), Carbon dioxide (CO_2) etc in the test chamber each up to a concentration of 500 ppm. (*patent filed and paper submitted)*

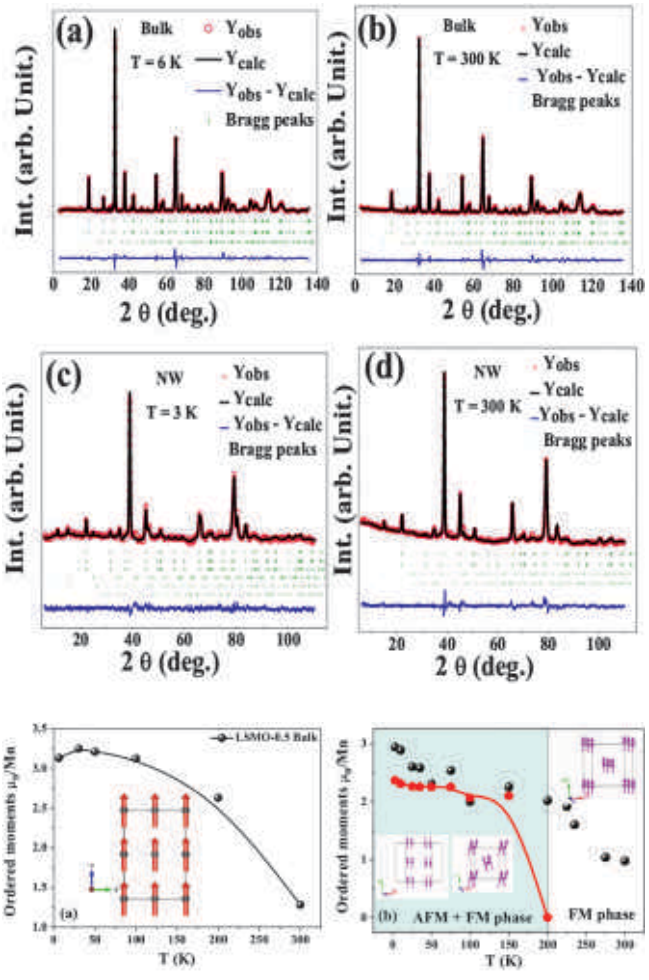


Fig1 A)The typical profile fits of neutron diffraction patterns obtained from the Rietveld refinement of $La_{0.5}Sr_{0.5}MnO_3$ bulk and nanowire at different temperatures.

B) Spontaneous magnetic moment for bulk and nanowire obtained from the neutron diffraction data. Bulk species shows only FM phase, whereas , nanowire below 200 K shows coexistence of FM and AFM phases.

3) Size induced magnetic phases in half doped manganite nanowires of La0.5Sr0.5MnO3: a neutron diffraction study:

We report size reduction induced modification of magnetic property leading to phase separation and its correlation with crystallographic structure in one dimensional nanostructure of manganite system (La0.5Sr0.5MnO3)—which has not previously been reported. Structural study has been undertaken using synchrotron x-ray and neutron diffraction. These studies show the coexistence of crystallographic (tetragonal and orthorhombic) and magnetic phases (ferromagnetic (FM) and antiferromagnetic (AFM) respectively) below the Néel temperature (< 200 K). Neutron depolarization experimentation also corroborates the neutron diffraction results. Our results demonstrate that the coexistence of the FM and AFM phases arises due to structural phase separation of tetragonal and orthorhombic phases. In contrast, bulk La0.5Sr0.5MnO3, showing FM (tetragonal phase) throughout the measured temperatures (6–300 K), does not show any phase separation. Our study will provide in-depth understanding of the underlying physics and basic mechanism of size induced phase separation in nanowires, and the role of crystal structure in stabilizing a specific ground state of these manganite nanowires. *(paper published)*

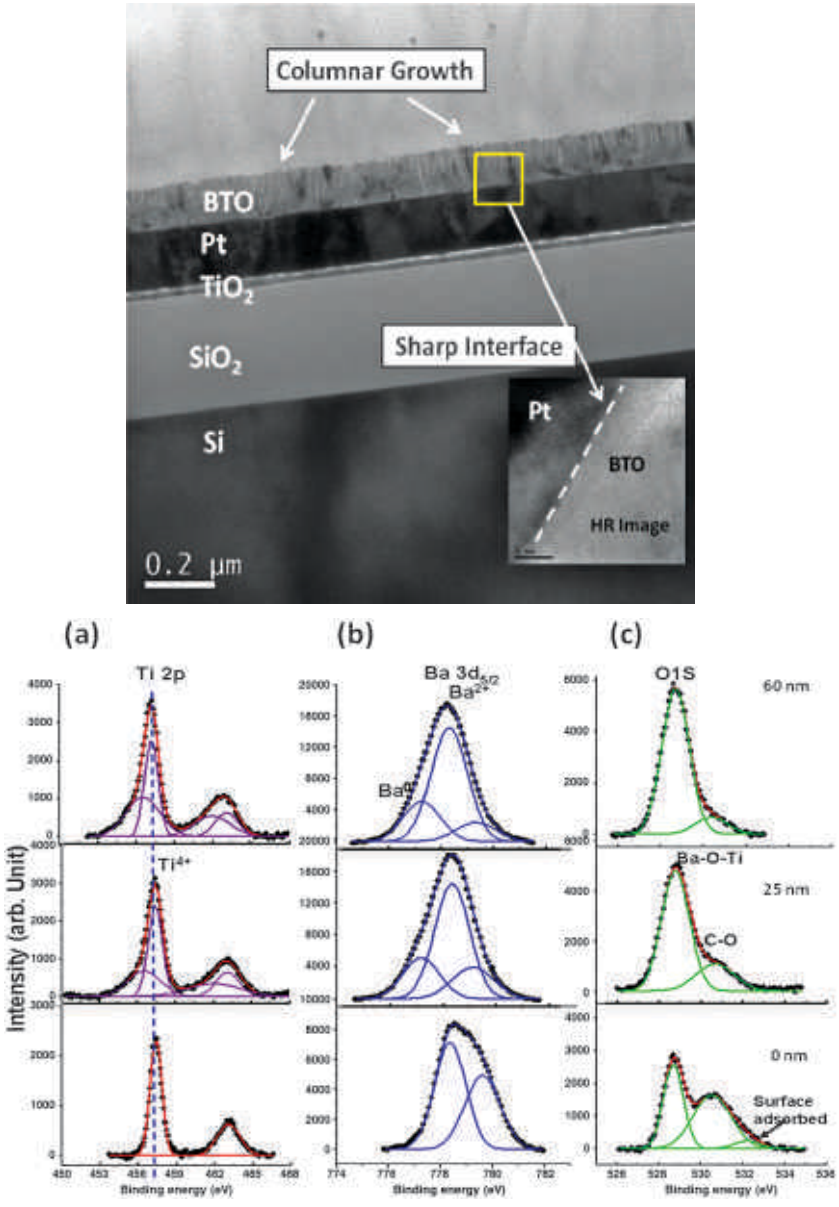


Fig.2: A) Bright field XTEM image of $BaiTO_3$ film on a platinized Si substrate showing nano-columnar morphology. B) depth dependent high-resolution XPS spectra of (a) Ti2p, (b) Ba3d, (c) O1s of the film as a function of Ar penetration depth

Proposed research activities for the coming year

Part A:

Technology related work:

Development of high sensitivity gas senor (< 500ppb) for hazarders gas detection and for breath analysis for non-invasive disease detection.

Part B:

Crystallographic structural study using synchrotron and Neutron diffraction experiments on perovskite oxides:

Size reduction induced modification of magnetic property leading to phase separation and its correlation with crystallographic structure in nanostructures of complex oxide systems would be studied by synchrotron and Neutron diffraction experiments.

Growth and physical property study of perovskite lead halide thin films and nanostructures

Growth and characterization of Perovskite halides would be done by wet chemistry route. Crystallographic structural study would be done by synchrotron x-ray diffraction experiment, photoconductivity and other physical properties will also be done using several characterization tools.

High Sensitive paper based flexible room temperature ammonia sensor based on electrical read outs

The work involves effective utilization of new material like perovskite halide which has not been utilized before for effective gas sensing. High sensitivity (better than 1 ppm) and high selectivity hazardous gas sensor for unheated operation with remote read-out capability. Quick and easy method to detect hazardous gases in work places and other installations is useful technology proposition. Desirable feature of such technology is high selectivity and specificity to hazardous gases. In this project we are working to develop highly sensitive (less than 1ppm level) yet inexpensive sensors operable at room temperature. The sensors will be put with measurement device allowing data access through Wi-Fi or wireless routes. Basic mechanism of gas sensing would be done using several characterization tools and techniques.

The proof of Concept has already been established and an a patent has been filed: 201831001993, Filed on: 17/01/20185)(details in "Patent/s submitted / granted" section)

Study of surface and interfaces of thin films of perovskite oxides

Growth of thin films would be done using wet chemistry and physical vapour deposition, and interface study would be done using cross-sectional transmission electron microscopy, energy filter imaging (EFTEM) and Electron energy loss spectroscopy study.

The proof of Concept has already been established and an a patent has been filed Patent No: 201731036353, Filed on: 12/10/2017 (details in "Patent/s submitted / granted" section)

Any other matter

50% of time spend for facility management, 50% time for academic work

Facility management related issue:

Scientist In-charge of Technical cell:

Technical cell: All the major instrumental facilities at our centre are under Technical cell, which looks after the overall running of the facilities. Technical Cell functions as a section and I am Scientist in-charge of the Cell. I/C of Technical Cell act as head of the section.

The major activity comes under the sections the following:

I) maintenance of equipments;

ii) purchase and installation of new instruments;

iii) up-gradation of existing instruments under Technical cell

iv) have to supervise smooth inflow of consumables and supplies that is needed for smooth running of the facility.

v) also involved in the appointment and job allotment of Technical staffs associated with Technical Cell

As the major instruments are central facility instrument of S.N Bose centre, the users are mainly internal users but we have 20% of the available time for external users also on payment basis. Thirty two universities/ institutes/ colleges from different parts of India, uses our central equipment facilities.

Kalyan Mandal

Senior Pofessor
CMPMS
kalyan@bose.res.in

Professor Kalyan Mandal is a former student of Ramkrishna Mission (Asansol), Presidency College (Kolkata) and the University of Calcutta. He received his Ph.D. degree in Physics from the Indian Institute of Technology (Kharagpur). He also worked in Queen's University (Canada), Instituto de Magnetismo Aplicado (Spain), IFW-Dresden (Germany), Durham University (UK) and Osaka University (Japan).

Supervision of Research / Students

Ph.D. Students

1. Souvanik Talukdar: "Magnetic and optical properties of oxide nanomaterials", on-going
2. Indranil Chackraborty: "Bio-medical applications of oxide nanostructures", on-going
3. Mahebub Alam: "Multiferroic materials", on-going
4. Keshab Karmakar: "Energy materials", on-going
5. Subrata Ghosh: "Magnetocaloric effect", on going
6. Dipika Mandal: "Frequency dependent properties of ferrite nanostructures", on going
7. Dipanjan Maity: "Water-splitting using solar energy", on going
8. Priyanka Saha: "Magnetorheology with nanostructured materials", on going

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Anupam Garai, SNBNCBS: "Study of exchange-coupled core-shell nanostructures", summer research project, July 2017
2. Smriti Mosel, Indian Institute of Technology (ISM) Dhanbad: "Magnetic Barkhausen noise and its applications", summer project, July 2017

Post Doctoral Research Scientist/s

1. Srabantika Ghose

Teaching activities at the Centre

1. Second semester/PHY291
2. Third semester/PHY391

Publications in Journals

1. C. Dey, K. Baishya, A. Ghosh, M. Mandal Goswami, A. Ghosh, **K. Mandal**, *Improvement of drug delivery by hyperthermia treatment using magnetic cubic cobalt ferrite nanoparticles*, Journal of Magnetism and Magnetic Materials, **427**, 168-174 (2017)
2. S. Arumugam, S. Ghosh, A. Ghosh, U. Devarajan, M. Kannan, L. Govindaraj, **K. Mandal**, *Effect of hydrostatic pressure on the magnetic, exchange bias and magnetocaloric properties of* $Ni_{45.5}Co_2Mn_{37.5}Sn_{15}$, Journal of Alloys and Compounds, **712**, 714-719 (2017)
3. K. Karmakar, A. sarkar, **K. Mandal** and G. G. Khan, *Nano-engineering of p-n* $CuFeO_2$*-ZnO heterojunction photoanode with improved light absorption and charge collection for photoelectrochemical water oxidation*, Nanotechnology, **28**, 325401 (2017)
4. S. Talukdar, D. Mandal, **K. Mandal**, *Surface modification of Cobalt ferrite nano-hollowspheres for inherent multiple photoluminescence and enhanced photocatalytic activities*, Chemical Physics Letters, **672**, 57–62 (2017)
5. I. Chakraborty, R. Rakshit, **K. Mandal**, *Synthesis and functionalization of* $MnFe_2O_4$ *nano – hollow spheres for novel optical and catalytic properties*, Surfaces and Interfaces, **7**, 106-112 (2017)
6. I. Chakraborty, U. Saha, R. Rakshit, S. Talukdar, G. S. Kumar, **K. Mandal**, *Design and development of bioactive α-hydroxy*

carboxylate group modified $MnFe_2O_4$ nanoparticle: Comparative fluorescence study, magnetism and DNA nuclease activity, Materials Today Chemistry, **5**, 92-100 (2017)

7. I.Chakraborty, D. Majumder, S. Talukdar, S. Roy, **K. Mandal**, *Surface engineered magneto fluorescent $MnFe_2O_4$ nanoparticles in the realm of biomedical applications*, Surfaces and Interfaces, **9**, 154-159 (2017)
8. R. Rakshit, E. Khatun, M. Pal, S. Talukdar, D. Mandal, P. Saha, **K. Mandal**, *Influence of functional group of dye on the adsorption behaviour of $CoFe_2O_4$ nano-hollow spheres*, New Journal of Chemistry, **41**, 9095-9102 (2017)

Other Publications

1. S. Talukdar, R. Rakshit, A. Kramer, F. A. Muller and **K. Mandal**, "Facile Surface Modification of Nickel Ferrite Nanoparticles for Inherent Multiple Fluorescence and Catalytic Activities", Proceedings of International Conference on Nanotechnology: Ideas, Innovations & Initiatives-2017, IIT Roorkee, India, December 06-08, 2017.

2. I. Chakraborty, U. Saha, R. Rakshit, S. Talukdar, G. Suresh Kumar, **K. Mandal**, "Design and development of bioactive a-hydroxy carboxylate group modified $MnFe_2O_4$ nanoparticle: Comparative fluorescence study, magnetism and DNA nuclease activity", Proceedings of International Conference on Nanotechnology: Ideas, Innovations & Initiatives-2017, IIT Roorkee, India, December 06-08, 2017.

3. M. Alam and **K. Mandal**, "High temperature ferroelectric, ferromagnetic and magnetoelectric properties in double perovskite Y_2NiMnO_6 nanowires" IEEE Magnetic Society Summer School 2017, Spain.

4. K. Karmakar, D. Maity, **K. Mandal**, "Role of oxygen vacancies and lattice strain defects on enhanced photoelectrochemical property of alkali metal (Li, Na and K) doped ZnO nanorods photoanodes", Proceedings of National Conference on Hydrogen Energy and Advanced Materials. March 5-6, 2018. University of Kerala (for HEAM Scholar Award).

5. S. Arumugam, S. Ghosh, A. Ghosh, U. Devarajan, M. Kannan, L. Govindaraj and **K. Mandal**, "Effect of hydrostatic pressure on the magnetic, exchange bias and magnetocaloric properties of $Ni_{45.5}Co_2Mn_{37.5}Sn_{15}$", Proceedings of Recent Trends in Condensed Matter Physics (RTCMP-2017), Oct 31-Nov 3, 2017, Bose Institute, Kolkata, India

6. D. Mandal, M. Mandal Goswami and **K. Mandal**, "Magnetic Properties of AOT Functionalized Cobalt-Ferrite Nanoparticles in Search of Hard-Soft Marginal Magnet", Proceedings of Recent Trends in Condensed Matter Physics (RTCMP-2017), Oct 31-Nov 3, 2017, Bose Institute, Kolkata, India

7. D. Maity, K. Karmaker and **K. Mandal**, "Visible light water electrolysis with C, N, S functionalized ZnO nanorods photoanodes", Clean and Renewable Energy Technologies via Chemical Route, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India, 27th Nov -2nd Dec, 2017

Lectures Delivered

1. "Transition Metal Oxide Nanostructures and Their Novel Properties", New York University, Abu Dhabi, 08 October 2017
2. "Magnetic nanomaterials", C. K. Majumdar Memorial Summer Workshop in Physics-2017, on 30 May 2017
3. "Finite size effect on magnetic properties", Out Reach Programme as a part of celebration of 125th Birth Anniversary of Professor S. N. Bose, 16 March 2018, Tripura University, Tripura
4. "Magnetism: Bulk to Nano", Out Reach Programme as a part of celebration of 125th Birth Anniversary of Professor S. N. Bose, 19 March 2018, Assam University, Silchar
5. "Transition Metal Oxide Nanostructures: Surface Effects", in the conference on, "Recent trend in condensed matter physics" on 16 January 2018 at Indian Association for the Cultivation of Science, Kolkata

Academic Visits

International

1. Collaborative research, New York University, Abu Dhabi, 01 – 15 October, 2017

Membership of Committees

External Committee

Executive Committee member, Materials Society of India (Kolkata Chapter); Executive Committee member, Magnetic Society of India; Executive Committee Member, Council 15, Indian Association of Physics Teachers

Internal Committee

Internal Complaint Committee; Library Committee; Purchase Committee; Students Curriculum & Research Evaluation Committee

Awards / Recognitions

1. Our paper entitled, "Investigating the Role of Oxygen Vacancies and Lattice Strain Defects on the Enhanced Photoelectrochemical Property of Alkali Metal (Li, Na, and K) Doped ZnO Nanorod Photoanodes", by K. Karmakar, A. Sarkar, K. Mandal and G. G. Khan, Chem Electro Chem, 5, (2018), 1–7 has been selected as the cover page of the journal ChemElectroChem

Sponsored Projects

1. "Functionalization of ferrite nanoparticles for biomedical applications and catalysis", SNBNCBS, April 2016 – March 2018

Conference / Symposia / Workshops / Seminars etc. organized

1. "C. K. Majumdar Memorial Summer Workshop in Physics", 23 May – 02 June 2017, at SNBNCBS, Convener
2. "Young Scientist Colloquium", 11 October 2017, at IIEST-Howrah, Organising Committee member

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Dr. G. G. Khan, Tripura University (Sl. No. 3)

Participation in Science Outreach program

- Out-reach Programme as a part of celebration of 125th Birth Anniversary of Professor S. N. Bose, 16 March 2018, at Tripura University, Tripura, Organising committee member
- Out-reach Programme as a part of celebration of 125th Birth Anniversary of Professor S. N. Bose, 19 March 2018, Assam University, Silchar, Assam

Societal impact of Research

- Hydrogen produced from the water splitting using solar energy can be a source of renewable energy
- Magnetic refrigeration using magnetocaloric materials will be more energy efficient and environment friendly compared to existing gas-refrigeration technology
- Magnetic oxide nanoparticles have tremendous potential to be used in many biomedical applications

Significant research output / development during last one year

General research areas and problems worked on

- Study of magnetic and optical properties of surface functionalised nanostructures of transition metal oxides and their biomedical applications
- Magnetoicaloric effect,
- Stable and enhanced Visible-Light Water Electrolysis

Interesting results obtained

Magnetocaloric effect: Heusler alloys exhibiting Inverse Magnetocaloric properties across their structural transition, possesses large field induced hysteresis which reduces the net relative cooling power (RCP) of that material. Si substitution in place of Sn is found an effective way to reduce the average hysteresis loss which in turn enhances the RCP value of $Ni_{48}Co_{1.5}Mn_{35}Sn_{15.5-x}Si_x$ (x = 1, 2, 4) alloys.

Energy materials: We have fabricated P-N $CuFeO_2$-ZnO heterojunction photoanode materials and have investigated the role of oxygen vacancies and lattice strain of alkali metal (Li,Na,K) doped ZnO nanorods for enhanced photoelectrochemical properties for water splitting.

Proposed research activities for the coming year

- To develop more efficient nanostructured oxides for stable and enhanced visible-light water electrolysis for clean and sustainable energy
- To find better multiferroic materials with stronger magnetoelectric coupling.
- To prepare surface functionalized hydrophilic magnetic nanoparticles with good magnetic as well as fluorescent properties for biomedical applications

Madhuri Mandal Goswami

Visinting Faculty Fellow
CMPMS
madhuri@bose.res.in

Dr. Madhuri Mandal Goswami has expertise on synthesis of several kinds of functionalized nano-scale materials and their use in cancer therapy, catalysis, biosensor etc. She completed Ph.D from IIT,Kharagpur and 2years Postdoctoral research in University of Alabama, USA. Currently she is working in S.N.Bose Centre, Kolkata as Visiting Faculty Fellow.

Supervision of Research / Students

Ph.D. Students

1. Chaitali Dey (submit her thesis soon), Title: Synthesis and Characterization of Transition Metal Based Magnetic Nanoparticles for Drug Delivery and Catalytic Activity Study
2. Debarati De (continuing), Title: Synthesis, characterization and engineering of fluorescent magnetic nanoparticles for their use in imaging of cancer cells and release of drugs by hyperthermic technique

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Arpita Das, Calcutta University, Title: 'DNA ENGINEERED COBALT FERITTE NANOPARTICLES: MAGNETIC AND OPTICAL STUDIES FOR HYPERTHERMIA APPLICATION', Completed her thesis under supervision of Dr. Madhuri Mandal

Teaching activities at the Centre

1. Fall semester-2017/PHY-391, Experimental Method in Physics (Spectroscopy practical), IPhD

Publications in Journals

1. D. Mandal, M. M. Goswami and K. Mandal, *Magnetic Properties of AOT Functionalized Cobalt-Ferrite Nanoparticles in Search of Hard-Soft Marginal Magnet*, IEEE Transactions on Magnetics, 54, 6000406-6000411 (2018)

Sponsored Projects

1. Title of the project (No. SR/WOS-A/CS-158/2016): "Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release"; Sponsor: DST, New Delhi; PI: Dr. Madhuri Mandal Goswami; Period of funding: For 3 years
2. Title of the project "Synthesis and Engineering of Magnetic Nanoparticles for their in-vitro Application in Hyperthermia Therapy" (SNB/MM/15-16/164-1); Sponsor: S. N. Bose National Centre for Basic Sciences, Kolkata; PI: Dr. Madhuri Mandal; Period of funding: For 3 years
3. Title of the project (No. SR/WOS-A/CS-158/2016): "Design of biocompatible fluorescent magnetic nanoparticles for imaging the cancer cells and their possible theranostic use"; Sponsor: DST, New Delhi; PI: Dr. Madhuri Mandal Goswami; Period of funding: For 3 years

Societal impact of Research

- Our research direction will show a new avenue in cancer research.
- These types of researches will be very helpful for cancer diagnosis and treatment
- Development of biosensor will help in diagnosis many other diseases like kidney failure, lungs problem etc.

Significant research output / development during last one year

General research areas and problems worked on

Development of fluorescent magnetic nanoparticles by tagging them with fluorescent molecules and tuning their different physical properties to apply them in cell imaging, disease diagnosis, drug delivery, hyperthermia therapy etc.

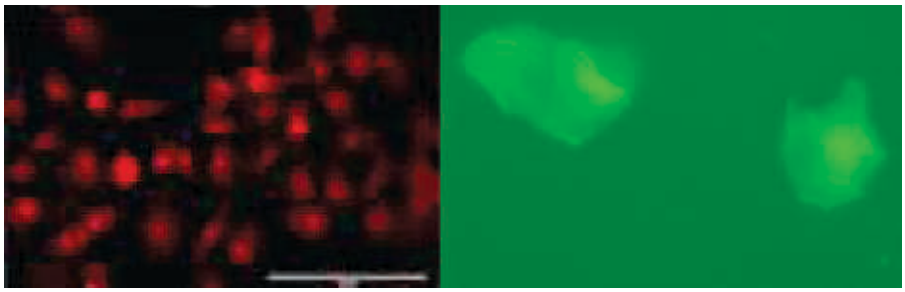


Fig. Fluorescence from dye functionalized DNA-CF NPs and Cancer cell imaging

Application of magnetic nanoparticles as biosensor for disease diagnosis and in energy harvesting

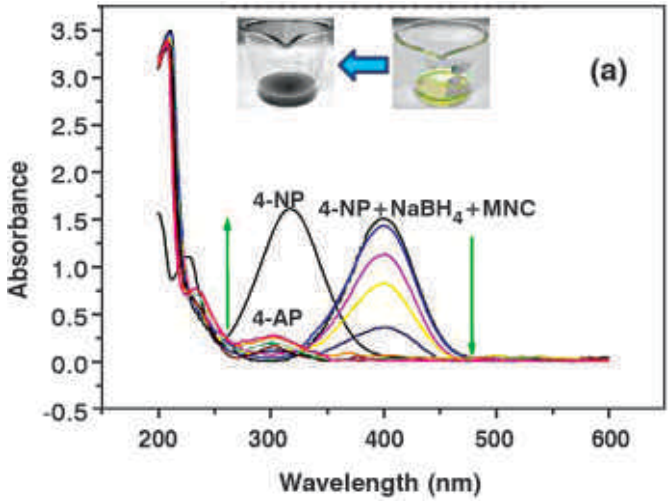
Interesting results obtained

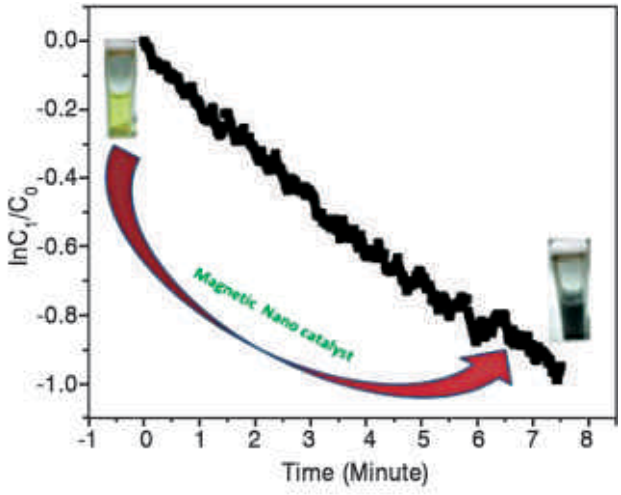
We have synthesized different types of transition metal based ferrites and alloy type compounds, which are used as catalyst for reduction of organic compounds. This reduced compound is a precursor molecule for analgesic drug preparation. More over we used our magnetic particles for hyperthermia therapy, cell imaging etc. by exploiting their magnetic properties. Detailed characterizations of these materials were done by XRD, TEM and FESEM which confirm the structural features and morphology of the materials. The catalysis of reduction of nitro phenol was monitored using UV-Visible spectrometer by using different types of catalysts. The catalytic activity, recyclability or reusability, rate constant of the reaction etc. were investigated in detail to understand the betterment in catalytic property. It shows a better rate constant compared to a previous published works. Our developed catalysts are very much cheaper and hence cost effective. They are highly stable and environment compatible. After use of this catalyst it can be separated from the media by magnetic separation method and can be reused it for several times, more than 100 times. Hence these materials are very efficient catalyst.

We have discovered a DNA functionalized cobalt ferrite nanoparticles (CFNPs) which are very much useful for cell imaging and hyperthermia therapy due to their fluorescence properties and heating effect under AC magnetic field. Due to DNA functionalization the materials become very much biocompatible. These materials help in enhancement of fluorescence properties of the dye if it binds with such DNA functionalized materials. The cell imaging with such functionalized materials are shown below.

Proposed research activities for the coming year

We have seen in our previous studies that the magnetic





nanoparticles after tagging with some non-fluorescent molecules show highly fluorescent properties though individually they are non-fluorescent. On the other hand it has been observed that magnetic nanoparticles under an alternating magnetic field produce heat and helps to kill cancer cell if heating can be controlled. Magnetic nanoparticles with tunable magnetic properties, biocompatibility, stability etc. are very useful in such application, where hyperthermia technique is considered. Using these properties stimulated drug release is also possible in a control way. From these results we are motivated to utilize these functionalized particles for cancer therapy by employing hyperthermia technique. These types of fluorescent magnetic materials will be useful for cancer cell imaging by probing them through fluorescence microscope. Our concern is to synthesize the fluorescent magnetic nanoparticles and to tag them selectively to the cancer cell for proper theranostic use and hence do the characterization of the particles in this direction.

Manoranjan Kumar

Associate Professor
CMPMS
manoranjan.kumar@bose.res.in

Dr. Manoranjan Kumar completed his MSc in Physics from School of Physical Sciences JNU New Delhi and PhD from IISc Bangalore. He joined Princeton University, USA as postdoctoral fellow.

Supervision of Research / Students

Ph.D. Students

1. Aslam Parvej, 'Exotic Phases in Frustrated Low Dimensional Spin Systems' (Submitted)
2. Hrishit Banerjee, 'Study of Electronic Structure of Organic and Inorganic Complexes', In collaboration with Tanushree Saha Dasgupta (Submitted)
3. Rakesh Das, 'Coarsening, steady-state and phase transition in self-propelled particles', In collaboration with Shradha Mishra (Submitted)
4. Debasmita Maiti, 'Frustrated magnetic ladders: a DMRG study' (Ongoing)
5. Monalisa Singh Roy, 'Edge Modes in 1D Chains of Correlated Electrons and Their Junctions' (Ongoing)
6. Sudipta Pattanaik, 'Collective Behaviour of Polar Self-Propelled Particles' (Ongoing)
7. Sudip Kumar Saha, 'Topological Orders in Low dimensional Materials ' (Ongoing)
8. Sk. Saniur Rahaman
9. Monalisa Chatterjee
10. Jyotirmoy Sau

Post Doctoral Research Scientist/s

1. Dayasindhu Dey

Teaching Activities at the Centre

1. Computational Methods in Physics II, PHY204, ~8 students, shared with Professor S S Manna

Publications in Journals

1. Rahul Singh, Vinod K Gangwar, DD Daga, Abhishek Singh, AK Ghosh, **Manoranjan Kumar,** A Lakhani, Rajeev Singh, Sandip Chatterjee, *Unusual negative magnetoresistance in $Bi_2Se_{3-y}S_y$ topological insulator under perpendicular magnetic field*, Applied Physics Letter, **112** (10), 102401 (2018)
2. Dayasindhu Dey, **Manoranjan Kumar**, Siân E. Dutton, Robert J. Cava, and Zoltán G. Soos, *Spin-specific heat determination of the ratio of competing first- and second-neighbor exchange interactions in frustrated spin-1/2 chains*, Phys. Rev. B, **97**, 064407 (2018)
3. G Giri, D Dey, **Manoranjan Kumar**, S Ramasesha and Z G Soos, *Quantum Phases of Frustrated 2-Leg spin-1/2 Ladders with Skewed Rungs*, Physical Review B, **95**, 224408 (2017)
4. R Das, **Manoranjan Kumar** and Shradha Mishra, *Order-Disorder Transition in Active Nematic: A Lattice Model Study*, Scientific Reports, **7**, 7080 (2017)
5. D Dey, S. Saha, P S Deo, **M Kumar** and S Sarkar, *A study of Topological Quantum Phase Transition and Majorana Localization Length for the Interacting Helical Liquid System*, J. Phys. Soc. Jpn., **86**, 074002 (2017)
6. Aslam Parvej and **Manornajan Kumar**, *Multipolar phase in frustrated spin-1/2 and spin-1 chains*, Physical Review B, **96**, 054413 (2017)

7. Dayasindhu Dey, Debasmita Maiti and **Manoranjan Kumar,** *Frustrated spin-1/2 ladder with ferro- and antiferromagnetic legs*, Journal of Magnetism and Magnetic Materials, **446**, 170 (2018)

Conference / Symposia / Workshops / Seminars etc. organized

1. Emergent Phenomena in Classical and Quantum Systems (EPCQS18) with Professor Punyabrata Pradhan Feb 26-28 (2018)
2. HyPe-2017 (A discussion meeting on hybrid perovskites with Professor Priya Mahadevan 14 - 15 Dec, 2017
3. Young Investigator Meet on Quantum Condensed Matter Theory 26-27 Oct 2017

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

Sl. No. 5

National

Sl. No. 1& 4

International

Sl. No. 2 & 3

Significant research output / development during last one year

General research areas and problems worked on

Strongly correlated systems, Topological Insulators, Majorana Fermions, Frustrated Magnets and their dynamical properties, Development of Numerical methods

Interesting results obtained

1. The magnetic susceptibility χ (T) of spin-½ chains is widely used to quantify exchange interactions, even though χ (T) is similar for different combinations of ferromagnetic J_1 between first neighbors and antiferromagnetic J_2 between second neighbors. We point out that the spin-specific heat C (T) directly determines the ratio $\alpha = J_2/|J_1|$ of competing interactions. The $J_1 - J_2$ model is used to fit the isothermal magnetization M (T, H) and C (T, H) of spin-1/2 Cu (II) chains in $LiCuSbO_4$. By fixing α, C (T) resolves the offsetting J_1, α combinations obtained from M (T, H) in cuprates with frustrated spin chains.

2. The $J_1 - J_2$ spin-chain model with nearest-neighbor J_1 and next-nearest-neighbor antiferromagnetic J_2 interaction is one of the most popular frustrated magnetic models. This model system has been extensively studied theoretically and applied to explain the magnetic properties of the real low-dimensional materials. However, the existence of different phases for the $J_1 - J_2$ model in an axial magnetic field *h* is either not understood or has been controversial. In this paper, we show the existence of higher order $p > 4$ multipolar phase near the critical point $(J_2/J_1)c = -0.25$. The criterion to detect the quadrupolar or spin nematic (SN)/spin density wave of type two (SDW_2)phase using the inelastic neutron scattering (INS) experiment data is also discussed, and INS data of $LiCuVO_4$ compound is modeled. We discuss the dimerized and degenerate ground state in the quadrupolar phase. The major contribution of binding energy in the spin-1/2 system comes from the longitudinal component of the nearest-neighbor bonds. We also study spin nematic/SDW_2 phase in spin-1 system in large J_2/J_1 limit.

3. We introduce a lattice model for active nematic composed of self-propelled apolar particles, study its different ordering states in the density-temperature parameter space, and compare with the corresponding equilibrium model. The active particles interact with their neighbors within the framework of the Lebwohl-Lasher model, and move anisotropically along their orientation to an unoccupied nearest neighbor lattice site. An interplay of the activity, thermal fluctuations and density gives rise distinct states in the system. For a fixed temperature, the active nematic shows a disordered isotropic state, a locally ordered inhomogeneous mixed state, and bistability between the inhomogeneous mixed and a homogeneous globally ordered state in different density regime. In the low temperature regime, the isotropic to the inhomogeneous mixed state transition occurs with a jump in the order parameter at a density less than the corresponding equilibrium disorder-order transition

density. Our analytical calculations justify the shift in the transition density and the jump in the order parameter. We construct the phase diagram of the active nematic in the density-temperature plane.

4. Two-leg spin-1/2 ladder systems consisting of a ferromagnetic leg and an antiferromagnetic leg are considered where the spins on the legs interact through antiferromagnetic rung couplings J_1. These ladders can have two geometrical arrangements either zigzag or normal ladder or these systems are frustrated irrespective of their geometry. This frustration gives rise to incommensurate spin density wave, dimer and spin fluid phases in the ground state. The magnetization in the systems decreases linearly with J_1^2, and the systems show an incommensurate phase for $0.0 < J_1 < 1.0$. The spin-spin correlation functions in the incommensurate phase follow power law decay which is very similar to Heisenberg antiferromagnetic chain in external magnetic field. In large J_1 limit, the normal ladder behaves like a collection of singlet dimers, whereas the zigzag ladder behaves as a one dimensional spin-1/2 antiferromagnetic chain.

Proposed research activities for the coming year

Currently we are working on the exotic properties of topological Insulator materials, Majorana fermions in one dimensional system and frustrated magnets.

Pratip Kumar Mukhopadhyay

Senior Professor
CMPMS
pkm@bose.res.in

As an experimentalist in Condensed Matter Physics, Professor Pratip Kumar Mukhopadhyay worked in many areas, and recently is working on smart materials. His lab was the first one in Eastern India to start work on Ferro Magnetic Shape Memory Alloys. In this they discovered a new physical phenomenon of photo induced microactuation (PIMA). This effect is now being tried in robotics and interventional surgery. He was also the joint convenor of a world series of scientific conference on these materials. To the best of his knowledge, so far this is the first and only world series conference that started in India, on any subject. On the soft materials, he and his students could design a smart fluid that is ordinarily free flowing, turns into a solid wall in a microsecond when hit by a fast projectile. After successful testing with defense organization, it is now under trial with Kolkata Police. Central Forensic Lab in Kolkata also expressed interest.

Supervision of Research / Students

Ph.D. Students

1. Tanmoy Ghosh, Experimental and theoretical studies of magnetic alloys – submitted
2. Sarowar Hossain, ongoing
3. Abhishek Bagchi, ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Ankit Kargeti , Invertis University, Bareily, Summer Project
2. P. Gokul, Amrita vishwavidyapeetham, M.Sc. project (17/1/2018 to 15/6/2018)

Post Doctoral Research Scientist/s

1. Alo Dutta (WoS)
2. S. Vinoth Kumar (PDRA)
3. Suman Sarkar (Scientist C, TRC)

Teaching activities at the Centre

1. Phy 291, Spring 2018 (jointly with Prof. K. Mandal)

Publications in Journals

1. K. Srinivasrao, P. Mohanbabu and **P. K. Mukhopadhyay,** *Physical investigations on transparent conducting Mo:ZnO thin films*, Advanced Composites and Hybrid Materials, **1 (2),** 364 (2018)
2. S. Agarwal and **P. K. Mukhopadhyay,** *Compositional invariance of magnetocaloric effect near room temperature in Ni-Mn-Sb-Al systems*, Indian J Phys., **92 (2)**, 177 (2018)
3. Alo Dutta, Santosh Kumar Singh, V.R.K. Murthy, **P.K. Mukhopadhyay** and T.P. Sinha, *Crystal structure, Raman spectroscopy and microwave dielectric properties of* $xBa_3MgNb_2O_9$-$(1-x)Ba_2InNbO_6$ *[x = 0.4, 0.6, 0.8]*, Mater Res Bull, **100**, 178 (2018)
4. Abhishek Bagchi, Susenjit Sarkar and **P. K. Mukhopadhyay,** *Investigations on colour dependent photo induced microactuation effect of FSMA and proposing suitable mechanisms to control the effect*, Indian J Phys, **92 (7)**, 883 (2018)
5. Md. Sarowar Hossain, M. A. Hakim and **P. K. Mukhopadhyay,** *Interesting low temperature magneto-elastic behavior of a FINEMET metglass*, AIP Advances, **7**, 115221, 2017
6. Md Sarowar Hossain, B. Rajini Kanth and **P. K. Mukhopadhyay,** *Effect of annealing on elastic moduli of a FSMA*, Shap. Mem. Superelasticity, **3 (3),** 199, 2017

Books / Book Chapter / Monographs Published / Edited

1. Ritayan Chatterjee, Dinabandhu Ghosh, Surajit Biswas, Sandeep Agarwal, P. K. Mukhopadhyay and Saikat K. Kuila - Characterization of Minerals, Metals, and Materials 2018, Springer, Cham

Lectures Delivered

1. Effect of grain growth inhibitor in magnetoelastic behaviour of FINEMET melt spun ribbons, Md Sarowar Hossain, M.A. Hakim and P.K. Mukhopadhyay, RTCMP, Kolkata, November 2017
2. Elastic moduli of Ni-Fe-Al ferromagnetic shape memory alloy studied by resonant ultrasound spectroscopy, Md Sarowar Hossain, Ankit Kargeti, S. Vinodh Kumar, Barnana Pal and P.K.Mukhopadhyay, NSU 2017, Central University, Dharmshala, November 2017
3. Introduction to Smart materials, the future generation materials – P. K. Mukhopadhyay, Vidyasagar University, March 2018
4. Introduction to Smart materials, the future generation materials – P. K. Mukhopadhyay, Dhaka University, Dhaka, Bangladesh, March 2018

Membership of Committees

External Committee

Executive committee, IPS; Organizing committee member, ICFSMA (world) series of conference

Fellow / Member of Professional Body

1. Life member of ISC
2. Member of APS
3. Life member of IACS

Sponsored Projects

1. TRC – DST – Ongoing

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. K. Srinivasrao, P.Mohanbabu (Sl. No. 1)
2. Santosh Kumar Singh, V.R.K. Murthy, T.P. Sinha (Sl. No. 3)
3. Susenjit Sarkar (Sl. No. 4)

International

1. S. Agarwal (Sl. No. 2)
2. M. A. Hakim (Sl. No. 5)

Societal impact of Research

- The PIMA effect, although not yet understood, is now getting tested for a) Robotic actions that work solely on light shone from a remote control. Without any motor, battery or other electronics, this will be lightest robot known, resulting in lower power demand.
- Similarly it is also being tried with invasive surgical procedure to remove blockages causing strokes. This will be a lifesaving procedure if properly implemented.
- Body armour work is now going to be tested with Kolkata Police for effectiveness against smaller fire arms. If successful, this will be another lifesaving research that came out of my work.

Significant research output / development during last one year

General research areas and problems worked on

General Research area revolved around smart materials, be it FSMA materials, Smart fluids or Ferroelectric materials. Most of these were magnetic materials, either in the solid or in fluid form. In a disordered magnetic alloy, we found an interesting effect of disorder in structure was promoting long range magnetic order – here AFM.

Interesting results obtained

1. The work on theoretical and experimental understanding of origin of disordered magnetism in a simple binary alloy system has thrown open a very interesting scenario that long range magnetic order occurred simultaneously with structural disorder, something that was never found before. Figure 1 shows a representative graph. [Reference: Tanmoy Ghosh, Takashi Fukuda, Tomoyuki Kakeshita, S. N. Kaul, and P. K. Mukhopadhyay; Concomitant antiferromagnetic transition and disorder-induced weak localization in an

interacting electron system; Phys. Rev. B; 2017; 95; 140401 (R)].

2. The PIMA effect was found to be affected simultaneously by color and intensity of the incident beam. This means that while the amplitude of actuation was directly affected by the input flux (like heating effect), similar linear dependence on light frequency hints at some type of photonic effect. Reference 4 gives more information on this effect, Figure 2 shows the color dependence. While we still do not understand the effect and we are trying various ways to do so, we are trying to harness the effect in two diversified applications, namely robotics and surgery. While recently we have demonstrated a prototype for end effector of a robotic arm, working only under laser guidance of a remote source, we are now preparing a patent on it. For the surgical procedure, the work is elaborate and vast. It is operating under the aegis of TRC project and under the active guidance of a medical practitioner.

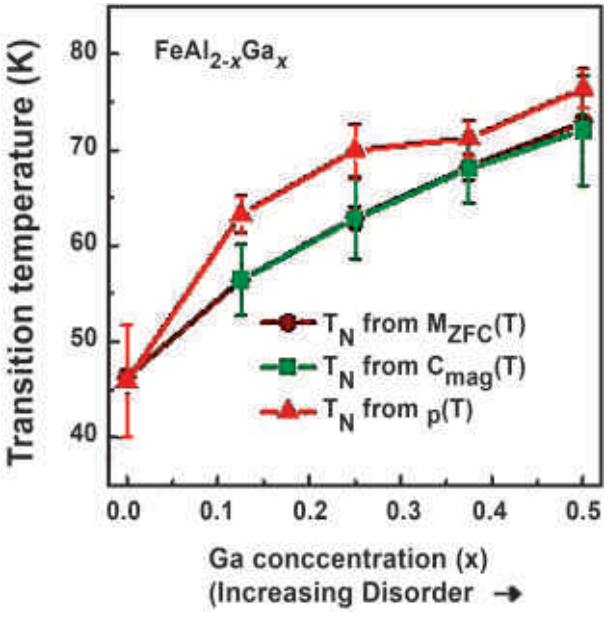


Fig.1 : Increasing structural disorder brings more magnetic ordering

3. On elastic property measurements of FSMA alloys (a characteristic that will eventually decide the practical utility value of the alloy), we made significant progress about improving the property of some of the alloys.

4. We prepared and worked on various nano and microparticles of ferromagnetic alloys and made measurements of their magnetorheological properties.

5. Finally we worked on Perovskite and other oxides and characterized them..

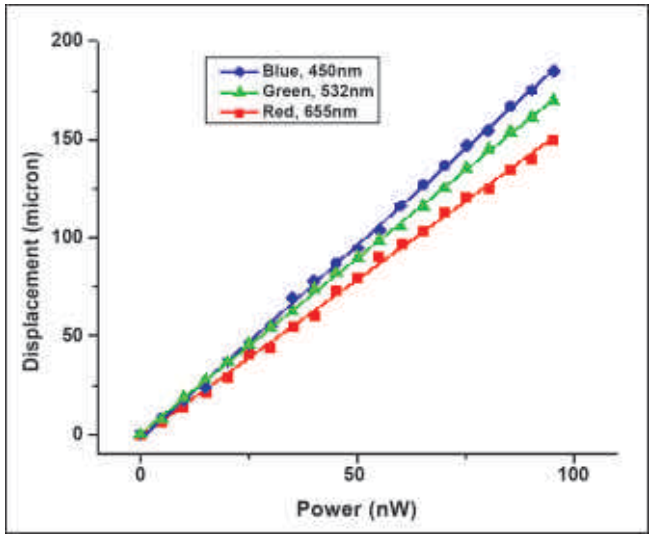


Fig.2 : Color dependence of PIMA effect

Proposed research activities for the coming year

We will continue to develop various prototypes for robotic and interventional cardiological applications, while looking for the original and explanation for the PIMA effect. Body armor work will be continued with patronage from various law enforcing agencies.

Priya Mahadevan

Senior Professor
CMPMS
priya@bose.res.in

Professor Priya Mahadevan is a Condensed Matter theorist working on understanding how materials behave using both ab-initio as well as model Hamiltonian calculations.

Supervision of Research / Students

Ph.D. Students

1. Shishir Kumar Pandey, Microscopic model for spin, charge and orbital ordering in transition metal compounds, Completed
2. Sagar Sarkar, Role of structure in determining properties of transition metal/post transition metal compounds, Completed
3. Poonam Kumari, The effect of spin-orbit coupling on electronic structure, magnetism and optical properties of transition metal compounds, Ongoing
4. Joydeep Chatterjee, Electronic and structural properties of semiconductor heterostructures, Ongoing
5. Sumanti Patra, Growth, electronic and optical properties of two-dimensional nanoplatelets, Ongoing
6. Sowmyadipta Pal (external), Electronic structure of Ni-Mn based heusler alloys, Ongoing

Teaching activities at the Centre

1. Aug-Dec 2017: Condensed Matter Physics I-PhD

Publications in Journals

1. Shishir Kumar Pandey, **Priya Mahadevan** and D.D. Sarma, *Doping an antiferromagnetic insulator: A route to an antiferromagnetic metallic phase*, Europhys. Lett., **117**, 57003 (2017)
2. N Vijay Prakash Chaudhary, S. Sarkar, N. Sharma, Ashis K Kundu, K.S.R. Menon, A. Das, **Priya Mahadevan** and A. Venimadhav, *Doping a Dipole into an incipient ferroelectric: Route to relaxor ferroelectrics*, Phys. Rev. B, **96**, 024107 (2017)
3. B. Mandal, Hirak Kumar Chandra, Poonam Kumari and **Priya Mahadevan**, *Quantum confinement : A route to enhance the Curie temperature of Mn doped GaAs*, Phys. Rev. B, **96**, 014430 (2017)
4. S. Sarkar and **Priya Mahadevan**, *Role of the A-site cation in determining the properties of hybrid perovskite* $CH_3NH_3PbBr_3$, Phys. Rev. B, **95**, 214118 (2017)
5. Poonam Kumari, Saikat Debnath and **Priya Mahadevan**, *Structural distortions in monolayers of binary semiconductors*, Phys. Rev B, **97**, 041404(R) (2018)
6. **Priya Mahadevan**, *HyPe-2017: A Discussion Meeting on Hybrid Perovskites*, ACS Energy Lett., **3**, 733 (2018)

Lectures Delivered

1. Magnetism beyond 3d transition metal oxides, CSIC, Madrid Spain, June, 2017
2. Role of A site cation in determining the properties of hybrid perovskites of the form ABX_3, Workshop on Semiconductor Physics, Hohhot China, August, 2017
3. Quantum confinement – a route to enhance the Curie temperature of Mn doped GaAs, Recent Advances In Condensed Matter Physics and Nonlinear Dynamics, Pune University, Pune India, October, 2017

4. Doping an antiferromagnetic insulator: Route to an antiferromagnetic metal, Young Investigators Meet on Condensed Matter Theory, SN Bose centre, Kolkata, October, 2017
5. Quantum confinement – a route to enhance the Curie temperature of Mn doped GaAs, Recent Trends in Condensed Matter Physics - 2017, Bose Institute, Kolkata, November, 2017
6. Hybrid Perovskites under pressure: Revisiting some structural chemistry concepts, HyPe-2017, S.N.Bose centre, Kolkata, December, 2017
7. Role of A site cation in determining the properties of hybrid perovskites of the form ABX_3, IWAM 2017, NIST Berhampur, Berhampur, December, 2017
8. What holds the atoms together in a solid, 9th Vidyasagar-Satyendranath Bose National Workshop on Science of Materials: Challenges and Prospects (SMCP-2018), Vidyasagar University, Midnapore, January 2018

Membership of Committees

External Committee

Various DST committees; Member - INSA-ICSU; Member - IUPAP committee on computational physics

Internal Committee

Thesis committees of several students; Internal Complaints Committee; SCRE; CWEP

Sponsored Projects

1. Materials for sustainable Energy and Electronics: Linking Communities at Duke and in India, Duke-India Initiative, Dec 2017 – Dec 2018

Conference / Symposia / Workshops / Seminars etc. organized

1. HyPe-2017, 14-15 December 2017, S.N.Bose centre, Convenor

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

Sl. No. 1 & 2

Participation in Science Outreach program

As a part of Science Outreach program I participated at the SN Bose centre- Vidyasagar University workshop on Science of Materials

Societal impact of Research

- Examining energy materials: A key aspect has been to understand the structure and electronic structure of hybrid perovskites that plays a key role in their device operation
- Optimal material for antiferromagnetic spintronics: Provided a route to antiferromagnetic metals
- A route to increase the ferromagnetic transition temperature in dilute magnetic semiconductors so that one can explore if we can use them in room temperature spintronic applications

Significant research output / development during last one year

General research areas and problems worked on

Examined doping an antiferromagnetic insulator as a route to antiferromagnetic metals. Another aspect that we explored in spintronic materials was the possibility of increasing the Curie temperature in dilute magnetic semiconductors. Analogous to dilute magnetic semiconductors, we explored doping a dipole in an incipient ferroelectric towards ferroelectric order

Interesting results obtained

Antiferromagnetic metals are rare, just as ferromagnetic insulators are. Any examples of either require a mechanism different from the ones conventionally used to explain the origin of magnetic order. In a recent work (EPL 117 57003 (2017)) we have explored the possibility of doping an antiferromagnetic insulator and retaining the antiferromagnetic order while driving the system metallic. At first sight, this seems an impossibility as all the phase diagrams of the doped 3d transition metal oxides have only ferromagnetic metallic phases. We trace this to the fact that the 3d transition metal atoms have a large Hund's intraatomic exchange interaction strength. This is what leads to a phase diagram in which there are only ferromagnetic metallic phases present. However, we show that in the

limit of small intraatomic exchange interaction which is applicable for the later group transition metal oxides and realizable in the osmates for instance, one can have an antiferromagnetic metallic phase in the phase diagram.

Bulk transition metal compounds have been studied for a long time and their electronic structure is well established within the framework of the Zaanen-SawatzkyAllen (ZSA) phase diagram and its variants. A similar framework should be possible for dilute magnetic semiconductors which we examine in the present work. We consider a multiband Hubbard model to describe the electronic structure of the dilute magnetic semiconductors with Coulomb interactions included on the transition metal site. Parameters appropriate for Mn doped GaAs place it in the regime of a p-d metal of the ZSA phase diagram, thereby explaining why correlation effects don't drive it insulating. Quantum confinement effects can be used to tune the charge transfer energy Δ, driving a change in the character of the hole state. We show that this also serves as a parameter to change the Curie temperature. Confinement arising from the presence of the surface could lead to the same effect of enhancing the Curie temperature, from that observed in the bulk. A manuscript based on this work has been published in PRB 96, 014430 (2017).

Recent interest in two-dimensional semiconductors that began with graphene has looked for other examples of semiconductors in which one has planar structures. Considering the examples among the III-V and II-VI semiconductors, one finds that they favour four atom coordination in their bulk structures. If they were to adopt a graphitic structure, to make up for the lost coordination, they form shorter bonds. However what we show (PRB 97 041404 (2018)) is that as a result of increased Coulomb interactions between electrons on neighbouring atoms, one has a buckling with the cations moving out of the plane of the anions. Interestingly, this structure is found to be non-polar. Strain is found to be a parameter which can stabilize a planar graphitic phase in these systems also.

Proposed research activities for the coming year

In the coming year, we will extend our work in identifying experimentally viable parameter regimes to look for antiferromagnetic metals. There have been some systems which do not become metallic inspite of doping beyond the percolation threshold and these will be examined in detail.

Our earlier work pointed out that strain was a parameter which could be used to stabilize free standing graphitic phases among compounds formed with later row elements. A route to apply strain is via a substrate. In the future we will consider the easily available experimental substrates and determine the modifications in the structure and the electronic structure that the presence of a substrate brings in.

Prosenjit Singha Deo

Professor
CMPMS
deo@bose.res.in

Professor Prosenjit Singha Deo did his PhD from Institute of Physics, Bhubaneswar and a couple of post docs abroad. He works in mesoscopic physics

Teaching activities at the Centre

1. From August to December 2017 I taught Mathematical methods (PHY102) to 1st semester MSc (post BSc) students at S.N. Bose Centre. Co-teacher – Prof. Samir Paul

Publications in Journals

1. Dayasindhu Dey, Sudip Kumar Saha, **P. Singha Deo,** Manoranjan Kumar and Sujit Sarkar, *A study of topological quantum phase transition and majorana localization length for the interacting helical liquid system*, Journal of Physical Society of Japan, **86,** 074002 (2017)
2. **P. Singha Deo,** *Negative partial density of states in mesoscopic systems*, Journal of Material Science and Engineering, **6,** 73 (2017)
3. **P. Singha Deo,** *Negative time scales in quantum systems*, J Astrophys Aerospace Technol, **5,** 59 (2017)

Lectures Delivered

1. Key note talk on "Negative partial density of states in mesoscopic systems" at 3rd international conference on theoretical and condensed matter physics in New York, October 2017
2. Special session talk on "non-ergodic systems" in Physicists congress Japan in May 2018, Tokyo, Japan
3. High energy physics conference in Rome, Italy in December 2017. Delivered a talk titled "negative time scales in mesoscopic systems"

Societal impact of Research

- Teaching MSc course
- Research may lead to development of new devices in future

Significant research output / development during last one year

General research areas and problems worked on

- Scattering phase shifts in low dimensional systems
- Role of evanescent modes in transport and thermodynamic properties of mesoscopic systems

Interesting results obtained

We have shown that one can build an apparatus to experimentally measure the density of states and other related quantities of small mesoscopic systems without having to do an averaging on impurity configuration.

Proposed research activities for the coming year

Dispersion of wavepackets in low dimensional quantum systems and their technological importance.

Ranjan Chaudhury

Professor
CMPMS
ranjan@bose.res.in

Professor Ranjan Chaudhury received his PhD (Science) from TIFR, Mumbai (Bombay University) in 1988 ; he was a Post-doctoral and collaborating Visiting Scientist at ICTP (Trieste, Italy), McMaster University (Hamilton, Canada), University of Minnesota (Minneapolis, USA), LEPES-CNRS (Grenoble, France) & BLTP-JINR (Dubna, Russia) ; Full Faculty at S.N. Bose Centre since 1994 ; his Awards/Honours include : NSTS scholarship by NCERT (1976) ; Biography selected and published in Marquis Who's Who in the World, New Jersey, USA (1999 & 2011) and in Marquis Who's Who in Asia, New Jersey, USA (2007) ; Awarded International Scientist of the Year 2007 by IBC, Cambridge, Great Britain (2007); Visiting Professor at AUST (Abuja, Nigeria) under NMI (Washington DC, USA) during 2009-2010; Member of Physics Division of American Chemical Society since 2010 ; Fellow of Minnesota Supercomputer Institute (Minneapolis, USA) since 1992 ; Member of Rayonnement du CNRS since 1995.

Supervision of Research / Students

Ph.D. Students

1. Subhajit Sarkar, Topological Excitations and Spin Dynamics in Magnetic Systems in Low Dimensions, PhD degree obtained
2. Suraka Bhattacharjee, Study of generalized spin and charge stiffness constants of strongly correlated doped quantum antiferromagnet on low-dimensional lattices based on t-J-like models, Ongoing
3. Soumi Roy Chowdhury, Studies on Superconducting Pairing Mechanism in Low Dimensional Materials, Ongoing
4. Koushik Mandal, Superconducting Pairing in Correlated Fermionic Systems, Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Sayan Routh| Post-B.Sc. student at SNBNCBS, Landau Diamagnetism and its application in Condensed Matter Systems, Ongoing
2. Karabi Chatterjee|M.Sc. student at Diamond Harbour Womens' University, Study of Cooper Pairing Mechanism Using One and Two Square Well Potential Models and Isotope Exponent From The BCS Theory, Ongoing

Publications in Journals

1. **Ranjan Chaudhury,** *Topological Excitations in Low Dimensional Magnetic systems*, Journal of Material Science & Engineering (special issue as the Proceedings of CMP 2017), **6**, Issue 7, 78 (2017)

Lectures Delivered

1. Topological Excitations in Low Dimensional Magnetic Systems, Invited Talk at 3rd International Conference and Exhibition on Theoretical and Condensed Matter Physics, New York (USA), October 2017, 1 lecture

Fellow / Member of Professional Body

1. Continued as a Member of the Physical Chemistry Division of the American Chemical Society (USA)
2. Continued as an Active Member of Physics Unit of Athens Institute For Education And Research (ATINER) Athens (Greece)

Conference / Symposia / Workshops / Seminars etc. organized

1. International Workshop on Bose-Einstein Condensation and

Related Phenomena (IWBECRP), 26-28 March 2018, S.N. Bose National Centre For Basic Sciences, Convenor

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

1. With S.K. Paul (Theoretical Sciences department) [ongoing]

International

1. With M. P. Das (ANU, Canberra, Australia) [ongoing]

Participation in Science Outreach program

- Became an Adjunct Professor at RKMVERI (Belur) in department of Physics since July 2017 and started teaching there. I have taught 2 Condensed Matter Physics courses viz. (I) General and (ii) Advanced at the Master's level during 2017-18. Beside this, I have also given guidance to some of the students there on their dissertation thesis.
- Participated in the "Workshop In Theoretical Physics" held at RKMVERI (Belur) during 18-21 December 2017, as a Registered Participant.

Societal impact of Research

- The research related to high temperature superconductivity and allied problems is aimed towards the understanding of the microscopics for achieving the dream of dissipationless power transmission at room temperature.
- The research related to quantum modelling of bio-molecules like DNA, has the potentiality of understanding the mutational damage to the living cells and the possible repair as well.

Significant research output / development during last one year

General research areas and problems worked on

(i) Calculation of generalized spin and charge stiffness constants and connection with effective exchange coupling and charge-charge coupling in strongly correlated doped quantum antiferromagnets on low-dimensional lattices in the form of t-J -like models , with inclusion of long range hoppings, on 1D lattice in particular

(ii) Revisiting Cooper's pairing problem on 2D lattice with long range hoppings in the presence of both excitonic and phononic mechanisms and possible application to Cuprate superconductors under various normal state scenarios, corresponding to different doping regimes

(iii) Theoretical investigation of anisotropic superconductivity in multi-layered systems with the inclusion of intra-layer pair formation and inter-layer pair tunneling processes with possible application to Fe-pnictides and Cuprates

Interesting results obtained

(i) In 1D case, the generalized spin stiffness constant as a function of doping shows quite distinct behaviour for the contributions from the hopping term and the exchange term. Detailed analysis of ours show that the former is very similar to that due to a ferromagnetic-like coupling and the latter resembling an anti-ferromagnetic like response. Overall, the system shows a cross-over from decaying anti-ferromagnetic coupling to a ferromagnetic-like coupling developing amongst the itinerant spin degrees of freedom in low doping regime. For 2D case, the point of singularity in spin stiffness function as a function of doping, shifts to lower doping concentration value in the presence of higher neighbour hoppings. The charge stiffness constant shows distinct possibility of fermionic pairing in some region of doping in the underdoped regime in the 2D situation. This has tremendous consequences for both Cuprate and Fe-pnictide superconductors.

(ii) Taking into account the realistic single electron Green function in the normal phase with the inclusion of all the self energy corrections arising from the relevant many-body effects, the Cooper's pairing equation was investigated in 2D in the band context, invoking various boson exchange mechanisms. Taking the single electron density of states to be of a modified Marginal Fermi Liquid type, as suggested by photo-emission experiments, the pairing equation was solved. Invoking excitonic mechanism for pairing interaction in the intermediate coupling regime, good results were obtained for coherence length and binding

energy in agreement with experiments for Cuprates in the optimal to overdoped regimes.

(iii) The condition of the non-negativity of the energy of the Bogoliubov quasi-particles in the superconducting phase of the multi-layered system was tested more rigorously and found to be genuine. The consequences like the existence of the threshold magnitude of the out-of-plane gap in some region in the vicinity of the Fermi-line in the pair forming 2D layer, was analysed in more detail for comparison with experiments on Cuprates and Fe-pnictides.

Proposed research activities for the coming year

(i) Finite temperature field theory based calculation for determining the spin dynamical structure function for quantum XY-anisotropic models on 2D lattice with a synthesis with numerical techniques, for studying the effect of topological excitations more clearly.

(ii) Theoretical investigation of the consequences of the variation of inter-strand couplings on various processes of DNA through quantum modelling based calculations.

(iii) Theoretical determination of the phase diagram of the anisotropic multi-layered multi-band superconductors corresponding to both strongly correlated and weakly correlated normal phases.

Any other matter

I have been invited by ATINER to deliver a talk in the International Conference on Physics to be held in Athens (Greece) in July 2018.

Samit Kumar Ray

Director & Senior Professor
CMPMS
samit@bose.res.in

Study of semiconductor quantum structures for nanoscale devices such as quantum dot infrared photodetectors, nanowire heterostructures and single nanowire devices. Plasmonic semiconductor structures are being studied for piezo-phototronics, sensors and tunable photodetector devices. The group is also active on the integration of 2D materials based photonics on Si platforms.

Supervision of Research / Students

Ph.D. Students

1. Didhiti Bhattacharya (Jointly with Dr. Rajib Mitra)
2. Subhrasish Mukherjee (Jointly with Dr. Atindra Nath Pal)

Publications in Journals

1. RK Chowdhury, TK Sinha, AK Katiyar, **S. K. Ray**, *Synergistic effect of polymer encapsulated silver nanoparticle doped WS_2 sheets for plasmon enhanced 2D/3D heterojunction photodetectors*, Nanoscale, **9**, 15591-15597 (2017)
2. S Bhattacharya, A Ghorai, S Raval, M Karmakar, A Midya, **SK Ray**, P.K. Datta, *A comprehensive dual beam approach for broadband control of ultrafast optical nonlinearity in reduced graphene oxide*, Carbon, **134**, 80-91, 2018
3. S. Bayan, A. Midya, N. Gogurla, A. Singha and **S. K. Ray**, *Origin of Modified Luminescence Response in Reduced Graphitic Carbon Nitride Nanosheets*, J. Phys. Chem. C, **121** (35), 19383 (2017)
4. R. Maiti, T. K. Sinha, S. Bhattacharya, P. K. Datta, and **S. K. Ray**, *Facile One-Pot Synthesis of Highly Stable Graphene – Ag^0 Hybrid Nanostructures with Enhanced Optical Properties*, J. Phys. Chem. C, **121**, 21591-21599 (2017)
5. R. Bar, A. Katiyar, R. Aluguri and **S. K. Ray**, *Emission characteristics of self-assembled strained $Ge_{1-x}Sn_x$ islands for sources in the optical communication region*, Nanotechnology, **28**, 295201 (2017)
6. S Singh, A Katiyar, A Midya, A Ghorai, **S. K Ray**, *Superior heterojunction properties of solution processed copper-zinc-tin-sulphide quantum dots on Si*, Nanotechnology, **28**, 435704 (2017)
7. S. Bayan, N. Gogurla, A. Midya, A. Singha and **S. K. Ray**, *Plasmon mediated enhancement and tuning of optical emission properties of two dimensional graphitic carbon nitride nanosheets*, Nanotechnology, **28**, 485204 (2017)
8. A. Ghorai, A. Midya and **S. K Ray**, *Superior Charge Storage Performance of WS_2 Quantum dots in a Flexible Solid State Supercapacitor*, New J. Chemistry, **42** (5), 3609-3613, 2018
9. S Samanta, S.Z Rahaman, A Roy, S Jana, S Chakrabarti, R Panja, S Roy, M. Dutta, S. Ginnaram, A. Prakash, S. Maikap, H. Cheng, L. Tsai, J. Qiu, **S. K. Ray**, *Understanding of multi-level resistive switching mechanism in GeO_x through redox reaction in H_2O_2/sarcosine prostate cancer biomarker detection*, Scientific Reports, **7**, 11240 (2017)
10. N. Gogurla, S. Bayan, P. Chakrabarty, **S. K. Ray**, *Plasmon Mediated Enhancement of Visible Light Emission of Au-ZnO Nanocomposites*, Journal of Luminescence, **194**, 15 (2018)
11. S.S. Sarkar, A. K. Katiyar, A. Sarkar, A. Dhar, A. Rudra, R.K. Khatri, **S. K. Ray**, *Germanium growth on electron beam lithography patterned Si_3N_4/Si(001) substrate using molecular*

beam epitaxy, Applied Surface Science, **437**, 144–151 (2018)

12. A. Garai, S. Mukherjee, **S.K. Ray**, and K. Biradha, *Tuning Emission Properties via Aromatic Guest Inclusion in Organic Salts Composed of 4,4 -Dinitro-2,2 ,6,6 -tetracarboxybiphenyl and Acridine*, Crystal Growth & Design, **18** (2), 581-586, 2018

Other Publications

1. S Santra, AD Luca, PK Guha, F Udrea, **SK Ray**, JW Gardner, "Integration of Au-SnO_2 Nanocomposites with Power Efficient MEMS Substrate for Acetone Sensing, IEEE sensors, Glasgow, UK, Oct. 30 – Nov. 1, 2017
2. S Dey, S Santra, S Sen, D Burman, **SK Ray**, PK Guha - Photon assisted ultra-selective Formaldehyde sensing by defect induced NiO nanostructured sensing layer, IEEE SENSORS, Glasgow, UK, Oct. 30 – Nov. 1, 2017
3. S. Pal, N. Gogurla, S. Bayan, D. K. Goswami and **S. K. Ray**, "Enhanced Photodetection in Plasmonic Au-ZnO nano-composites", Intl. Workshop on Physics of Semiconductor Devices, New Delhi, Dec. 11-15, 2017
4. S. Singh, A. K. Katiyar, A. Midya, A. Ghorai, D. K. Goswami and **S. K. Ray**, "CZTS nanocrystals on Si Substrates: an efficient heterojunction solar cell", Emerging Trends in the physics of Surfaces, Interfaces and Nanostructures, Kolkata, Nov. 24-25, 2017
5. S. Singh, A. K. Katiyar, A.Midya, A. Ghorai, D. K. Goswami and **S. K. Ray**, "Green route synthesis of CZTS nanocrystals for photovoltaic applications". Intl. Workshop on Physics of Semiconductor Devices, New Delhi, Dec. 11-15, 2017
6. Ghorai, A. Midya and **S. K Ray**, "Enhanced Energy Storage performance of Exfoliation WS2 QD by a new Lithium Intercalation Method", Emerging Trends in the physics of Surfaces, Interfaces and Nanostructures, Kolkata, Nov. 24-25, 2017
7. T. Dey, S. Mukherjee, A. Ghorai, A. Midya, S. Das and **S.K. Ray**, "Tunable Optical Properties of Graphene Quantum Dots". Intl. Workshop on Physics of Semiconductor Devices, New Delhi, Dec. 11-15, 2017
8. R.K.Chowdhury, S.Nandy, M. Karmakar, S. Bhattacharya, B N S. Bhaktha, A. Taraphder, P. K Datta and **S.K. Ray**, "Generation and Evolution of Quasiparticles in Layered WS2: A Time-Resolved Pump-Probe Spectroscopy", UFS-2017, Hyderabad, Nov. 2-4, 2017
9. M. Karmakar, **S. K Ray**, P. K Datta et. al, "Effect of size confinement in C exciton dynamics of few-layered MoS_2 nano-sheets", UFS-2017, Hyderabad, Nov. 2-4, 2017

Lectures Delivered

1. Two-dimensional Materials for Multi-functional Applications, Intl. Conf. on Materials Engineering, IIT Kanpur, June 2017
2. Strained Ge Films and Nanostructures for Optoelectronic Devices, Intl. Conf. on Thin Films, NPL Delhi, Nov., 2017
3. Semiconductor Nanostructures – Role of Surfaces & Interfaces, Physics of Surfaces & Interfaces, IACS Kolkata, Nov. 2017
4. Nanophotonic Devices using 2D/3D Heterostructures on Si Platform, Intl. Workshop on Phys. of Semiconductor Devices, IIT Delhi, Dec., 2017
5. Plasmonic Semiconductor Nanostructures for Multifunctional Devices, Indo-US Discussion Meeting on Surfaces & Interfaces, SINP Kolkata, January 2018
6. Quantum Structures for Photonic Devices, CTMSE 2018, SNBNCBS, Kolkata, January 2018
7. Silicon Nanostructures for Green Photonic Devices, Meeting of Asia Pacific Academy of Materials, Trichy, Feb., 2018
8. Plasmonic Nanostructures, Physics & Chemistry of Materials, Thimpu, March 2018

Academic Visits

International

1. Collaborative Research, Chang Gung University, Taiwan, July 2017

2. Editorial Board meeting of the Journal "Nanotechnology", IOP, UK at London, July 2017

Fellow / Member of Professional Body

1. Fellow, National Academy of Sciences India (NASI)

Conference / Symposia / Workshops / Seminars etc. organized

1. Emerging Trends in the physics of Surfaces, Interfaces and Nanostructures, Nov. 24-25, IACS & SNBNCBS, Kolkata 2017, Jt. Convener
2. International Collaboration on Bose Einstein Condensation & Related Phenomena, March 26 – 28, SNBNCBS, Kolkata, Jt. Convenor

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

Sl no. 1 to 12 with IIT Kharagpur

Participation in Science Outreach program

Delivered following lectures for College / University students

- Silicon Based Multifunctional and Green Photonic Devices at Science City, Kolkata - 29/04/17
- CKM Majumdar Memorial Summer Workshop on Physics at SNBNCBS – 29/05/2017
- Vidyasagar – S. N. Bose Workshop at Vidyasagar University – 17/01/18
- S. N. Bose Memorial lecture at Bangiya Bigyan Parishad – 25/01/18
- Bijoy Krishna Girls College, Howrah – 7/2/18

Societal impact of Research

- Development for prototypes for security & defence applications
- Development of new earth abundant materials for low cost energy solution on cheap substrates

Significant research output / development during last one year

General research areas and problems worked on

- Semiconductor quantum structures
- Nanoelectronic & Nano-photonic devices
- 2D heterostructures on Si platform
- Earth abundant photovoltaic Materials
- Sensors for environment monitoring

Interesting results obtained

(a) Plasmonic 2D/ 3D Heterojunction

Chemical doping and plasmonic enhanced photoresponsivity of two dimensional (2D) n-WS2/p-Si heterojunctions have been studied. l PVP coated Ag0 intercalation induced synthesis has led to the formation of impurity-free, chemically doped few-layer n-WS2 with reversed conductivity following the Maxwell–Wagner–Sillars interfacial effect. The resultant composite film exhibits excellent stability and tunable plasmonic absorption due to silver nanoparticles of different sizes. A sharp band edge absorption of the hybrid material indicates the presence of spin–orbit coupled direct band gap transitions in WS2 layers, in addition to a broader

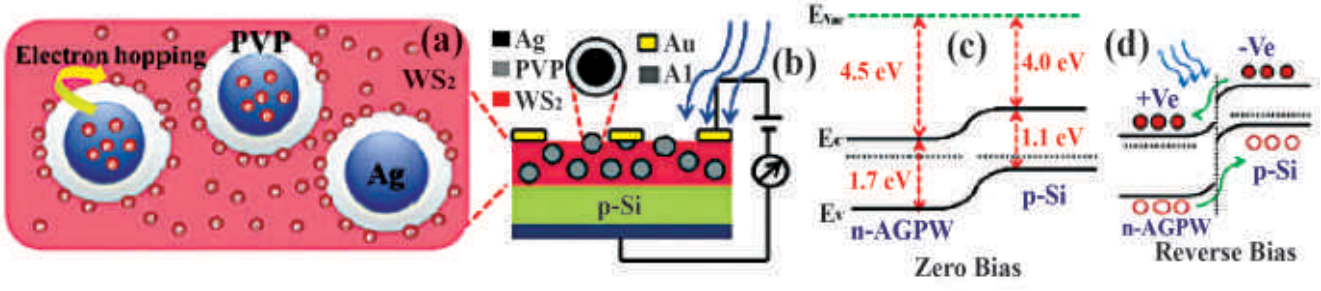


Fig.1 (a) Schematic representation of the Maxwell–Wagner–Sillars interfacial effect in PVP coated Ag nanoparticles embedded WS_2 layers (b) schematic n-AGPW/p-Si heterojunction device. Corresponding band diagram for (c) zero and (d) reverse bias conditions.

plasmonic peak attributed to Ag nanoparticles. Stabilized Ag-nanoparticle (~ 4–6 nm) embedded electron rich n-WS2 has been used to fabricate plasmon enhanced, silicon compatible heterojunction photodetectors. The detectors exhibited superior properties, possessing a photo-to-dark current ratio of ~ 10^3, a very high responsivity (8.0 A W^{-1}) and an EQE of 2000% under 10 V bias with a broad spectral photo-response in the wavelength range of 400–1100 nm. The results provide a new paradigm for intercalant impurity-free metal nanoparticle assisted exfoliation of n-type few-layer WS2, with the nanoparticles playing a dual role towards the realization of 2D materials based broadband heterojunction optoelectronic devices by inducing chemical doping as well as tunable plasmon enhanced absorption.

(b) Ge1 – xSnx Quantum Dots : Direct Band Gap Emission

Self-assembled strained Ge1 – xSnx islands on Si (100) have been grown at a low temperature using molecular beam epitaxy. The in-built strain and fraction of Sn in the islands have been estimated using x-ray photoelectron spectroscopy and high-resolution x-ray diffraction study of grown samples. No-phonon assisted transition in the optical communication wavelength range of 1.4–1.8 μm has been observed in the Ge1 – xSnx island samples. The direct band gap transition intensity is found to increase with an increase in Sn concentration and the emission is sustained up to a temperature of 130 K in Ge1 – xSnx islands. The observed electroluminescence in p-i-n devices fabricated on Ge1 – xSnx island samples above a threshold bias of 4 V makes them attractive for future Si based optical emitters.

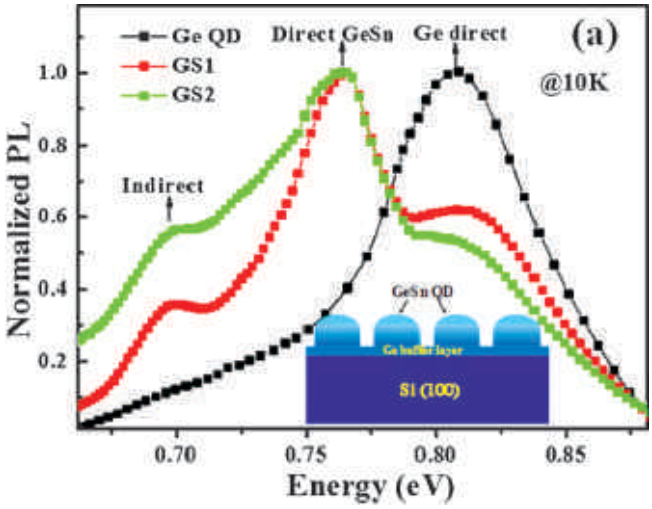


Fig.2 Low temperature photoluminescence spectra of Ge and SnxGe1-x quantum dots with Sn concentration of 2.5% and 3.5%.

Tanusri Saha Dasgupta

Senior Professor (on Lien to IACS)
CMPMS
tanusri@bose.res.in

Prof. Tanusri Saha Dasgupta is a Computational Condensed Matter Physicist interested in novel materials properties both in bulk and in nanoscale.

Supervision of Research / Students

Ph.D. Students

1. Kartik Samanta, First principle study on Transition Metal compound using Density Functional Theory (DFT), Submitted in August 2017
2. Hrishit Banerjee, Electronic Structure Study of Organic and Inorganic complexes, to be submitted in June 2018
3. Dhani Nafday, Electronic Structure of graphene and related materials, Ongoing (expected Submission in August 2018)
4. Ransell Disuza, First-principles Study of 2D materials, Ongoing (expected Submission in August 2018)
5. Paulomi Chakraborty, Mechanical and Electronic Properties of Technological Important Materials, Ongoing
6. Anita Haldar, Study and prediction in Double Perovskite Compounds, Ongoing
7. Shreya Das, Computational Study of Oxohalides, Ongoing

Post Doctoral Research Scientist/s

1. Shamik Chakrabati
2. Aurab Chakrabarty

Publications in Journals

1. A Halder, D Nafday, P Sanyal, **T Saha-Dasgupta**, *Computer predictions on Rh-based double perovskites with unusual electronic and magnetic properties*, npj Quantum Materials, **3**, 17 (2018)
2. Anindita Sahoo, Dhani Nafday, Tathagata Paul, Roald Ruiter, Arunesh Roy, Maxim Mostovoy, Tamalika Banerjee, **Tanusri Saha-Dasgupta**, Arindam Ghosh, *Out-of-plane interface dipoles and anti-hysteresis in graphene-strontium titanate hybrid transistor*, npj 2D Materials and Applications, **2**, 9 (2018)
3. Olga Yakubovich, Galina Kiriukhina, Larisa Shvanskaya, Olga Maximova, Anatoliy Volkov, Olga Dimitrova, Evgeniy Ovchenkov, Oleg Yumashev, Asif Iqbal, Badiur Rahaman, **Tanusri Saha-Dasgupta**, Alexander Vasiliev, *Canted antiferromagnet superimposed on a buckled kagomé network in* $RbMn_4(PO_4)_3$, Acta Crystallographica Section C: Structural Chemistry, **74**, 641 (2018)
4. K Samanta, **T Saha-Dasgupta**, *Comparative Study of Electronic Structure and Magnetic Properties of Osmate Double Perovskites:* Ca_2FeOsO_6 *versus* $Ca_2Co(Ni)OsO_6$, J. Phys. Soc, Jpn, **87**, 041007 (2018)
5. Kengo Oka, Touru Yamauchi, Sudipta Kanungo, Taku Shimazu, Katsuyohi Oh-ishi, Yoshiya Uwatoko, Masaki Azuma, **Tanusri Saha-Dasgupta,** *Experimental and Theoretical Studies of the Metallic Conductivity in Cubic* $PbVO_3$ *under High Pressure*, J. Phys. Soc. Jpn, **87**, 024801 (2018)
6. P Das, **T Saha-Dasgupta**, S Puri, *Universality of domain growth in antiferromagnets with spin-exchange kinetics*, Euro Phys. J E, **40**, 94 (2017)

7. T Das, S Chatterjee, S Ghosh, **T Saha-Dasgupta**, *First-principles prediction of Si-doped Fe carbide as one of the possible constituents of Earth's inner core*, Geo. Res. Lett., **44**, 8776 (2017)
8. P Paul, P Chakraborty, T Das, D Nafday, **T Saha-Dasgupta**, *Properties at the interface of graphene and Ti_2C MXene*, Phys. Rev. B, **96**, 035435 (2017)
9. H Banerjee, S Chakraborty, **T Saha-Dasgupta**, *Design and Control of Cooperativity in Spin-Crossover in Metal–Organic Complexes: A Theoretical Overview*, Inorganics, **5**, 47 (2017)

Other Publications

1. A Paul, A Mukherjee, A Paramekanti, I Dasgupta, **T Saha-Dasgupta**, Theory of pressure induced insulator to metal transition in $BiNiO_3$, Bulletin of the American Physical Society C45.00012 (2018)

Lectures Delivered

1. Metalorganics, TU Vienna, Vienna, Austria, May 2017
2. 24th Workshop on Oxide Electronics, Chicago, September 2017
3. International workshop on advanced materials (IWAM-2017) organized by National Institute of Science and Technology (NIST), Berhampur, Odisha, India and Drexel University, Philadelphia, USA, December 2017
4. International conference on current trends in material sciences and engineering (CTMSE 2018) organised by Institute of Engineering & Management, Kolkata, India, January 2018.
5. Workshop on Advanced Materials in the UAE in Ras al Khaima (RAK) February 2018
6. "Physics and Chemistry of Materials", Thimpu Bhutan, March (2018)

Academic Visits

International

1. Indo-Russian project, Moscow State University, April 2017
2. Indo-Austria project, TU Graz, Austria, May 2017

Membership of Committees

External Committee

Nanomission Apex committee; Scienticific Council Member, Indo-French Centre for the Promotion of Advanced Research (CEFIPRA); DST-SERB PAC in Physical Sciences

Internal Committee

Faculty Search Committee, Comvener; Associate Dean Faculty till November 2017

Awards / Recognitions

1. Dr A P J Abdul Kalam HPC (High Performance Computing) Award

Sponsored Projects

1. Thematic Unit of Excellence on Computational Materials Science, PI
2. Technology Research Center, Co-PI

Collaborations including publications (Sl. No. of the paper listed in 'Publications in journals' jointly published with collaborators)

National

1. Sl. No. 2 Arindam Ghosh (IISc)
2. Sl. No. 6 Sanjay Puri (JNU)
3. Sl. No. 7 Sujoy Ghosh (IIT KGP)

International

1. Sl. No. 3 A. Vasiliev (Moscow State University)
2. Sl. No. 5 Masaki Azuma (Tokyo Tech)

Participation in Science Outreach program

- Resource person at at the Science Academies Lecture-Workshop in Bhairab Ganguly College
- Resource person at at the Science Academies Lecture-Workshop in Central University of Tripura
- Resource person at at the Science Academies Lecture-Workshop in Vishabharati University

Significant research output / development during last one year

General research areas and problems worked on

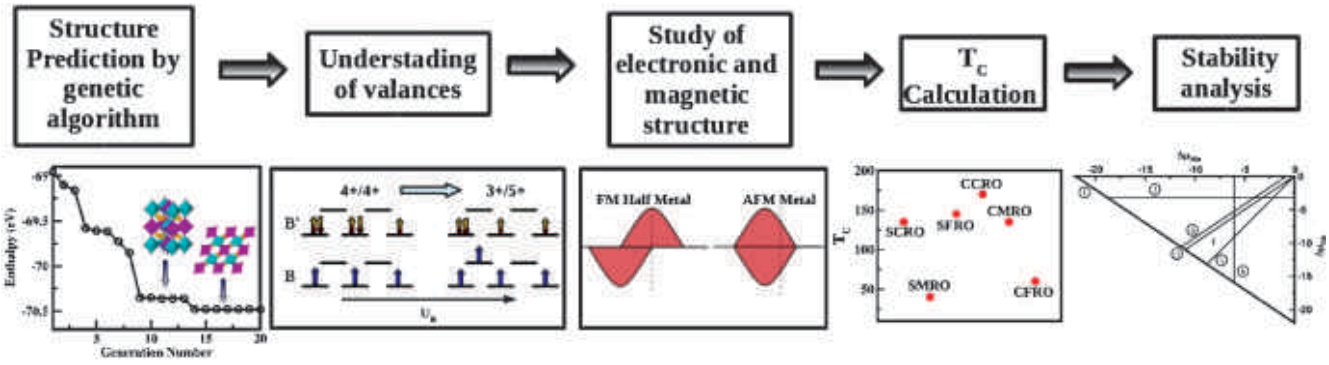
Prediction of new magnetic compounds with novel properties, study of properties at graphene-oxide, graphene-MXene interfaces, quantum magnetism, metal-insulator transition, perovskite oxides, metal-organics

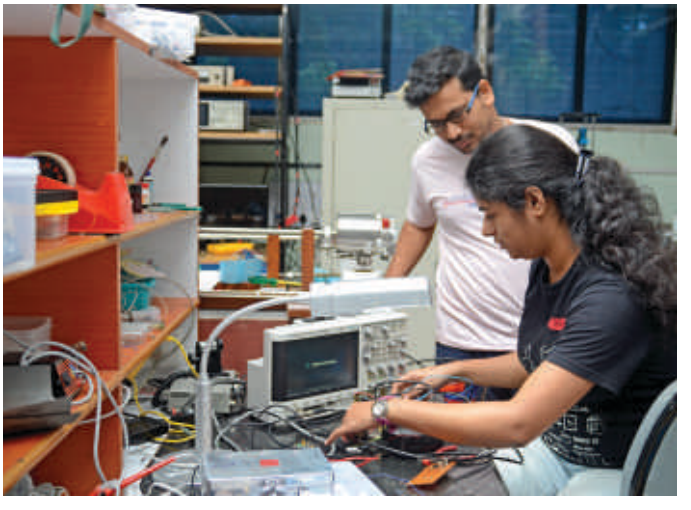
Interesting results obtained

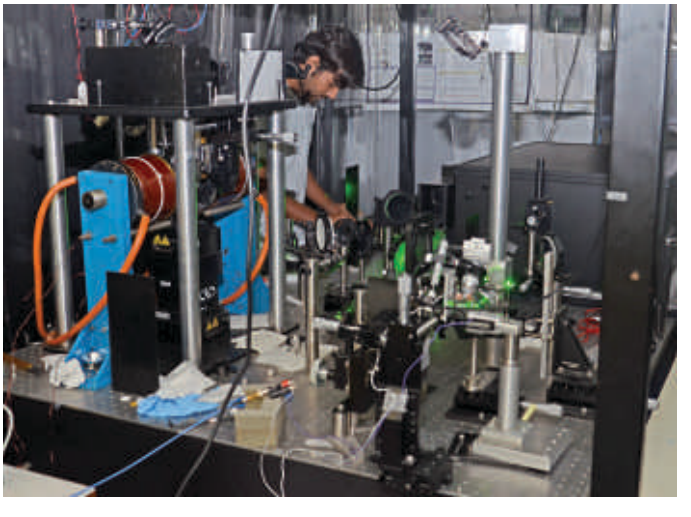
In a specific research work, combination of evolutionary algorithm, density functional theory, and statistical-mechanical tool (see figure) was used to make computer prediction of structural, electronic and magnetic properties of yet-to-be synthesized Rh based double perovskite compounds, $Sr(Ca)_2BRhO_6$ (B = Cr, Mn, Fe). Interestingly, while the Cr-Rh and Mn-Rh compounds were predicted to be ferromagnetic half-metals, the Fe-Rh compounds were found to be rare examples of antiferromagnetic and metallic transition-metal oxide with three-dimensional electronic structure. The computed magnetic transition temperatures of the predicted compounds, obtained from finite temperature Monte Carlo study of the first principles derived model Hamiltonian, were found to be reasonably high. The prediction of favorable growth condition of the compounds, as reported in this work, obtained through extensive thermodynamic analysis should be useful for future synthesize of this interesting class of materials with intriguing properties.

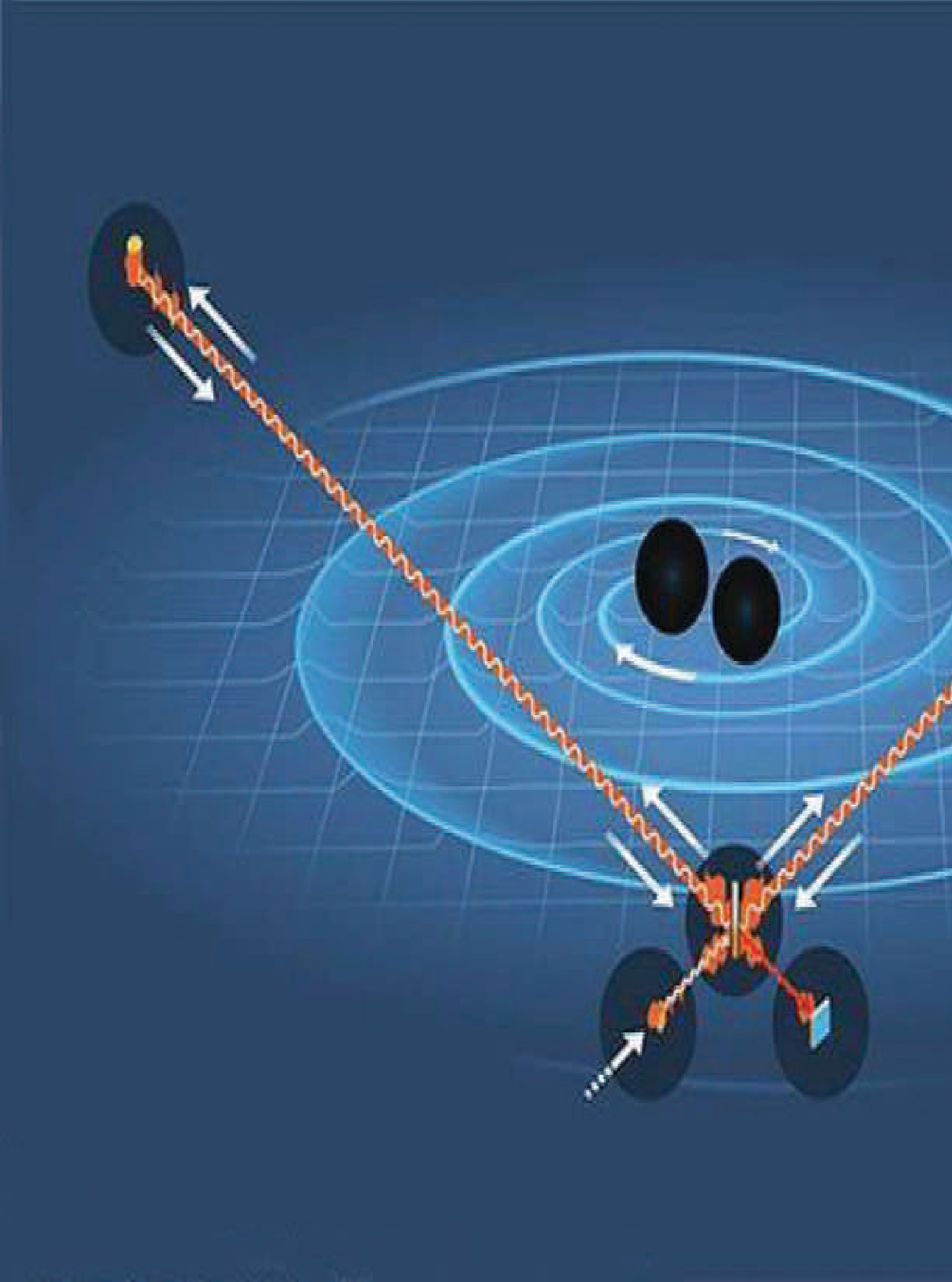
Proposed research activities for the coming year

1. Use of Machine learning technique in prediction of Materials
2. Use of Quantum Chemistry tools in study of light induced spin state trapping









Department of

Theoretical Sciences

Department of Theoretical Sciences

Makhtedar Sanjay Kumar

Department profile indicators

Table_A : Manpower and resources	
Number of faculties	10
Number of Post -doctoral research associate (centre + project)	04
Number of Ph.D students	31
Number of other project staff	01
Number of summer students	04
Projects (ongoing)	02
Table B: Research Activities indicators	
Number of research papers in Journals	35
Number of Book-chapters/books	nil
Number of other publications	01
Number of Ph.D students graduated (submitted + degree awarded)	Submitted = 4 Awarded = 3
Number of M.Tech/M.Sc projects	12
Table C: Academic activities and likeage	
Number of courses taught by faculties	13
Number of Visitors (non -associates)	04
Number of associates	01
Number of Seminars organized	13
Number of Conference/Symposia/Advanced Schools organized	nil
Number of talks delivered by members of department in conferences/Symposia	National 12 International 02

Most important research highlights

- Meissner effect and a stringlike interaction
- Inverse spatial Laplacian of spherically symmetric spacetimes
- Quantum mechanics on noncommutative space-time taken as doubled Moyal plane, Connes distance in this plane, and relation between noncommutativity and dissipation
- Equivalence among stress tensors in a gauge-fluid system
- Galilean gauge theory, galileons in curved spacetime and cosmological implications
- Symmetries in nonrelativistic diffeomorphism-invariant theories
- Electrovacuum solutions in nonlocal gravity
- Noncommutative effects on holographic superconductors with power Maxwell electrodynamics
- Quantum mechanical systems interacting with different polarizations of gravitational waves in noncommutative phase space
- Einstein relation and hydrodynamics of nonequilibrium mass transport processes
- Phase-ordering in coupled nonequilibrium systems
- Force generation by actin filaments
- Optimal methylation noise for best chemotactic performance of E. Coli
- Colored percolation, Double Transition in a Model of Oscillating Percolation
- Chiellini integrability condition, Hamiltonian structures and nonstandard Lagrangians of various nonlinear equations
- Inhomogeneous Heisenberg spin chain and quantum vortex filament as non-holonomically deformed NLS systems

Summary of research activities

- Geometric constructions that could be useful in describing dynamics of charged strings, in particular QCD strings, have been investigated.
- Green function of the static Laplacian operator on Schwarzschild and Schwarzschild-de Sitter spacetimes has been constructed.
- Quantum mechanics on noncommutative space-time, taken as doubled Moyal plane, has been formulated. The impact on Connes distance in this plane in presence of a Higgs field has been studied and the relation between noncommutativity and dissipation analyzed.
- Physical significance of Milne boosts has been illuminated. It has been identified with the boost symmetry in the local frame characterizing the nonrelativistic curved background. Contrary to earlier approaches, no additional gauge field was required to discuss this invariance.
- A systematic method of taking the flat limit of nonrelativistic theories coupled to gravity has been discussed. Shift symmetric galileon models have been constructed in a curved background, and their cosmological implications analysed. Gauge fluid systems have been discussed and the role of stress tensors in such cases highlighted.
- Relation between critical temperature and charge density has been found for s-wave holographic superconductors in the background of a Schwarzschild-AdS spacetime in the framework of Born-Infeld electrodynamics.
- Ratio of shear viscosity to entropy density has been calculated for non-extremal Gauss-Bonnet (GB) black holes coupled to Born-Infeld (BI) electrodynamics in 5 dimensions.
- Response of simple quantum systems to different polarizations of gravitational waves in noncommutative phase-space has been studied with a view to the possibility of detection of noncommutative effects using present day gravitational wave detector set-ups.
- Flat FRW cosmology with a scalar field coupled with the metric along with generalized Chaplygin gas and perfect fluid comprising the matter sector has been studied.

- Bulk-diffusion coefficient and conductivity in conserved-mass transport processes on a ring have been calculated. An equilibrium-like Einstein relation between these transport coefficients has been found, even when the microscopic dynamics violates detailed balance and systems are far from equilibrium.
- Effect of pathway noise on the chemotactic performance of E.coli bacterial cell has been studied. The result that an optimum noise strength at which the performance is at its best has been found and explained.
- Effect of elasticity of a membrane on the force generation of actin filaments has been studied.
- A model of percolation in two dimensions, named `Colored Percolation', has been introduced and aspects such as phase diagrams, transition points, etc investigated.
- Non-standard Lagrangians and Hamiltonian structures for Lienard equations satisfying Chiellini condition have been constructed, and their connection to time dependent Hamiltonian formalism pointed out.
- Equation of inhomogeneous XXX Heisenberg spin chain and that of a thin vortex filament moving in a superfluid with drag have been shown to be particular kind of non-holonomic deformations of the standard NLS system involving generalized parameterizations.

Makhtedar Sanjay Kumar
Head, Department of Theoretical Sciences

Amitabha Lahiri

Senior Professor
Theoretical Sciences
amitabha@bose.res.in

Professor Amitabha Lahiri did his PhD in theoretical high energy physics from Syracuse University, followed by post-docs at Los Alamos National Laboratory and University of Sussex at Brighton. He joined SNBNCBS in 1996. His research interests are quantum field theory, general relativity, and mathematical physics.

Supervision of Research / Students

Ph.D. Students

1. Debmalya Mukhopadhyay, Some phenomenological aspects of topologically massive gauge theories, PhD Awarded (March 2018)
2. Ishita Dutta Choudhury, Some implications of gauge invariant mass of vector bosons, Thesis Submitted (July 2017)
3. Subhasish Chakrabarty, Field theoretic approach to gravity (Ongoing)
4. Karan Savio Fernandes, Field theories on curved spacetimes with boundaries (Ongoing)
5. Ambalika Biswas, Aspects of two Higgs doublet models (Ongoing)
6. Pratik Tarafdar, Accreting black hole systems as classical analogue gravity models (Ongoing, jointly with T.K. Das, HRI)
7. Ritam Basu (Ongoing)
8. Shantonu Mukherjee (Ongoing)

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Raghvender SNBNCBS (IPhD), Quantum Gravity as an effective field theory

Teaching activities at the Centre

1. Autumn 2017, Classical Dynamics, PHY 101, 6 students

Publications in Journals

1. C. Chatterjee, I. Dutta Choudhury and **Amitabha Lahiri**, *Meissner effect and a stringlike interaction*, Eur.Phys.J. C, **77**, 300 (2017)
2. K. Fernandes and **Amitabha Lahiri**, *The inverse spatial Laplacian of spherically symmetric spacetimes*, Class. Quant. Grav., **34**, 175004 (2017)

Independent publications of student/s

1. Arpita Mitra, K. Fernendes *Gravitational anomalies on the Newton-Cartan background*, Phys.Rev. D, **96**, No.8, 085003 (2017)

Lectures Delivered

1. Quark Confinement and Magnetic Monopoles, University of Hyderabad, February 2018

Membership of Committees

External Committee

Technical expert committee (network), IACS

Internal Committee

Grievance redressal committee

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

International

1. Keio University, Japan (Sl. No. 1)

Significant research output / development during last one year

General research areas and problems worked on

Mathematical Physics: Construction of fiber bundles on the path space of a manifold, and of connections on those bundles; Quantum Field Theory: Study of a non-local coupling between fermions and an antisymmetric tensor gauge potential; General Relativity: Green functions of the Laplacian operator on static spherically symmetric black hole spacetimes

Interesting results obtained

1. We studied a way of coupling an antisymmetric tensor gauge potential to fermions via a non-local term. We had earlier shown that this gave rise to a mass of the photon also coupled to the fermions in the usual way. Now we showed that the effective static potential between nonrelativistic fermions had a component that was linear and attractive, like the confining potential of QCD.

2. We studied the Green function of the static Laplacian operator on Schwarzschild and Schwarzschild-de Sitter spacetimes and found its expression in terms of elementary functions in the first case and hypergeometric functions in the second case. The results are useful in studying Maxwell theory on these backgrounds as a constrained system.

Proposed research activities for the coming year

1. Mathematical Physics: I plan to investigate gauge transformations on path space fiber bundles in terms of the connection. This can be later translated, with further work, into gauge transformations of the local fields of the connection.

2. General Relativity: I plan to study torsion, in particular that generated by fermions, in a gauge theory of gravity, and its behavior under conformal transformations. I also plan to extend earlier work on constrained field theories on curved backgrounds with horizons to Kerr and Kerr-de Sitter spacetimes.

3. Quantum Field Theory: I plan to extend previous work on the non-local field theory to relate it to topological defects in field theories. I also plan to complete the study of Higgs-Higgs bound states in 2HDM.

Biswajit Chakraborty

Professor
Theoretical Sciences
biswajit@bose.res.in

Professor Biswajit Chakraborty was born and brought up in Shillong, Meghalaya, where he had his schooling and also had his Pre-University education from St. Edmund's College, affiliated to North Eastern Hill University, Shillong. His batchelor's and master's degrees were then obtained from Delhi University (Hindu College) and Ph.D. from Institute of Mathematical Sciences, Chennai (affiliated to Madras University) in 1992. He was then a post-doctoral fellow in IIT, Kanpur, HRI, Allahabad and SNBNCBS. Finally, he joined the faculty here in 1997. Currently, he is a Professor in this institute.

Supervision of Research / Students

Ph.D. Students

1. Partha Nandi, Sayan Pal and Soumya Majumdar are working on various aspects of Quantum theories on Noncommutative space-time
2. Debabrata Ghorai (jointly with Dr. Sunandan Gangopadhyay) is working on the connections on Superconductivity and AdS/CFT correspondence

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Anwesha Chakraborty of SNBNCBS, did her 3rd semester IPhD (Post B.Sc) project (PHY 304) under my supervision. The title of the project was "Analysis of topologically massive theories in Quantum Field theory". She continued to carry out her project work (PHY 401) under my supervision during her 4th semester. The title of the project was "Certain aspects of free field quantization".

Post Doctoral Research Scientist/s

1. Rabi Kant Verma was a PDF under my mentor-ship till February 2018

Teaching activities at the Centre

1. 3rd semester course (PHY-303) for the IPhD (Post B.Sc.) students, on "Advanced Quantum Mechanics and Applications" was taught by me, jointly with Prof. Archan S. Majumdar, during Aug-Nov' 2017
2. The Post-M.Sc. Course (PHY-604) on "Quantum Physics (Applications)" was taught by me during the spring 2018 semester

Publications in Journals

1. Partha Nandi, Sayan Kumar Pal, Aritra N. Bose, **Biswajit Chakraborty**, *Revisiting quantum mechanics on non-commutative space–time*, Annals Phys., **386**, pp. 305-326 (2017)

Lectures Delivered

1. Gave an invited Talk on "A Hilbert Schimdt operatorial approach to study quantum mechanics and geometry of NC spaces" in the conference "Quantum Physics :Fields, Particles and Information Geometry", held during 22nd-26th January 2018 at Dublin Institute of Advanced Studies, Dublin, Ireland, to celebrate 80th birthday of Prof. A.P. Balachandran

Membership of Committees

External Committee

I am one of the members of Board of Research Studies, Physics Department, West Bengal State University, Barasat, West Bengal; I was one of the external members in the Post-Graduate expert committee (Physics) meeting, held in Gurudas College, Kolkata on 10th January 2018.

Internal Committee

I am a member of several internal committees: Consultative Advisory Committee (CAC); Admission Committee; Conference, Workshop and Extension Programme (CWEP); Faculty Search Committee (FSC); Besides, currently I am holding the position of Dean (Academic Programme) from Feb' 2017.

Conference / Symposia / Workshops / Seminars etc. organized

1. I was a member of the local organizing committee of the recently held symposium, "International Symposium on New Frontiers in Quantum Correlations(ISNFQC18)" held during 29th Jan- 2nd Feb' 2018, at SNBNCBS.

Participation in Science Outreach program

As a part of 125th year birthday celebration of Prof. S.N.Bose, I, along with Prof. Kalyan Mandal visited Tripura University, Agartala on 16th March 2018; Assam University, Silchar on 19th March 2018 and Karimganj College, Karimganj, Assam, on 21st march 2018 and gave talks on "Bosons, Fermions and Geometry".

Significant research output / development during last one year

General research areas and problems worked on

Using Hilbert-Schmidt operatorial framework, we have have worked on the following problems:

1. We have formulated quantum mechanics on noncommutative space-time, taken to be 1 + 1 dimensional Moyal plane
2. Studied the impact on Connes distance in the doubled Moyal plane in presence of "Higgs field"
3. Relation between noncommutativity and dissipation was analyzed

Interesting results obtained

1. We show that the space-time noncommutativity in Moyal space-time can be taken care of by analyzing the system using coherent state basis in space-time, where the time evolution is naturally given by a c-number parameter, like its commutative counterpart, although time by itself is operator-valued. Here, one-dimensional harmonic oscillator is shown to have no deformation, of noncommutative origin, in the spectrum of the Hamiltonian but exhibits a parity-violating shift in the probability density, which cannot be squeezed to a length scale smaller in size compared to the length scale associated with the noncommutative parameter itself, even in the limit of infinite confining potential. This can thus stall the process of localization, preventing a potential gravitational collapse. We further show that Fermi's Golden rule also undergoes a noncommutative deformation.

2. We compute various spectral distances, a la Connes, between various pure states corresponding to the algebra, describing the doubled Moyal plane after constructing appropriate spectral triples in our Hilbert-Schmidt operatorial formulation. With this, we compute the so-called "transverse" distance between a state in coherent state basis, associated with one copy of the algebra, and its "clone", associated with the other copy. We then show that the so-called "longitudinal" distance between a state and its translated counterpart, both associated to the same copy of the algebra. is just the same as that of the single Moyal plane. Finally, we compute the so-called "hypotenuse" distance between a pair of states, which are not clones of each other, but are associated with different copies of the algebra. We find these distances satisfy Pythagoras equality. We then fluctuate the Dirac operator to include a prototype of "Higgs field", which can also be interpreted as a connection like other gauge fields in the Connes formulation of Noncommutative geometry. In presence of Higgs field, the transverse distance is shown to fluctuate, invalidating Pythagoras equality.

3. A pair of damped and anti-damped oscillators-the so-called Bateman oscillators, can be described by a Lagrangian, although the individual oscillators do not allow a time-independent Lagrangian description. The Hamiltonian, describing this Bateman system, however, does not lend itself to a straightforward quantization, as it is not bounded from below. In the literature the quantization of this system was carried out by adopting `t Hooft scheme. We provide an alternative and novel method of quantization, when

the system is placed in the ambient non-commutative space, taken particularly to be the Moyal plane, by augmenting the Hamiltonian by suitable additional terms with appropriate set of coefficients, so that the Hamiltonian is rendered positive. Carrying out the quantization in both path-integral and canonical approach, we obtain a new pair of equations, where one can take vanishing limit of the above mentioned coefficients in a smooth manner, resulting in a new pair of Bateman oscillators, except that the damping parameter gets renormalized. This form indicates that noncommutativity can induce damping at the quantum level, even if the "bare" damping parameter is zero to begin with. In the particular case, where the non commutative parameter is of the order of squared-Planck length, this induced dissipation can be regarded to be controlled by gravity alone. It then becomes quite plausible that it bears some connection with black hole formation through the process of localization and eventually to dissipation through information loss. On the the other hand, a pre-existing bare parameter can be made to vanish by suitably fine tuning the non commutative parameter. This indicates a duality between these two aspects, viz. Noncommutativity and dissipation.

Makhtedar Sanjay Kumar

Associate Professor
Theoretical Sciences
sanjay@bose.res.in

Dr. M. Sanjay Kumar received his M. Sc. (1984) and Ph. D. (1989) in Physics from University of Hyderabad. He had been a post-doctoral fellow at University of Rochester, Institute of Mathematical Sciences, Chennai and Raman Research Institute, Bangalore. He joined the Satyendra Nath Bose National Centre for Basic Sciences as faculty in 1999.

Supervision of Research / Students

Ph.D. Students

1. Soumyakanti Bose (Ongoing), 'Information-theoretic aspects of non-gaussian quantum optical fields'

Teaching activities at the Centre

1. Quantum Mechanics I (IPhd course)
2. Quantum Mechanics II (IPhD course)

Lectures Delivered

1. 5 lectures in the SERB School on 'Frontiers of Quantum Optics', (Dec. 2017) at IIT Guwahati

Membership of Committees

Internal Committee

Member, Admissions Committee & Admissions Coordinator; Member, EVLP (VASP) Committee; Head, Dept of Theoretical Sciences; Member, SCRE Committee; Member, APMP Committee; Chairperson, Medical Committee

Significant research output / development during last one year

General research areas and problems worked on

QUANTUM OPTICS & QUANTUM INFORMATION

Aspects of Quantum Teleportation with entangled resources generated by a beam splitter with a class of non-Gaussian single mode states at the input.

Interesting results obtained

We have done a detailed investigation of quantum teleportation using the Braunstein-Kimble protocol with entangled resources states generated under BS action with a class of input non-Gaussian states.

We have considered the question of which ingredients besides entanglement may be necessary to achieve quantum teleportation. Two such ingredients studied in the literature are squeezed vacuum affinity and EPR uncertainty. Our study shows that neither of the above is in fact necessary for quantum teleportation.

We have proposed that two-mode squeezing (as defined by R. Simon et al (1994)) could be considered as another essential ingredient. In fact, our numerical results seem to point us to the conclusion that two-mode squeezing is a necessary condition for achieving quantum teleportation. Some preliminary analytical results in the case of two-mode symmetric Gaussian entangled sources makes this conclusion plausible.

Proposed research activities for the coming year

Extension to general two-mode Gaussian entangled states resource states the analytical study that shows that two-mode squeezing is a necessary condition for quantum teleportation.

A detailed investigation of various aspects of convertibility of single-mode nonclassicality into two-mode entanglement using an array of beam splitters.

Manu Mathur

Professor
Theoretical Sciences
manu@bose.res.in

Professor Manu Mathur finished his PhD at The Institute of Mathematical Sciences, Chennai in 1992. He was a Post-Doctoral Fellow at TIFR-Mumbai and then an INFN fellow at University of Pisa, Italy.

Supervision of Research / Students

Ph.D. Students

1. T. P Sreeraj, "Canonical Transformations & Loop formulation of Lattice Gauge Theories", Completed
2. Atul Rathore, "Duality in Lattice Gauge Theories (tentative)" Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Neeraj Kumar, SNBNCBS, "Bosonization", Completed

Membership of Committees

Internal Committee

Member of the VASP committee (Visitor, Associates and Students' Programme); Member of the Hindi Committee

Participation in Science Outreach program

Member of the NECC-2018 (National Essay Competition Committee)

Significant research output / development during last one year

General research areas and problems worked on

Quantum field theories on lattice, Duality in gauge theories and statistical mechanics, Group theory & Coherent states.

We are constructing the Irreducible Schwinger bosons for the direct product of two SU(3) groups by exploiting SU(3)XSU(3) invariant constraints. This should also lead to a complete set of projection operators for irreducible representations of SU(3)XSU(3). The corresponding results for SU(2) are easily obtained as the corresponding constraints are much simpler.

Interesting results obtained

Through exact duality we are construction the most general SU(3) disorder operator for SU(3) lattice gauge theory in (2 + 1) dimension. This disorder operator creates U(1)XU(1) vortices on a plaquette.

Proposed research activities for the coming year

Generalizing Duality Transformation to (3 + 1) dimensions

Partha Guha

Professor
Theoretical Sciences
partha@bose.res.in

Research interests of Professor Partha Guha are centered around nonlinear dynamics, integrable systems and geometrical mechanics.

Supervision of Research / Students

Ph.D. Students

1. Sumanto Chanda
2. Ankan Pandey

Post Doctoral Research Scientist/s

1. Deepika Kumari

Publications in Journals

1. A. Ghose Choudhury and **Partha Guha,** Chiellini integrability condition, planar isochronous systems and Hamiltonian structures of Liénard equation, Discrete and Continous Dynamical Systems B (AIMS), **22**, no. 6, 2465-2478 (2017)
2. A. Ghose Choudhury and **Partha Guha**, Monotonicity of the period function of the Liénard equation of second kind, Qualitative theory of Dynamical Systems, **16**, no. 3, 609-621 (2017)
3. Sumanto Chanda, Gary William Gibbons and **Partha Guha**, *Jacobi-Maupertuis metric and Kepler equation*, International J. Geometrical Methods in Modern Physics, **14**, no. 7, 1730002 (2017)
4. Ankan Pandey, A. Ghose Choudhury and **Partha Guha**, *Chiellini integrability and quadratically damped oscillators*, International Journal of Nonlinear Mechanics, **92**, pp. 153-159 (2017)
5. O. Essen, A. Ghose Choudhury and **Partha Guha**, *On Integrals, Hamiltonian and Metriplectic Formulations of Polynomial Systems in 3D*, Theoretical and Applied Mechanics, **44**, Issue 1, 15-34 (2017)
6. Kumar Abhinav and **Partha Guha,** *Inhomogeneous Heisenberg spin chain and quantum vortex filament as non-holonomically deformed NLS systems*, Eur. Phys. J. B, **91**, no. 3, Paper No. 52, 7pp. (2018)
7. Sumanto Chanda, Sarbarish Chakravarty and **Partha Guha**, *On a reduction of the generalized Darboux-Halphen system*, Phys. Lett. A, 382, no. **7**, 455–460 (2018)
8. Kumar Abhinav, Anindya Ghose Choudhury, **Partha Guha,** *Backlund Transformation and Quasi-Integrable Deformation of Mixed Fermi-Pasta-Ulam and Frenkel-Kontorova Models*, Discontinuity, Nonlinearity and Complexity, **7**, no.1, 31-41 (2018)

Lectures Delivered

1. Invited speaker at Workshop on solitons: Integrability, Duality and Applications at ICTP South American Institute for Fundamental Research, April 17 - 20, 2017
2. Delivered one semester course on ''Integrable Systems'' at IFSC, University of Sao Paulo from March – July 2017

Academic Visits

International

1. IFSC, University of Sao Paulo, Sao Carlos, Brazil, March-July 2017
2. IHES, Bures-sur-Yvette, France September- December 2017

Awards / Recognitions

1. Grant obtained from Brazil, FAFESP, S˜ao Paulo Research Foundation, for a Project on Nonlinear dynamics and gravity to spend one academic year 2017 in at USP, Sao Carlos, Brazil

2. External grants obtained through IHES to support research at IHES September-December 2017

Collaborations including publications (Sl. No. of the paper/s listed in 'Publications in journals' jointly published with collaborators)

Intra Organizational

Sl. No. 3, 4, 6, 7, 8

National

Sl. No. 1, 2, 4, 8

International

Sl. No. 3, 5, 7

Significant research output / development during last one year

General research areas and problems worked on

Geometrical Mechanics: Hamiltonization of nonlinear ODEs and generalized symplectic geometry, Nambu-Poisson mechanics. Mechanics on curved spaces. Infinite-dimensional Lie algebras and integrable PDEs.

Nonlinear Dynamics: dynamics of variable mass systems and nonlinear vibrations; dynamics of delay-differential equations.

Interesting results obtained

Construction of non-standard Lagrangians and Hamiltonian structures for Lienard equations satisfying Chiellini condition was studied. We showed its connection to time-dependent Hamiltonian formalism. We also showed that the non-standard Lagrangians is a deformation of a simpler standard Lagrangian and exhibited its connection with contact Hamiltonian mechanics. We provide a metriplectic and complex Hamiltonian formulation of the Liénard equation through the use of Chiellini condition for integrability.

An equation of the Liénard type with a strong quadratic damping is studied based on Jacobi's last multiplier and Chiellini's integrability condition. We obtain a closed form solution of the transcedental characteristic equation of the Liénard type equation using the Lambert W-function.

The equations for the general Darboux–Halphen system obtained as a reduction of the self-dual Yang–Mills can be transformed to a third-order system which resembles the classical Darboux–Halphen system with a common additive terms. A Lax pair and Hamiltonian for this reduced system is derived and the solutions are prescribed in terms of hypergeometric functions.

Using Hasimoto map we showed that the inhomogeneous XXX Heisenberg spin chain equation and that of a thin vortex filament moving in a superfluid with drag are particular kind of non-holonomic deformations (NHDs) of the standard NLS system involving generalized parameterizations.

Proposed research activities for the coming year

We show recently that the dynamics of the damped oscillator system can be mapped to contact Hamiltonian mechanics but the generic Li\'enard equation can only be mapped to metriplectic form. We present a complex Hamiltonian and metriplectic geometric structure of the Li\'enard equation.

We wish to study the contact lift of the Li\'enard type system and establish its connection with the geometry of irreversible thermodynamics. It should be noted that the dynamics is confined to Legendre submanifold.

The role of Legendre transformation is very important in information geometry, which uses mutually dual (conjugate) affine connection, dual potentials in dual coordinate systems and dual metric that are studied in the framework of Hessian differential geometry, formulated mainly by Amari. We wish to explore or enter into information geometry via the thermodynamic formulation or contact lift of Li\'enard equation.

Entropy is considered to be an extensive property, but recently Tsallis proposed nonextensive entropy. Tempesta showed that theory of generalized entropies can be mathematically studied by means of an approach based on formal group theory, She introduced new family of infinitely many multi-parametric entropies, so-called Z-entropies. Formal groups have played an important role in algebraic topology for several decades. In the 70s these ideas were used to introduce analogues of classical arithmetic properties like Bernoulli numbers and polynomials in connection to algebraic topology. We wish to study Sharma-Mittal entropy, two parameter generalization of Tsallis entropy. We want to explore Tempesta's construction with that of Marcolli's, based on tropical geometry.

Punyabrata Pradhan

Associate Professor
Theoretical Sciences
punyabrata.pradhan@bose.res.in

Dr. Punyabrata Pradhan obtained B. Sc. (1998) and M. Sc. (2000) degrees from the University of Calcutta, Kolkata, India and Ph. D. degree (2006) from the Tata Institute of Fundamental Research, Mumbai, India. After doing his postdoctoral research in the Israel Institute of Technology - Technion, Haifa, Israel (2006 - 2009) and in the University of Stuttgart, Germany (2009 - 2011), Dr. Pradhan joined the S. N. Bose National Centre for Basic Sciences, Kolkata, India (2011 - present).

Supervision of Research / Students

Ph.D. Students

1. Ms. Sayani Chatterjee, "Additivity property and mass fluctuation in conserved-mass transport processes" (registered for Ph.D. in the University of Calcutta), Completed (currently postdoctoral fellow at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru)
2. Mr. Arghya Das, "Thermodynamic characterisation of nonequilibrium steady states and study of phase transitions" (registered for Ph.D. in the University of Calcutta), Completed (currently postdoctoral fellow at the International Centre forTheoretical Sciences, Bengaluru)
3. Mr. Subhadip Chakraborti, "Studies of fluctuations in systems of self-propelled particles" (registered for Ph.D. in the University of Calcutta), Ongoing (thesis to be submitted soon)
4. Mr. Dhiraj Tapader (under SERB/DST project), Studies of higher dimensional mass transport processes, Ongoing
5. Mr. Anirban Mukherjee (joined recently)

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Mr. Anirban Mukherjee; Studies of current distribution in mass transport processes (work report to be submitted soon)

Post Doctoral Research Scientist/s

1. Shubhashis Rana (NPDF)

Teaching activities at the Centre

1. 5th Semester, Advanced Statistical Mechanics (PHY 603), Advanced, 12 students

Publications in Journals

1. Arghya Das, Anupam Kundu, and **Punyabrata Pradhan**, *Einstein relation and hydrodynamics of nonequilibrium mass transport processes*, Physical Review E, **95**, 062128 (2017)

Other Publications

1. Subhadip Chakraborti, Sayani Chatterjee, Arghya Das, and **Punyabrata Pradhan**, Proceedings of the workshop "Recent Advances in Research of Statistical Physics: A School for Undergraduate Students – 2017", 1, 16 (2017)

Lectures Delivered

1. Hydrodynamics, density fluctuation and universality in conserved stochastic sandpiles, International Centre for Theoretical Sciences (ICTS), Bangalore, February, 2018, 1
2. Characterizing fluctuations in driven active- and passive-matter systems, International Centre for Theoretical Sciences (ICTS), Bangalore, August, 2017, 1
3. Additivity and fluctuations in nonequilibrium steady states, Scottish Church College, Kolkata, July, 2017, 1
4. Characterizing fluctuations in driven many-particle systems, S. N. Bose National Centre for Basic Sciences, Kolkata, May, 2017, 2

Membership of Committees

External Committee

Doctoral thesis committee for Mr. Sunil Yadav at the Jawaharlal Nehru University, New Delhi; Doctoral thesis committee for Ms. Karthika at the Indian Institute of Space Science and Technology, Thiruvananthapuram, India

Internal Committee

Library committee, Newsletter committee, computer service cell committee, various administrative committees, and interview committees

Sponsored Projects

1. "Additivity Principle and Thermodynamic Characterization of Mass Transport Processes", SERB (DST), 2015 – 2018

2. "Interacting particles in a periodically moving potential" and "Studies of fluctuations in self-propelled particles", Thematic Unit of Excellence on computational material science under DST (Nanomission), 2012 – 2018, collective (all PI's included)

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

Sl. No. 1

Participation in Science Outreach program

I have given a series of lectures in the two schools mentioned above, with the aim to train manpower (B.Sc./ M.Sc. level students) in our country.

Societal impact of Research

Development of manpower and knowledge base in higher-education sector in terms of teaching (as mentioned above, I taught one course) and training of the doctoral students as well as the postdoctoral researchers. In my research group, presently there are three students, two of them registered for Ph. D. (another two students have recently submitted their Ph. D. thesis) and one postdoctoral research associate.

Significant research output / development during last one year

General research areas and problems worked on

Fluctuation relation and hydrodynamics of conserved-mass transport processes; characterization of transport in systems driven by time-periodic forces

Interesting results obtained

1. We derive hydrodynamics of paradigmatic conserved-mass transport processes on a ring. The systems, governed by chipping, diffusion, and coalescence of masses, eventually reach a nonequilibrium steady state, having nontrivial correlations, with steady-state measures in most cases not known. In these processes, we analytically calculate two transport coefficients, bulk-diffusion coefficient and conductivity. Remarkably, the two transport coefficients obey an equilibrium-like Einstein relation even when the microscopic dynamics violates detailed balance and systems are far from equilibrium. The processes studied by us generally have a nontrivial spatial structure in their steady states. That is, they have finite spatial correlations in the steady state. Not surprisingly, the exact probability weights of microscopic configurations in the steady state, except for a few special cases, are not yet known. In fact, precisely due to this nontrivial spatial steady-state structure in out-of-equilibrium interacting-particle systems, finding hydrodynamics in such systems poses a great challenge. This is because, in the absence of knowledge of the exact steady-state weights, it is usually difficult to calculate averages of local observables. However, there is an important feature, we pointed out in these conserved-mass transport processes, arising from the fact that the Bogoliubov-

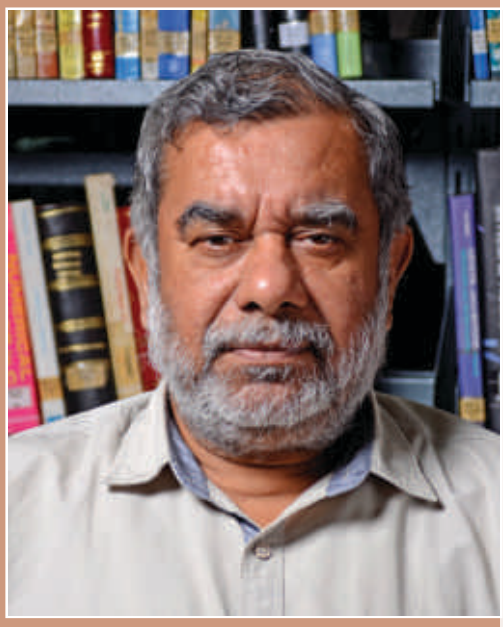
Born-Green-Kirkwood-Yvon (BBGKY) hierarchy involving n-point spatial correlations in the steady states closes. In other words, n-point spatial correlations in the steady state do not depend on (n + 1)-point or any higher-order spatial correlations. This particular property enabled us to exactly calculate the steady-state 2-point spatial correlations and, consequently, the second moment of local mass, which determines the functional dependence of the conductivity on density. (Published)

2. We derive an exact hydrodynamic structure of a broad class of conserved-mass (fixed-energy) stochastic sandpiles (CSS). Importantly, these systems possess a 'gradient property', where local diffusive current and, therefore, time-evolution of local densities can be written as a gradient (discrete) of local observable like the activity. The gradient property essentially originates from the fact that, in the sandpiles studied here, the particle hopping rates depend only on the departure site, but not on the destination sites. We use the property, and recently developed macroscopic fluctuation theory, to uncover a remarkable thermodynamic structure, where bulk-diffusion coefficient, conductivity and mass fluctuations are shown to be connected to the activity, through an equilibrium-like Einstein relation.

Proposed research activities for the coming year

(1) We aim to characterize steady-state mass fluctuations in the systems, which undergo active-absorbing phase transitions upon tuning global density. To this end, we have been exploring sandpiles, the paradigmatic models of "self-organized criticality'", to understand their large-scale properties and critical behaviours. We have already obtained some interesting results in stochastic sandpiles models with unbounded state space. Further studies on the long-debated question of universality in the conserved stochastic sandpiles are also being carried. Also, many of these sandpiles, with bounded state-space, can have 'non-gradient' structures in density evolution, which requires further studies and still remains open. (Part of the work has already been submitted and part of it is under progress.)

(2) Until now, we have studied mass transport in only one dimensional systems. It would be of great interest to study the mass transport processes in higher dimensions, where there may be some anisotropic driving, which could give rise to interesting spatial structures. We have already obtained some exact results concerning spatial two-point correlations in the system, and demonstrate that an equilibrium like additivity property can be used to determine steady-state subsystem mass distributions in the systems.



Rabin Banerjee

Emeritus Professor
Theoretical Sciences
rabin@bose.res.in

Professor Rabin Banerjee completed hisMasters from IIT KGP, Ph.D from Saha Institute and he is at SNBNCBS from 1989 onwards.

Supervision of Research / Students

Ph.D. Students

1. Arpita Mitra: Nonrelativistic Diffeomorphism Invariance and its Applications; Completed Degree; awarded January 2018
2. Arpan Mitra: Aspects of fluid dynamics as field theory; Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. student/s

1. Sayan Routh; SNBNCBS; Nambu Mechanics; Completed
2. Raghavendra; SNBNCBS; Newon-Cartan Geometry; Completed
3. Deep Ghosh; IIT KGP; Generalised Uncertainty Principle and its Applications; Completed

Teaching activities at the Centre

1. Fall (Jan-Apr. 18); Advanced Quantum Field Theory; IPHD 10

Publications in Journals

1. A. K. Mitra, **R. Banerjee**, S. Ghosh, *On the equivalence among stress tensors in a gauge-fluid system*, Int.J.Mod.Phys. A, **32** (2017)
2. **R. Banerjee**, S. Gangopadhyay, P. Mukherjee, *On the question of symmetries in nonrelativistic diffeomorphism-invariant theories*, Int.J.Mod.Phys. A, **32**, No.19n20, 1750115 (2017)
3. **R. Banerjee** and P. Mukheree, *Taming galileons in curved spacetime*, Class. Quant. Grav., **34**, No.23, 235005 (2017)
4. **R. Banerjee**, S. Chakraborty, A. Mitra, P. Mukherjee, *Cosmological implications of a shift symmetric Galileon field*, Phys.Rev. D, **96**, No.6, 064023 (2017)
5. **R. Banerjee**, P. Mukherjee, *Milne boost from Galilean gauge theory*, Phys.Lett. B, **778**, pp. 303-308 (2018)

Independent publications of student/s

1. Arpita Mitra, *Nonrelativistic fluids on scale covariant Newton–Cartan backgrounds*, Int.J.Mod.Phys. A, **32**, No.36, 1750206 (2017)
2. Arpita Mitra, K. Fernendes *Gravitational anomalies on the Newton-Cartan background*, Phys.Rev. D, **96**, No.8, 085003 (2017)
3. Arpita Mitra, K. Fernendes, *Electrovacuum solutions in nonlocal gravity*, Phys.Rev. D, **97**, No.10, 105003 (2018)

Lectures Delivered

1. S.N.Bose: The Man and His Work Burdwan Univ. Feb 2018 Invited lecture
2. Contributions of S.N.Bose, WB State S&T Congress Science City Kolkata March 2018 Lecture in the special session dedicated to S.N.Bose on his 125th Birth Anniversary

Academic Visits

International

1. Collaborative Deptt. of Physics & Astrophysics Lund University Sweden Aug-Sept 2017

Participation in Science Outreach program

1. Researched on the Documentary on S. N. Bose, commemorating his 125th birth anniversary
2. Gave popular talks on S.N.Bose (Man and His Work) in both English and Bengali

Societal impact of Research

To build awareness in science at various levels

Significant research output / development during last one year

General research areas and problems worked on

- Gauge-Fluid systems
- Cosmology with shift symmetric galileons
- Nonrelativistic diffeomorphism invariant theories

Interesting results obtained

Physical significance of Milne boosts was illuminated. It was identified with the boost symmetry in the local frame characterizing the nonrelativistic (NR) curved background. Contrary to earlier approaches, no additional gauge field was required to discuss this invariance.

A systematic method of taking the flat limit of NR theories coupled to gravity was discussed. It was able to eliminate problems that plague the conventional approaches.

Shift symmetric galileon models were constructed in a curved background for the first time. Their cosmological implications were analysed.

Gauge fluid systems were discussed and the role of stress tensors in such cases was highlighted.

Proposed research activities for the coming year

We wish to study the connection between Poincare gauge theories obtained by localizing the Poincare symmetry with Galilean gauge theory, developed by me in a collaborative work, obtained by localizing the Galilean symmetry.

We would like to extend our work on the Galilean gauge theory to NR fluids in a curved background, with or without torson.

Sakuntala Chatterjee

Associate Professor
Theoretical Sciences
sakuntala.chatterjee@bose.res.in

Dr. Sakuntala Chatterjee finished her PhD from Tata Institute of Fundamental Research, Mumbai in 2007. She spent 2007-09 in Research Centre Juelich, Germany and 2009-11 in Technion, Israel, as postdoctoral fellow. Since 2011 she is at S.N. Bose Centre. She is interested in the field of Nonequilibrium Statistical Physics and Biological Physics.

Supervision of Research / Students

Ph.D. Students

1. Subrata Dev, Effect of extra-cellular nutrient environment and intra-cellular biochemical conditions on the chemotactic performance of E. Coli, Thesis to be submitted soon
2. Raj Kumar Sadhu, Force generation of actin filaments growing against a barrier, Ongoing
3. Shauri Chakraborti, Dynamics of propagating modes and characterisation of ordering in coupled non-equilibrium systems, Ongoing

Teaching activities at the Centre

1. Spring semester 2018, Statistical Mechanics, IPhD second semester, 6 students

Publications in Journals

1. Subrata Dev and **Sakuntala Chatterjee**, *Optimal methylation noise for best chemotactic performance of E. Coli*, Physical Review E, **97**, 032420 (2018)
2. Raj Kumar Sadhu and **Sakuntala Chatterjee**, *Actin filaments growing against an elastic membrane: Effect of membrane tension*, Physical Review E, **97**, 032408 (2018)
3. Shauri Chakraborti, **Sakuntala Chatterjee** and Mustansir Barma, *Ordered phases in coupled nonequilibrium systems: dynamic properties*, Physical Review E, **96**, 022128 (2017)
4. Shauri Chakraborti, **Sakuntala Chatterjee** and Mustansir Barma, *Ordered phases in coupled nonequilibrium systems: static properties*, Physical Review E, **96**, 022127 (2017)

Lectures Delivered

1. "Optimal methylation noise for best chemotactic performance of E.coli" at ICTS Bangalore in August 2017
2. "Novel ordered phases in coupled driven systems: large compact clusters and fast dynamics" at Jagiellonian University, Krakow, Poland in September 2017
3. "Optimal methylation noise for best chemotactic performance of E.coli" at TIFR Hyderabad in November 2017
4. "Filaments growing against a membrane with shape fluctuations" at S.N. Bose Center Kolkata, in February 2018

Sponsored Projects

1. Study of E.coli chemotaxis at the single cell level: a statistical physics approach, SERB, DST, 27th Feb 2017 - 26th Feb 2020

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Sl. No. 3,4

Participation in Science Outreach program

Gave a lecture "Coupled nonequilibrium systems: ordering and

dynamics" during a workshop "Recent Advances in Research of Statistical Physics: A school for Undergraduate Students" held at Scottish Church College, Kolkata in April 2017

Societal impact of Research

Man power training: teaching and supervising research

Significant research output / development during last one year

General research areas and problems worked on

Phase-ordering in coupled systems, Force generation by actin filaments, Bacterial chemotaxis

Interesting results obtained

1. Presence of stochastic noise in the biochemical pathway of a cell has important consequence on its behavior. We study the effect of pathway noise on the chemotactic performance of E.coli bacterial cell. We find an optimum noise strength at which the performance is at its best. While it is expected that chemotaxis will be weaker for very large noise, it is counter-intuitive that the performance worsens even when noise level falls below a certain value. We explain this striking effect by showing that when the motor protein CheY-P concentration falls below a certain threshold, the cell shows a tendency to move towards region of less nutrient concentration, which has a detrimental effect on its chemotactic response. This threshold value decreases as noise is increased, and this effect is responsible for noise-induced enhancement of chemotactic performance.

2. We study the effect of elasticity of a membrane on the force generation of actin filaments. The elastic membrane tries to stay flat and any deformation from this flat state, either caused by thermal fluctuations or due to protrusive polymerization force exerted by the filaments, costs energy. We study two lattice models to describe the membrane dynamics. In one case, the energy cost is assumed to be proportional to the absolute magnitude of the height gradient (gradient model) and in the other case it is proportional to the square of the height gradient (Gaussian model). For the gradient model, we find the growth velocity of the filaments is a non-monotonic function of the membrane tension. We show that this a result of interplay between the elastic force of the membrane and polymerization force of the filaments. For small values of the membrane tension, polymerization force wins over and the system fails to reach a steady state in this regime. Different parts of the membrane moves with different velocity and the energy of the membrane keeps increasing with time. For large membrane tension, the system reaches steady state and all parts of the membrane moves with the same velocity. For Gaussian model, the system always reaches a steady state and the membrane velocity decreases monotonically with the elastic constant. Multiple filaments give rise to protrusions at different regions of the membrane and the elasticity of the membrane induces an effective attraction between the two protrusions in the Gaussian model which causes the protrusions to merge and a single wide protrusion is present in the system. In both the models, the relative time-scale between the membrane and filament dynamics plays an important role in deciding whether the shape of elasticity-velocity curve is concave or convex.

Proposed research activities for the coming year

1. Characterization of dynamical modes in coupled driven systems
2. Force generation of growing biopolymers

Subhrangshu Sekhar Manna

Emeritus Professor
Theoretical Sciences
manna@bose.res.in

Dr. S. S. Manna worked for his Ph. D. in Saha Institute of Nuclear Physics and received the degree from the Calcutta University. Later, he did Post doctoral researches in Mebourne University, Australia; Forschungzentrum, Germany; St. Francis Xavier University, Canada and Yale University, USA. He joined the Physics department in I. I. T. Bombay in June 1992 and later moved to Satyendra Nath Bose National Centre for Basic Sciences in January, 1998.

Supervision of Research / Students

Ph.D. Students

1. Biplab Bhattacherjee, Spontaneous Evolution of Long-range Correlations in Dynamical Systems, submitted thesis to Calcutta University on 31.07.2017
2. Sumanta Kundu, Some Studies of Percolation Phenomena in Disordered Systems, ongoing
3. Chandreyee Roy, Some studies of the brittle to quasi-brittle transition in fiber bundle models, ongoing

Teaching activities at the Centre

1. Fall semester 2017, Computational Methods in Physics I, PHY 104 in I. Ph. D. course, Eight students

Publications in Journals

1. Sumanta Kundu and **S. S. Manna**, *Colored percolation*, Phys. Rev. E, **95**, 052124 (2017)
2. Sumanta Kundu, Amitava Datta, **S. S. Manna**, *Double Transition in a Model of Oscillating Percolation*, Phys. Rev. E, **96**, 032126 (2017)

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

International

Sl. No. 3 (Professor Amitava Datta, School of Computer Science and Software Engineering, University of Western Australia, Perth, WA 6009, Australia)

Member of Editorial Board

1. Managing Editor of the journal "FRACTALS", published by the World Scientific

Significant research output / development during last one year

General research areas and problems worked on

Statistical Physics in general. In particular, equilibrium and non-equilibriam critical phenomena. Typical examples are the the percolation phenomena and the self-organized criticality. Last couple of years I am involved in the time dependent percolation, collective behaviour of flocks, breakdown properties of fiber bundle models etc.

Interesting results obtained

Asymptotic properties of the symmetric and asymmetric naming games have been studied under some restrictions in a community of agents. In one version, the vocabulary sizes of the agents are restricted to finite capacities. In this case, compared to the original naming games, the dynamics takes much longer time for achieving the consensus. In the second version, the symmetric game starts with a limited number of distinct names distributed among the agents. Three different quantities are measured for a quantitative comparison, namely, the maximum value of the total number of names in the community, the time at which the community attains the maximal number of names, and the global convergence time.

Using an extensive numerical study, the entire set of three power law exponents characterizing these quantities are estimated for both the versions which are observed to be distinctly different from their counter parts of the original naming games.

A model named 'Colored Percolation' has been introduced with its infinite number of versions in two dimensions. The sites of a regular lattice are randomly occupied with probability p and are then colored by one of the n distinct colors using uniform probability q = 1/n. Denoting different colors by the letters of the Roman alphabet, we have studied different versions of the model like AB, ABC, ABCD, ABCDE, ... etc. Here, only those lattice bonds having two different colored atoms at the ends are defined as connected. The percolation thresholds $p_c(n)$ asymptotically converges to its limiting value of p_c as 1/n. The model has been generalized by introducing a preference towards a subset of colors when m out of n colors are selected with probability q/m each and rest of the colors are selected with probability (1 - q)/(n - m). It has been observed that $p_c(q,m)$ depends non-trivially on q and has a minimum at q_{min} = m/n. In another generalization the fractions of bonds between similar and dissimilar colored atoms have been treated as independent parameters. Phase diagrams in this parameter space have been drawn exhibiting percolating and non-percolating phases.

Two distinct transition points have been observed in a problem of lattice percolation studied using a system of pulsating discs. Sites on a regular lattice are occupied by circular discs whose radii vary sinusoidally within $[0,R_0]$ starting from a random distribution of phase angles. A lattice bond is said to be connected when its two end discs overlap with each other. Depending on the difference of the phase angles of these discs a bond may be termed as dead or live. While a dead bond can never be connected, a live bond is connected at least once in a complete time period. Two different time scales can be associated with such a system, leading to two transition points. Namely, a percolation transition occurs at R_{0c} = 0.908 when a spanning cluster of connected bonds emerges in the system. Here, information propagates across the system instantly, i.e., with infinite speed. Secondly, there exists another transition point R_0^* = 0.5907 where the giant cluster of live bonds spans the lattice. In this case the information takes finite time to propagate across the system through the dynamical evolution of finite size clusters. This passage time diverges as $R_0 \rightarrow R_0^*$ from above. Both the transitions exhibit the critical behavior of ordinary percolation transition. The entire scenario is robust with respect to the distribution of frequencies of the individual discs. This study may be relevant in the context of wireless sensor networks.

Subodh Kumar Sharma

Emeritus Professor
Theoretical Sciences
sharma@bose.res.in

Dr. Sharma obtained his Ph.D from Calcutta University in 1977. He worked at BITS Pilani, SINP Kolkata, IWMED Kolkata, UWCC Cardiff, Imperial College London and S N Bose National Centre for Basic Sciences, Kolkata. He has contributed three book chapters and authored two books related to electromagnetic scattering.

Fellow / Member of Professional Body

1. Member, Optical Society of America
2. Member, SPIE

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

National

1. Dr. Ashim Kumar Roy, Indian Statistical Institute, Kolkata

Significant research output / development during last one year

General research areas and problems worked on

Development of theoretical light scattering methods of characterization of particles and particle groups

Interesting results obtained

A novel procedure for parameterising a scattering phase function of a collection of particles of known size distribution has been obtained. The procedure is based on the Lagrange mean value theorem. Interesting applications to atmospheric aerosols and interstellar dust have been demonstrated.

Proposed research activities for the coming year

Applications of the above approach to soft biomedical tissues will be examined.

Sunandan Gangopadhyay

Assistant Professor
Theoretical Sciences
sunandan.gangopadhyay@bose.res.in

Dr. Sunandan Gangopadhyay has joined the Department of Theoretical Sciences, S. N. Bose National Centre for Basic Sciences, Kolkata, on 12th December, 2017. His broad area of research interest are quantum field theory, general relativity and any area of theoretical physics. Previously, he has been teaching and carrying out research in the Department of Physics, West Bengal State University, for more than 7 years starting from 2009. He then shifted to Department of Physical Sciences, Indian Institute of Science Education and Research, Kolkata and served there for a period of 1 year 6 months approximately. He did Physics (Hons.) from St.Xavier's College and his Masters and Ph.D from S. N. Bose National Centre. So far one of his Ph.D. students has submitted his thesis. He also has two Ph.D. students in this Centre and 3 more are about to join. He has three Ph.D. students in IISER, Kolkata.

Supervision of Research / Students

Ph.D. Students

1. Swarup Saha, Investigating the response of particles to linearized gravitational wave in noncommutative space, Thesis submitted
2. Debabrata Ghorai, Ongoing (SNBNCBS)
3. Rituparna Mandal, Ongoing (SNBNCBS)
4. Abhijit Dutta, (given pre-thesis submission seminar) about to submit
5. Suchetana Pal, Ongoing (IISER, Kolkata)
6. Saumya Ghosh, Ongoing (IISER, Kolkata)

Teaching activities at the Centre

1. I have taught a course on Electromagnetic Theory (PHY203) in the second semester of the Int. Ph.D Programme of our Centre. I shall also teach in the third semester.

Publications in Journals

1. Saumya Ghosh, **Sunandan Gangopadhyay**, Prasanta K. Panigrahi, *Scalar-metric quantum cosmology with Chaplygin gas and perfect fluid*, Eur. Phys. J. C, **78** (2018)
2. Anirban Saha, **Sunandan Gangopadhyay**, Swarup Saha, *Quantum mechanical systems interacting with different polarizations of gravitational waves in noncommutative phase space*, Phys. Rev. D, **97**, 044015 (2018)
3. Suchetana Pal, **Sunandan Gangopadhyay**, *Noncommutative effects on holographic superconductors with power Maxwell electrodynamics*, Annals of Physics, **388**, pp. 472 (2018)
4. Sukanta Bhattacharyya, **Sunandan Gangopadhyay**, Anirban Saha, *Quantum mechanics of a particle in an accelerated frame and the equivalence principle*, Euro.Phys.Lett., **120**, 30005 (2017)
5. Saurav Das, **Sunandan Gangopadhyay**, Debabrata Ghorai, *Viscosity to entropy density ratio for non-extremal Gauss-Bonnet black holes coupled to Born-Infeld electrodynamics*, Euro. Phys. J. C, **77**, pp. 615 (2017)
6. Rabin Banerjee, **Sunandan Gangopadhyay**, Pradip Mukherjee, *On the question of symmetries in nonrelativistic diffeomorphism-invariant theories*, Int. J. Mod. Phys. A, **32**, 1750115 (2017)
7. Aslam Halder, **Sunandan Gangopadhyay**, *Phase-space noncommutativity and the thermodynamics of the Landau system*, Mod.Phys.Lett. A, **32**, 1750102 (2017)

8. Debabrata Ghorai, **Sunandan Gangopadhyay**, *Non-linear effects on the holographic free energy and thermodynamic geometry*, Euro. Phys. Lett., **118**, 31001 (2017)
9. Subhajit Saha, Saumya Ghosh, **Sunandan Gangopadhyay**, *Interacting Chaplygin gas revisited*, Mod.Phys.Lett. A, **32**, 1750109 (2017)
10. Saumya Ghosh, **Sunandan Gangopadhyay**, *Thermodynamics and emergent universe*, Mod.Phys.Lett. A, **32**, 1750089 (2017)

Academic Visits

National

1. Visited ICTS, Bangalore in January, 2018 for the Kavli Winter School on Strings

Awards / Recognitions

1. Visiting Associate in IUCAA, Pune from 2011-till date

Collaborations including publications (Sl. No. of paper/s listed in 'Publications in Journals' jointly published with collaborators)

Intra Organizational

1. Mr. Debabrata Ghorai, (Sl. No. 5 and 8 in Item 4)
2. Prof. Rabin Banerjee, (Sl. No. 6 in Item 4)

National

1. Prof. Prasanta K. Panigrahi, (Sl. No. 1 in Item 4)
2. Dr. Anirban Saha, (Sl. No. 2 and 4 in Item 4)
3. Dr. Subhajit Saha, (Sl. No. 9 in Item 4)
4. Saumya Ghosh, (Sl. No. 1, 9 and 10 in Item 4)
5. Aslam Halder, (Sl. No. 7 in Item 4)
6. Sukanta Bhattacharyya, (Sl. No. 4 in Item 4)

Societal impact of Research

The impact of my research on the society would be the following:

- The research carried out by me will produce Ph.D. students who shall surely become the people to carry forward Science in the future.
- It would train students in Theoretical Physics which is one of the thrust areas of research in Science. The research in new Theoretical ideas would help us to understand our Universe in a deep way and may also help in building up new Technologies in the future.

Significant research output / development during last one year

General research areas and problems worked on

I have been working in the following areas :

1. Applications of gauge/gravity duality in strongly coupled systems (analytical investigation of holographic superconductors with non-linear electrodynamics)
2. Quantum gravity phenomenology (black hole thermodynamics with generalized uncertainty principle (GUP), rainbow gravity, constraints on the GUP and rainbow functions)
3. Noncommutative quantum mechanics (Response of simple quantum systems to different polarizations of gravitational waves in noncommutative phase-space)
4. Quantum Cosmology (scalar metric quantum cosmology with Chaplygin gas and perfect fluid, Wheeler-DeWitt Hamiltonian formalism)

Interesting results obtained

The interesting results obtained are the following:

1. I have been analytically investigating several properties of holographic s-wave superconductors in the background of a Schwarzschild-AdS spacetime in the framework of Born-Infeld electrodynamics. Based on a perturbative approach, we explicitly find the relation between the critical temperature and the charge density and also the fact that the Born-Infeld coupling parameter indeed affects the formation of scalar hair at low temperatures. Higher value of the Born-Infeld parameter results in a harder condensation to form.
2. I have calculated the ratio of the shear viscosity to the entropy density calculated for non-extremal Gauss-Bonnet (GB) black holes coupled to Born-Infeld (BI) electrodynamics in 5 dimensions. The result is found to get corrections from the BI parameter and is analytically exact upto all

orders in this parameter. The computations are then extended to D dimensions.

3. I have studied study the effect of acceleration of a uniformly accelerated frame on the freeparticle dynamics in a quantum domain. Specifically we demonstrate how the behaviour of a free quantum particle, as observed by an observer with uniform acceleration, completely changes from that of a quantum particle immersed in a uniform gravitational field. We also extend our analysisto the simplest noncommutative space scenario to show that while spatial noncommutativity doesnot affect the quantum particle in a gravitational field, it does alter the energy eigenvalues of a quantum particle as seen from a frame with uniform acceleration.

4. Owing to the extreme smallness of any noncommutative scale that may exist in nature, both in the spatial and momentum sector of the quantum phase-space, a credible possibility of their detection lies in the present day gravitational wave detector set-ups . With this motivation, I have considered how a free particle and harmonic oscillator in a quantum domain will respond to linearly and circularly polarized gravitational waves if the given phase-space has a noncommutative structure. The results show resonance behaviour in the responses of both free particle and HO systems to GW with both kind of polarizations. We critically analyze all the responses, and their implications in possible detection of noncommutativity. We use the currently available upper-bound estimates on various noncommutative parameters to anticipate the relative size of various response terms. We also argue how the quantum harmonic oscillator system we considered here can be very relevant in context of the resonant bar detectors of GW which are already operational currently.

5. I have considered the flat FRW cosmology with a scalar field coupled with the metric along with generalized Chaplygin gas and perfect fluid comprising the matter sector. The Schutz's formalism is used to deal with the generalized Chaplygin gas sector. The full theory is then quantized canonically using the Wheeler-DeWitt Hamiltonian formalism. The WD equation is then solved with appropriate boundary conditions. Then by defining a proper completeness relation for the self-adjointness of the WD equation we arrive at the wave packet for the universe. It is observed that the peak in the probability density gets affected due to both fluids in the matter sector, namely, the Chaplygin gas and perfect fluid.

Proposed research activities for the coming year

I wish to persue these areas further in the coming year. I would also like to investigate holographic entanglement entropy and holographic complexity in non-relativistic systems having a scaling symmetry.

In the quantum cosmology side, I am presently trying to look at anisotropic cosmological models.





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 15500 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.

Resources and Services Added in the F.Y. 2017-18

1 Approximately 245 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 2016, 2002, 2001 and 2000 have been uploaded in the repository.

3. In the Financial Year 2017-18, the Fiction Section has been enriched by procuring 37 books of classic literature, novel, short story, biography and books of general interests.

4. 32 Hindi books are added in the Library collection the mentioned financial year.

5. Ph.D. collection has been renovated with systematic arrangement procedure for convenient searching of desired Ph.D. thesis.

6. Five new Desktop Computers are added in the library with dual operating system to provide smooth service library users.

Saumen Adhikari
Librarian – cum – Information Officer

ENGINEERING SECTION

1. Report on Engineering Section (Infrastructure Development, Maintenance & Housekeeping and Support Services):

A. CIVIL

i) Construction of Integrated Hostel Building and Transit Quarters Complex (I HB&TQC) G + 3 Phase-I:

After the completion of Building upto G + 3 floors, named 'Basundhara' the Building has been made to use for various purposes. The 1st phase of work consists of 25 nos. Single room with attached bath, 6 nos 2 BR Suits, and 10 nos 1 BR Suits apart from 2 nos Dining Halls, Kitchen, Recreation Room, Halls etc at Ground Floor with modern amenities with future provision of Lift facility.

The process of Construction for further 2 floors has been initiated and construction work will start shortly.

IHB&TQC Building (Basundhara) Front View

IHB&TQC Building (Basundhara) Side View

ii) Construction of 2 Nos. Laboratory Buildings at SNBNCBS:

To increase the laboratory spaces for providing the facility for research work to the scientists, two bigger size and one smaller size laboratories at three different places are being constructed. For Laboratory-1 which is near to Pump House and Laboratory-2 near the Clean Room Building and VSM laboratory attached to main building are being constructed. The balance work for completion of the buildings including structural, Civil, electrical and Air-conditioning is at the last stage of finalisation.

Lab Building under Construction

Inside of TRC-1 Lab

iii) Construction of Cycle Shed

For protection of Cycles of the employees and students and also to avoid haphazard parking of Cycles inside the Campus, it has been decided to erect three nos modern-type Stainless Steel Cycle sheds at different locations and the Second one of the same has been erected near Helium Plant.

SS Cycle Shed

iv) Creation of new Student bay with PDRA bay and Academic Visitors' room.

To accommodate growing number of Students, PDRAs and Academic Visitors, 3 nos new bay with customized Furnising, Illumination and Air-conditioning have been created in the 2nd Floor of Main building with a total capacity of 38 heads.

Students Bay

PDRA Bay

Visitors Bay

v) Furnishing Offices, Hostels, Staff Quarters and Laboratories:

According to the demand of different faculties and other officials, different types of cubicles sometimes in modular shape suitable to their office spaces are constructed.

vi) Apart from above mentioned construction works, the Engineering Section has to look after day to day Upkeep, sweeping and Cleaning Service for the Main Building, the Hostel Buildings, Guest House, Director's Bunglow and Subarnarekha Building.

Main Building (Front)

Main Building internal Courtyard






Krishnachura Hostel Building

vii) The Centre has around 3.5 Km of Water pipeline network of various sizes spread all over the Campus and also in the buildings.

viii) There is also a vast network of sewerage and storm water drainage line of an approximate length of about 3 Km with in numerous Gulley pits, Yard gulley, Manholes etc which are being maintained and kept congestion-free round the year.

ix) The Centre has about 27 nos. of overhead PVC water tanks over roof of various buildings which gets water supply from the RCC Overhead Water Tank (Capacity 1,60,000 It.) all of which are maintained and regularly cleaned and periodically tested to ensure hygiene for the users. There is also an Iron-removal plant of 35,000 litre/hr. capacity efficiently operated and maintained to supply Iron-free potable water for the entire Campus.

x) **RCC Overhead Water Tank :** In addition, it is the responsibility of the Engineering section to nurture and grow the flora and fauna of the entire Campus to maintain a pleasant green environment for the Horticulture & Landscaping beauty of the Centre. The cleaning of all the open area including Roads and parking area and disposal of huge garbage generated day by day is also under the purview of the Engineering Section.

B. Estate Management Activities:

Making allotment of hostel rooms and office spaces, maintaining all the records of the allotment of the offices, hostels, Guest houses, proper co-ordination during allotment and surrender of office/living areas by new entrants and outgoing students/PDRAs.

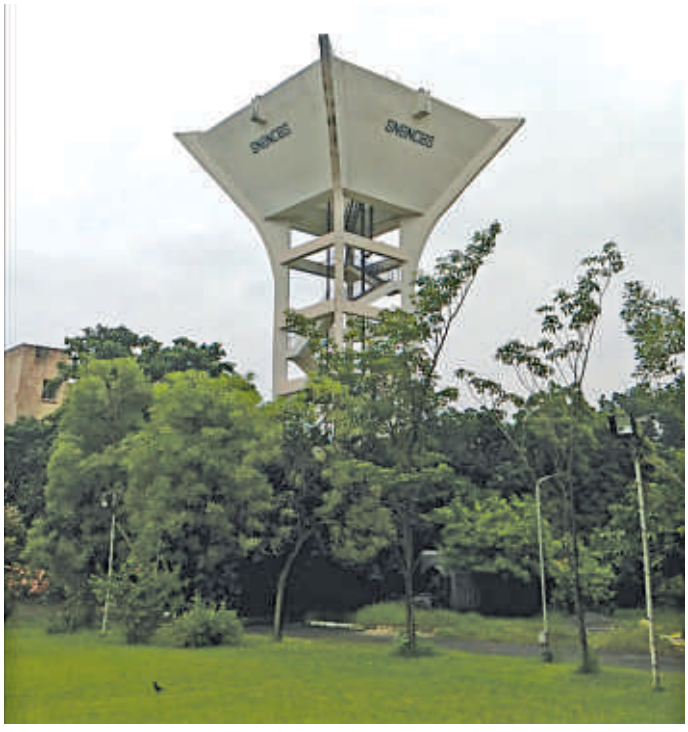
C. Electrical Work:

(a) **Erection, Installation, Testing and Commissioning of 11KV/433V New Electrical Sub-Station.:** The Erection and installation of various components of the substation has been successfully completed. Final inspection of Central Electricity Authority has been completed and clearance has been obtained. Waiting for the date to be fixed by the WBSEDCL for commissioning.

(b) **Basundhara Building :** The entire electrical work including cable laying, internal electrical installation work, including arrangement of Illumination has been completed. Air-conditioning, and Fire-fighting facilities are being taken up.

(c) **Maintenance of DG Sets** : The Centre is having Two 500 KVA and one 320 KVA DG sets are maintained to provide emergency power back-up.

d) **Air-conditioning work and Lifts:** The Centre is having approximately 600 Nos of Air-conditioners of various capacities and various makes which need to be maintained



RCC Overhead Water Tank

Electrical Panels in New Sub Station

Generators

periodically and systematically to take care of the requirement of various labs as well as offices. Upkeep and maintenance work for 4 nos of 8-passenger lifts in the Centre are also looked after by the Engineering Section.

(e) **Water and Fire Pump**: Apart from 2 nos. 12.5 H.P. Submersible Pump (Borewell type), 4 nos. 10 HP Centrifugal Pumps, 2 nos. Submersible Domestic Pump, 1 no. 3HP and 1 no. 5 HP Mono Block Pump are being maintained for ensuring adequate water supply of the Campus. Besides, there are 1 no. 75 HP Fire Pump, 1 no. 75 HP Diesel Driven Pump, 1 no. 5HP Jocky Pump for fire fighting of Krishnachure Building which are also being regularly maintained. In addition to that there is an Iron removal unit at Pump house, the operation and maintenance for which is looked after by the Engineering Section.

(f) **Elementary Training for Fire Fighting and Fire Prevention at S N Bose Centre:-**

Periodical Fire training and drill are being conducted for the basic awareness of Fire-fighting by involving the Center's staff, students as well a security personnel. Training is based on the guideline of Fire Fighting and Fire Prevention Safety Management, covering types of fire extinguishers, Hydrant systems, classes and types of Fire, along with practical fire fighting skills, of West Bengal Fire Training institute at Shilpara (Behala).

(g) **Misc. Electrical Maintenance Work at the Centre:** Preventive and as and when basis maintenance work was carried out by the Section.

(h) **New Minor Electrical Works:**

(i) SITC of 5 TR HAT (light commercial ceiling mount AC at inner server room and NCR Lab.

(ii) New electrical cable laying work at Director's Bungalow.

(iii) Electrical power supply work at newly constructed 2nd floor Students' Bay and Visitors' Bay.

(iv) Modification of electrical wiring for Ground Floor and Second Floor Labs at Main Building, SNBNCBS.

Sujit Kr. Dasgupta
Superintending Engineer

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. Massive astronomical data pipeline using hybrid computing: A collaborative research work

   The Proposed Real life fully automated fault-tolerant Massive Astronomical Data Movement and Processing using data pipeline through Multiscale Parallel Hybrid Computing.

   The purpose of this research work is to help astrophysicists analyse the available massive data, by creating better algorithms and applying distributed computing technique.

2. Working on parallelizing big data analysis algorithms & performance analysis for health care data.

   The Proposed work has described that even though usage of EMR has been underway for decades now; its performance is still questionable and prone to inefficiency.

   Hadoop (data analysis algorithms) method has only been verified on a trivial cluster using a moderately small medical dataset dimension.

3. Working on Molecular computing in the field of Computer Science and Engineering with Molecular Computing:

   i) Using Molecular Dynamics (GROMACS, NAMD, and Quantum WISE) simulation to explore the modalities of Carbon Nanotubes.

   ii) Hybrid Computing (CPU and GPU, Collaborative Research Work with- Institute of Bioinformatics and Applied Biotechnology (IBAB)): High-throughput DNA sequences are becoming indispensable in our understanding of diseases at molecular level, in marker-assisted selection in human Genome and in microbial genetics research. These sequencing instruments produce enormous amount of data (often terabytes of raw data in a month) that requires efficient analysis, management and interpretation.

   iii) Fastest way to compute Massive Human Genome Raw Data Processing and Analysis using data pipeline through Multiscale Parallel Hybrid Programming.

The Computer Services Cell (CSC) is equipped with most modern and advanced infrastructure to provide a distributed computing environment to cater to the computing and networking needs of the inmates of the institute. The centre has a state of art Computer Network along with blade server and HPC infrastructure. The Computer Centre is providing Electronics class facility to scholars as part of their academic curriculum. It has a wide range of specialized licensed software mined in the software vault of the institute intranet for easy use of researchers. Frequently the centre organizes training programs on specialized software by specialized trainer for students, researchers and staffs. The computer centre also has many dedicated logical servers such as HPC, Mail server, Backup server, Intranet server, Webserver, Authentication server, Blog server, Antivirus server, etc. which provide dedicated resources to different applications.. The Computer Services Cell Advisory Committee (CSC-AC) governs the cell and the Computer Services Cell Working Group Committee (CSC-WG) carries out required services. CSC In-charge (Mr. Sanjoy Choudhury), Jr. Computer Engineers (Mr. Abhijit Ghosh, Mr. Sagar S. De, Ms. Deblina

Mukherjee and Ms. Somasree Mal) and Jr. Assistant (Mr. Bijay Pramanik) had supported all day-to-day activities associated to the cell.

Centre's Computing Facilities are all facilities related to numerical and symbolic computations and communications and network access such as, but not limited to, e-mail and Internet access.CSC provides these to facilitate the research, education and administrative efforts of its members and staff. To this end the Computer Centre (CC) provides support in networking and information resources for its computing community. The Computer Centre undertakes security and monitoring measures to preserve the integrity and performance of its networking and computing resources.

The Computer Centre is solely responsible for keeping the Information and Communication Technology & Computation related facilities available to each and every member of the Centre.

These facilities are constantly upgraded to meet the evolving standards of Centre. The Centre is also engaged in designing and facilitates the NKN Project with NIC. National Knowledge Network (NKN) project is aimed at establishing a strong and robust internal Indian network which will be capable of providing secure and reliable connectivity. Using NKN, all vibrant institutions with vision and passion will be able to transcend space and time limitations in accessing information and knowledge and derive the associated benefits for themselves and for the society towards ushering in a knowledge revolution in the country. NKN is intended to connect all the knowledge and research institutions in the country using high bandwidth / low latency network.

At the end of the academic year 2017-18, there were more than 700 users including faculty members, administrative staffs, PDRAs, and students. The Centre is backboned with a fibre optic based internal network capable to support up to 1Gbps. Internet facility had been pulled up to support up to 1Gbps access supported by NKN and an 15Mbps line by Sify Technologies Pvt. Ltd. as a backup. Web, Intranet server configuration had been extended. Wi-Fi support had been extended for better coverage. Desktops, Printers, UPSes, Xerox machines and other Network devices had been maintained regularly. Activities such as updation of website, tenders, and jobs, web-based General Notice Board (where the Centre's general, official, academic, seminar and placement related notices are posted regularly) are followed regularly. CSC facilited Centre by developing new web applications, taking care of email facility, online admission. CSC also looks after other centre computational facilities including Serial Computing Clusters and Parallel Computing Clusters built by Super Micro. Project Clusters are also maintained by the cell. New super computer (CRAY) has been installed as a part of TUE-CMS project. As a part of the Centre's vision towards Academic/Scientific society, CSC allows external users (Academic/Research) to use center's computational facilities.

Summary of central computational facilities

Machine Name	Processor Core	Storage	User
Photon	84	-	55
Phonon	84	-	27
HPC	344	2.2 TB	72
UNANST	480	12 TB	25
UNANST	96	12 TB	30
AMRU1	360	6 TB	31
AMRU2	48	-	27

Summary of project sponsored computational facilities

Machine Name	Processor Core	Storage	User
ATHENA	320	-	12
CRAY	7808	255	50

CSC-AC Members: Sr. Prof. Priya Mahadevan, Prof. Jaydeb Chakrabarti, Dr. Sakuntala Chatterjee, Dr. Soumen Mondal, Dr. Manoranjan Kumar, Deputy Registrar(Finance), Deputy Registrar(Administration) Campus Engineer cum Estate Officer, Mr. Sanjoy Choudhury.

CSC-WG Members: Sr. Prof. Priya Mahadevan, Prof. Jaydeb Chakrabarti, Dr. Manoranjan Kumar, Mr. Sanjoy Choudhury, Ms. Nibedita Konar, Deputy Registrar(Administration) , Mr. Soumen Adhikari, Mr.

Sanjoy Choudhury, Mr. Abhijit Ghosh, Mr. Sagar S. De, Ms. Deblina Mukherjee, Ms.Somasree Mal

Central Computational Resources (2017-18):

S.N. Bose National Centre for Basic Sciences, Computing Facility for its academic research & administrative pursuit:

SNBNCBS is the top 17 in the List of Top Supercomputers in India as of June 2015, Cray XE6 cluster, Massively Parallel Cray Supercomputing Facility with 75 TF Theoretical Peak Performance.

SNBNCBS Computing Facility provides researchers from national laboratories, academia, and industry with access to high-performance computing capabilities – some of the most powerful in the India – to conduct breakthrough in Basic Science research.

Range of research: 4 Basic science research seeks to understand how nature works. This research includes modelling and simulation of physical, chemical, and biological processes, and high-energy physics. This research focuses primarily on Basic Sciences and related challenges.

Resources for open science: This program allocates time on computational resources. Innovative and Novel Computational Impact on Theory and Experiment. This program competitively awards large blocks of time for computationally intensive, large-scale research projects that address grand challenges in science and engineering.

User support and services: Skilled experts at the SNBNCBS enable researchers to conduct breakthrough science on the High Performance Computing (HPC) system in key ways. Operations ensures that system hardware and software work reliably and optimally; system tools are matched to the unique system architectures and scale of SNBNCBS resources; the entire system software stack works smoothly together; and I/O performance issues, bug fixes, and requests for system software are addressed. User Services and Outreach provides frontline services and support to existing and potential SNBNCBS users.

Access to primary high-performance computing (HPC) resource facility is allowed to external users also (Academic/Research, Organizations only) on case-to-case basis and in the mode of research projects through a peer-reviewed proposal system. The Proposal should have detail requirements of specific facility and persuasive narration describing the work. These clusters are a shared Linux environment for most of the popular applications, compilers and programs to support the research. It has been heavily utilized by researchers from a very broad range of disciplines.

The SNBNCBS using National Knowledge Network (NKN) as live line for its Basic research pursuit:

SNBNCBS Computing Facility provides researchers from national laboratories, academia, and industry with access to high-performance computing capabilities – some of the most powerful in the India – to conduct breakthrough in Basic Science research.

At present Centre is using 1Gbps internet leased line from National Knowledge Network as live line for its Basic research pursuit:

1. Establishing Connectivity for Knowledge and information sharing.
2. Conducting Collaborative Research in emerging research areas.
3. The Centre has digital repository, which is connected to world through NKN.
4. S. N. Bose National Centre for Basic Sciences uses the NKN for easy access to knowledge, better knowledge services and dissemination of knowledge, the Centre has own scalable campus wide local area network.
5. The Centre has a set of servers, 114 nodes/884 cores storage more than 9TB with maximum speed nearly 3.5 TF for parallel computing and serial machines.
6. The Centre has sophisticated computing facility with extra mural research support include high performance cluster and recently a Cray (244 node, 7808 Core) has been installed with extramural support that allows 75 TF speed with 255 TB memory network security components, and set of applications.
7. S N Bose National Centre for Basic Sciences used NKN for high speed Internet, VPN, in addition to this NKN also helps connecting nodes to provide

mail, messaging, DNS, Video portals and streaming etc.

8. S. N. Bose National Centre for Basic Sciences utilizes NKN network for Country wide Virtual Classroom, Collaborative Research, Virtual Library, and Sharing of Computing Resources, and Security.
9. Centre has procured pool of 256 public IP addresses along with Autonomous System Number (ASN) from Indian Registry for Internet Name and Numbers (IRINN) to reducing dependencies from ISPs and to increase network reliability. Through NKN, the Centre configured Linux based personal firewall, gateway for the Centre, VPN service has been revised and reconfigured in the dedicated gateway firewall supporting LAN as well as Journal access.
10. Centre Website had been developed for bilingual (English and Hindi) facility.
11. For day-to-day use, new web applications had been developed and deployed - to work within intranet.
12. Newly developed Administrative & Academic software has been deployed for keeping records of all the staffs and students of the Centre.
13. New Faculty Search cum Selection blog has been developed as per the recommendations of Faculty Search Committee.
14. Ticketing system for the Engineering and Estate Office Complaints had been introduced.
15. Hall booking application had been developed for reliable and sophisticated use with new feature.
16. Backup systems had been configured for any unusual accidental breakdown.
17. GeM, Govt. of Indian e-marketplace has been implemented for day to day purchasing of common goods and services.
18. Govt. of India Central Public Procurement Portal (CPPP) E-Procurement Portal has been implemented for the transparency of every new procurement through Centre.
19. Initiate Computational Training/Workshop for the Scientists and Researchers for the better way of utilizing Central Computational Resources.
20. Enable the Centre Website for social networking site for publishing the Centre's novel and innovative research ideas and day-to-day broad discussions with the academic and research communities of the entire world.
21. Network racks had been rearranged for better arrangement and maintenance concern.
22. CSC configured Linux based new personal firewall, gateway for the centre.
23. Web applications such as Radhachura booking, Guesthouse Billing, Visitor pass, Asset Manager, Online Confreg had been developed and deployed in the intranet server.
24. Admission application has been modified to fulfil 2018 admission criteria.
25. BCRC blog has been created & upgraded.
26. Guesthouse Wi-Fi has been re-established after building repair. Entire guest house is now covered by enterprise class Wi-Fi equipment to provide internet facilities.
27. Old CO_2 and Dry Powder based fire extinguishers had been replaced with safer clean agent based fire extinguishers in the cell.
28. Comprehensive fire safety solution had been design and proposed for the entire computer centre, which will be implemented very soon.
29. CSC have started to do security audit of the Centre network and systems recently and identified various vulnerabilities -- and we plan to carry this out as a yearly exercise to ensure that the institute network and systems is less risk prone. Currently the Centre are also working on awareness of digital governance in the center.

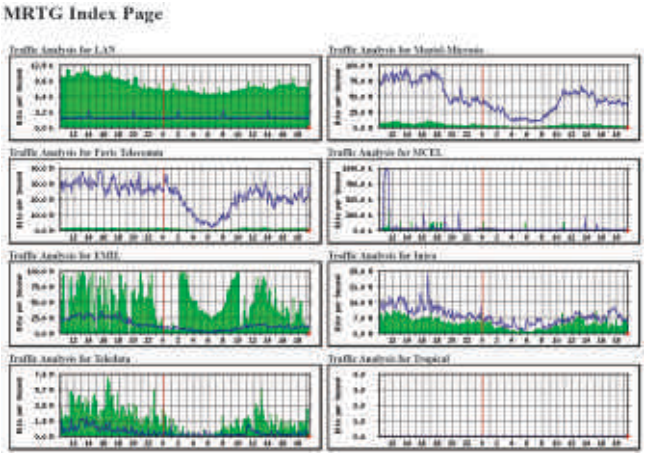
Our Future Vision:

- Currently our goal is to build up the center of excellence in DATA Center for Research & Academic Infrastructure at the Centre. Centralized State-of-the–Art Data Centre for content storing

- The eventual goal is to establish our center as "the" center for excellence in research, education and training in India, and be counted as one of most productive research centers in the world.
- To up-grade the campus network to next generation IP Infrastructure. The proposed 10G solution will provide the latest state-of-the-art content delivery enabled multilayer switched campus network with very high reliability, scalability and performance to provide video/voice/data applications.
- Design and Implementation of centralised SAN based storage solution for the Centre.
- Design and Implementation of redundant core switch with Next Generation IP Infrastructure features and enhanced back plane and uplink.
- Implementation of Multipoint-to-Multipoint Video Conferencing Solution.
- WiMax base secure wireless Internet Access in Campus
- Implementation UTM and Internet Policy Deployment
- Upgrading Network Active/Passive Devices for Next Generation IP Infrastructure Application in a High availability mode and redundancy.
- Implementation of EDUROAM in the Campus.
- Complete Office Automation (ERP) Implementation

sanjoy choudhury

Sanjoy Choudhury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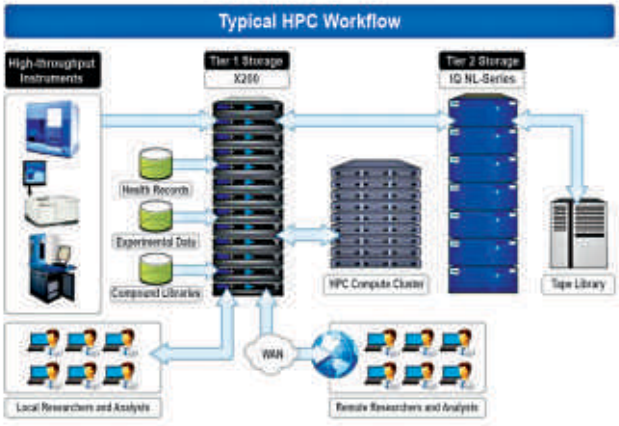
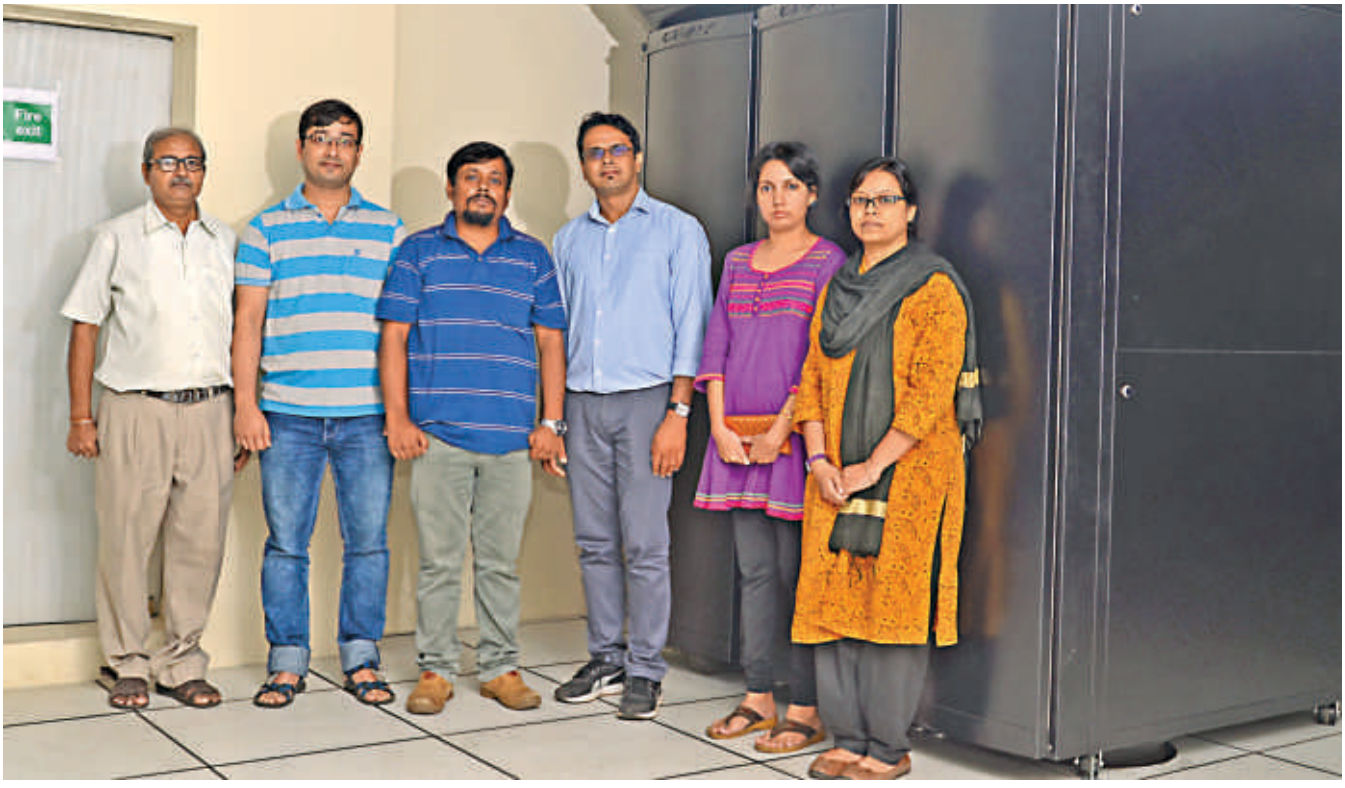

Typical HPC Workflow
High-throughput Instruments
Tier 1 Storage
X200
Tier 2 Storage
IG NL-Series
Health Records
Experimental Data
Compound Libraries
HPC Compute Cluster
Tape Library
WAN
Local Researchers and Analysts
Remote Researchers and Analysts


CRAY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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. The cell also keeps track of the manpower under projects. 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 2017-18:

- Prof. S. K. Pal, Convener
- Prof. Pratip K Mukhopadhyay
- Prof. Gautam Gangopadhyay
- Dr. Soumen Mondal
- Deputy Registrar (Admin)
- Senior Assistant Registrar (Projects)
- Office Assistant, Office of Dean (Faculty)
- Office Assistant, Academic Section
- Mr. Achyut Saha, PA to Director will render Secretarial Assistance to the Project & Patent Cell

The following table summarizes the details of the externally funded projects in the Centre, for the last five years:

Year	No. of Projects	Amount Received (Rs.)
2013-14	31	10,10,54,463=00
2014-15	32	4,72,26,394=00
2015-16	38	4,71,50,347=00
2016-17	35	4,05,49,788=00
2017-18	32	3,04,37,606=00

The report of the Project and Patent Cell for the year 2017-18 is as under:

Running projects during 2017-18

Project Title	PI / Co – PI	Funding Agency
"J.C. Bose Fellowship" DST/AKR/11-12/63 –"Thematic Unit for Excellence on Nanodevice Technology"	Prof. A.K. Raychaudhuri Prof. A.K. Raychaudhuri / Dr. Anjan Barman (Coordinator)	DSTSR/S2/JCB-17/2006 DSTSR/NM/NS-09/2011
"Thematic Unit of Excellence on Computational Materials Science at the SNBNCBS, Kolkata"	Prof. Tanusri Saha Dasgupta	DSTSR/NM/NS-29/2011
"Ramanujan Fellowship"	Dr. Manoranjan Kumar	DST (SERB) SR/S2/RJN-69/2012
DST/MP/11-12/81 –"New Frontiers in Quantitative mid-Infrared High Resolution Cavity ring-Down Spectroscopy using Quantum Cascade Laser"	Dr. Manik Pradhan	DST (SERB)SB/S2/LOP-18/2013dated 20-7-2015

MES/MP/11-12/85 -"Development of a mid-IR Cavity Ring-Down Spectrometer for High-Precision Real-Time Continuous Monitoring of Multiple Trace Gases and Stable Isotopic Species in the Atmosphere"	Dr. Manik Pradhan	MoES/16/26/12-RDEAS
DST-NWO/TSD/12-13/98 –"Graphene Spintronics with Complex Oxides"	Prof. Tanusri Saha–Dasgupta (From SNBNCBS)	DST (India-Netherland) INT/NL/FM/P-001/2013
DST/ASM/13-14/112 –"Fundamental aspects of Quantum Theory and Quantum Information Science"	Prof. Archan S. Majumdar	SERBSB/S2/LOP-008/2013
DST/MM/13-14/113–"Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release"	Dr. Madhuri Mandal	DSTSR/WOS-A/CS-15/2013 (G)
DAE(BRNS)/TSD/13-14/114"Development and validation of a Modified Embedded Atom Method (MEAM) Potential for Aluminum Alloys"	Prof. Tanusri Saha - Dasgupta	BRNS(DAE)37(3)/14/41/ 2014-BRNS1466 dated 1-9-14
CSIR/RB/13-14/116 –"Jump Dynamics in Ionic Liquids and non-exponential Relaxation"	Prof. Ranjit Biswas	(CSIR)01(2811)/14/EMR-II
DAE(BRNS)/PM/13-14/117 –"Functional transition metal oxides"	Dr. Priya Mahadevan	BRNS (DAE) 37(3)/14/22/2014-BRNS/554
DST/RKM/13-14/119 –"Real Time structure and solvation dynamics of proteins during folding/unfolding in crowded environment"	Dr. Rajib Kumar Mitra	DST(SERB) SB/S1/PC-056/2013
DBT/SKP/13-14/126-2 – "Nanogels: Biophysical characterization and Potential Biomedical Applications in Drug Delivery"	Prof. S.K. Pal	DBTBT/PR11534/ NNT/28/766/2014
DST/AB/14-15/133 – "Nanoscale Modifications and Active Control of Magnonic Crystals for On-Chip Microwave Communication"	Prof. Anjan Barman	DSTDST/INT/POL/P-11/2014 dated 20-4-2015
DST(DST-BMWF)/TSD/14-15/140 –"Search for Superconductivity and Magnetism in Mxene Phases"	Prof. Tanusri Saha Dasgupta	INT/AUA/BMWF/P-33/2015 dated 21-5-2015
DST(SERB)/PP/14-15/141 – "Additivity Principle and Thermodynamic Characterization of Mass Transport Processes"	Dr. Punyabrata Pradhan	DST (SERB) EMR/2014/000719 dated 8-6-2015
DST/SJ/14-15/142 – "Solution phase conversion of Nanoscale Metals into Intermetallics: Efficient Catalysts for Chemoselective Organic Transformations"	Dr. Subhra Jana	DSTSR/NM/NS-18/2014 Order dated: 23-5-2016
ICMR/SKP/14-15/147 – "Development and Optimization of a Non-contact Optical Device for Online-Monitoring of Neonatal and Maternal Jaundice"	Prof. S.K. Pal	ICMR5/3/8/247/2014-ITR Dt: 3-3-2017
DST(SERI)/SKP/14-15/151 –"In(Ga)As/GaAs Quantum Dot Solar Cells"	Prof. S.K. Pal (Co.PI) Prof. Subhananda Chakrabarti, IITB (PI)	DSTDST/TM/SERI/FR/117(G) dated 21-7-2015

SERB (DST)/AD/14-15/154"Microwave dielectric properties and collective vibrational modes of double perovskite oxides"	Dr. Alo Dutta	SERB (DST)SB/FTP/ PS-175/2013
DST(SERB-NPDF)/JR/16-17/168 –"Investigation of electrostatic charge induction in Superconductors"	Dr. Jashashree Ray	DST(SERB-NPDF) PDF/2015/000684
DST(SERB-NPDF)/AG/16-17/169 –"Interface Physics in Multilayered Perovskite Complex Oxides"	Dr. Ankita Ghatak	DST (SERB-NPDF) PDF/2015/000179
DST/SC/16-17/170 – (SERB) – "Study of E.Coli Chemotaxis at the single cell level: A Statistical Physics Approach"	Dr. Sakuntala Chatterjee	DST (SERB) EMR/2016/001663 Dt: 27-2-2017
SERB(DST)/AKR/16-17/171 – "An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide films"	Prof. A.K. Raychaudhuri & Dr. Barnali Ghosh Saha	DST (SERB) EMR/2016/002855 Dt: 24-03-2017
NTRF/SKP/16-17/172 – "Development of low cost, easy to use instrument for quick validation of Geographical Indication, Darjeeling Tea" Code No. NTRF: 198/2017	Prof. S.K. Pal	NTRFNTRF: 17(404)/2016 Dt: 9-06-2017
SERB/SKP/16-17/173 – "Exploration of key photoinduced dynamics in inorganic nanohybrids for enhanced biological activities"	Prof. S.K. Pal	SERBEMR/2016/004698 Dt: 9-6-2017
DST/MM/16-17/175– "Design of biocompatible fluorescent magnetic nanoparticles for imaging the cancer cells and their possible theranostic use"	Dr. Madhuri Mandal Goswami	DST (KIRAN DIVISION) SR/WOS-A/CS-158/2016 (G) Dt: 6-11-2017
DST(RFBR)/TSD/16-17/176 – "Topological phase transitions in quasi-two-dimensional magnets"	Prof. Tanusri Saha Dasgupta	DSTINT/RUS/RFBR/ P-274Date: 26-7-2017
SERB (DST)/SJ/16-17/180 – SERB Women Excellence Award - "Low Temperature Synthesis of Multi Metallic Inorganic Nanostructures for Catalysis and Chemical Sensing"	Dr. Subhra Jana	DST (SERB)SB/WEA-08/2016 Dt: 27-03-2017
SERB(DST)/JS/17-18/183 –Ramanujan Fellowship – "Developing Ferromagnetic Thin Film Hetero-structures viable for Spintronics based Devices and to Investigate the Magnetization Dynamics by means of Electrical Current and / or Laser Light"	Dr. Jaivardhan Sinha	DST (SERB) SB/S2/RJN-093/2014 Dt: 28-04-2017
SERB(DST)/TD/18-19/209 (NPDF) – "Remediation of pharmaceutical waste-products and other industrial pollutants using diverse metal-organic frameworks"	Dr. Tanushree Dutta	SERB (NPDF) PDF/2017/002448 Dt: 6-03-2018

*** Apart from this, the Centre has also received the TRC project during January 2016.

DST INSPIRE Faculty Projects Running During 2017-18 –		
Name	**Designation**	**Project Name**
Dr. Subhra Jana	DST INSPIRE Faculty	Low Temperature Chemical Routes to Alloys, Intermetallics, and Hybrid Nanomaterials
Dr. Soumendu Dutta	DST INSPIRE Faculty	Materials for Photocatalytic water splitting
Dr. Amlan Dutta	DST INSPIRE Faculty	Development of statistical model of dislocation dynamics
Post Docs & Above under Project –		
Name	**Designation**	**Project Name**
Dr. Madhuri Mandal	Visiting Faculty Fellow	Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release
Dr. Madhuri Mandal	Visiting Faculty Fellow	Design of biocompatible fluorescent magnetic nanoparticles for imaging the cancer cells and their possible theranostic use
Dr. Biswaroop Mukherjee	Scientist D	TUE on Computational Materials Science
Dr. Jaivardhan Sinha	Scientist D	TUE on Nano Device Technology
Dr. Jaivardhan Sinha	Ramanujan Fellow	
Dr. Alo Dutta	Young Scientist of SERB Fast Track Scheme of DST	Microwave Dielectric properties and collective vibrational modes of double perovskite oxides
Dr. Jashashree Ray	National Post Doctoral Fellow	Investigation of electrostatic charge induction in Superconductors
Dr. Ankita Ghatak	National Post Doctoral Fellow	Interface Physics in Multilayered Perovskite Complex Oxides
Dr. Tanushree Dutta	National Post Doctoral Fellow	Remediation of Pharmaceutical Waste-products and Other Industrial Pollutants Using Diverse Metal-Organic Frameworks
Mr. Bhushan Omprakash Awasarmol	Scientist D Computer Engineer	TUE on Computational Materials Science
Dr. Shreemoyee Ganguly Computational Materials Science	Scientist D	TUE on Computational Materials Science
Dr. C. Jebarathinam	Research Associate – I	Fundamental Aspects of Quantum Theory and Quantum Information

Project students during this time-					
Name of the Student	**Project Instructor**	**Dept.**	**Name of the Project**	**Joined On**	**No. of Students**
Sangita Dutta	Soumendu Datta	CMPMS	DST INSPIRE Faculty Award Materials for photocatalytic water spliting for hydrogen production	06.07.2016	
Sudipta Chatterjee	Arup K Raychaudhuri, Barnali Ghosh (Saha)	CMPMS	An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide flims (SERB)	27.11.2017	
Anirban Goswami	Arup K Raychaudhuri, Barnali Ghosh (Saha)	CMPMS	An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide flims (SERB)	11.12.2017	
	DEPT. TOTAL				**3**
Partha Pyne	Rajib Kumar Mitra	CBMS	Real Time Structure and Solvation Dynamics of Proteins during Folding / Unfolding in Crowded Environment	17.05.2017	
Arnab Samanta	Subhra Jana	CBMS	Solution Phase Conversion of Nanoscale Metals into Intermetallics: Efficient Catalysts for Chemoselective Organic Transformations	20.09.2016	
Animesh Halder	Samir Kumar Pal	CBMS	Nanogels: Biophysical Characterization and Potential Biomedical Applications in Drug Delivery	07.10.2016	
	DEPT. TOTAL				**3**
Suchetana Goswami	Archan S Majumdar	AC	Fundamental Aspects of Quantum Theory & Quantum Information Science	12.11.2014	
Bihalan Bhattacharya	Archan S Majumdar	AC	Fundamental Aspects of Quantum Theory & Quantum Information Science	08.09.2016	
	DEPT. TOTAL				**2**
Dhiraj Tapader	Punyabrata Pradhan	TS	Additivity Principle and Thermodynamic Characterization of Mass Transport Processes	06.06.2016	
Arnab Chandra	Sakuntala Chatterjee	TS	Study of E.coli Chemotaxis at the single cell level: a statistical physics approach	26.10.2017	
	DEPT. TOTAL			**2**	
	TOTAL 10 Patent Granted during 2017-18:				

(1) Patent No.: 288554
Application No.: 1478/KOL/2009
Date of Filing: 29/12/2009
Date of Grant: 20/10/2017
Process for the preparation of Stable Nanosized Silver Colloid.

(2) Patent No.: 292623
Application No.: 466/KOL/2009
Date of Filing: 17/03/2009
Date of Grant: 06/02/2018
A method and system for non-invasive quantitative estimation of hemoglobin in human body

Patents Applied during 2017-18:

(1) Flexible thin film transistor using electric double layer as gate dielectric and a method of fabricating thereof
(Dr. Barnali Ghosh, Prof. A.K. Raychaudhuri & others)
Application No: 201731015268 dated 29/04/2017

(2) Advancement in methodology and system to control isotopic fractionations in carbon containing gases
(Dr. Barnali Ghosh & others)
Application No: 201731017087 dated 16/05/2017

(3) (Cu)PP-TiO2 -based photo-catalytic converter of toxic metal ions in water including Cr (VI)
(Prof. Samir Kumar Pal & others)
Application No.: 201731027537 (Date: 02-08-2017) (Provisional)

(4) Dual Action Zinc Nano-Fertilizer Cum Nano-Pesticide And Its Customized Sustainable Release In Agricultural Soils For Higher Crop Productivity
(Prof. Samir Kumar Pal & others)
Application No.: 201731027542 (Date: 02-08-2017) (Provisional)

(5) A Low Cost Test Kit For High Throughput Detection of Thalassemia
(Prof. Samir Kumar Pal & others)
Application No.: 201731027543 (Date: 02-08-2017) (Provisional)

(6) Digital Camera based Spectrometric System for Point-of-Care Analysis of Ultra-Low Volume Whole Blood Sample
(Prof. Samir Kumar Pal & others)
Application No.: 201731029433 (Date: 19-08-2017) (Provisional)

(7) DNA-Based Fiber Optic Sensor for Direct In-Vivo Measurement of Oxidative Stress
(Prof. Samir Kumar Pal & others)
Application No.: 201731029434 (Date: 19-08-2017) (Provisional)

(8) A technique to regenerate ferroelectric phase by surface and subsurface engineering of BaTiO3 thin films
(Dr. Ankita Ghatak, Shubhamita Sengupta, Shaili Sett, Prof. A.K. Raychaudhuri, and Dr. Barnali Ghosh)
Application No: 201731036353 dated 12/10/2017

(9) A Gas-Sensing System for Selective Detection of (Nitric Oxide) NO Gas and a Method for Fabricating the same
(Prof. A.K. Raychaudhuri, Dr. Barnali Ghosh & others)
Patent Application No: 201731038036 dated 26-10-2017

(10) An Improved Method for the Synthesis of d-Mno_2 Nanocomposites with Enhanced Photocatalytic Activity
(Dr. Subhra Jana)
Patent Application No: 201731040027 dated 9/11/2017

(11) A system for monitoring Hemodialysis Efficacy of a subject
(Dr. Manik Pradhan & others)
Patent Application No: 201731042502 dated 27/11/2017

(12) A clay based nano confined Reactor
(Dr. Subhra Jana)
Patent Application No: 201731043481 dated 04/12/2017

(13) A paper based ammonia gas selective sensor with electrical read out and a method for manufacturing the same
(Dr. Barnali Ghosh Saha)
Patent Application No: 201831001993 dated 17/01/2018

Samir Kumar Pal
Convenor, Project and Patent Cell

TECHNICAL RESEARCH CENTRE

The **Technical Research Centre (TRC)**, funded by Department of Science & Technology and Ministry of Science & Technology, Government of India at S. N. Bose National Centre for Basic Sciences has been launched on 1st January 2016. The aim is to establish an innovation cum incubator 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 primary focus will be in the areas of:

- *Health care*
- *Environment and mitigation of hazards in work environment*
- *Food and agro sector*
- *Innovations for low cost instrumentation*
- *Material and alloy industry*

National Advisory Committee (NAC):

Dr. Srikumar Bannerjee, Chairman, Governing Body of SNBNCBS – Chairman

Prof. R.C.Budhani, Nominee of GB

Prof. Archana Bhattacharyya, Nominee of GB

Prof. V. Ramgopal Rao, Nominee of DST

Prof. Bansi Dhar Malhotra, Nominee of DST

Dr. Praveer Asthana, Nominee of Secretary DST

Joint Secretary and Financial Adviser of DST or nominee Ex-officio

Prof. S.K.Ray Director, SNBNCBS (Ex-officio)

Prof. A.K.Raychaudhuri Nodal officer of TRC (Ex-officio)

Local Management Committee (LMC):

Prof. Samit Kr. Ray, Director, SNBNCBS – Chairman

Prof. Arup Kumar Raychaudhuri, Nodal officer of TRC – Member

Prof. Archan S. Majumdar, Dean of Faculty – Member

Prof. Kalyan Mandal, HOD, CMPMS – Member

Prof. Jaydeb Chakrabarti, HOD, CBMS – Member

Prof. Samir K. Pal, Convenor of Project & Patent Cell – Member

Dr. Soumen Mondal, PI of TRC – Member Secretary

All Project Investigators – Permanent Invitee

Ms. Shohini Majumder, Registrar – Member

Deputy Registrar (Finance) – Member

Project Investigators :

Prof. A.K.Raychaudhuri (Nodal Officer); Prof. Tanusri Saha Dasgupta (on-lien); Prof. Samir K. Pal; Prof. P. K. Mukhopadhyay; Prof. Jaydeb Chakrabarti; Prof. Ranjit Biswas; Dr. Barnali Ghosh Saha; Dr. Manik Pradhan; Dr. Soumen Mondal and Dr. Subhra Jana.

Manpower and Resources

- Number of Scientists (C & D): 03
- Number of Project Students: 09
- Number of Project Assistants: 04
- Number of Project Officers: 01

Research Activities

A. Activities undertaken under TRC Project:

- A non-invasive breath analysis system and process based detection of peptic ulcer disease, non-ulcerous dyspepsia and Helicobacter Pylori infection.
- Flexible paper-based highly sensitive sensor for ammonia gas detection by visual effects (color change).
- Low cost portable thermal analyzer (working range 30°C – 400°C).
- Development of Non-Contact Optical Device for Clinical Diagnostics of Anaemia, Jaundice and Oxygen Deficiency (AJO Device,) at Resource Limited Point of Care Setting.
- High sensitivity (better than 1 ppm) and high selectivity hazardous gas sensor for unheated operation with remote read-out capability.
- Hand held device for detection of adulteration of milk.
- Synthesis of hybrid nanocomposites for use as efficient carbon dioxide capture materials.

- Piezoelectric energy generation and harvesting using PZT nanowires.
- Development of light operated micro-actuator using photomechanical actuation of specific alloys.
- Analysis of adulterated milk using NIR spectroscopic method.
- Computational materials design.

B. Number of Patents (submitted during 01.04.2017 - 31.03.2018)

Sl. No.	Title	Inventors	Country	File No.	Status
1.	Flexible thin film transitor using electric double layer as gate dielctric and a method of fabricating thereof	Rishi Ram Ghimire, Chandan Samanta, Barnali Ghosh and Arup Kumar Raychaudhuri	India	201731015268	Filed on 29/04/2017
2.	Advancement in methodology and system to control isotopic fractionations in carbon containing gases	Samik Roy Moulik, Abhijit Maity, Mithun Pal, Manik Pradhan, and Barnali Ghosh	India	201731017087	Filed on 16/05/2017
3.	Digital camera based spectrometric system for point-of-care analysis of ultra-low volume whole blood sample	Samir Kumar Pal	India	201731029433	Filed on 19/08/2017
4.	A technique to regenerate ferroelectric phase by surface and subsurface engineering of BaTiO3 thin films	Ankita Ghatak, Shubhamita Sengupta, Shaili Sett, A.K. Raychaudhuri, and Barnali Ghosh	India	201731036353	Filed on 10/10/2017
5.	A gas-sensing system for selective detection of (Nitric Oxide) NO gas and a method for fabricating the same	Sanchi Maithani, Abhijit Maity, Chandan Samanta, Kaustuv Das, Barnali Ghosh, Manik Pradhan, Arup Kumar Raychaudhuri	India	201731038036	Filed on 26/10/2017
6.	An improved method for the synthesis of ä-MnO_2 nanocomposites with enhanced photocatalytic activity	Sankar Das, Arnab Samanta and Subhra Jana	India	201731040027	Filed on 09/11/2017
7.	A system for monitoring hemodialysis efficacy of a subject	Santanu Mandal, Chiranjit Ghosh and Manik Pradhan	India	201731042502	Filed on 27/11/2017
8.	A clay based nano confined reactor	Sankar Das and Subhra Jana	India	201731043481	Filed on 04/12/2017
9.	A paper based ammonia gas selective sensor with electrical read out and a method for manufacturing the same	Avisek Maity, Arup Kumar Raychaudhuri and Barnali Ghosh	India	201831001993	Filed on 17/01/2018

C. 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

D. Other Activities:

- Published TRC Newsletters (three issues)
- Number of Seminar Organized: 04
- Number of Visitors: 04

Soumen Mondal

Soumen Mondal
Member Secretary, LMC of TRC
Technical Research Centre

TECHNICAL CELL

Central Equipment Facility of the Centre

Technical Cell is maintaining all the central experimental facilities. The facilities are available to use for free to the Centre's staffs and students and are made available to the external users on payment basis.

The details about the facility is available in the website http://newweb.bose.res.in/facilities/TechnicalCell/

The report has six (6) different sections:

A) Instruments related

B) Maintenance, Utilization & Up-gradation related

C) Outreach programme related

D) Manpower management related:

E) Revenue Generation related

F) Website updated as per order of DST

A Instruments related:

Current experimental facilities and infrastructure under Technical Cell

No	Name of instruments
1	X-ray Diffractometer (XRD)
2	Mini X-ray Diffractometer (Mini XRD)
3	Field Emission Scanning Electron Microscopy (FESEM)
4	High Resolution Transmission Electron Microscope (HRTEM)
5	Vibrating Sample Magnetometer (VSM)
6	Atomic Force Microscopy (AFM)
7	Pulsed Laser Deposition (PLD)
8	Thermo Gravimetry/Differential Thermal analyzer (TG/DTA)
9	Dynamic Light Scattering (DLS)
10	Spectroscopic Ellipsometer
11	DSC / Modulated DSC
12	FTIR 6300
13	Dual beam Helios
14	Flurolog
15	FluroMax
16	UV-VIS 2600
17	UV/VIS 2450
18	Helium Leak Detector
19	DC/RF Sputtering unit
20	Millipore Water system
21	Circular Dichroism (CD)
22	Viscometer
23	Density meter
24	Cross sectional HRTEM Sample preparation Facility

(New up-gradation) date 19/02/2018

TRC funded

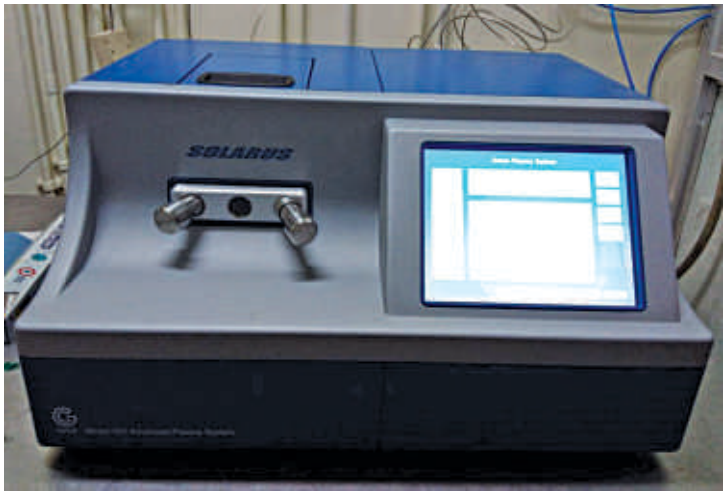
B Maintenance, Utilization & Up-gradation related:

Major equipment s, UPS, chillers are maintained by AMC on non- comprehensive basis.

The four major facilities are maintained from Technology Research Centre (TRC) Project and up-gradation of few facilities has been initiated by technical cell, funding from TRC project.

Up-gradation of facility :

1) Up-gradation of HTEM facility under Technical Cell (for cross sectional sample preparation), from Technology Research Centre (TRC) project is done and the instrument is installed and working satisfactorily.



Newly installed upgraded Cross- sectional HRTEM facility set up

2) Upgradation of Helios Dual beam system:

a) Upgradation of Helios with two GIS systems

GIS (Gas injection sources)

i) Tungsten Source and ii) SiOx source installed.

b) Up gradation of the interfacing system by replacing the old workstation (purchase under process)

Equipment utilization time:

The usage and status reports of the equipments underTechnical cell are kept in the intranet at the URL,http://intranet.bose.res.in/TechnicalCell.html on monthly basis.

Item	USAGE Time (hour)	Up Time (%)	Down Time (%)
PLD	1166	95%	5%
FESEM	730	92%	8%
XPERT PRO	698	53%	47%
MINI XRD	220	90%	10%
TG/DTA	455	90%	10%
DSC	189	34.79%	65%
AFM	638	81%	19%
VSM	1653	97%	3%
TEM	600	65%	35%

Our users:

External users: There are external users from 35 institutes, universities, colleges from different parts of our country.

Internal users: A substantial number of students, post -doctoral fellow, Scientists, Faculties are using all the facilities from our centre as internal users. The slots to the users are giving to all the users by a transparent slot booking on regular basis. The requisition forms are kept in our intranet.

EVLP users: The Students, Scientists, and Faculties from different colleges, universities and institutes, who are working under EVLP program are using the facilities on regular basis. They have separate

requisition form for using the facility and they are using the facilities as internal user.

C Outreach programme related:

Visits of sophisticated instruments organized by Technical Cell:

1) Visit of Hon'ble Union Minister for Science and Technology and Earth Science, Dr. Harsha Vardhan:

Hon'ble Union Minister for Science and Technology and Earth Science, Dr. Harsha Vardhan visited the Nano –Lithograpy and nano fabrication facility. The facility was Funded by Nano Mission: UNANST, established on year 2011 and has been dedicated to nation by the Hon'ble Minister in the gracious presence of DST, Secretory, Prof Ashutosh Sharma on 7th May 2017.

2) C.K. Majumdar Workshop :

30 number of participants in C. K. Majumdar Memorial Summer Workshop (during 23May-02 June, 2017, at S. N. Bose Centre had visited and performed hands on experiments on X-ray diffraction, Scanning Electron Microscope, VSM and Atomic Force microscope laboratories for 4days, during 29 May-01 June, 2017. They have performed experiments successfully.

3) Visit of College students:

Department of Physics, Charuchandra College visited our Technical Cell facilities. 25 students along with three faculties visited on 14.02.2018. It was a one day programme, a lecture about the facilities was delivered from Technical Cell before the visit. 1st and 2nd year under graduate students visited X-ray diffraction, Scanning Electron Microscope, Atomic Force microscope, Vibrating Sample Magnetometer and Transmission electron Microscope, Pulsed Laser Deposition unit.

4) Visit of students from different institutes:

Several visits are being organized to the most of the sophisticated instrumental facilities for the students under various colleges, universities and institutes from all over India. Some visits are also organized for the visitors from abroad.

Internal matter:

5) **Course work of SNBNCBs students:** Every year a part of course " methods of experimental Physics" (PHY391), Technical Cell facility, X-Ray diffraction experiment facility is being used.

D) Manpower management related:

a) All the technical assistants are operating the technical cell equipments.

b) Two Technical assistants alternately involved in C.K.M. laboratory for the PHY191, Basic laboratory class and PHY 291 course.

c) They are also involved in the course work based experiment in X-ray Diffraction. under "methods of experimental Physics" (PHY391),

E) Website updated as per order of DST:

For our central equipment facility, a national portal has been created as per DST order following the IIT-Bombay SAIF website as a template.

The link is:

http://newweb.bose.res.in/facilities/Technical_Cell/

F) Revenue generation:

Revenue generation from the facilities is being done form external users.

Modified rate chart: Rate chart for external users has been modified.

Barnali Ghosh (Saha)

Barnali Ghosh (Saha)
Scientist in-charge,
Technical Cell

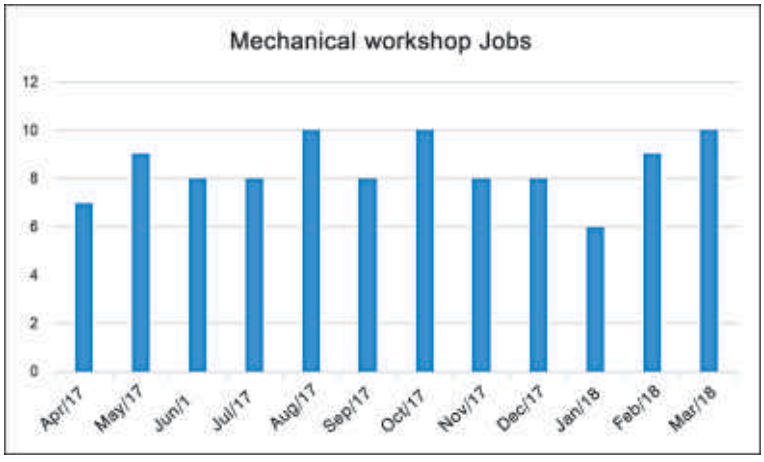
MECHANICAL WORKSHOP AND GLASS BLOWING UNIT

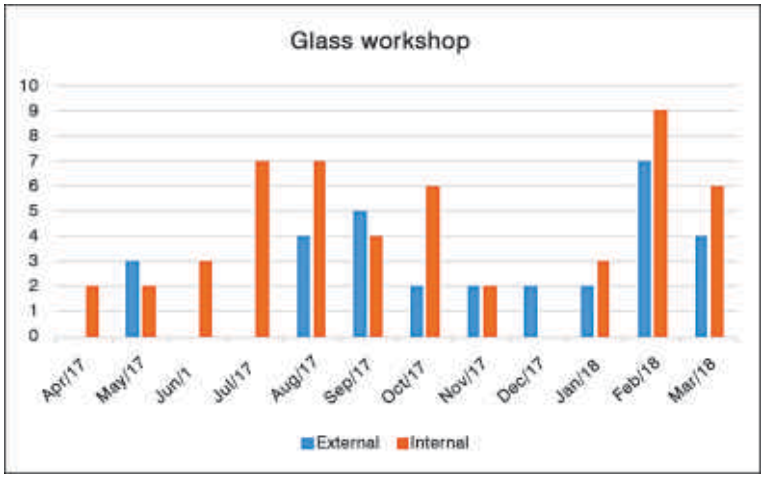
Throughout the year these two units functioned and catered to the demands of different departments and to the outside. While the mechanical workshop is handled by a mechanic in all days of the week, the glass blowing section operated one fixed day in a week and is also available on other days on demand.

The specialized vacuum glass (and quartz) ampouling facility is a special feature in the glass blowing section. Since this facility is not available for any institute nearby, we get demands from them, like CRNN, Calcutta University. The mechanical section has a lathe machine, a milling machine and a drilling machine among other facilities for use. The users are required to enter their demands of major jobs in a log book for record, along with at least a rough sketch each.

Total number of jobs finished: mechanical workshop – 101, glass blowing section – 51 inside and 31 jobs for outside.

Month wise breakups are given below: (2017 – 2018)





Pratip Kumar Mukhopadhyay
In-charge, Mechanical Workshop

GUEST HOUSE

BHAGIRATHI - THE GUEST HOUSE

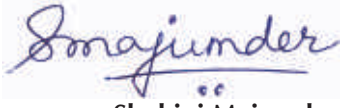
The Centre has its own upfront modern guest house named 'Bhagirathi' located within the premises. It houses five (5) fully air conditioned suites and three (3) fully air conditioned transit rooms each having attached bath and kitchenette. There are also eight (8) double-bedded rooms and forty six (46) 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. 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 students. There is a seminar room within the guest house building for hosting seminars, conferences, meetings etc. The doctor's chamber is also located at the guest house building. The Centre's modern cafeteria with a state-of-the art kitchen is also 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 and high-tea on special occasions like seminars, conferences etc. of the Centre. Apart from accommodating Centre's guests and visitors, the Centre also extends its guest house facility to various government departments, organizations, research laboratories, universities etc.

Shohini Majumder
Registrar

RECREATIONAL AND CULTURAL PROGRAMMES

Throughout the year, the Centre organized number of cultural events involving participation of all staff and students of the Centre.

- On the occasions of the 69th Republic Day on 26th January 2018 and 71st Independence Day on 15th August 2017, the Director hoisted the national flag in the premises of the Centre. On both the occasions, national anthem was sung by students and staff present and parade was performed by the Centre's security personnel. Small replicas of national flags were distributed amongst the members present in the gathering and snacks and sweets were distributed.
- Muktangan' organised the following events:-
  - "Rabindrajayanti", an in-house cultural programme on 9th May 2017.
  - "International Day of Yoga" on 21st June 2017 under the aegis of 'Muktangan' featuring an Interactive Yoga Session conducted by Mr. Rakesh Pandey, certified Yogacharya from Patanjali where the staff and students participated enthusiastically.
  - Fresher's Welcome - 2017 was organised by 'Muktangan' on 7th September 2017.
  - "Bose Football League" was organised 20th and 21st September 2017 among the students.
  - An Intra-Institute Carrom Tournament 2017 (both Singles & Doubles) on 6th and 7th December 2017 followed by Intra-Institute Badminton Tournament 2018 on 9th & 10th January 2018. Both the events were a grand success.
  - An "Intra-Institute Cricket Tournament-2018" organised among the students on 14th January 2018 along with a friendly football match on the evening of 16th January 2018 with an external guest team.
- All the staff and students of the Centre took Cleanliness Oath/Pledge followed by in-house hindi drama on the occasion of "Swachhta Hi Seva" on 25th September 2017 and also celebrated 'Swachhta Pakhwada' from 1st November 2017 to 15th November 2017.
- On the occasion of 'BOSE FEST 2018' held during 8th February 2018 – 10th February 2018, Family Day was celebrated in the evening of 10th February 2018. On 10th February 2018, the Performing Arts Group of 'Muktangan' organised an in-house programme comprising of individual and group performances of singing, recitation and a Hindi Play "Suborno Golok". 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 9th February 2018, Bengali Band "Surajit o Bondhura" entertained the audience with their popular numbers. Oral & Poster presentations by the students were also held during the above period.



Shohini Majumder
Registrar

Publications

LIST OF PUBLICATIONS 2017-18

Journal Publications

Department of Astrophysics and Cosmology

1. D. Das, S. Datta, S. Goswami, **A. S. Majumdar**, D. Home, *Bipartite qutrit local realist inequalities and the robustness of their quantum mechanical violation*, Phys. Lett. A, **381**, 3396 (2017)
2. R. Chatterjee, **A. S. Majumdar**, *Preservation of quantum coherence under Lorentz boost for narrow uncertainty wave packets*, Phys. Rev. A, **96**, 052301 (2017)
3. A. G. Maity, S. Datta, **A. S. Majumdar**, *Tighter Einstein-Podolsky-Rosen steering inequality based on the sum-uncertainty relation*, Phys. Rev. A, **96**, 052326 (2017)
4. S. Sasmal, T. Pramanik, D. Home, **A. S. Majumdar**, *A tighter steering criterion using the Robertson-Schrodinger uncertainty relation*, Phys. Lett. A, **382**, 27 (2018)
5. B. C. Paul and **A. S. Majumdar**, *Emergent universe with wormholes in massive gravity*, Class. Quant. Grav. **35**, 065001 (2018)
6. D. Das, S. Datta, C. Jebaratnam, **A. S. Majumdar**, *Cost of Einstein-Podolsky-Rosen steering in the context of extremal boxes*, Phys. Rev. A, **97**, 022110 (2018)
7. S. S. Bhattacharya, B. Paul, A. Roy, A. Mukherjee, C. Jebaratnam, M. Banik, *Improvement in device-independent witnessing of genuine tripartite entanglement by local marginals*, Phys. Rev. A, **95**, 042130 (2017)
8. S. S. Bhattacharya, A. Mukherjee, A. Roy, B. Paul, K. Mukherjee, I. Chakraborty, C. Jebaratnam, N. Ganguly, *Absolute non-violation of a three-setting steering inequality by two-qubit states*, Quant. Inf. Process., **17**, 3 (2018)
9. A. Mondal, G. C. Anupama, U. S. Kamath, **R. Das**, G. Selvakumar, **S. Mondal**, *Optical spectroscopy of the recurrent nova RS Ophiuchi – from the outburst of 2006 to quiescence*, MNRAS, **474**, 4211 (2018)
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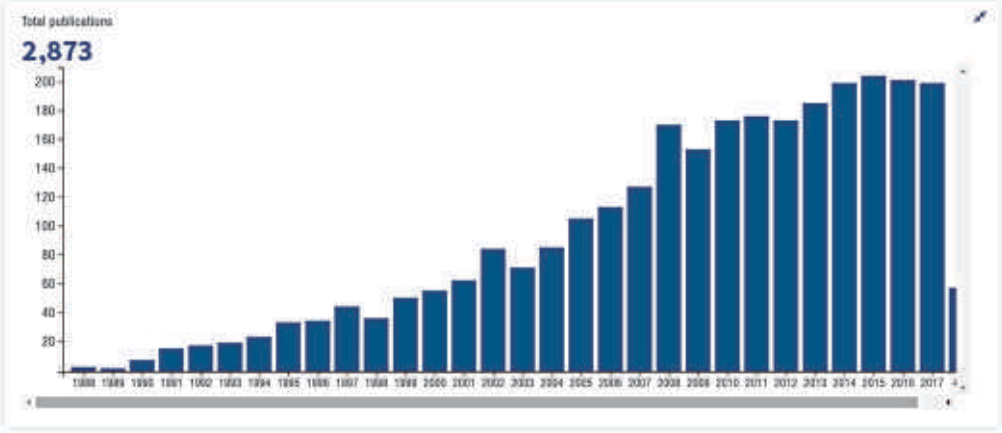
1. Subhadip Chakraborti, Sayani Chatterjee, Arghya Das, and **Punyabrata Pradhan**, Proceedings of the workshop "Recent Advances in Research of Statistical Physics: A School for Undergraduate Students – 2017", 1, 16 (2017)

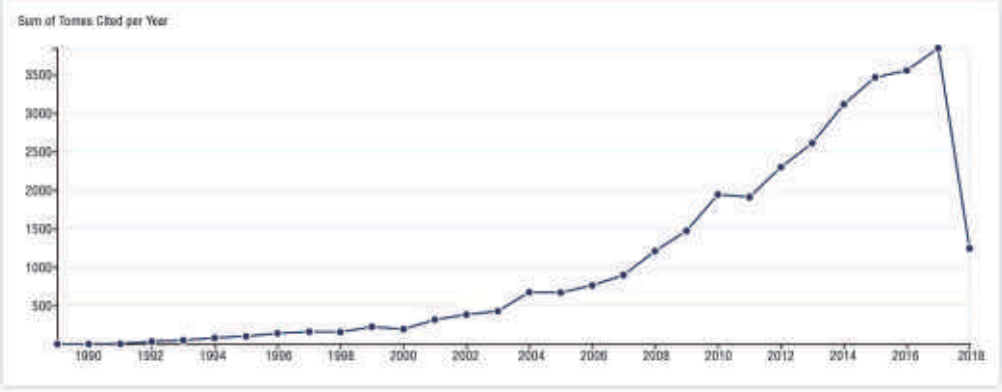
Total number of Other Publications : 29

RESEARCH PUBLICATION STATUS

Citation Report (On 23rd April, 2018)

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





No. of Publications	:	2873
Sum of the Times Cited	:	31985
Sum of Times Cited without self-citations	:	24982
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Citing Articles without self-citations	:	18543
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2873	31985	31985 / 2873 = 11.13	31985 / 31 = 1031.77	63

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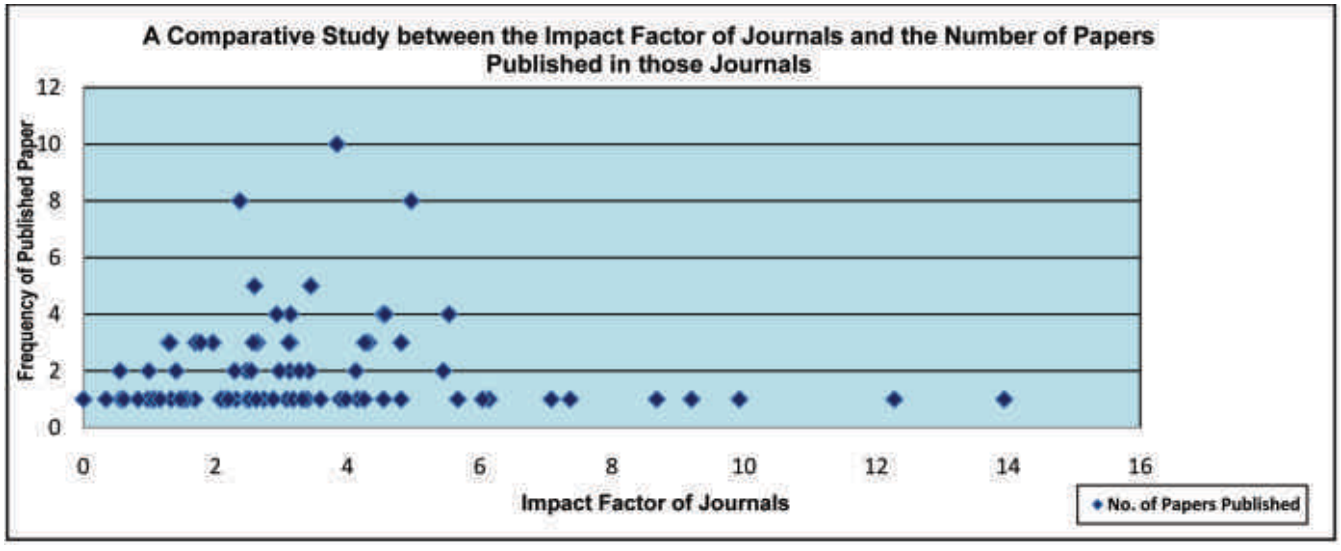
IMPACT FACTOR FOR PUBLICATIONS IN THE FINANCIAL YEAR 2017-18

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
1	ACS Energy Letters	12.277	1	12.277
2	ACS Nano	13.942	1	13.942
3	ACS Sustainable Chemistry & Engineering	6.14	1	6.14
4	Acta Crystallographica Section C: Structural Chemistry	8.678	1	8.678
5	Advanced Composites and Hybrid Materials	0	1	0
6	Advances in Space Research	1.401	2	2.802
7	AIP Advances	1.568	1	1.568
8	Analyst	3.885	1	3.885
9	Analytical Chemistry	6.042	1	6.042
10	Annals of physics	2.465	2	4.93
11	Applied Physics Letters	3.411	2	6.822
12	Applied Surface Science	3.387	1	3.387
13	Astronomical Journal	4.15	1	4.15
14	Astrophysical Journal	5.533	4	22.132
15	Beilstein Journal of Nanotechnology	3.13	3	9.39
16	Bulletin of Ligue Royal Society of Sciences	0	1	0
17	Carbon	7.082	1	7.082
18	Chemical Physics Letters	1.686	1	1.686
19	ChemistrySelect	1.05	1	1.05
20	ChemPhysChem	3.075	1	3.075
21	Classical and Quantum Gravity	3.119	3	9.357
22	Colloids and Surfaces B: Biointerfaces	3.887	1	3.887
23	Crystal Growth & Design	3.972	1	3.972
24	Discontinuity, Nonlinearity and Complexity	0	1	0
25	Discrete and Continuous Dynamical Systems - Series B	0.972	1	0.972
26	Elsevier Journal of Atmospheric and Solar-Terrestrial Physics	1.326	1	1.326
27	European Physical Journal B	1.536	1	1.536
28	European Physical Journal C	1.288	3	3.864
29	European Physical Journal E	1.464	1	1.464
30	Europhysics letters	1.957	3	5.871
31	Experimental Astronomy	2.313	1	2.313

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
32	Ferroelectrics	0.551	2	1.102
33	Fluid Phase Equilibria	2.473	1	2.473
34	Geophysical Research Letters	4.25	1	4.25
35	IEEE Sensors Journal	2.512	1	2.512
36	IEEE Transactions on Magnetics	1.467	1	1.467
37	Indian Journal of Physics	0.988	2	1.976
38	Inorganics	0	1	0
39	International Journal of Geometric Methods in Modern Physics	1.068	1	1.068
40	International Journal of Modern Physics A	1.699	3	5.097
41	International Journal of Non-linear Mechanics	2.074	1	2.074
42	J. Biomolecular Structure and Dynamics	3.123	2	6.246
43	Journal of Alloys and Compounds	3.133	4	12.532
44	Journal of Astrophysics & Aerospace Technology	0.56	1	0.56
45	Journal of Breath Research	4.318	3	12.954
46	Journal of Chemical Physics	2.965	2	5.93
47	Journal of Geodynamics	2.142	1	2.142
48	Journal of Geophysical Research: Space Physics	3.42	2	6.84
49	Journal of Luminescence	2.732	1	2.732
50	Journal of Magnetism and Magnetic Materials	2.63	3	7.89
51	Journal of Material Sciences and Engineering (Open Access)	5.447	2	10.894
52	Journal of Materials Chemistry A	9.931	1	9.931
53	Journal of Materials Chemistry B	4.543	1	4.543
54	Journal of Physical Chemistry B	3.177	1	3.177
55	Journal of Physical Chemistry C	4.536	4	18.144
56	Journal of Physics Communications	0	1	0
57	Journal of Physics D: Applied Physics	2.588	5	12.94
58	Journal of Physics: Condensed Matter	2.617	1	2.617
59	Journal of the Physical Society of Japan	2.572	3	7.716
60	Laser Physics Letters	2.537	2	5.074
61	Laser Physics	1.158	1	1.158
62	Materials Chemistry and Physics	2.084	1	2.084
63	Materials Research Bulletin	2.873	1	2.873
64	Materials Science and Engineering B	3.316	1	3.316
65	Materials Today Chemistry	0.339	1	0.339
66	Modern Physics Letters A	1.308	3	3.924
67	Molecular Astrophysics	0.611	1	0.611
68	Monthly Notices of the Royal Astronomical Society	4.961	8	39.688

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
69	Nanoscale	7.367	1	7.367
70	Nanotechnology	3.44	5	17.2
71	New Journal of Chemistry	3.269	2	6.538
72	npj 2D Materials and Applications	0	1	0
73	npj Quantum Materials	9.206	1	9.206
74	Optics Letters	3.589	1	3.589
75	Physical Chemistry Chemical Physics	4.123	2	8.246
76	Physical Review A	2.925	4	11.7
77	Physical Review Applied	4.808	3	14.424
78	Physical Review B	3.836	10	38.36
79	Physical Review D	4.568	4	18.272
80	Physical Review E	2.366	8	18.928
81	Physics Letters A	1.772	3	5.316
82	Physics Letters B	4.807	1	4.807
83	Proteins: Structure, Function, Bioinformatics	2.289	2	4.578
84	Qualitative theory of Dynamical Systems	0.825	1	0.825
85	Quantum Information Processing	2.195	1	2.195
86	Royal Society of Chemistry Advances	3.108	3	9.324
87	Scientific Reports (Nature Publishing Group)	4.259	3	12.777
88	Sensors & Actuators B: Chemical	5.667	1	5.667
89	Shape Memory and Superelasticity	0	1	0
90	Surfaces and Interfaces	1.33	2	2.66
91	Theoretical and Applied Mechanics	0.783	1	0.783
92	Thin Solid Films	1.879	1	1.879
93	Water, Air, & Soil Pollution	1.702	1	1.702
	Total	**287.552**	**179**	**568.817**




Accounts

Satyendra Nath Bose National Centre for Basic Sciences

Block JD, Sector-III, Salt Lake, Kolkata - 700 106

BUDGET SUMMARY 2017-2018

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2017-2018.

(Figure in Lakhs)

	Actuals 2016-2017	Budget Estimate 2017-2018	Revised Estimate 2017-2018
Non-Plan	8.23	8.59	8.26*
Plan	3605.91	3882.20	3737.38*
TOTAL	**3614.14**	**3890.79**	**3745.64***

* Sanctioned by DST Plan **Rs.** 3970.62 released as under:

Plan

Sl no.	Sanction Letter No.	Dated	Amount (Rs.)
1	AI/SNB/SC-SAL/003/2017/1	13.06.2017	16,30,000.00
2	AI/SNB/GEN/003/2017/1	13.06.2017	2,57,95,000.00
3	AI/SNB/CAP/003/2017/1	11.04.2017	1,30,90,000.00
4	AI/SNB/SAL/003/2017/1	14.06.2017	5, 04,81,000.00
5	AI/SNB/SC-SAL/003/2017/2	22.09.2017	35,32,000.00
6	AI/SNB/GEN/003/2017/2	22.09.2017	6,01,04,000.00
7	AI/SNB/SAL/003/2017/2	21.09.2017	11,33,12,000.00
8	AI/SNB/CAP/003/2017/2	22.09.2017	4,62,65,000.00
9	AI/SNB/CAP003/2017/3	23.02.2018	1,57,30,000.00
10	AI/SNB/SAL003/2017/3	23.02.2018	4,31,32,000.00
11	AI/SNB/SC-SAL/003/2017/3	23.02.2018	13,58,000.00
12	AI/SNB/GEN/003/2017/3	23.02.2018	2,26,33,000.00
	TOTAL (PLAN)		**Rs. 39,70,62,000.00**

Mookerjee Biswas & Pathak
Chartered Accountants

5 & 6, Fancy Lane, Kolkata-700 001
Phone : 2248 1733, 2231 8869,
2243 8542, 2242 1789
Fax : (033) 2248 0080
Website : www.mbpkol.com
e-mail : mbpkol@vsnl.net

INDEPENDENT AUDITORS' REPORT

To the Governing Body of Satyendra Nath Bose National Centre for Basic Sciences

1. Report on the Financial Statements

We have audited the accompanying financial statements of SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES ("the Centre") which comprise the Balance Sheet as at March 31, 2018, the Income and Expenditure Account and the Receipts and Payments Account for the year then ended, and a summary of Significant Accounting Policies and Notes on Accounts.

2. Management's Responsibility for the Financial Statements

Management of the Centre is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

3. Auditor's Responsibility

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

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

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

4. Opinion

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

(a) in the case of the Balance Sheet, of the state of affairs of the Centre as at March 31, 2018.

(b) in the case of the Income & Expenditure Account, of the surplus for the year ended on that date; and

(c) in the case of the Receipts & Payments Account, of the Receipts & Payments for the year ended on that date.

5. Emphasis of matter

Without qualifying our opinion we draw attention to the following:

i) Note No. 2.2.1 of schedule 25 regarding physical verification of fixed assets.

ii) Note No.2.5 of schedule 25 regarding interest earned on Fixed Deposits and Savings Bank Deposits.

iii) Centre has invoked bank guarantee of Dutsan G Engineers Pvt. Ltd. for non-performance of work and amount realized Rs.12,70,577 has been shown under other liabilities of Current Liabilities in Schedule 7. We are given to understand that adjustment will be made in the accounts in the subsequent year on verification of records and obtaining legal opinion.

iv) Rs. 44,70,366.86 lying in credit in respect of completed projects and Rs. 42,19,993 lying in debit in respect of completed projects as reported by us in the F.Y 2013-14 still remains unresolved.

6. a) We have obtained all the information and explanations which to the best of knowledge and belief were necessary for the purpose of our audit.

b) In our opinion proper books of account as required by law have been kept by the Centre so far as appears from our examination of those books.

c) The Balance Sheet, Income & Expenditure Account and Receipts & Payments Account dealt with by this Report are in agreement with the books of account.

d) In our opinion the Balance Sheet, the Income & Expenditure Account dealt within this report complies with the appropriate Accounting Standard.

For **Mookerjee Biswas & Pathak**
Chartered Accountants
FRN No. 301138E

(**S P Mukerjee**)
Partner
Membership No. 10807

Date: 03.09.2018

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

BALANCE SHEET AS AT 31ST MARCH 2018 **Amount (Rs.)**

	Schedule	Current Year	Previous Year
FUNDS AND LIABILITIES			
CAPITAL / CORPUS FUND	**1**	1048440173.65	1018592287.34
RESERVES AND SURPLUS	**2**	-	
EARMARKED/ENDOWMENT FUNDS	**3**	477094566.55	511238579.43
SECURED LOANS AND BORROWINGS	**4**		
UNSECURED LOANS AND BORROWINGS	**5**		
DEFERRED CREDIT LIABILITIES	**6**		
CURRENT LIABILITIES AND PROVISIONS	**7**	99768471.31	42302504.31
TOTAL		**1625303211.51**	**1572133371.08**
ASSETS			
FIXED ASSETS	**8**	729966880.69	738252385.67
INVESTMENTS-FROM EARMARKED/ ENDOWMENT FUNDS	**9**	156885405.38	123424415.38
INVESTMENTS - OTHERS	**10**	624873415.00	568248614.00
CURRENT ASSETS, LOANS, ADVANCES ETC.	**11**	113577510.44	142207956.03
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
TOTAL		**1625303211.51**	**1572133371.08**
SIGNIFICANT ACCOUNTING POLICIES	**24**		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	**25**		

As Per our report of even date

Date: 03.09.2018
Place: Kolkata

For **Mookherjee Biswas & Pathak**
Chartered Accountants
FRN: 301138E

(**S P Mukerjee**)
Partner
Membership no:10807

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES
BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2018 **Amount (Rs.)**

	Schedule	Current Year	Previous Year
INCOME			
Income from Sales/Services	**12**	6317259.00	7432761.00
Grants/Subsidies	**13**	321977000.00	291264000.00
Fees/Subscriptions	**14**		
Income from Investments (Income on Investment	**15**		
from earmarked/endowment Funds transferred to Funds)			
Income from Royalty, Publication etc.	**16**		
Interest Earned on fixed deposit(including interest on loan to employees)	**17**	16393426.00	10898186.00
Other Income	**18**	527117.00	363045.00
Increase/(decrease) in stock of finished goods and works-in-progress	**19**		
TOTAL (A)		**345214802.00**	**309957992.00**
EXPENDITURE			
Establishment Expenses	**20**	153121589.00	100513232.00
Other Administrative Expenses etc.	**21**	162195523.71	133243468.89
Expenditure on Grants, Subsidies etc.	**22**		
Interest earned on fixed deposit and savings bank (adjustable)		16126971.00	10529332.00
TOTAL (B)		**331444083.71**	**244286032.89**
Balance being excess of Income over Expenditure(A-B)		13770718.29	65671959.11
Prior period adjustments (Debit)		453237.00	-531241.00
Transfer to/from Capital Fund			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**14223955.29**	**65140718.11**
SIGNIFICANT ACCOUNTING POLICIES	**24**		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	**25**		

As Per our report of even date

Date: 03.09.2018
Place: Kolkata

For Mookherjee Biswas & Pathak
Chartered Accountants
FRN: 301138E

(S P Mukerjee)
Partner
Membership no:10807

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

RECEIPTS AND PAYMENTS ACCOUNTS

For the year ended 31st March 2018

Amount (Rs.)

RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
I. Opening Balances			**I. Expenses :**		
a) Cash in hand	36760.00	53541.00	a) Establishment Expenses	123730495.00	119275705.00
b) Bank Balances :			b) Administrative Expenses	155367087.83	93660698.00
i. In current accounts(Schd 11A)	36822075.95	11003610.72	c) Maintenance	33758024.00	24862761.00
ii. In deposit accounts			**II. Payments made against funds for various Projects**		
Schedule - 10	568248614.00	362531415.00			
Schedule - 11A	16134692.00	22589916.00			
iii. Savings accounts (Schd 11A)	18466138.76	34734802.44	**III. Investments and deposits made**		
iv. Remittance-in-Transit			a) Out of Earmarked/Endowment	107084939.00	140612227.00
II. Grants Received			b) CPWD Deposit and NBCC Deposit		0.00
a) From Government of India			c) Bank Gurantee & LC A/C		1596487.00
– For the year	427503787.00	505965164.00	d) Out of Own Fund	123187790.00	77043032.00
– For the previous year					
b) From State Government			**IV. Expenditure on Fixed Assets & Capital Work-in-Progress**		
c) From Other sources (details)			a) Purchase of Fixed Assets	63986926.05	20533199.00
(Grants for capital & revenue exp. To be shown separately)			b) Expenditure on Capital Work-in-Progress	4444758.00	18792343.00
			V. Refund of surplus money/Loans		
			a) To the Government of India		
			b) To the State Government		
III. Interest Received			c) To other providers of funds		
a) On Bank deposits	2809326.00	3635082.00	**VI. Finance Charges (Interest)**		
IV. Other Income	6883496.00	10839306.72	**VII. Other Payments**	36517612.11	59567857.17
V. Amount Borrowed		-	**VIII. Closing Balances**		
VI. Any other receipts	3180848.15	2097326.00	a) Cash in hand	25681.00	36760.00
			b) Bank Balances :		
VII. Amount transferred from Current Account/ Savings Account to Deposit Account.	267735328.00	242202426.00	i. In current accounts(Schd 11A)	17173847.86	36822075.95
			ii. In deposit accounts		
			Schedule - 10	624873415.00	568248614.00
			Schedule - 11A	35689927.00	16134692.00
			iii. Savings accounts(Schd.11A)	21980563.01	18466138.76
			iv. Remittance-in-Transit		
1347821065.86	**1195652589.88**		**1347821065.86**	**1195652589.88**	

Per our report of even date
For Mookerjee Biswas & Pathok
Chartered Accountants
FRN: 301138E

(S P Mukerjee)
Partner
Membership no: 10807

Date :03.09.2018
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 31.03.2018 **Amount (Rs.)**

	Current Year		Previous Year	
SCHEDULE 1 -CAPITAL FUND:				
Balance as at the beginning of the year	1018592287.34		958290018.36	
Add: Interest earned on FD and savings bank(adjustable) for last year	10529332.00		11455120.00	
Add : Contributions towards Corpus/ Capital Fund	75085000.00		50737000.00	
Less: Depreciation for the year	69990400.98		67030569.13	
Add : Surplus during the year	14223955.29		65140718.11	
		1048440173.65		1018592287.34
BALANCE AS AT THE YEAR - END		**1048440173.65**		**1018592287.34**

	Current Year		Previous Year	
SCHEDULE 2 - RESERVES AND SURPLUS:				
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 31.03.2018 — **Amount (Rs.)**

SCHEDULE 3 - EARMARKED/ ENDOWMENT FUNDS

	FUND-WISE BREAK UP					TOTAL	
	Technical Research Centre	Project Fund	Retirement Benefits Fund	Medical Fund	Corpus Fund	Current Year	Prev. Year
a) Opening balance of the funds	355780239.00	62824797.05	75815434.00	5582985.00	11235124.38	511238579.43	379800108.79
b) Additions to the Funds							
i) Donations/grants/ Contributions	0.00	30437606.00	17959306.00	565370.00	705000.00	49667282.00	167904660.00
ii) Income from investments made on account of funds	18376074.00	2852946.00	10436376.00	643334.00	1324773.00	33633503.00	26168743.00
iii) Other additions -Provision during the year							
TOTAL (a + b)	**374156313.00**	**96115349.05**	**104211116.00**	**6791689.00**	**13264897.38**	**594539364.43**	**573873511.79**
c) Utilisation/Expenditure towards objectives of funds							
i) Capital Expenditure							
Fixed Assets	44959830.00	7385207.05	-	-	0.00	52345037.05	17832756.00
Others							
Total							
ii) Revenue Expenditure							
Salaries, Wages and allowances etc.	6008635.00	18740974.00	-	-	0.00	24749609.00	27148853.00
Rent							
Other Administrative expenses							
Other Payments	19337563.48	10911195.35	9458059.00	643334.00	0.00	40350151.83	17653323.36
iii) Adjustment (Interest)							
TOTAL (c)	**70306028.48**	**37037376.40**	**9458059.00**	**643334.00**	**-**	**117444797.88**	**62634932.36**
NET BALANCE AS AT THE YEAR-END (a+b-c)	**303850284.52**	**59077972.65**	**94753057.00**	**6148355.00**	**13264897.38**	**477094566.55**	**511238579.43**

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 31.03.2018 **Amount (Rs.)**

	Current Year		Previous Year	
SCHEDULE 4 - SECURED LOANS AND BORROWINGS:				
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**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2018 **Amount (Rs.)**

	Current Year		Previous Year	
SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS				
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

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 31.03.2018 — **Amount (Rs.)**

	Current Year		Previous Year	
SCHEDULE 6 - DEFERRED CREDIT LIABIILTIES:				
a) Acceptances secured by hypothecation of capital equipment and other assets				
b) Others				
TOTAL	Nil	Nil	Nil	Nil

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2018 — **Amount (Rs.)**

		Current Year		Previous Year	
SCHEDULE 7 - CURRENT LIABILITIES AND PROVISIONS					
A. CURRENT LIABILITIES					
1.	Acceptances				
2.	Sundry Creditors:				
	a) For Capital expenditure	6267288.00			725558.00
	b) Others - Revenue expend. (including TRC Rs.333342.00)	54024139.00			10282456.00
3.	Othert Liabilities	4032924.00			4158843.00
4.	Deposit from Contractors (including Project & TRC)	10397119.88			7680615.88
5.	Deposit from Students	1542500.00			1387900.00
6.	Deposit from Contractual Employees	1700776.00			1710256.00
7.	Provident Fund Account (Payable)	425390.00			425390.00
8.	Project Overhead Fund	5251363.43			5298141.43
9.	Interest earned on fixed deposit and savings bank (adjustable)	16126971.00			10529332.00
	TOTAL (A)	**99768471.31**			**42198492.31**
B. PROVISIONS					
1.	For Taxation				
2.	Gratuity				
3.	Superannuation/Pension				
4.	Accumulated Leave Encashment				
5.	Trade Warranties/Claims				
6.	Others - Adhoc Bonus	0.00			104012.00
	TOTAL (B)	**0.00**	**-**		**104012.00**
	TOTAL (A + B)	**99768471.31**			**42302504.31**

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 31.03.2018

Amount (Rs.)

SCHEDULE 8 -FIXED ASSETS

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	Adjustment during the year	Total up to the Year-end	Current year-end	Previous year-end
A. FIXED ASSETS:										
1. LAND:										
a) Freehold										
b) Leasehold	10950654.60	0.00		10950654.60	0.00	0.00		0.00	10950654.60	10950654.60
2. BUILDINGS:										
a) On Leasehold Land	306451448.86	110586337.00		417037785.86	48221238.45	4856945.08		53078183.53	363959602.33	258230210.41
b) On Freehold Land										
c) Ownership Flats/Premises										
d) Superstructures on Land not belonging to the entity										
3. PLANT MACHIENRY & EQUIPMENT	463496658.22	9281258.00		472777916.22	278238021.58	56683370.59		334921392.17	137856524.05	185258636.64
4. VEHICLES	321013.00	0.00		321013.00	321011.00	0.00		321011.00	2.00	2.00
5. FURNITURE, FIXTURES	38968008.22	149682.00		39117690.22	25548020.59	2624559.55		28172580.14	10945110.08	13419987.63
6. OFFICE EQUIPMENT	5216360.29	603569.00		5819929.29	2751270.46	763517.00		3514787.46	2305141.83	2465089.83
7. COMPUTER & LAN INSTALLATION	70988229.44	1576190.00		72564419.44	60939476.44	4062232.56		65001709.00	7562710.44	10048753.00
8. ELECTRIC INSTALLATIONS	11699040.00	0.00		11699040.00	4539917.78	999776.20		5539693.98	6159346.02	7159122.22
9. LIBRARY BOOKS	220974532.11	10590231.00		231564763.11	69586478.05	0.00		69586478.05	161978285.06	151388054.06
10. TUBEWELLS & W.SUPPLY	-	-		0.00	-	-		0.00	0.00	-
11. OTHER FIXED ASSETS	84225.55	0.00		84225.55	80014.27	0.00		80014.27	4211.28	4211.28
TOTAL OF CURRENT YEAR	**1129150170.29**	**132787267.00**	**0.00**	**1261937437.29**	**490225448.62**	**69990400.98**	**0.00**	**560215849.60**	**701721587.69**	**638924721.67**
PREVIOUS YEAR	**1106202694.29**	**22947476.00**	**-**	**1129150170.29**	**423194879.49**	**67030569.13**	**-**	**490225448.62**	**638924721.67**	**683007814.80**
B. CAPITAL WORK IN PROGRESS	**99327664.00**	**4444758.00**	**75527129.00**	**28245293.00**					**28245293.00**	**99327664.00**
TOTAL (A + B)	**1228477834.29**	**137232025.00**	**75527129.00**	**1290182730.29**	**490225448.62**	**69990400.98**	**0.00**	**560215849.60**	**729966880.69**	**738252385.67**

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 31.03.2018 **Amount (Rs.)**

SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS

		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 Nationalised Banks		
7.	Project Fund Investment	48592470.00	37009590.00
8.	Retirement Benefit Fund Investment	92789961.00	74712036.00
9.	Staff Medical Fund Investment	5342523.00	4227029.00
10.	Corpus Fund Investment (Project Overhead)	10160451.38	7475760.38
	TOTAL	**156885405.38**	**123424415.38**

SCHEDULE 10 - INVESTMENTS - OTHERS		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 & TRC)	227123674.00	193617915.00
	Fixed Deposit with Union Bank of India	397749741.00	374630699.00
	TOTAL	**624873415.00**	**568248614.00**

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 31.03.2018 **Amount (Rs.)**

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.

	Current Year		Previous Year	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares		33691.57		60524.32
2. Cash balances in hand		25681.00		36760.00
3. Bank Balances:				
a) With Scheduled Banks:				
On Current Accounts:				
Indian Overseas Bank (CA-089302000000220)	11953444.84		13919879.97	
Indian Overseas Bank (CA-089302000000273)	5070477.12		18041881.25	
Union Bank of India (CA-460901010034252)	149925.90	17173847.86	4860314.73	36822075.95
On Deposit Accounts for LC&BG:				
Indian Overseas Bank (CA-089302000000220)	9419568.00		14034154.00	
Indian Overseas Bank (SB-089301000018596 TRC)	25353179.00			
Indian Overseas Bank (CA-089302000000273 PROJECT)	917180.00	35689927.00	2100538.00	16134692.00
On Savings Accounts:				
Indian Overseas Bank (SB-089301000010662 UNAST)	542784.00		1536914.94	
Indian Overseas Bank (SB-089301000012029 SYNC.)	716446.00		689644.00	
Indian Overseas Bank (SB-089301000011479 NANO TECH)	508026.00		489021.00	
Union Bank of India (SB-460901110050013)	7177027.49		4290478.82	
Axis Bank (SB-775010100024408)	2474087.00		555867.00	
Axis Bank (SB-775010100017860)	1625.00		1566.00	
Union Bank of India (SB-460902010097273 TRC)	2207745.00		2437696.00	
Indian Overseas Bank (SB- 089301000018598 TRC)	8352822.52	21980563.01	8464951.00	18466138.76
5. Remittance - in - Transit				
6. Post Office-Savings Accounts				
TOTAL (A)		**74903710.44**		**71520191.03**

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 31.03.2018 **Amount (Rs.)**

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC. (Contd.)

		Current Year		Previous Year
B. LOANS, ADVACNES AND OTHER ASSETS				
1. Loans:				
a) Staff including HBA ,Vehicle &PC Advance (includes Project A/c)	1539991.00	1539991.00		1149476.00
2. Advances and other amounts recoverable in cash or in kind or for value to be received:				
a) On Capital Account - Bridge & Roof and CPWD Deposit Account	438840.00			35261612.00
b) GST payment	3492.00			
c) Others	404048.00			389048.00
d) Contractors & Suppliers	3008608.00	3854988.00		1996636.00
3. Income Accrued:				
a) On Investments from Earmarked/ Endowment Funds (Including Project & TRC)	25478371.00			29157454.00
b) On investmetns - Others	7800450.00			2733540.00
c) On Loans and Advances	0.00	33278821		
4. Claims Receivable - Grant -in- Aid Receivable	-	–		
TOTAL (B)		**38673800.00**		**70687766.00**
TOTAL (A + B)		**113577510.44**		**142207957.03**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 12 - INCOME FROM SALES/SERVICES

	Current Year	Previous Year
1. Income from Sales		
a) Sale of Finished Goods		
b) Sale of Raw Material		
c) Sale of Scraps		
2. Income from Services		
a) Guest House Rent	1822900.00	2320800.00
b) Hostel Charges (Recovery of HRA)	2685404.00	3217415.00
c) Equipment Utilisation Fees	394926.00	506100.00
d) Hostel Maintenance Fees	1004024.00	913436.00
e) Project Overhead	282000.00	333000.00
f) Income from BSNL	73205.00	85360.00
g) Course Fees	17000.00	10000.00
h) Seminer Hall Rent	28900.00	44500.00
I) Dining Hall Rent	8900.00	2150.00
TOTAL	**6317259.00**	**7432761.00**

SCHEDULE 13 - GRANTS/SUBSIDIES	Current Year	Previous Year
(Irrevocable Grants & Subsidies Received)		
1. Central Government	321977000.00	291364000.00
2. State Government(s)		
3. Government Agencies		
4. Institutions/Welfare Bodies		
5. International Organsations		
6. Others		
TOTAL	**321977000.00**	**291364000.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 14 - FEES/SUBSCRIPTIONS

	Current Year	Previous Year
1) Entrace Fees		
2) Annual Fees/Subscriptions		
3) Seminar/Program Fees		
4) Consultancy Fees		
5) Others		
TOTAL	**Nil**	**Nil**

Note: Accounting Policies towards each item are to be disclosed

Amount (Rs.)

SCHEDULE 15 - INCOME FROM INVESTMENTS

(Income on Invest. From Earmarked/ Endowment Funds transferred to Funds)

	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) Dividents:				
a) On Shares				
b) On Mutual Fund Securities				
3) Rents				
4) Others				
TOTAL	**Nil**	**Nil**	**Nil**	**Nil**
TRANSFERRED TO EARMARKED/ ENDOWMENT FUNDS	**Nil**	**Nil**	**Nil**	**Nil**

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATION ETC.

	Current Year	Previous Year
1. Income from Royalty		
2. Income from Publications		
3. Others		
TOTAL	**Nil**	**Nil**

SCHEDULE 17 - INTEREST EARNED	Current Year	Previous year
1) On Term Deposits:		
a) With Scheduled Banks	16056277.00	10072086.00
b) With Institutions		
c) Others		
2) On Savings Accounts:		
a) With Scheduled Banks	70694.00	457246.00
b) Post Office Savings Accounts		
c) Others		
3) On Loans:		
a) Employees/Staff (Interest on HBA etc.)	266455.00	368854.00
b) Others		
4) Interest on Debtors and Other Receivables		
TOTAL	**16393426.00**	**10898186.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 18 - OTHER INCOME		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	527117.00	363045.00
	TOTAL	**527117.00**	**363045.00**

SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS		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	113006276.00	90479224.00
b)	Other Allowances and Bonus	0.00	206193.00
c)	Contribution to Provident Fund	8582428.00	1915164.00
d)	Contribution to Retirement Benefits Fund	24317111.00	2103983.00
e)	Staff Welfare Expenses (Medical)	3158497.00	2663820.00
f)	Contribution to NPS	2521015.00	1494557.00
f)	Others (LTC, Leave Encashment on LTC, Re-imbursement of Tuition Fees etc.)	1536262.00	1650291.00
	TOTAL	**153121589.00**	**100513232.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.	Current Year	Previous Year
a) Extended Visitors Programme.(Including Seminars & Workshops)	17849904.00	9156132.00
b) Meeting Expenses	1313161.00	990195.00
c) Library General Expenses	180614.00	108233.00
d) Electricity and Power	38272262.00	37770037.00
e) Laboratory Expenses	13012905.00	8333674.00
f) Insurance	3266.00	12492.00
g) Repairs and Maintenance	45304867.75	31319066.80
h) TPSC Programme	1060039.00	807040.00
I Student Hostel Rent		180222.00
j) Vehicles Hire Charges	2339062.00	1455728.00
k) Postage, Telephone and Communication Charges	1240625.00	1220429.00
l) Printing and Stationary	1218221.00	704067.00
m) Travelling and Conveyance Expenses	4274630.00	2602827.00
n) Contingency to Faculty	82822.00	58339.00
o) Auditors' Remuneration	47200.00	47200.00
p) Bank Charges	193330.11	257511.09
q) Professional Charges (Legal Charges)	402050.00	455216.00
r) Staff Training & Welfare	236496.00	540751.00
s) Patent & Trademark	101450.00	346000.00
t) Integrated Ph.D.	32936717.00	34790736.00
u) Hindi Programme	161301.00	129577.00
v) Advertisement and Publicity	894556.00	615396.00
w) Others	848338.85	1195632.00
x) Municipal Tax	141388.00	146968.00
z) Bose Archive Expenses	80318.00	0.00
TOTAL	**162195523.71**	**133243468.89**

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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2018

Amount (Rs.)

SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.	Current Year	Previous Year
a) Grants given to Institutions/Organisations		
b) Subsidies given to Institutions/Organisations		
TOTAL	**Nil**	**Nil**

SCHEDULE 23 - INTEREST	Current Year	Previous Year
a) On Fixed Loans		
b) On Other Loans (including Bank Charges)		
c) Others		
TOTAL	**Nil**	**Nil**

SCHEDULE 24 - SIGNIFICANT ACCOUNTING POLICIES

1. ACCOUNTING CONVENTION

The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the accrual method of accounting. Interest on interest bearing loans/advances granted to the staff and Guest House Rent are accounted on cash basis. Interest on Fixed deposit on lien against LC/BG is accounted on Cash basis.

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.

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.

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 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.86,73,658.00 against 100% margin money by way of fixed deposit (Previous year Rs.86,73,658.00). Interest earned on such deposit is accounted on cash basis.
- Letters of Credit opened by Bank on behalf of the Centre and Project– Rs. 2,70,16,269.00 (Previous year Rs.74,61,034.00) 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)
Sales-tax	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).

2. NOTES ON ACCOUNTS

2.1.1 Capital Commitments:

Estimated value of contracts remaining to be executed on capital account and not provided for Rs. 29,16,667.00 (Previous year Rs. Nil).

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2.2.1 Physical verification of fixed assets was conducted by the Centre internally in August, 2013.Pending final reconciliation no adjustment is given in the Accounts in this year. Fixed assets register is in the process of being updated.

2.2.2 Capital work-in-progress as on 1st April, 2017 was Rs.9,93,27,644/- addition during the year is Rs.44,44,758/- totaling to Rs.10,37,72,402/- an amount of Rs.7,55,27,129 has been capitalized, leaving balance of Rs.2,82,45,293/- 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/-	Unadjusted since 2012-13
Venkata Kamalakar	Rs. 70000/-	Unadjusted since 2008-09

2.3 Taxation

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

2.4 Foreign Currency Transactions

i) Value of Imports Calculated on C.I.F basis :

(Amount in Rs.)

	Current Year	Previous Year
- Capital Goods	4,87,27,247/-	2,96,72,150 /-
- Consumables	13,65,136/-	11,17,919 /-

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

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2.5 We have examined the Finance Committee's observations/recommendations regarding accounting treatment of interest earned on Fixed Deposits and Savings Bank Deposits with relevant Accounting Standards of the Institute of Chartered Accounts of India (ICAI) and notes and instructions as issued by the Department of Science & Technology(DST), New Delhi for compilation of Financial Statements of the Autonomous Institute and terms and conditions as mentioned in the grant sanction letters as issued by the DST. In our opinion, the said recommendations as recorded under the Agenda Item No.23.3 of the Minutes of the 32nd meeting of the Finance Committee held on 09.10.2015 regarding accounting treatment of Interest earned on Fixed Deposits and Savings Deposits are not in conformity of general practice of accounting and also not supported by specific instruction/ orders in the grant memo on the instruction manual issued by The Department of Science and Technology (DST).However , disclosures of Interest Earned on Fixed Deposits and Savings Bank Deposits in Income and Expenditure Account and Balance Sheet for the financial year 2017-18 are made as per the recommendations of the Finance Committee.

2.6 Corresponding figures for the previous year have been re-grouped/re-arranged, wherever necessary.

Kolkata

Dated: 03.09.2018

PARA-WISE REPLIES TO THE AUDIT OBSERVATIONS

SL	Audit Observation	Para-wise replies
1	Note No. 2.2.1 of schedule 25 regarding physical verification of fixed assets	A fresh physical verification of Fixed assets is under process in order to identify unserviceable/ condemned items . The said physical verification will be completed very soon and necessary adjustments will be given in the Accounts accordingly.
2	Note No. 2.5 of the schedule 25 regarding interest earned on Fixed Deposit and Saving Bank Deposits	Disclosures of Interest Earned on Fixed Deposits and Savings Bank Deposits in Income and Expenditure Account and Balance Sheet for the financial year 2017-18 are made as per the recommendations of the Finance Committee.
3	Centre has invoked bank guarantee of Dutsan G Engineers Pvt. for non-performance of work and amount realized Rs. 12,70,577/- has been shown under other liabilities of Current Liabilities in Schedule 7. We are given to understand that adjustment will be made in the accounts in the subsequent year on verification of records and obtaining legal opinion.	M/s Dutsan G Engineering Pvt. Ltd. has submitted 7th R/A and Final Bill which is under scrutiny of the Engineering Section. While finalizing the said Bill for payment, necessary adjustment in respect of amount realized on invocation of Bank Guarantee will be made.
4	Rs. 44,70,366.86 lying in credit in respect of completed projects and Rs. 42,19,993.00 lying in debit in respect of completed project as reported in the FY 2013-14 still remains unresolved.	In order to resolve the matter , a letter No. SNB/CSIR/2018-19/665/1 dated 28/08/2018 has been sent to Council of Scientific & Industrial Research (CSIR) requesting for necessary approval for transferring net unspent amount of Rs. 2,50,373.86 to the General Fund of the Centre.

Satyendra Nath Bose National Centre for Basic Sciences
Block - JD, Sector-III, Salt Lake, Kolkata - 700106
Phone: +91 33 2335 5706/07/08, Fax: +91 33 2335 3477
http://www.bose.res.in

Designed & Printed at Sailee Press Pvt. Ltd. e-mail:saileepress@yahoo.com