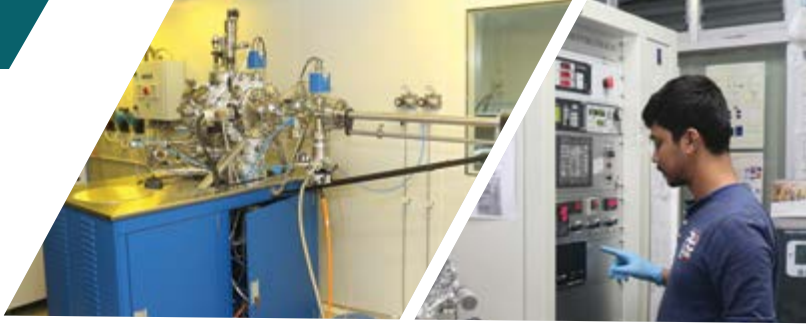
Annual Report 2016-17

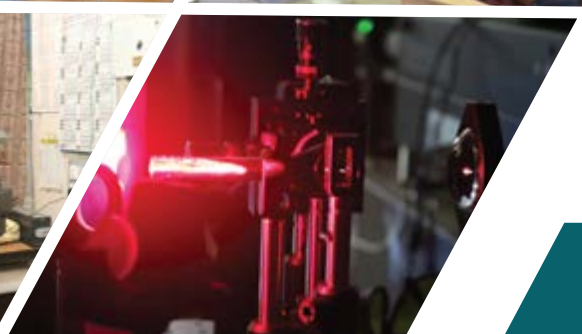










CENTRE FOR BASIC SCIENCES 1986
S. N. BOSE NATIONAL
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SATYENDRA NATH BOSE
NATIONAL CENTRE
FOR BASIC SCIENCES

Annual Report
2016-17

SATYENDRA NATH BOSE
NATIONAL CENTRE FOR BASIC SCIENCES

Annual Report 2016-17

Satyendra Nath Bose National Centre
for Basic Sciences

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for Basic Sciences

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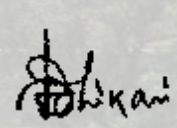
Acknowledgement

Annual Report of the 'Satyendra Nath Bose National Centre for Basic Sciences' is a brief representation of its activities of a financial year. The report reflects research activities, administrative activities, academic progress and achievement of young research scholars, development of infrastructure and facilities, and establishment of network with advanced research groups around the world. It's seventh 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 first 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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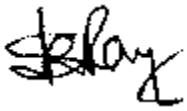
MESSAGE FROM THE DIRECTOR

It is my privilege to present the Annual Report of the Satyendra Nath Bose National Centre for Basic Sciences for the year 2016-17. I took over as the Director of this institute on 14th October 2016, which is around the middle of the fiscal year 2016-17 . My experience here in this curtailed period has strengthened the belief that I have taken over an institute which possesses not only very strong academic potential but also offers a bright and prosperous future. The Annual Report of an autonomous research institute supported by the Government funding is not only a statutory requirement, rather it is a mirror, reflecting the growth and achievements of the Centre to the outside world. The performance of the Centre during the financial year 2016-17 is reflected by the usual parameters on which the performance of a scientific institution should be based on. It indicates that the Centre has improved its standing over the past year. In the last one year there have been 178 publications in referred journals and 14 of other types of publications, 17 students were awarded PhD degree and 17 others submitted their PhD theses. There are 184 PhD students and 22 Post-Doctoral Research students associated with active and productive faculty strength of 32 during 2016-17. The Centre has the privilege of having the presence of International Ph.D. students at the campus through TWAS - S. N. Bose postgraduate fellowship program, of which two of them submitted their Ph.D. thesis in 2016-17. I sincerely congratulate all my colleagues for their excellent work and stupendous efforts for achieving excellence. The contributions of several emeritus Professors, INSPIRE and visiting faculty members are also gratefully acknowledged.

An important requirement of an autonomous research institute is to attract extramural research funding through competitive and stringent expert review. The Centre is proud to have one of the five prestigious TRC projects supported by DST to establish an application inspired innovation and technology Centre. In addition, the Centre has 35 ongoing/ new projects amounting an extramural annual funding of Rs. 4,05,49,788. The Centre is also quite vibrant in science networking and several outreach activities for serving the society and mentoring the junior researchers through Theoretical Physics Seminar Circuit (TPSC), EVLP visiting Associates, C. K. Majumdar Memorial Summer Workshop for post-B.Sc. students, and Vidyasagar – Satyendranath Bose National Workshop etc.

Our sincere 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 faculty members, staff members, administration and support services and students of the Centre for their sincere involvement towards the continuous growth of the Centre. Let me also thank the Annual Report Committee for completing the report timely.

I wish more productive years ahead and hope our endeavour to mandated tasks will benefit the society to a greater extent.

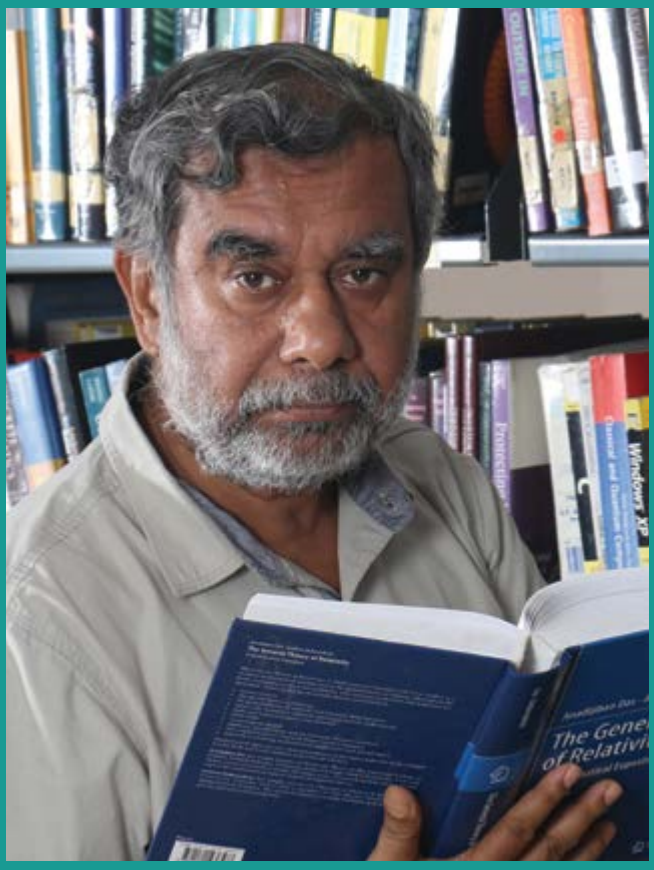


Samit Kumar Ray

Director

S. N. Bose National Centre for Basic Sciences

DEAN, FACULTY



In the year 2016-2017, the Centre was involved in several academic activities related to scientific collaborations, hosting national and international conferences, workshops etc. In this fiscal year, the total number of publications was 178.

Throughout the year, we had numerous seminars on various topics delivered by scientists ranging from young graduate students to well established ones. Our ongoing collaborations with various countries like UK, Russia, Germany, Sweden etc. in terms of academic visits and exchange programmes including collaborations in conferences further bolstered the research work at the Centre.

This year one Scientist and four Post Doctoral Research Associates joined the Centre. Also, two of our faculty members were promoted to Senior Professor and two have superannuated.

Rabin Banerjee

Dean, Faculty

S. N. Bose National Centre for Basic Sciences

DEAN, ACADEMIC PROGRAMME

We are proud to present the Annual report covering the academic year 2016-17.

This report highlights achievements in each of our programme conducted at the Centre i.e, Integrated PhD. Programme & PhD. Programme. In the academic year 2016-17, a total of 22 students joined the PhD programme. Of these, 04 joined Astrophysics & Cosmology, 06 joined Condensed Matter Physics and Material Science, 07 joined Chemical, Biological and Macromolecular Sciences and 05 joined Theoretical Sciences. In addition, 09 students joined Integrated PhD Programme of the Centre.

The Academic Activities expanded considerably during this time period in different areas of Basic Sciences. Our ongoing commitment towards fostering and promote the growth of advanced studies in selected branch of basic Sciences drives us to develop Scholars through the discovery, application and communication of knowledge. We work with our vast network of collaborators who help us to prepare young minds to meet the changing needs of the society.

I have been privileged to work with incredibly thoughtful, energetic and inspiring faculty leaders, 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 efforts by countless individuals whose dedication to the program and our students has been unwavering.

COURSES TAUGHT IN 2016-17

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

1st Semester:

- PHY 101, *Classical Dynamics,* Amitabha Lahiri;
- PHY 102, *Mathematical Methods*, Samir Kumar Paul;
- PHY 103, *Quantum Mechanics I*, Sakuntala Chatterjee;
- PHY 104, *Computational Methods in Physics I,* Subhrangshu S Manna;
- PHY 191, *Basic Laboratory I*, Arup K Raychaudhuri & Soumen Mondal.

2nd Semester:

- PHY 201, *Statistical Mechanics*, Jaydeb Chakrabarti;
- PHY 202, Quantum Mechanics *II*, Rabin Banerjee & Soumendu Datta;
- PHY 203, *Electromagnetic Theory*, Manu Mathur & Subodh K Sharma;
- PHY 204, *Computational Methods in Physics II*, Subhrangshu S Manna & Manoranjan Kumar;
- PHY 291, *Basic Laboratory II*, Kalyan Mandal & Amlan Dutta.

3rd Semester:

- PHY 301, *Atomic & Molecular Physics*, Anjan Barman & Rajib K Mitra;
- PHY 302, *Condensed Matter Physics*, Tanusri Saha Dasgupta & Shreemoyee Ganguly;
- 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 404, *Chemical Physics*, Gautam Gangopadhyay;
- PHY 405, *Biological Physics*, Samir K Pal & Rajib K Mitra;
- PHY 409, *Magnetism & Superconductivity*, Ranjan Chaudhury & Kalyan Mandal;
- PHY 412, *Physics of Materials*, Sugata Mukherjee.

Ph.D. Programme
Course Work Programme

- PHY 501, *Research Methodology*, Sanjoy Choudhury & Pratip Kumar Mukhopadhyay;
- PHY 502, *Review of the Topical Research*, Faculty Supervisors;
- PHY/CB 591, *Project Research,* Faculty Supervisors;
- PHY 509, *Relativity & Cosmology*, Archan S Majumdar;
- •• PHY 511, *High Energy Astrophysics around Compact Stars*, Sandip K Chakrabarti & Soumen Mondal;
- CB 524, Physical Chemistry*: Experiments & Theory*, Ranjit Biswas;
- •• CB 526, *Fundamentals of Biophysics*, Samir Kumar Pal & Rajib K Mitra;
- •• CB 527, *Molecular Physics & Spectroscopy*, Anjan Barman & Rajib K Mitra;
- •• PHY 601, *Advanced Condensed Matter Physics: Magnetism & Superconductivity,* Ranjan Chaudhury & Kalyan Mandal;
- •• PHY 602, *Advanced Condensed Matter Physics: Electronic Structure & Physics of Materials,* Sugata Mukherjee;
- PHY 603, *Statistical Physics,* Punyabrata Pradhan;
- PHY 604, *Quantum Physics (Application),* Biswajit Chakraborty.

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

Ph.D. AWARDS

1. ***Non-Linear Aspects of Black Hole Physics,*** Arindam Lala, Supervisor: Rabin Banerjee, in University of Calcutta, in April 2016
2. ***Investigation of Static and Dynamic Magnetic Properties of Two-Dimensional Magnetic Crystals,*** Ruma Mandal, Supervisor: Anjan Barman, in University of Calcutta, in April, 2016
3. ***Collective Magnetization Dynamics in Magnetic Nanostructures at Various Length Scales and Time Scales,*** Susmita Saha, Supervisor: Anjan Barman, in University of Calcutta, in May 2016
4. ***Surface Modification of Metal Oxides to Induce Multifunctionality at the Nanoscale,*** Monalisa Pal, Supervisor: Kalyan Mandal, in University of Calcutta, in May, 2016
5. ***Structural, Magnetic, Optical and Electronic Properties of Transition Metal Compounds and Semiconductors, Saikat*** Debnath, Supervisor: Priya Mahadevan, in University of Calcutta, in June, 2016
6. ***Investigation of transition metal based nanostructures and their application in storage devices,*** Ashutosh Kumar Singh, Supervisor: Kalyan Mandal, in University of Calcutta, in June, 2016
7. ***Magnetic, Magnetocaloric and Magneto-Transport Properties of Heusler Alloys,*** Arup Ghosh, Supervisor: Kalyan Mandal, in University of Calcutta, in September, 2016
8. ***Understanding of Interaction and Dynamics in Multi-component Chemical Systems,*** Sandipa Indra, Supervisor: Ranjit Biswas, in Jadavpur University, in September, 2016
9. ***Coherence Phenomenon in Mesoscopic Systems,*** Urbashi Satpathi, Supervisor: Prosenjit Singha Deo, in University of Calcutta, in October 2016
10. ***Spectroscopic Studies On Light Harvesting Materials Toward Enhanced Solar Energy Conversion,*** Samim Sardar, Supervisor: Samir Kumar Pal, in University of Calcutta, in October, 2016
11. ***Spectroscopic Studies on the Medicinally Important Molecules with Various Nanoparticles and their Interaction with Different Cell Lines,*** Siddhi Chaudhuri, Supervisor: Samir Kumar Pal, in University of Calcutta, in November, 2016
12. ***Structure, Dynamics and Activity of Water in Restricted Environments,*** Animesh Patra, Supervisor: Rajib Kumar Mitra, in University of Calcutta, in November, 2016
13. ***Investigation And Control Of Magnetization Dynamics In Ferromagnetic / Nonmagnetic Bi-Layer Systems,*** Arnab Ganguly, Supervisor: Anjan Barman, in University of Calcutta, in November, 2016
14. ***Magnetorheological Fluids with Ferromagnetic Binary Alloys and Oxides,*** Md. Injamamul Arief, Supervisor: Pratip Kumar Mukhopadhyay, in University of Calcutta, in January, 2017
15. ***Electronic Structure of Crystalline Solids and Finite-Sized Clusters,*** Swarnakamal Mukherjee, Supervisor: Tanusri Saha Dasgupta, in University of Calcutta, in February, 2017

16. ***Pattern Formation in Two Component Systems,*** Sukla Pal, Supervisor: Jayanta K Bhattacharjee, in University of Calcutta, in February, 2017
17. ***Tuning of Magnetic and High Frequency Electromagnetic Response of Transition Metal Oxide Based Magnetic Nanostructures,*** Rupali Rakshit, Supervisor: Kalyan Mandal, in University of Calcutta, in March, 2017

Ph.D. THESES SUBMITTED

1. ***Heterogeneity and its effects on simple chemical events in molten multi-component systems,*** Suman Das, Supervisor: Ranjit Biswas, in Jadavpur University, in May, 2016
2. ***Study On Quantum Properties Of Non-Gaussian States,*** Priyanka Chowdhury, Supervisor: Archan S Majumdar, in University of Calcutta, in June, 2016
3. ***Manipulating Terahertz Radiation Using Nanostructures,*** Debanjan Polley, Supervisor: Rajib Kumar Mitra & Anjan Barman, in University of Calcutta, in July, 2016
4. ***Topological excitations and spin dynamics in magnetic systems in low dimensions,*** Subhajit Sarkar, Supervisor: Ranjan Chaudhury & Samir Kumar Paul, in University of Calcutta, in July, 2016
5. ***Microscopic description of protein-ligand and protein-protein interactions,*** Samapan Sikdar, Supervisor: Jaydeb Chakrabarti & Mahua Ghosh, in University of Calcutta, in July, 2016
6. ***Biophysical and Structural Characterization of Bacterial Proteins,*** Paramita Saha, Supervisor: Mahua Ghosh, in University of Calcutta, in July, 2016
7. ***Structure and Dynamics of Mixed Microemulsions / Reverse Micellar Systems,*** Arindam Das, Supervisor: Rajib Kumar Mitra, in University of Calcutta, in July, 2016
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 August, 2016
9. ***Canonical Transformations and Loop Formulation of SU(N) Lattice Gauge Theory,*** Sreeraj T P, Supervisor: Manu Mathur, in University of Calcutta, in August, 2016
10. ***Study on Entanglement and its Utility in Information Processing,*** Sovik Roy, Supervisor: Archan S Majumdar, in University of Calcutta, in August, 2016
11. ***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 September, 2016
12. ***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 September, 2016
13. ***Interaction and Dynamics in complex systems,*** Kallol Mukherjee, Supervisor: Ranjit Biswas & Anjan Barman, in Jadavpur University, in September, 2016
14. ***Study of Bipartite and Multipartite Quantum Nonlocality :*** Some Perspectives, Subhadipa Das, Supervisor: Archan S Majumdar, in University of Calcutta, in December, 2016
15. ***Study In Noncommutative Geometry Inspired Physics,*** Yendrembam Chaoba Devi, Supervisor: Biswajit Chakraborty, in University of Calcutta, in December, 2016
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 February, 2017
17. ***Experimental and Theoretical Studies of Magnetic Alloys,*** Tanmoy Ghosh, Supervisor: Pratip Kumar Mukhopadhyay, in University of Calcutta, in March, 2017

PLACEMENT OF PH.D. STUDENTS

Arindam Lala - PDRA, School of Physical Science, JNU, Delhi

Ruma Mandal - Postdoctoral Researcher, Research Center for Magnetic and Spintronic Materials, NIMS, Ibaraki, Japan

Susmita Saha - PDF, ETH, Zurich

Monalisa Pal - Postdoctoral Research Fellow, Dept. of Chemical Engineering POSTECH (Pohang University of Science and Technology), South Korea

Saikat Debnath - R&D Assistant, JNCASR, Bangalore

Ashutosh Kumar Singh - RA-I, Centre for Nano and Soft Matter Sciences, Bangalore

Arup Ghosh - Postdoctoral Research Fellow, IISER, Pune

Urbashi Satpathi - Postdoctoral Research Fellow, RRI, Bangalore

Samim Sardar - Postdoctoral Fellow, Linkoping University, Sweden

Siddhi Chaudhuri - National Post Doctoral Fellowship (SERB), SINP, Kolkata

Animesh Patra - Postdoctoral Fellow, Seoul National University, South Korea

Arnab Ganguly - Postdoctoral Fellow, National University of Singapore, Singapore

Md. Injamamul Arief - Postdoctoral Research Fellow, IISc., Bangalore

Swarnakamal Mukherjee - Postdoctoral Fellow, IIT, Kharagpur

Sukla Pal - Postdoctoral Fellow, PRL, Ahamedabad

Rupali Rakshit - PDF, IISER, Bhopal

Suman Das - PDRA, University of Toronto

Priyanka Chowdhury - Assistant Professor, Mahisadal Raj College, East Medinipur, WB

Debanjan Polley - Postdoctoral Fellow, Stockholm University, Sweden

Subhajit Sarkar - Postdoctoral Fellow, IOP, Bhubaneswar

Samapan Sikdar - PDRA, University of Oklahoma, USA

Arindam Das - National Post Doctoral Fellowship (SERB), IISER, Mohali, Punjab

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

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

Sovik Roy - Assistant Professor, Techno India

Kallol Mukherjee - Postdoc, Ruhr University, Bochum, Germany

Subhadipa Das - Assistant Professor, Hari Mohan Ghosh College

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

Tanmoy Ghosh - Research Associate, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)

Paramita Saha - Post Doctoral Research Fellow, University of Oklahoma, USA

AWARDS / ACHIEVEMENT RECEIVED BY RESEARCH SCHOLARS

1. ***Aniruddha Adhikari*** - Received Best Oral Presentation Award for presenting "Manganese Oxide in Nanotherapy of Hepatic Fibrosis" **1st International Conference on Nanocomputing and Nanobiotechnology (NanoBioCon 2016)** organized by IEEE and MAKAUT (formarly WBUT), Kolkata in October 2016.

   Received Best Abstract Award and Invitation for oral presentation for presenting "Nano sized Mn3O4 can treat hepatic fibrosis: Alteration in route of administration gives a new twist to the tale" **7th Masterclass in Liver Diseases (MCLD 2017) organized by Institute of Liver Disease and transplantation,** Gleneagles Global Hospitals, Chennai in January 2017.

2. ***Chiranjit Ghosh*** - Received "2nd Best Oral Paper Presentation" in **International Diabetes Summit-2017,** Pune in March 2017.

   Received "SIGMA-ALDRICH Excellent Poster Award" in **International Conference of the Korean Society for Molecular and Cellular Biology,** Seoul, South Korea in October 2016.

   Received "International Federation of Clinical Chemistry and Laboratory Medicine-Task Force Young Scientist Award (IFCC-TFYS) Young Scientists Award" by **International Federation of Clinical Chemistry** in Association of Clinical Biochemists of India, Mangalore in 2016.

3. ***Jayita Patwari*** - Received Best Poster Awards for presenting "Photo-Induced Electronic Properties in Single Quantum Well System: Effect of Excitonic Lifetime" in the DAE BRNS-Theme Meeting on **Ultrafast Science-2016** (UFS-2016) held at Bhaba Atomic Research Centre, Mumbai in November 2016.

4. ***Supriyo Ghosh*** - Received Best Poster Award for presenting "The Near-Infrared Spectral Calibration of Late-type Giant Stars from medium resolution HK-band Spectra" in the discipline "Stars, ISM and the Galaxy" during **35th Annual Meeting of Astronomical society of India** (ASI 2017) held at B. M. Birla Auditorium, Jaipur in March 2017.

RESEARCH SCHOLARS - PH.D. PROGRAMME (BY YEAR OF JOINING)

Extended Senior Research Fellow	**Supervisor**
2010–2011:	
• Animesh Patra (SNB)	Rajib Kumar Mitra
• Arindam Lala (CSIR)	Rabin Banerjee
2011–2012:	
• Siddhi Chaudhuri (CSIR)	Samir Kumar Pal
• Arup Ghosh (SNB)	Kalyan Mandal
• Sandipa Indra (UGC)	Ranjit Biswas

SENIOR RESEARCH FELLOW

2010-2011:	**Supervisor**
• Priyanka Chowdhury (UGC)	Archan S Majumdar
• Sreeraj T. P (CSIR)	Manu Mathur
• Subhajit Sarkar (CSIR)	Ranjan Chaudhury & Samir Kumar Paul
• Tanmoy Ghosh (SNB)	Pratip Kumar Mukhopadhyay
• Yendrembam Chaoba Devi (SNB)	Biswajit Chakraborty

2011-2012:

- Arindam Das (UGC) — Rajib Kumar Mitra
- Ishita Dutta Choudhury (SNB) — Amitabha Lahiri
- Kallol Mukherjee (CSIR) — Ranjit Biswas & Anjan Barman
- Paramita Saha (SNB) — Mahua Ghosh
- Pratik Tarafdar (UGC) — Archan S Majumdar
- Rishi Ram Ghimire (TWAS- BOSE) — Arup Kumar Raychaudhuri
- Samapan Sikdar (UGC) — Jaydeb Chakrabarti & Mahua Ghosh
- Sayani Chatterjee (CSIR) — Punyabrata Pradhan
- Suman Das (CSIR) — Ranjit Biswas
- Victor U J Nwankwo (TWAS- BOSE) — Sandip Kumar Chakrabarti

2012-2013:

- Abhijit Maity (INSPIRE) — Manik Pradhan
- Abhishek Roy (SNB) — Sandip Kumar Chakrabarti
- Ambalika Biswas (SNB) — Amitabha Lahiri
- Anindita Mondal (SNB) — Ramkrishna Das & Soumen Mondal
- Arnab Deb (SNB) — Sandip Kumar Chakrabarti
- Arpita Mitra (SNB) — Rabin Banerjee
- Aslam Parvej (SNB) — Manoranjan Kumar
- Chandrima Banerjee (CSIR) — Anjan Barman
- Chiranjit Ghosh (SNB) — Manik Pradhan
- Gourab Dutta Banik (INSPIRE) — Manik Pradhan
- Hrishit Banerjee (SNB) — Tanusri Saha Dasgupta & Manoranjan Kumar
- Karan Savio Fernandes (SNB) — Amitabha Lahiri
- Kartik Samanta (SNB) — Tanusri Saha Dasgupta
- Krishnendu Pal (SNB) — Gautam Gangopadhyay
- Nabarun Polley (INSPIRE) — Samir Kumar Pal
- Nirnay Samanta (SNB) — Rajib Kumar Mitra
- Poulami Chakraborty (SNB) — Tanusri Saha Dasgupta
- Rupali Rakshit (SNB) — Kalyan Mandal
- Sagar Sarkar (CSIR) — Priya Mahadevan
- Samim Sardar (SNB) — Samir Kumar Pal
- Somnath Dutta (SNB) — Soumen Mondal
- Subarna Datta (SNB) — Barnali Ghosh (Saha)
- Subrata Dev (SNB) — Sakuntala Chatterjee
- Suman Som (SNB) — Manik Pradhan
- Sumanto Chanda (SNB) — Partha Guha
- Supriyo Ghosh (SNB) — Soumen Mondal
- Susobhan Choudhury (CSIR) — Samir Kumar Pal

2013-2014:

- Arindam Ghosh (SNB) — Sandip Kumar Chakrabarti
- Poonam Kumari (SNB) — Priya Mahadevan
- Prasenjit Kar (SNB) — Samir Kumar Pal
- Raj Kumar Sadhu (SNB) — Sakuntala Chatterjee
- Rakesh Das (SNB) — Manoranjan Kumar
- Ransell Richard Dsouza (SNB) — Sugata Mukherjee &Tanusri Saha Dasgupta
- Ravindra Singh Bisht (SNB) — Arup Kumar Raychaudhuri
- Sankar Das (SNB) — Subhra Jana
- Shaili Sett (SNB) — Arup Kumar Raychaudhuri
- Souvanik Talukdar (SNB) — Kalyan Mandal
- Subhadip Chakraborti (SNB) — Punyabrata Pradhan
- Sutapa Dutta (INSPIRE) — Jaydeb Chakrabarti & Mahua Ghosh

JUNIOR RESEARCH FELLOW

2014-2015:

- Anuvab Banerjee (SNB) — Sandip Kumar Chakrabarti
- Aritra Narayan Bose (SNB) — Biswajit Chakraborty
- Atanu Baksi(CSIR) — Ranjit Biswas
- Debasmita Maiti (SNB) — Manoranjan Kumar
- Ejaj Tarif (SNB) — Ranjit Biswas
- Indranil Chakraborty (SNB) — Kalyan Mandal
- Juriti Rajbangshi (SNB) — Ranjit Biswas
- Pallabi Paul (SNB) — Tanusri Saha Dasgupta
- Priya Singh (SNB) — Samir Kumar Pal
- Sudipta Pattanayak (SNB) — Shradha Mishra & M. Sanjay Kumar
- Suraka Bhattacharjee (INSPIRE) — Ranjan Chaudhury
- Joydeep Chatterjee (CSIR) — Priya Mahadevan
- Sarowar Hossain (TWAS BOSE) — Pratip Kumar Mukhopadhyay
- Anulekha De (INSPIRE) — Manik Pradhan
- Damayanti Bagchi (INSPIRE) — Samir Kumar Pal
- Debabrata Ghorai (INSPIRE) — Biswajit Chakraborty
- Dhrimadri Khata (INSPIRE) — Soumen Mondal
- Keshab Karmakar (INSPIRE) — Kalyan Mandal
- Mahebub Alam (INSPIRE) — Kalyan Mandal
- Mithun Pal (INSPIRE) — Manik Pradhan
- Samrat Ghosh (INSPIRE) — Soumen Mondal
- Santanu Pan (INSPIRE) — Anjan Barman
- Sucheta Mondal (INSPIRE) — Anjan Barman
- Sandip Saha (RGNF) — Gautam Gangopadhyay
- Tuhin K Maji (INSPIRE) — Samir Kumar Pal

2015-2016:

- Kajal Kumbhakar (CSIR) — Ranjit Biswas
- Jayita Patwari (CSIR) — Samir Kumar Pal
- Aniruddha Adhikari (SNB) — Ranjit Biswas
- Probir Kumar Sarkar (RGNF) — Samir Kumar Pal
- Rajib Adhikary (SNB) — Jaydeb Chakrabarti

- Paulamee Pandit (SNB) — Arup Kumar Raychaudhuri
- Kartik Adhikary (UGC) — Anjan Barman
- Souvik Roy (SNB) — Prosenjit Singha Deo
- Chandan Samanta (SNB) — Barnali Ghosh (Saha)
- Avisek Maity (SNB) — Barnali Ghosh (Saha)
- Rahul Bandyopadhyay (SNB) — Ramkrishna Das
- Alik Panja (SNB) — Soumen Mondal
- Arnab Sarkar (SNB) — Archan S Majumdar
- Shounak Datta (INSPIRE) — Archan S Majumdar
- Dipika Mandal (CSIR) — Kalyan Mandal
- Subrata Ghosh (CSIR) — Kalyan Mandal
- Sudip Kumar Saha (INSPIRE) — Manoranjan Kumar
- Shreya Das (INSPIRE) — Tanusri Saha Dasgupta

2016-2017:

- Piklu Santra (UGC) — Sandip Kumar Chakrabarti
- Prantik Nandi (CSIR) — Sandip Kumar Chakrabarti
- Sk Imadul Islam (UGC) — Rajib Kumar Mitra
- Partha Nandi (SNB) — Manu Mathur & Biswajit Chakraborty
- Subhamita Sengupta (UGC) — Arup Kumar Raychaudhuri
- Sumanti Patra (SNB) — Priya Mahadevan
- Jaydeb Das (SNB) — Biswajit Chakraborty
- Sayan Kumar Pal (UGC) — Biswajit Chakraborty
- Anirban Dinda (UGC) — Manu Mathur
- Akash Das (UGC) — Manik Pradhan
- Saikat Pal (CSIR) — Rajib Kumar Mitra
- Ikbal Ahmed (INSPIRE) — Manik Pradhan
- Sasthi Charan Mandal (CSIR) — Manik Pradhan
- Koushik Mandal (UGC) — Ranjan Chaudhury & Manoranjan Kumar
- Priyanka Saha (INSPIRE) — Kalyan Mandal
- Dipanjan Maity (CSIR) — Kalyan Mandal

PROJECT FELLOWS / ASSISTANTS / TRAINEES

2011-2012: — Project PI

- Shishir Kumar Pandey (PROJECT SRF) — Priya Mahadevan

2013-2014:

- Camelia Manna (PROJECT JRF) — Jaydeb Chakrabarti
- Suvankar Das (PROJECT Assistant) — Amlan Dutta

2014-2015:

- Suchetana Goswami (PROJECT JRF) — Archan S Majumdar
- Somonnita Roy (PROJECT JRF) — Abhijit Mookerjee

2015-2016:

- Animesh Basak (PROJECT JRF) — Pratip Kumar Mukhopadhyay
- Dhiraj Tapader (PROJECT JRF) — Punyabrata Pradhan
- Ramesh Nandi (PROJECT JRF) — Samir Kumar Pal

2016-2017:

- Shubham Agarwal (PROJECT JRF) — Soumendu Datta
- Sangita Dutta (PROJECT JRF) — Soumendu Datta
- Partha Pyne (PROJECT Assistant) — Rajib Kumar Mitra
- Animesh Halder (PROJECT SRF) — Samir Kumar Pal
- Bihalan Bhattacharya (PROJECT JRF) — Archan S Majumdar
- Arnab Samanta (PROJECT JRF) — Subhra Jana

RESEARCH SCHOLARS - INTEGRATED Ph.D. PROGRAMME

SENIOR RESEARCH FELLOW — **Supervisor**

2009–2010:

- Arnab Ganguly (SNB) — Anjan Barman
- Biplab Bhattacherjee (SNB) — Subhrangshu Sekhar Manna
- Debanjan Polley (SNB) — Anjan Barman & Rajib Kumar Mitra
- Subhasish Chakrabarty (SNB) — Amitabha Lahiri
- Arghya Das (SNB) — Punyabrata Pradhan

2010–2011:

- Arpan Krishna Mitra (SNB) — Rabin Banerjee
- Soumyakanti Bose (SNB) — M. Sanjay Kumar
- Suman Dutta (SNB) — Jaydeb Chakrabarti

2011–2012:

- Anita Halder (SNB) — Tanusri Saha Dasgupta
- Chandreyee Roy (SNB) — Subhrangshu Sekhar Manna
- Debasish Das Mahanta (INSPIRE) — Rajib Kumar Mitra
- Shauri Chakrabarty (SNB) — Sakuntala Chatterjee
- Sumanta Kundu (SNB) — Subhrangshu Sekhar Manna

JUNIOR RESEARCH FELLOW

2013–2014:

- Ayan Bhattacharjee (SNB) — Sandip Kumar Chakrabarti
- Kausik Chanda (SNB) — Ranjit Biswas
- Monalisa Singh Roy (SNB) — Manoranjan Kumar
- Samiran Choudhury (SNB) — Anjan Barman
- Sudhanshu Ranjan (CSIR) — Gautam Gangopadhyay
- Vibhuti Narayan Rai (SNB) — Arup Kumar Raychaudhuri

2014–2015: — **Supervisor**

- Amal Garai (SNB) — Punyabrata Pradhan
- Ankan Pandey (SNB) — Partha Guha
- Avinash Kumar Chaurasiya (INSPIRE) — Anjan Barman
- Debalina Banerjee (SNB) — Priya Mahadevan
- Kumar Neeraj (SNB) — Rajib Kumar Mitra
- Riddhi Chatterjee (SNB) — Archan S Majumdar
- Ritam Basu (SNB) — Amitabha Lahiri
- Sanchi Maithani (INSPIRE) — Manik Pradhan
- Santanu Mandal (SNB) — Manik Pradhan
- Sourav Kumar Misra (SNB) — Jaydeb Chakrabarti

2015–2016:

- Amit Barh (SNB) — Rajib Kumar Mitra
- Ananda Gopal Maity (SNB) — Archan S Majumdar
- Arunava Adak (SNB) — Jaydeb Chakrabarti
- Balwant Singh Bisht (SNB) — M. Sanjay Kumar
- Ruchi Pandey (SNB) — Ramkrishna Das
- Sourav Sahoo (SNB) — Anjan Barman

INTEGRATED Ph.D. PROGRAMME

2015–2016:
- Anupam Gorai
- Atul Rathor
- Shantonu Mukherjee
- Shashank Gupta
- Sudip Majumder
- Swarnali Hait
- Surya Narayan Panda

2016-2017:
- Achintya Low
- Ankur Srivastav
- Anuj K Dhiman
- Anwesha Chakraborty
- Manjari Dutta
- Megha Dave
- Raghvendra Pandey
- Sayan Routh
- Neeraj Kumar

PART TIME RESEARCH SCHOLARS - Ph.D. PROGRAMME

Abhishek Bagchi, Condensed Matter Physics and Material Sciences, under Pratip K. Mukhopadhyay

Asit Kumar Chaudhury, Astrophysics & Cosmology, under Sandip Kumar Chakrabarti, Current Affiliation: LMSM High School, Malda Town.

Chaitali Dey, Condensed Matter Physics and Material Sciences, under Kalyan Mandal and Madhuri Mandal

Deblina Majumder, Condensed Matter Physics and Material Sciences, under Kalyan Mandal

Debmalya Mukhopadhyay, Theoretical Sciences, under Amitabha Lahiri

Manotosh Chakravorty, Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB

Oindrila Ganguly, Condensed Matter Physics and Material Sciences, under Debasish Gangopadhyay

Piya Patra, Chemical, Biological & Macro-Molecular Sciences, under Jaydeb Chakrabarti

Putul Chakravorty (Malla Chowdhury), Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB

Samik Roy Moulik, Condensed Matter Physics & Material Sciences, under Barnali Ghosh (Saha), Current Affiliation: Icon Analytical Equipment Pvt. Ltd., Mumbai

Shahnewaz Mondal, Condensed Matter Physics and Material Sciences, under Arup Kumar Raychaudhuri, Current Affiliation: School Service, WB

Shirsendu Dey, Theoretical Sciences, under Rabin Banerjee, Current Affiliation: Kalyani Govt. Engineering College

Soumendra Singh, Chemical, Biological & Macro-Molecular Sciences, under Samir K Pal, Current Affiliation: Bose Institute

Soumi Roy Chowdhury, Condensed Matter Physics and Material Sciences, under Ranjan Chaudhury

Soumyadipta Pal, Condensed Matter Physics and Material Sciences, under Chhayabrita Biswas / Priya Mahadevan (Co-Supervisor), Current Affiliation: Calcutta Institute of Technology

Sovik Roy, Astrophysics & Cosmology, under Archan S. Majumdar, Current Affiliation: Techno India, Kolkata.

Subhadipa Das, Astrophysics & Cosmology, under Archan S. Majumdar, Current Affiliation: Harimohan Ghosh College, Kolkata.

PROJECT RESEARCH

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

- **"One Dimensional Si Nanostructures for Optoelectronic Devices: Fabrication and Characterization", Sumit Kumar Singh,** M. Tech, Indian Institute of Technology, Kharagpur, Supervisors: Prof. Samit Kumar Ray and Prof. Arup Kumar Raychaudhuri
- **"Preparation and Charactetization of some FSMA alloys", Chiranjit Deb, Tushar Ajitsaria, Jinesh Surana,** B. Tech, Visvesvaraya National Institute of Technology, Nagpur, Supervisor: Prof. Pratip Kumar Mukhopadhyay

Biswajit Chakraborty

Dean, Academic Programme

EXTENDED VISITORS & LINKAGE PROGRAMME

The Extended Visitor Linkage Programme add significant dynamism and value to the Academic and research Activities of the Centre. It is an important vehicle for expanding the Science base in the Country through its outreach programme in terms of organizing Memorial lectures, seminars/ colloquium, visits of the associates, arranging visits and lectures to the School & college students at a regular interval. The programme is based upon the understanding that the scientists, the most learned people of the Society through their activities outside the laboratories shall enhance general awareness and scientific temper in young minds.

Memorial lecture

3rd G.N. Ramachandran Memorial Lecture

Speaker: **Prof. Richard N Zare, Margurite Blake Wilbur Porofessor, University Of Stanford, USA.**

Title: Microdroplet Chemistry

Date: 01.03.2017

12th C.K Majumdar Memorial Lecture

Speaker: **Robert Ziff, Professor: Chemical Engineering, Macromolecular Science and Engineering; University Of Michigan**

Title : Percolation in finite matching lattices and holes in clusters

Date: 24/01/2017

Bose Colloquium

Title: **Physical Chemistry in a Single Live Cell: Confocal Microscopy**

Speaker: Prof. Kankan Bhattacharyya Indian Institute of Science Education and Research, Bhopal Title: Physical Chemistry in a Single Live Cell: Confocal Microscopy

27th January 2017.

Title: **Electronics in Flatland**

Speaker: Prof. Sanjay Banerjee Cockrell Family Regents Chair Professor & Director, Microelectronics Research Center, University of Texas, Austin ,

16th December 2016

Title: **From Conic Sections to Quantum Mechanics, Field Theory and Gravity**

Speaker: Prof. Rabin Banerjee Department of Theoretical Sciences, S.N. Bose National Centre for Basic Sciences, 25th November 2016

Title: **Semiconductor Quantum Structures: Recent Trends**

Speaker: Prof. Samit K. Ray Director, S. N. Bose National Center for Basic Sciences, 13th January 2017

Institute Seminars/Colloquium

Title: **Design of Advanced Materials**

Speaker: Prof. Ashok K Ganguli, Institute of Nanoscience & Technology, Mohali, Punjab 160062, India, 17th April, 2017

Title: **Many Faces of Carbon**

Speaker: Prof. Purusottam Jena, Affiliation: Distinguished Professor, Department of Physics, Virginia Commonwealth University Richmond, VA, USA , 2nd March 2017

Title: **Continuous Transitions between Quantum and Classical Electrodynamics**

Speaker: Prof. Partha Ghose Affiliation: NASI Emeritus Professor, 22nd February 2017

Title: **Microbial diversity of Sunderbans, the world heritage site**

Speaker: Maitree Bhattacharyya Affiliation: Director, Jagadis Bose National Science Talent Search & Professor, Department of Biochemistry, University of Calcutta,

8th February 2017.

Title: **Is standard quantum mechanics enough?**

Speaker: Prof. John Corbett Macquarie University, Sydney, Australia,

19th January 2017

Title: **Compact stars in the modified gravity theories**

Speaker: Dr. Subharthi Ray Affiliation: Astrophysics and Cosmology Research Unit (ACRU), Univ. of KwaZulu-Natal, Durban, South Africa,

15th December 2016

Title: **Electronic structure of the elusive metastable state in chemically exfoliated few layer MoS2**

Speaker: Prof. D.D. Sarma Honorary Professor, SNBNCBS Affiliation: Solid State and Structural Chemistry Unit Indian Institute of Science, Bengaluru,

12th December 2016

Title: **Marriage of Health and Technology may produce Amazing Results**

Speaker: Prof. Debasis Bhattacharyya Principal, NRS Medical College, Kolkata,

2nd December 2016

Title: **Fermiology in Condensed Matter Physics**

Speaker: Prof. Mukunda P. Das (VASP Short Term Visitor to Dr. Ranjan Chaudhury) Affiliation: Department of Theoretical Physics, The Australian National University, Canberra, 30th November 2016

Title: **Exploring the sub-mm wavelength region in the electromagnetic spectrum**

Speaker: Dr. Rajib Kumar Mitra CBMS, SNBNCBS, 21st October 2016

Title: **A tale of three slits: From Superposition to Correlated qutrits**

Speaker: Urbasi Sinha Raman Research Institute, Bangalore, 14th September 2016

Title: **Kinetics of First Order Phase Transitions: Nucleation, Ostwald Step Rule and Spinodal Decomposition**

Speaker: Biman Bagchi Professor, SSCU, Indian Institute of Science, Bangalore

14th September 2016

Title: **Growth and characterisations of silicon nanowires for applications in photovoltaics**

Speaker: Dr. Sekhar Bhattacharya, Meghnad Saha Institute Of Technology, Kolkata,

12th September 2016

Title: **Low cost space exploration with weather balloon borne X-ray detectors**

Speaker: Dr. Ritabrata Sarkar (VASP short term visitor to Prof. Sandip Chakrabarti) Affiliation: Indian Centre for Space Physics, Kolkata, 19th August 2016

Title: Facile synthesis of Cobalt Ferrite nano hollow spheres for efficient bilirubin adsorption

Speaker: Dr. Arka Chaudhuri , Haldia Institute of Technology, 20th July 2016

Title: **Are the extreme underdoped high Tc cuprates topological?**

Speaker: Prof. Debanand Sa,Department of Physics, Banaras Hindu University,

Varanasi, 20th July 2016

Title: **Gauge/String duality: Overview & Applications**

Speaker: Dr. Dibakar Roychowdhury , IIT, Kanpur, 19th July 2016

Title: **First Principle DFT calculations for electronic structure of pure and doped Zno**

Speaker: Dr. Vishwajeet Mukherjee , SUIIT, Sambalpur University, Odisha,

29th June 2016

Title: **Stress induced Martensitic transformation in a CoNiAl Ferromagnetic Shapememory alloys using Vibrating Reed Apparatus**

Speaker: B. Rajini Kanth, T.K.R College of Engineering and Technology, Hyderabad , 23th June 2016

Title: **Metal oxo-clusters in MOFs – Synthesis, Structure and magnetism**

Speaker: Prof. S. Natarajan Framework Solids Laboratory, Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore, 26th May 2016

Title: **Locally driven random average process**

Speaker: Dr. Anupam Kundu International Centre for Theoretical Sciences, Bengaluru,

01st April 2016

Conferences, Workshops and Extension Programme (CWEP)

Discussion meeting on the occasion of 60 years of Broadbent and Hammersley (1957) paper on percolation phenomena

Conveners: Prof. Subhrangshu S Manna and Dr. Punyabrata Pradhan

23rd – 24th Jan, 2017

Discussion Meeting on Quantum Mechanics

Convener: Prof. Archan S. Majumdar

19th Jan, 2017

Indo - US Bilateral Workshop On Physics and Chemistry of Oxides: Theory Meets Experimnet

Convener: Prof. Tanusri Saha Das-Gupta,

3rd - 7th Jan, 2017

Ramanujan Conclave

Organized by S N Bose National Centre for Basic Sciences at Kolkata

22nd - 23rd December, 2016

XXI st National Symposium on Ultrasonics

Convener: Prof. P. K. Mukhopadhyay,

8th – 10th Nov, 2016

Young Scientists' Colloquium - 2016 of MRSI

Convener: Prof. Kalyan Mandal

16th Sep, 2016

C.K. Majumder Memorial Summer Workshop in Physics -2016

In Association with IAPT(RC15)

14th June - 24th June 2016

VISITOR, ASSOCIATES & STUDENTS' PROGRAMME (VASP)

• Distinguished Lecture Series

Title: **"The Topological Phase in Proximity Induced Superconductors"**

Speaker: Professor Krishnendu Sengupta Department of Theoretical Physics Indian Association for the Cultivation of Sciences, Kolkata

• Associates Visited the centre

Sl.	Name of the Visitor	Affiliation	Category of Visit	Duration of Visit
1	Prof. Debanand Sa	Dept. of Physics, BHU, Varanasi	Short Term Visitor	10.07.2016 – 20.07.2016
2	Dr. Arka Chaudhuri	Assistant Prof., Dept. of Applied Science & Humanities, Haldia Institute of Technology, WB	Associate ship	01.07.2016 – 20.07.2016
3	Dr. Sekhar Bhattacharya	Senior Research Scientist, SSN Research Centre, Rajiv Gandhi Salai, Kalavakkam, Tamil Nadu	Associate ship	20.06.2016 – 01.07.2016
4	Dr. Dibakar Roychowdhury	Post Doctoral Fellow, IIT-Kanpur, UP	Short Term Visitor	07.07.2016 – 20.07.2016
5	Dr. B Rajini Kanth	Professor & HOD, T.K.R. College of Engineering and Technology, Hyderabad, Telangana	Short Term Visitor	01.06.2016 – 15.06.2016
6	Dr. Vishwajeet Mukherjee	Assistant Professor, SUIIT, Sambalpur University, Odisha	Short Term Visitor	07.05.2016 – 30.06.2016
7	Dr. Sujit Sarkar	Assistant Professor, Poornaprajna Institute of Scientific Research, Bangalore	Associate ship	18.06.2016 – 26.06.2016
8	Prof. Pradip Mukherjee	Barasat Government College, Barasat, WB	Associate ship	04.05.2016 – 21.05.2016
9	Dr. Ritabrata Sarkar	Assistant Professor, Indian Centre for Space Physics, Garia, Kolkata	Short Term Visitor	16.08.2016 – 20.08.2016
10	Dr. Sujit Srakar	Assistant Professor, Poornaprajna Institute of Scientific Research, Bangalore	Associateship	07.11.2016 – 11.11.2016
11	A.M. Jayannavar, FNA, FASc., FNASc.	Senior Professor, IOP, Bhubaneswar	Short Term Visitor	27.09.2016 – 03.10.2016
12	Prof. M. P. Das	Research School of Physics and Engineering, The Australian National University, Canberra, Australia	Short Term Visitor	27.11.2016 – 01.12.2016
13	Prof. Subharthi Ray	Associate Professor, Astrophysics and Cosmology Research Unit (ACRU), University of KwaZulu-Naral, Westville Campus, Durban, South Africa	Short Term Visitor	12.12.2016 – 16.12.2016
14	Dr. Bikash Chandra Paul	Physics Department, North Bengal University, Siliguri	Associate ship	03.12.2016 – 11.12.2016
15	Dr. Bikash Chandra Paul	Physics Department, North Bengal University, Siliguri	Associate ship	24.12.2016 – 01.01.2017

Advanced Post Doc Manpower Programme

Post Doctoral Research Associates (PDRA) on roll – 16

Sl. No.	Name	Status	Mentor / Department
1	Amna Ali	PDRA – II	Prof. Archan S. Majumdar / Astrophysics & Cosmology
2	Ankita Ghatak	PDRA – I	Dr. Barnali Ghosh (Saha) / Condensed Matter Physics and Material Sciences
3	Dayasindhu Dey	PDRA – I	Dr. Manoranjan Kumar / Condensed Matter Physics and Material Sciences
4	Dipak Kumar Das	PDRA – I	Dr. Rajib Kumar Mitra / Chemical, Biological & Macro-Molecular Sciences
5	Kumar Abhinav	PDRA – I	Dr. Samir Kr. Paul & Prof. Partha Guha / Theoretical Sciences
6	Lakshmi Maganti	PDRA – I	Prof. Jaydeb Chakrabarti / Chemical, Biological & Macro-Molecular Sciences
7	Manas Mondal	PDRA – I	Prof. Jaydeb Chakrabarti / Chemical, Biological & Macro-Molecular Sciences
8	Pabitra Mandal	PDRA – I	Prof. Arup Kumar Raychaudhuri / Condensed Matter Physics and Material Sciences
9	Ravikant Verma	PDRA – I	Prof. Biswajit Chakraborty / Theoretical Sciences
10	Shamik Chakrabarti	PDRA – I	Prof. Tanusri Saha-Dasgupta / Condensed Matter Physics and Material Sciences
11	Shreyasi Dutta	PDRA – I	Prof. Samir Kumar Pal / Chemical, Biological & Macro-Molecular Sciences
12	Shubhashis Rana	PDRA – I	Dr. Punyabrata Pradhan / Theoretical Sciences
13	Sourav Kundu	PDRA – I	Prof. Priya Mahadevan / Condensed Matter Physics and Material Sciences
14	Soumen Dhara	PDRA – II	Prof. Arup Kumar Raychaudhuri / Condensed Matter Physics and Material Sciences
15	Sumona Sinha	PDRA – I	Prof. Anjan Barman / Condensed Matter Physics and Material Sciences
16	Tapas Paramanik	PDRA – I	Prof. Pratip Kumar Mukhopadhyay / Condensed Matter Physics and Material Sciences

Summer Research Programme 2016-17:

The centre also provide opportunity to the young science scholars to interact with the scientists of the Centre and foster ,train young minds through it s “Eight week” long Summer Resaercch Programme during May –July session of each year.

Selected students are provided with Honorarium and T.A reimbursement by the centre.

Candidate Name	Affiliation	Faculty
Kaushlendra Kumar	IISER, Kolkata	Biswajit Chakraborty
Anupa Bhattacharya	Amity University,Kolkata	Manik Pradhan
Lalit Kumar Sahoo	ISM, Dhanbad	Soumendu Datta
Poulami Dutta Roy	IIT, Kharagpur	Archan S Majumder
Tanwistha Chakrabarti	Presidency University	Anjan Barman
Kartik Panda	Ramakrishna Mission Vivekananda University, Belur	P.K Mukhopadhyay
Poulami Mondal	IIT, Kharagpur	Rabin Banerjee
Priya Maity	ISM, Dhanbad	Kalyan Mandal
Ashabari Majumdar	IIT, Kanpur	S.S Manna
C.V.K.L Ramya	Central University of Tamil Nadu	Subhra Jana
Koyel De	Jadavpur University	Soumen Mondal
Sounak Banerjee	University of Calcutta	Samir Kumar Pal
Jayeeta Chattopadhyay	Presidency University	Jaydeb Chakrabarti
Robert Wilson Joute	IIT, Kharagpur	Ramkrishna Das

Educational visit / Laboratory visit Conducted:

1. Lady Brabourne College
2. Presidency University
3. Rammohan College
4. Ramakrishna Mission Residential College, Narendrapur
5. Prabhu Jagatbandhu College
6. Ramakrishna Mission Vidyamandira, Belur Math
7. Serampore College
8. Raja Peary Mohan College
9. Jadavpur University
10. Handique Girls College,Assam

Celebrated National Science Day 2017 with students from different university and colleges:

126 no. of students participated from different Colleges.

BOSE FEST 2017

Every year, our Centre celebrates "BOSE FEST" showcasing the spirit of creativity and science through a 2-day long in-house science sessions followed by cultural programmes in the evenings.

"BOSE FEST 2017" held at the Centre during 9-10th February, 2017.

All Research Scholars of their 4th and 5th year grade delivered oral presentation and 2nd and 3rd year students prepared & presented their posters in different sessions of the two day Programme.

Cultural Programme was organized by "Muktanngan" (Bose Centre Recreation Club) followed by a family banquet dinner on 9th February 2017 while singer Lopamudra Mitra was invited to perform at the Centre on 10th February, 2017.

Nibedita Konar
Dy. Registrar (Academic)

Debashish Bhattacharjee
Dy. Registrar (Administration)

Rupam Porel
Office Assistant

THEORETICAL PHYSICS SEMINAR CIRCUIT

Grant released to other TPSC Centres in the Country

Physical Research Laboratory (1,00,000 INR)	Benaras Hindu University (42,000 INR)
Bharatidasan University (67,000 INR)	Viswa Bharati, Santiniketan (40,000 INR)
University of Pune (50,000 INR)	Indian Institute of Science, Bangalore (40,000 INR)
Indian Institute of Technology, Roorkee (50,000 INR)	Institute of Physics, Bhubaneswar (35,000 INR)
Cochin University of Science, Cochin (45,000 INR)	Indian Institute of Technology, Kanpur (20,000 INR)

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

Speaker	Affiliation	TPSC Centre Visited
Ms. Sangeetya Rani Ujjwal	School of physics,JNU	Bharatidarsan University
Dr Abhik Mukherjee	SINP, Kolkata	
Mr. A. Govindaraji,	Department of Physics, Presidency College, Chennai	
Prof. Shyamal Kumar Dana	IICB, Kolkata	
Mr. Theophine Fonzin Fozin	University of Cameroon	
Dr. Vishal Vasan	ICTS, TIFR, Bangalore	
Dr. Awadhesh Prasad	University Of Delhi	
Dr. K Suresh	A.M. Engineering College, Kovilveni, Thanjavur, India	
Dr. Tanmoy Banerjee	Burdwan University, West Bengal	
Dr. A. Arulgnanam	Department of Physics, St. John's College, Palayamkottai	
Dr. S. Sabarathinam,	Dept. of Physics,Karpagam,University, Coimbatore	
Mr. Partha Bagchi	VECC, Kolkata	IIT Roorkee
Dr. Ramkrishna Podili	Clemson University,USA	
Dr. Varinderjit Singh	Indiana University,Booomington,In,USA	
Dr. Trilochan Bhagarti	HRI, Allahabad	Institute of Physics, Bhubaneswar
Dr. Saytana Choudhury	TIFR, Mumbai	
Dr. Binoy Kumar Patra	IIT, Rookee	
Dr. Rajeev Kumar Jain	University of Southern Denmark, Denmark	
Dr. Y.P. Viyogi	VECC, Kolkata	
Dr. lobsong Dhargyl	IMSc. Chennai	
Prof. Satyaki kar	IACS, Kolkata	
Dr. Moymukh Gangopadhyaya	University of Norte dam, USA	
Dr. Biswajit Karmakar	IIT ,Guwahati	
Dr. Amruta Mishra	IIT,Delhi	
Debasish Majumdar	SINP,Kolkata	Indian Institute of Technology, Kanpur
Subhashish Banerjee	IIT Jodhpur	
Bidya Binay Karak	Nordita ,Stockholm, Sweden	
Kush Saha	University Of California	
Mridupawan Deka	Joint Institute of Nuclear Research, Russia	
Abhik Mukherjee	SINP,Kolkata	
J.S. Yadav	TIFR,Mumbai	

Academic visit at SNBNCBS

- Dr. Ronald Benjamin, Institute of Theoretical Physics II, Dusseldorf University, Germany, visited the Centre from 18th to 20th September 2016 and delivered a talk entitled "Investigating Statistical Mechanics problems via Molecular Simulations: Two Case Studies (i) Solid-Liquid Phase Transition and (ii) Thermodynamics of Buettiker-Landauer Brownian Motor".

The Advanced Research Workshop

- "Advanced School on Gravitational Waves" was organized by Presidency University during 12th -16th December 2016 at Presidency University Campus. The total number of participants was 50.
- 8th Vidyasagar-Satyendranath Bose National Workshop on "Nuclear and Astrophysics: Two Opposite ends of Dimension (NATD 2017)" was organized by Vidyasagar University during 17th -19th January, 2017 at Vidyasagar University Campus, Midnapore. The total number of participants was 180.

Sakuntala Chatterjee

Sakuntala Chatterjee

Convener, Theoretical Physics Seminar Circuit

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 2016-2017 successful. Staff comprising of strength of approximately 19 in permanent, 12 in temporary and 42 in contractual category as on 31st March 2017, 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 handled Audit Queries, Parliamentary Questions and various factual informations. 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.

No cases related to vigilance have been reported during the period of 2016-2017. The Centre has also adhered to the norms of the Right to Information Act and so far has received 5 (five) cases under the said Act in the last financial year all of which has been successfully disposed off. The Centre has also successfully faced the CAG Audit for the year 2016-17.

The Centre organized an in-house training programme for administrative staff of the Centre on 'Right to Information Act 2005/ Lokpal & Lokayukta Bills, Arbitration Act/Service Tax' in association with National Council for Training & Social Research (NCTSR), New Delhi from 15th November 2016 to 18th November 2016.

As part of Vigilance Awareness Week 2016 during 31st October 2016 to 5th November 2016, the Centre organised an Essay Competition (Topic: "Public Participation in Promoting Integrity and Eradicating Corruption"). The essay competition carried a cash award of Rs.5,000/- (1st prize), Rs.3,000/- (2nd prize) and Rs.1,000/- (3rd prize) with winners as:

- 1st Prize - Mr. Amit Roy, Technical Assistant (Library).
- 2nd Prize – Mr. Gurudas Ghosh, Technical Assistant (Library) & Mr. Surya Narayan Panda, IPhD student.
- 3rd Prize – Ms. Sonali Sen, Office Assistant.

The Centre celebrated the birth anniversary of Sardar Vallabhbhai Patel as "Rashtriya Ekta Diwas (National Unity Day) on 31st October 2016 and took Swachh Shapath (Cleanliness Oath) on 2nd October 2016 through pledge ceremonies. The Centre also organised an interactive yoga session for its staff and students on the occasion of the International Yoga Day on 21st June 2016.

Meetings of the Statutory Committees of the Centre :

(i) The 51st, 52nd and 53rd Governing Body (GB) meetings of the Centre were held on 23.07.2016, 05.10.2016 and 23.03.2017 respectively.

(ii) The 33rd and 34th Finance Committee (FC) meetings of the Centre were held on 05.10.2016 and 22.03.2017 respectively.

(iii) The 25th Academic & Research Programme Advisory Committee (ARPAC) meeting of the Centre was held on 24.02.2017.

(iv) The Building Committee meetings of the Centre were held on 27.05.2016 [2016/2], 27.10.2016 [2016/3] and 21.03.2017 [01/17].

Official Language Policy

The Centre paid emphasis on implementation of the Official Language in the year 2016-17. 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 Bilingual following rule 3(3) of Rajbhasha Act 1963. Many of the internal notings and signing in the Attendance Register (on the first of every month) 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. The Centre is a member of Calcutta Town Official Language Implementation Committee (CALTOLIC) office(2) 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, with the month of September being declared as Hindi month. It was officially inaugurated on 14th September 2016 by Prof. Rabin Banerjee, Dean (Faculty) in presence of Prof. Tanuja Majumder, HOD Hindi Department, Presidency 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 mahina was celebrated through screening of Hindi Film 'CHUPKE CHUPKE', staging of an in house Cultural programme by staff members 'BY MISTAKE GALTI HO GAYE', Hindi play 'TAJ MAHAL KA TENDER' performed by 'Ognam' group and a Hindi Quiz programme. The Centre organised a Hindi Essay Competition. The title of the essay was "Olympic – 2016 me Bharat ka Safar " with a maximum of 750 words. 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. Sonali Sen, Office Assistant.
- 2nd Prize – Ms. Ananya Sarkar, Technical Assistant (Library).
- 3rd Prize – Mr. Shashank Gupta, IPhD student.

The Centre also organised a Hindi Extempore (Topic viz. Swacchhatta Abhiyan, Bharatiya Sena, Pradushan, Ganga Nadi etc.)

The Centre organised quarterly 'Hindi Workshops' on i) 08.04.2016 where Shri R.N.Saroj, Dy. Director (East), Hindi Teaching Scheme, Dept. of OL, MHA, Govt. of India, spoke on "Official Language Policy, Act, Rules and Annual Program" ; ii) 05.08.2016 where Shri Priyankar Paliwal, Sr. Hindi Officer, CSIR-CGCRI, Kolkata spoke on "Constitutional provisions of the Official Language and our responsibility" ; iii) 20.12.2016 where Shri Prakash Chandra Thakur, Assistant Director (Official Language), Employees Provident Fund Organisation, Ministry of Labour and Employment, Govt. of India, Regional Office, Kolkata spoke on "Official Rules, 1976 (Addressing as 1987,2007 and 2011) the Nature of Hindi Correspondence and Noting" ; iv) 27.03.2017 where Shri Udayvir Singh, Official Language Officer, Bharat Coking Coal Limited, Dhanbad spoke on "Role of Technology in Official Language Implementation". The workshops on 08.04.2016 and 05.08.2016 were also graced by Shri Vipati, Hindi Professor, Hindi Teaching Scheme, MHA, Govt. of India.

Facilities

The Centre extends the following facilities under its aegis. 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.

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 and 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 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 created to promote various creative activities in the Centre divided into 5 broad activities viz. Performing Arts, Literary Arts, Visual Arts, Sports Activities and Social Outreach. 'Muktangan' organised several programmes under its aegis during the year 2016-17.

I express my sincere condolences on the untimely death of Mr. Partha Chakraborty, Attendant after a prolonged illness, on 29th March 2017.

While concluding, I would like to express my sincere thanks to the three Deputy Registrars of Administration, Finance and Academic sections and to all the administrative and academic staff members of the Centre for their strong support and cooperation for smooth running of the administration. I am also grateful to Prof. Santanu Bhattacharya, former Director (9th March 2016 to 13th October 2016) and Prof. Samit Kumar Ray, present Director (since 14th October 2016) for their valuable guidance and advice on administrative matters.

Smajumder

Shohini Majumder

Registrar

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. R.C.Budhani Department of Physics Center of Laser Technology 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. Swarnakanti Ghosh Director, NCRA, Pune	Member
Prof. Sanjay Puri Professor, JNU, New Delhi	Member
Prof. Amitabha Raychaudhuri Professor, Calcutta University, Kolkata	Member
Prof. Dilip G. Kanhere Distinguished Professor, University of Pune	Member
Prof. Amalendu Chandra Professor, IIT, Kanpur	Member
Prof. Raghavan Varadarajan Professor, IISc, Bangalore	Member

Prof. Samit Kumar Ray` Director S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Rabin Banerjee 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	Member
Prof. S. K. Chakrabarti Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Manu Mathur Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. P. K. Mukhopadhyay Head, Department of Condensed Matter Physics and Material Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Prof. Ranjit Biswas Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Permanent Invitee
Ms. Nibedita Konar Deputy Registrar (Academic) S. N. Bose National Centre for Basic Sciences Kolkata	Non-Member Secretary

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. Rabin Banerjee 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
Prof. Manu Mathur Head, Department of Theoretical Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. S. K. Chakrabarti Head, Department of Astrophysics and Cosmology S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Ranjit Biswas Head, Department of Chemical, Biological and Macromolecular Sciences S. N. Bose National Centre for Basic Sciences Kolkata	Member
Prof. Pratip Kumar Mukhopadhyay 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
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 (joined on 14.10.2016)	Director
2	Amitabha Lahiri	Professor, TS & Dean (AP) (till 31.01.2017)
3	Anita Mehta (superannuated on 31.07.2016)	Senior Professor, TS
4	Anjan Barman	Professor, CMPMS
5	Archan S. Majumdar	Senior Professor, A&C
6	Barnali Ghosh (Saha)	Scientist-E (Technical Cell), CMPMS
7	Biswajit Chakraborty	Professor, TS & Dean (AP) (from 01.02.2017)
8	Gautam Gangopadhyay	Professor, CBMS
9	Jaydeb Chakrabarti	Professor, CBMS
10	Kalyan Mandal	Senior Professor, CMPMS
11	Manik Pradhan	Associate Professor, CBMS
12	Manoranjan Kumar	Assistant Professor, CMPMS
13	Manu Mathur	Professor & HOD, TS
14	M. Sanjay Kumar	Associate Professor, TS
15	Partha Guha	Professor, TS
16	Pratip Kr. Mukhopadhyay	Professor & HOD, CMPMS
17	Priya Mahadevan	Professor, CMPMS
18	Prosenjit Singha Deo	Professor, CMPMS
19	Punyabrata Pradhan	Associate Professor, TS
20	Rabin Banerjee	Senior Professor, TS & Dean (Faculty)
21	Rajib Kumar Mitra	Associate Professor, CBMS
22	Ramkrishna Das	Assistant Professor, A&C
23	Ranjan Chaudhury	Associate Professor, CMPMS
24	Ranjit Biswas	Professor & HOD, CBMS
25	Sakuntala Chatterjee	Assistant Professor, TS
26	Samir K. Pal	Professor, CBMS
27	Samir K. Paul (superannuated on 30.04.2016)	Associate Professor, TS
28	Sandip K. Chakrabarti	Senior Professor & HOD, A&C
29	Sanjoy Choudhury	Scientist-C (Computer Services Cell)
30	Soumen Mondal	Associate Professor, A&C
31	Subhrangshu Sekhar Manna	Senior Professor, TS
32	Tanusri Saha Dasgupta	Senior Professor, CMPMS & Associate Dean (Faculty)

Distinguished Professor (Emeritus)

1	Arup Kumar Raychaudhuri	CMPMS

Emeritus Professors

1	Abhijit Mookerjee (till 30.04.2016)	CMPMS
2	Subodh Kumar Sharma	TS

Honorary Faculty (Under EVLP)

1.	D. D. Sharma, IISc., Bangalore	
2.	Biman Bagchi, IISc., Bangalore	

Research Scientist

1	Mahua Ghosh (till 29.06.2016)	CBMS

Visiting Reader

1	Mahua Ghosh (till 03.01.2017)	CBMS

Scientist-D

1	Bhushan Omprakash Awasarmol	TUECMS
2	Biswaroop Mukherjee	TUECMS
3	Jaivardhan Sinha	TUENDT
4	Kaustuv Das (till 28.08.2016)	TUENDT
5	Shreemoyee Ganguly	TUECMS

DST Inspire Faculty Members

1	Amlan Dutta	CMPMS
2	Soumendu Datta	CMPMS
3	Subhra Jana	CBMS

Visiting Faculty Members

1	Madhuri Mandal	CMPMS
2	Sugata Mukherjee	CMPMS
3	Samir Kumar Paul	TS

Young Scientist

1	Alo Dutta	CMPMS

Post Doctoral Research Associates

1	Amna Ali	A&C
2	Ankita Ghatak (till 31.05.2016)	CMPMS
3	Animesh Halder (till 15.09.2016)	CBMS
4	C. Jebarathinam	A&C
5	Dayasindhu Dey	CMPMS
6	Dipak Kumar Das	CBMS
7	Jashashree Ray (till 31.05.2016)	CMPMS
8	Kumar Abhinav	TS
9	Lakshmi Maganti (till 31.10.2016)	CBMS
10	Manas Mondal (till 14.03.2017)	CBMS
11	Pabitra Mandal (till 31.07.2016)	CMPMS
12	Rakhi Acharyya (till 01.09.2016)	CMPMS
13	Ravikant Verma	TS
14	Rabaya Basori (till 30.04.2016)	CMPMS
15	Shamik Chakrabarti (from 15.03.2017)	CMP&MS
16	Shreyasi Dutta (till 06.09.2016)	CBMS
17	Shubhashis Rana	TS
18	Sourav Kundu (till 21.09.2016)	CMP&MS
19	Soumen Dhara (till 21.04.2016)	CMPMS
20	Sumona Sinha	CMPMS
21	Tanumoy Pramanik (till 30.06.2016)	A&C
22	Tapas Paramanik	CMPMS

National Post Doctoral Fellow

1	Ankita Ghatak (from 01.06.2016)	CMPMS
2	Jashashree Ray (from 01.06.2016)	CMPMS

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
TRC: Technical Research Centre

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) & Officiating as Deputy Registrar (Administration) w.e.f. 01.01.17-28.02.17
Nibedita Konar	Deputy Registrar (Academic)
Debashish Bhattacharjee	Deputy Registrar (Administration) [joined on 01.03.2017]
Saumen Adhikari	Librarian cum Information Officer
Sukanta Mukherjee	Sr. Assistant Registrar (Projects)
Santosh Kumar Singh	Assistant Registrar (Purchase) & Officiating as Deputy Registrar (Administration) till 31st December 2016
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 Chakraborty	Attendant
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

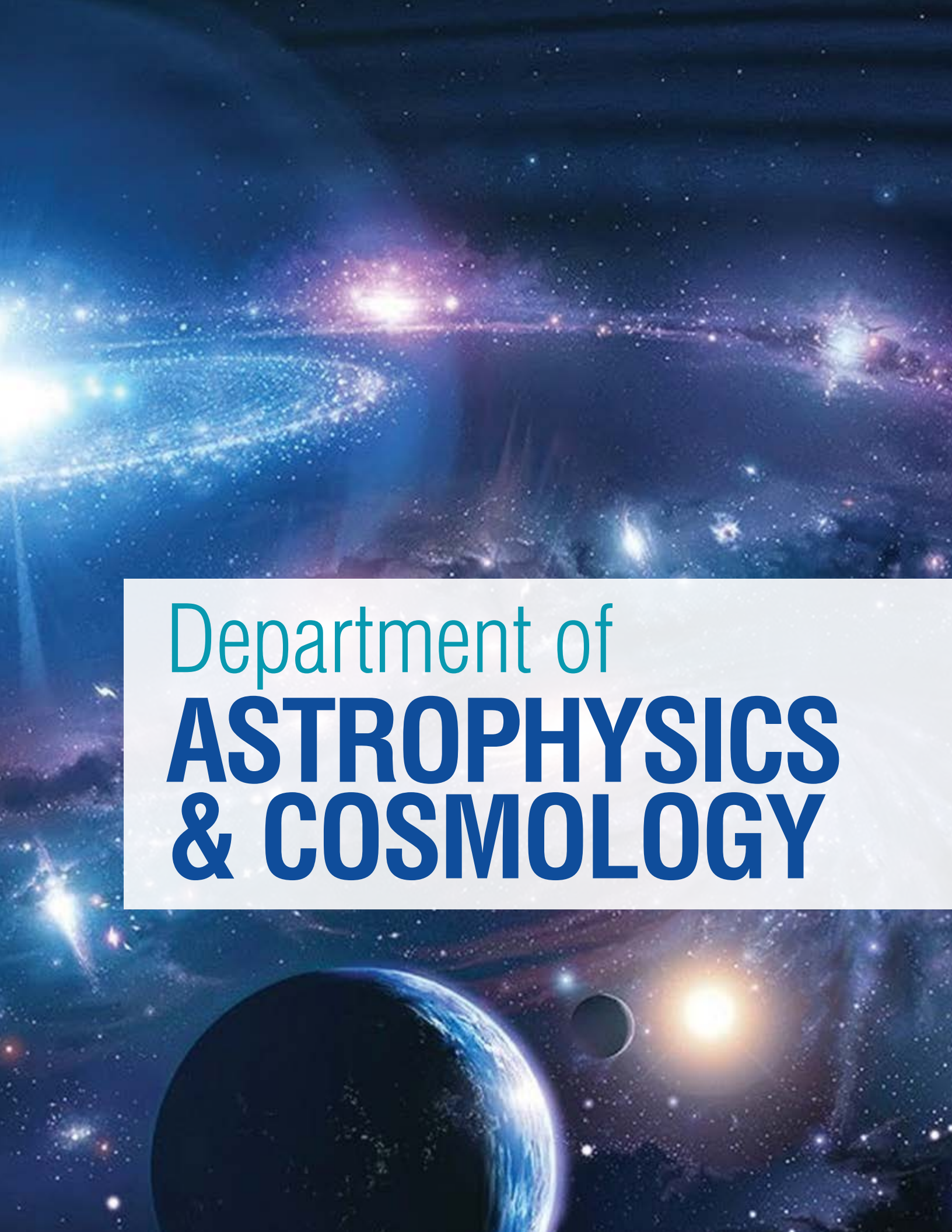
Sukumar Sarkar	Advisor (Administration) [till 30th June 2016]
Sunish Kumar Deb	Advisor (Liaison)
Sujit Kr. Dasgupta	Superintending Engineer
Debashree Bhattacharyya	EVLP Co-ordinator [till 31st March 2017]
Ayan Deb	Assistant Engineer (Electrical)
Sutapa Basu	PS to Registrar
Sadhana Tiwari	Hindi Officer
Abhijit Ghosh	Junior Computer Engineer
Abhijit Roy	Junior Computer Engineer [till 10th March 2017]
Sagar Samrat De	Junior Computer Engineer
Amit Roy	Technical Assistant (Library)
Gurudas Ghosh	Technical Assistant (Library)

Ananya Sarkar	Technical Assistant (Library)
Shakti Nath Das	Technical Assistant
Surajit Mukherjee	Technical Assistant
Urmi Chakraborty	Technical Assistant
Amit Kumar Chanda	Technical Assistant
Joy Bandopadhyay	Technical Assistant [joined on 02.05.2016]
Ganesh Gupta	Junior Engineer (Electrical)
Supriyo Ganguly	Junior Engineer (Electrical)
Amitava Palit	Junior Engineer (Civil)
Lakshmi Chattopadhyay	Junior Engineer (Civil)
Ashis Nandy	Junior Engineer (Civil) [till 17.08.2016]
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)
Babulal Sardar	Technician (AC & Refrigeration) [till 06.10.2016]
Arvind Paswan	Driver
Gobinda Das	Driver
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

PEOPLE AT THE CENTRE



Department of
ASTROPHYSICS & COSMOLOGY

Department of Astrophysics & Cosmology

Sandip Kumar Chakrabarti

Department profile indicators

Table A : Manpower and resources

Number of faculties	4	
Number of Post –doctoral research associate (centre+project)	3	
Number of Ph.D students	23	
Number of other project staff	0	
Number of summer students	1	
Projects (ongoing)	1	

Table B: Research Activities indicators

Number of research papers in Journals	22	
Number of Book-chapters/books	0	
Number of other publications	3	
Number of Ph.D students graduated (submitted+degree awarded)	7	
Number of M.Tech/M.Sc projects	7	

Table C: Academic activities and likeage

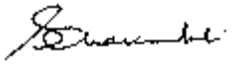
Number of courses taught by faculties	5	
Number of Visitors (non –associates)	0	
Number of associates	0	
Number of Seminars organized	4	
Number of Conference/Symposia/Advanced Schools organized	5	
Number of talks delivered by members of department in conferences/Symposia	National	12
	International	11

Most important research highlights

- Observational constraints on backreaction models in the context of analogous scalar field cosmology
- Optimal violation of Leggett-Garg inequality for arbitrary spin
- Preservation of teleportation fidelity for noisy channels using the technique of weak measurement
- Optical Photometric Variable Stars towards Galactic HiII region NGC 2282
- Phase dependent spectroscopy of a new Mira variable and fundamental parameters of M-giants from optical/IR spectra
- Effects of gravitational bending on the images of a black hole with accretion flows
- Estimation of mass of several stellar mass black holes
- Estimating the size of accretion disks around black holes
- Obtaining solar-soft X-ray spectra from VLF radio signal data from a ground based receiver.

Summary of research activities

- Gravitation & Cosmology: dark energy from various perspectives: We investigate the future evolution of the universe using the Buchert framework for averaged backreaction in the context of a two-domain partition of the universe and show that this approach allows for the possibility of the global acceleration vanishing at a finite future time,
- Quantum Information & Foundations: entanglement, nonlocality and uncertainty relations: We show that the reversal of decoherence phenomenon fails to preserve the quantum secret key rate derived under individual attack. We further show that the technique of weak measurement can be used to slow down the process of decoherence
- Exact time-dependent processes by which viscous matter accretes onto a black hole and emits radiations: We show how a Keplerian disk could be formed from an advective flow by transport of angular momentum by viscosity.
- Study of Ionospheric disturbances caused by various terrestrial and extraterrestrial perturbations: We study how the ionospheric composition changes at a 600km height at the time of solar eclipse using DEMETER satellite data.
- Exploration of near space by low-cost stratospheric balloon borne experiments: We obtained the cosmic ray intensity as a function of height and our combined results for many years show that they are anti-correlated with the solar activities.
- Chemical evolution of the Interstellar clouds: We study the reaction cross-sections of various complex molecules and study the stability of these molecules in the star forming region.
- Observational studies of novae and variable stars: From CCD I-band time series photometry of a young (2-5 Myr) cluster NGC 2282 using 1.3m Devasthal Optical Telescope and 2m Himalayan Chandra Telescope (HCT) we have identified and characterized the variability of Pre-main sequence (PMS) stars.
- Planetary Nebulae.
- Modeling of observed spectra: We completed photoionization modeling of RS Ophiucus. 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}
- Study of Brown dwarfs and low-mass stars in star-forming regions, specifically the variability properties.
- Study of M-Giants and Mira variables: Spectrophotometric studies of low-to-intermediate mass stars represent vital test of theoretical models of stellar evolution, structure, and atmospheres. In stellar evolution, low-to-intermediate main-sequence stars evolve to red giant branch (RGB) through Asymptotic Giant Branch (AGB) before planetary nebulae.



Sandip Kumar Chakrabarti

Head, Department of Astrophysics and Cosmology

Archan Subhra Majumdar

Senior Professor
Astrophysics and 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 fundamental 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.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Poulami Dutta Roy; IIT Kharagpur; An introduction to general theory of relativity and cosmology; Completed.
2. Riddhi Chatterjee; SNBNCBS; Study of general theory of relativity and cosmology; Completed.
3. Ananda Gopal Maity; SNBNCBS; Introduction to dark energy; Completed.
4. Shashank Gupta; SNBNCBS; Quantum Information theory; Completed.
5. Shantonu Mukherjee; SNBNCBS; A brief overview of cosmology; Completed.

Post Doctoral Research Scientists

1. Amna Ali
2. C. Jebaratnam

Teaching activities at the Centre

1. 2nd Semester; Summer project research (PHY 292); IPhD; 2
2. 3rd Semester; Advanced quantum mechanics and applications (PHY 303); IPhD; 7; shared with Biswajit Chakraborty
3. 3rd Semester; Project Research II (PHY 304); IPhD; 1
4. 5th Semester; Project Research Part – I (PHY 591); PhD; 1
5. 5th Semester; Relativity and cosmology (PHY 509); PhD; 3

Publications In journals

1. S. Mal, **A. S. Majumdar,** D. Home; Optimal violation of the Leggett-Garg inequality for arbitrary spin and emergence of classicality through unsharp measurements; Phys. Lett. A; 2016; **380**; 2265.
2. **A. S. Majumdar,** T. Pramanik; Some applications of uncertainty relations in quantum information; Int. J. Quant. Inf.; 2016; **14;** 1640022.
3. A. Ali, **A. S. Majumdar;** Future evolution in a backreaction model and the analogous scalar field cosmology; JCAP; 2017; **01**; 054.
4. S. Datta, S. Goswami, T. Pramanik, **A. S. Majumdar**; Preservation of a lower bound of quantum secret key rate in the presence of decoherence; Phys. Lett. A; 2017; **381**; 897.

Independent publications of students

1. S. Mal, D. Das, D. Home; Quantum mechanical violation of macrorealism for large spin and its robustness against coarse-grained measurements; 2016; Phys. Rev. A; **94**; 062117.
2. D. Adak, Amna Ali; Bounce and collapse in the slotheonic universe; Int. J. Mod. Phys. D; 2017; **26**; 1750089.
3. C. Jebaratnam, S. Aravinda, R. Srikanth; Nonclassicality of local bipartite correlations; 2017; Phys. Rev. A; 2017; **95**; 032120.
4. Sovik Roy, Biplab Ghosh; A revisit to non-maximally entangled mixed states: teleportation witness, noisy channel and discord; Quant. Inf. Process.; 2017; **16;** 108.

Lectures Delivered

1. Effect of backreaction on the future evolution of the accelerating universe; Recent developments in Gravity; Hellenic Society of Relativity, Gravitation and Cosmology; Mikonos, Greece; September; 2016.
2. Witnesses in quantum information theory; S. N. Bose Lecture at "International Conference on applications of mathematics in topological dynamics, physical, biological and chemical sciences"; Calcutta Mathematical Society; December; 2016.
3. Uncertainty relations and their application in quantum information; UGC-DSA-SAP Program; University of Calcutta; February; 2017; 2 lectures.
4. Fine-grained steering inequalities; "Recent trends in quantum theory"; Deptt. Applied Maths.; Univ. Calcutta; March; 2017.
5. Witnesses in quantum information processing; "Physics and Applied Mathematics Researchers Meet"; ISI Kolkata; March; 2017.
6. A backreaction model and the analogous scalar field cosmology; "Recent advances in astrophysics and cosmology"; Physics Department, North Bengal University; Siliguri; March; 2017.

Membership of Committees

Internal Committee

CEWP; FSC

Sponsored Projects

1. Fundamental aspects of quantum theory and quantum information; DST; 2014-2017.

Conference / Symposia / Workshops / Seminars etc. organized

1. Discussion meeting on quantum mechanics; 19.01.2017; SNBNCBS; Convener.

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

National

1. D. Home, Bose Institute, Kolkata (Sl. No. 1)

International

1. T. Pramanik, LTCI, Telecom ParisTech, France (Sl. No. 2)

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

We investigate the future evolution of the universe using the Buchert framework for averaged back reaction in the context of a two-domain partition of the universe. We show that this approach allows for the possibility of the global acceleration vanishing at a finite future time, provided that none of the sub-domains accelerate individually. The model at large scales is analogously described in terms of a homogeneous scalar field emerging with a potential that is fixed and free from phenomenological parametrization. The dynamics of this scalar field is explored in the analogous FLRW cosmology. We 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.

We discuss some applications of various versions of uncertainty relations for both discrete and continuous variables in the context of quantum information theory. The Heisenberg uncertainty relation enables demonstration of the EPR paradox. Entropic uncertainty relations are used to reveal quantum steering for non-Gaussian continuous variable states. Entropic uncertainty relations for discrete variables are studied in the context of quantum memory where fine-graining yields the optimum lower bound of uncertainty. The fine-grained uncertainty relation is used to obtain connections between uncertainty and the nonlocality of retrieval games for bipartite and tipartite systems. The Robertson Schrodinger uncertainty relation is applied for distinguishing pure and mixed states of discrete variables. In the context of temporal correlations of particles with arbitrary spin, we obtain optimal violation of the Leggett-Garg inequality (LGI), improving upon an earlier result [Phys. Rev. Lett. \textbf{99}, 180403 (2007)]. Our proof is accomplished through a suitable adaptation of a measurement scheme, previously employed for studying spatial correlations. We next consider unsharp measurements as a method of coarse graining, and show that LGI can not be violated below a precise value of the sharpness parameter. We then apply Fine's theorem in the context of LGI and derive a sufficient condition for emergence of classicality.

For multilevel spin systems, robustness of the quantum mechanical (QM) violation of macrorealism (MR) with respect to coarse-grained measurements is investigated using three different necessary conditions of MR, namely, the Leggett-Garg inequality (LGI), Wigner's form of the Leggett-Garg inequality (WLGI), and the condition of no-signaling in time (NSIT). It is shown that for dichotomic sharp measurements, in the asymptotic limit of spin, the algebraic maxima of the QM violations of all these three necessary conditions of MR are attained. Importantly, the QM violations of all these persist in that limit even for arbitrary unsharp measurements, i.e., for any nonzero value of the sharpness parameter characterizing the degree of fuzziness of the relevant measurements. The results clearly demonstrate that classicality does not emerge in the asymptotic limit of spin, whatever be the unsharpness and degree of coarse graining of the measurements.

Simulating quantum nonlocality and steering requires augmenting preshared randomness with nonvanishing communication cost. This prompts the question of how one may provide such an operational characterization for the quantumness of correlations due to even unentangled states. We show that for a certain class of states, such quantumness can be pointed out by superlocality, the requirement for a larger dimension of the preshared randomness to simulate the correlations than that of the quantum state that generates them. This provides an approach to define the nonclassicality of local multipartite correlations in convex operational theories.

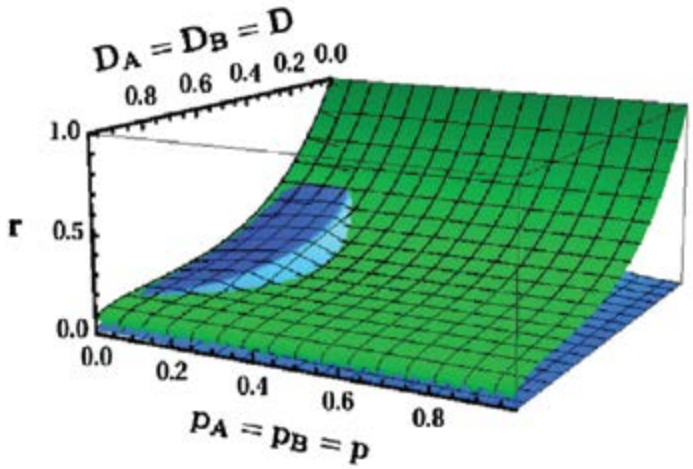
It is well known that the interaction of quantum systems with the environment reduces the inherent quantum correlations. Under special circumstances the effect of decoherence can be reversed, for example, the interaction modelled by an amplitude damping channel can boost the teleportation fidelity from the classical to the quantum region for a bipartite quantum state. Here, we first show that this phenomenon fails to preserve the quantum secret key rate derived under individual attack. We further show that the technique of weak measurement can be used to slow down the process of decoherence, thereby helping to preserve the quantum secret key rate when one or both systems are interacting with the environment via an amplitude damping channel. Most interestingly, in certain cases weak measurement with post-selection where one considers both success and failure of the technique is shown to be more useful than without it when both systems interact with the environment.

Proposed research activities for the coming year

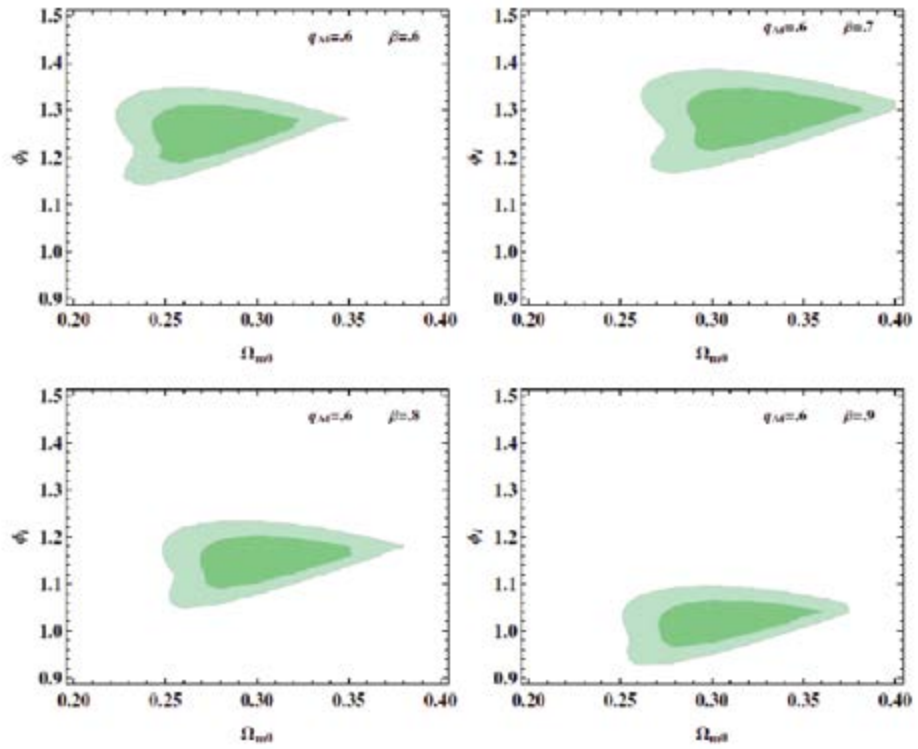
We will investigate the effect of backreaction due to inhomogeneities on the evolution of the present Universe by considering the Universe to be partitioned into multiple domains within the Buchert framework. Taking the observed present acceleration of the universe as an essential input, we will study the effect of inhomogeneities on the future evolution. We will investigate whether the backreaction from inhomogeneities causes the acceleration to slow down in the future for a range of initial configurations and model parameters, and even lead in certain cases to the emergence of a future decelerating epoch. 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.

For a bipartite local quantum correlation, superlocality refers to the requirement of a larger dimension of the random variable in the classical simulation protocol than that of the quantum states that generate the correlations. We will consider the classical simulation of local tripartite correlations in the protocol where one of the parties pre-share a random variable with the other parties who may also share arbitrary randomness in case of fully local correlations or arbitrary nonsignaling boxes in case of partially local correlations. In this context, we define superlocality and super-bi-locality for fully local and partially local tripartite correlations, respectively. A tripartite fully local (partially local) quantum correlation is genuinely superlocal} (genuinely super-bi-local) if it is superlocal (super-bi-local) across all bipartitions. We will present specific examples of genuine superlocality and super-bi-locality for tripartite correlations derived from three-qubit states. It will be argued that genuine quantumness as captured by the notion of genuine discord is necessary for demonstrating genuine superlocality.

It is known that the coherence of the input state is an upper bound of the entanglement generated in the two qubit state by incoherent operations. In general, the coherence of the reduced single qubit output state obtained by partial trace of either of the qubits decreases. We will show that the entanglement of formation is the upper bound of the sum of the coherence in the reduced output state. We will further show that there exists a cloning operation which can be regarded as an incoherent three qubit quantum operation that does not generate an entanglement in the two qubit reduced state when the cloning machine state vector is traced out. We will construct a coherent quantum operation which makes the coherence of the reduced two qubit output state free from input state parameters. We will study the entanglement generated under coherent three qubit quantum operations.



The average of secret key rate, r_{AV} is plotted against the strength of decoherence D_A=D_B=D(x-axis) and the strength of weak measurement PA=PB=P (y-axis). It is seen that the improvement of the average of secret key rate is possible for a range of values of the strength of decoherence and weak measurement.



The 1σ(dark) and 2σ(light) likelihood contours in the (Ω_{m0}, ϕ_i) phase plane for the total $\chi^2_{SN+BAO+CMB}$ for different values of β.

Ramkrishna Das

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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 (co-supervisor, 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. students

1. Ruchi Pandey; SNBNCBS; Photoionization Modeling of nova V1186 Sco; Completed.
2. Robert Wilson Joute; IIT Khargapur; Spectral Classification of Stars; Completed.

Teaching activities at the Centre

1. 3rd Sem (July – Dec, 2016); Advanced Experimental Physics (Astronomy); IPhD; 07

Publications in Journals

1. A. Raj, **R. Das,** F. M. Walter; *Optical and Near-infrared Study of Nova V2676 Oph 2012;* Astrophysical Journal (ApJ); 2017; **835;** 274.

Other Publications

Dutta S., Mondal S., **Das R.,** Joshi S., Jose J., Ghosh S.; "A census of variable stars in the young cluster NGC 2282"; 2016; 41st COSPAR Scientific Assembly, Abstract; 41; 514.

Lectures Delivered

1. Stellar Evolution| SNBNCBS; February; 2017; One.
2. Sky Watching Program (National Science Day); SNBNCBS; Kolkata; February; 2017; One.
3. Sky Watching Program (CK Majumder Memorial Summer Workshop); SNBNCBS; Kolkata; May; 2017; One.

Membership of Committees

Internal Committee

1. 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;
2. Reservation Cell for SCs, STs, Persons With Disabilities and Other Backward Classes;
3. Committee for "Deemed University" status of the centre;
4. Committee for poster preparation;
5. Committee for organizing Bose Fest 2017.

Awards / Recognitions

1. Adjunct faculty in Indian Centre for Space Physics.
2. Invited as reviewer in 'New Astronomy' and 'Research in Astronomy and Astrophysics'.

Sponsored Projects

1. Co-PI of the internal project "Establishment of Astronomical Observing facilities at the Centre and multi-wavelength observations from the National/International telescopes facilities".

Conference / Symposia / Workshops / Seminars etc. organized

1. Member of the organizing committee of Bose Fest 2017 at S N Bose Centre.

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

National

1. A. Raj (Sl. No. 1)

International

1. F. M. Walter (Sl. No. 1)

Significant research output / development during last one year

General research areas and problems worked on

1. Observational studies of novae and variable stars.
2. Planetary Nebulae.
3. Modeling of observed spectra.
4. Telescope project of S N Bose Centre.

Interesting results obtained

During 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.

We completed photoionization modeling of 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 (paper to be submitted soon).

In order to investigate the physical conditions in the nova-shell, we have constructed a comprehensive grid of model atmospheres using the basic parameters spanning over the probable parameter space appropriate for novae, e.g. effective temperatures, luminosities, hydrogen density, inner & outer radii and thickness of the shell. 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 analyzed optical spectrophotometric and near-infrared photometric observations of the nova V2676 Oph. The spectra were dominated by strong H I lines from the Balmer series, Fe II, N I, and [O I] lines in the initial days, typical of a Fe II type nova. The measured FWHM for the Hβ and Hα lines was 800-1200 km s^{-1}. There was pronounced dust formation starting 90 days after the outburst. The J - K color was the largest among recent dust-forming novae (ApJ, 2017, 835, 274)

We are also working on planetary nebulae which have not been studied in details earlier. We already have observed a few of them. Presently, we are analyzing those data and trying to model the spectrum.

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 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.

Sandip Kumar Chakrabarti

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Prof. Sandip Kumar Chakrabarti received PhD Degree from University of Chicago (1985) 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 tubes 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. Victor U J Nwankwo; Satellite drag in presence of solar activities; completed.
9. Dipen Sahu; Astrochemistry in interstellar clouds; completed.
10. Aslam Ali Molla; Determination of mass of black holes from spectral and timining properties; completed.

Post Doctoral Research Scientists

1. Indrani Banerjee

Teaching activities at the Centre

1. 4th Semester; PHY403; IPhD; 5; Dr. S. Mondal
2. 4th Semester; PHY511; PhD; 2; Dr. S. Mondal

Publications in Journals

1. Arka Chatterjee, **Sandip K. Chakrabarti**, Himadri Ghosh; *Images and spectral properties of two-component advective flows around black holes: effects of photon bending;* MNRAS; 2017; **465**; 3902.
2. Milan Sil, Prasanta Gorai, Ankan Das, Dipen Sahu, **Sandip K. Chakrabarti;** *Adsorption energies of H and H2: a quantum-chemical study*; EPJD; 2017; **71**; 45.
3. Prasanta Gorai, Ankan Das, Amaresh Das, Bhalamurugan Sivaraman, Emmanuel E. Etim, **Sandip K. Chakrabarti;** *A Search for Interstellar Monohydric Thiols;* ApJ; 2017; **836;** 70.
4. Aslam Ali Molla, **Sandip K. Chakrabarti,** Dipak Debnath, Santanu Mondal; *Estimation of Mass of Compact Object in H 1743-322 from 2010 and 2011 Outbursts using TCAF Solution and Spectral Index-QPO Frequency Correlation*; ApJ; 2017; **834;** 88.
5. Emmanuel E. Etim, Prasanta Gorai, Ankan Das, **Sandip K. Chakrabarti,** Elangannan Arunan; *Systematic Theoretical Study on the Interstellar Carbon Chain Molecules*; ApJ; 2016; **832**; 144.
6. Arnab Deb, Kinsuk Giri, **Sandip K. Chakrabarti;** *Numerical simulation of vertical oscillations in an axisymmetric thick accretion flow around a black hole;* MNRAS; 2016; **462;** 3502.
7. Shreeram Nagarkoti, **Sandip K. Chakrabarti;** *Viscosity parameter in dissipative accretion flows with mass outflow around black holes;* MNRAS; 2016; **462;** 850.
8. Broja G. Dutta, **Sandip K. Chakrabarti;** *Temporal Variability from the Two-Component Advective Flow Solution and Its Observational Evidence;* ApJ; 2016; **828;** 101.
9. A. Ghosh, **Sandip K. Chakrabarti**; *Smearing of mass accretion rate variation by viscous processes in accretion disks in compact binary systems;* Ap&SS; 2016; **361;** 310.
10. Santanu Mondal, **Sandip K. Chakrabarti,** Dipak Debnath; *Spectral study of GX 339-4 with TCAF using Swift and NuSTAR observation*; Ap&SS; 2016; **361**; 309.

11. Aslam Ali Molla, Dipak Debnath, **Sandip K. Chakrabarti,** S. Mondal, A. Jana; *Estimation of the mass of the black hole candidate MAXI J1659-152 using TCAF and POS models;* MNRAS; 2016; **460;** 3163.
12. Debjit Chatterjee, Dipak Debnath, **Sandip K. Chakrabarti,** Santanu Mondal, Arghajit Jana; *Accretion Flow Properties of MAXI J1543-564 during 2011 Outburst from the TCAF Solution*; ApJ; 2016; **827**; 88.
13. S. Palit, S. Ray, **S. K. Chakrabarti;** *Inverse problem in ionospheric science: prediction of solar soft-X-ray spectrum from very low frequency radiosonde results;* Ap&SS; 2016; **361;** 151.

Other Publications

1. D. Debnath, S. K. Chakrabarti, A. Jana, D. Chatterjee, A. A. Molla and S. Mondal; Accretion Flow Properties of three MAXI Black Hole Candidates: Analysis with the TCAF Solution; Proceeding of 7 years of MAXI: monitoring X-ray transients; 2017; 81; Eds. M. Serino, M. Shidatshu, W. Iwakiri, T. Mihara.
2. A. Jana, D. Debnath, S. K. Chakrabarti, D. Chatterjee, A. A. Molla and S. Mondal; Inflow-Outflow Properties of Accretion Disk around MAXI J1836-194 with TCAF Solution during its 2011 Outburst; Proceeding of 7 years of MAXI: monitoring X-ray transients; 2017; 87; Eds. M. Serino, M. Shidatshu, W. Iwakiri, T. Mihara.

Lectures Delivered

1. Black Holes and the Universe at the Golden Jubilee celebration meeting of LLSM Institution, Malda (July, 2016)
2. Food Habits of Black Holes, an Astronomy department seminar at the University of Durban, South Africa (Sept, 2016) and at the University of Cape Town, South Africa (Sept., 2016)
3. Chemical Evolution of the Universe since Big Bang and the Origin of Life, public lectures at the University of Durban and University of Cape Town (Sept. 2016)
4. Accretion processes in Astrophysics: A six-hour seminar series at the Astronomy Department of the University of Cape Town (Sept. 2016)
5. "Earth as a gigantic detector: Using VLF signals to recreate spectrum of injected radiation on earth'" and "Observations of long term VLF propagation effects from Antarctic Stations at Maitri and Bharati of India" oral presentations at the VERSIM conference at Harmanus, South Africa (Sept. 2016)
6. "Mysterious Black Holes" a public lecture at Malda College Ground (January, 2017)
7. "Excitements in Astronomy, Astrophysics and Space Research" at RKMR College (Auton.), Narendrapur (January, 2017)
8. Inaugural talk on "Accretion processes on black holes becomes Science" at the 'Wide Band Spectral and Timing Studies of Cosmic X-ray Sources' conference at TIFR (January, 2017)
9. Inaugural talk on "X-ray Studies of Compact objects: theory and observational support" at the satellite workshop of Astronomical Society of India meeting, Jaipur (March, 2017)

Membership of Committees

External Committee

Member, Board of Studies, Dept. Of Atmospheric Science (Calcutta University); Member, Board of Research Studies, University of Gour Banga; Member NAAC team for evaluation of TIFR and GMRT; In Charge and Secretary of Governing Body, Indian Centre for Space Physics

Internal Committee

Consultative Administrative Committee of SNBNCBS; Head of the Department, Astrophysics and Cosmology; Member, SCREC and APMP committees

Conference / Symposia / Workshops / Seminars etc. organized

1. Deputy Organizer of C0.3 Ionospheric Disturbances Observed through very low frequency Radio Waves for the Committee for Space Research (COSPAR) in 2016
2. Deputy Organizer of PSB.1 Scientific Ballooning: Recent Development in Technology and Instrumentation for the Committee for Space Research (COSPAR) in 2016
3. Main Organizer of E1.6 Black Hole Astrophysics: Observational Evidence of Theoretical Models for the Committee for Space Research (COSPAR) in 2016
4. Deputy Organizer of F3.1 Astrochemistry, Astrobiology, and the Formation of Life in the Universe for the Committee for Space Research (COSPAR) in 2016

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

National

1. Intense collaboration with Indian Centre for Space Physics, a Sister Institute of Calcutta University in fields of balloon borne science, black hole data analysis, Astrochemistry and ionospheric science.

International

1. Numerical Simulations of flow dynamics in Kerr Geometry: collaboration with University of Notre Dame, USA.

Member of Editorial Board

1. Indian Journal of Physics

Significant research output / development during last one year

General research areas and problems worked on

(a) Exact processes by which matter accretes onto a black hole and emits radiations. (b) Study of Ionospheric disturbances caused by various terrestrial and extraterrestrial perturbations. (c) Exploration of near space by low-cost stratospheric balloon borne experiments. (d) Chemical evolution of the Interstellar clouds.

Interesting results obtained

Black Hole accretion is a complex process, so is the mechanism of emission of radiations. My work has been to theoretically predict the thermodynamic conditions and then compute the spectral and temporal properties of accretion. Furthermore I compare these results with satellite observations. Sophisticated fitting process require only four physical parameters as opposed to 6-10 parameters used by other solutions. Furthermore I also estimate the mass of black holes. Numerical simulations of hydrodynamics coupled with Monte-Carlo simulations, photon bending effects etc. have also been carried out.

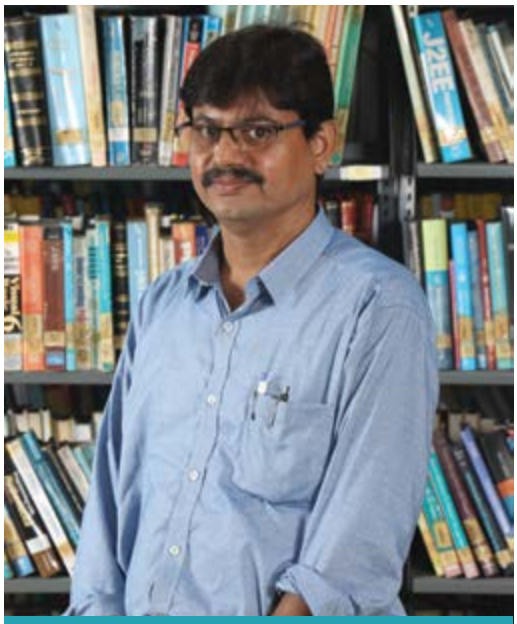
In another work I compute the effects of various types of perturbations, such as the solar flares, solar eclipses, magnetic perturbations, earthquakes, gamma ray bursts etc. on the very low frequency radio signal received from a transmitter. In one work we have been able to show the effects of ice melting (affecting reflection coefficient) on the signal behaviour.

In Astrochemistry, major challenge is to produce very complex biomolecules in very tenuous, frigid conditions of interstellar molecules. To this effect we have computed various reaction cross-sections to obtain yields of chemical reactions which take place in interstellar medium and determined the line intensities from these radiations. These would provide the guidance to ALMA users to search for various molecules.

Exploration of near space (~ 42km) using low cost method has been started under my leadership at Indian Centre for Space Physics. So far, 100 missions have been completed and many exciting results including bahaviour of cosmic rays at various heights, X-rays from compact objects, solar flares etc. have been understood. We are also able to determine the dose of radiation that a regular air-traveller receives when there are solar flares. This is useful to estimate radiation hazards in commercial flights.

Proposed research activities for the coming year

The work on radiation emitted from accreting matter is to be expanded in presence of magnetic fields and also for systems containing neutron stars. Networking is being done to obtain VLF data from many stations simultaneously to predict exact location of earthquake from radio signal anomaly. Efforts are being made to use the weather data of our balloon missions for long term weather predictions.



Soumen Mondal

Associate Professor
Astrophysics and Cosmology
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Dr. Soumen Mondal received his Ph.D. degree from Physical Research Laboratory (PRL), Ahmedabad 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" registered at CU expected to submit thesis by August 2017.
2. Supriyo Ghosh (5th yr.) - "Study of cool and evolved stars" registered at CU, expected to submit thesis by 2017.
3. Anindita Mondal (5th year, jointly RK Das) - "Multi-wavelength studies of Novae",registered at CU, expected to submit thesis by 2017.
4. Samrat Ghosh (3rd yr.)- "A search for Photometric Variability in Young/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. students

1. Koyel De – M.Sc(Physics) – Jadavpur University -2016 Summer project.

Teaching activities at the Centre

1. PHY-403 – Astrophysics and Astronomy Elective part (4th Sem) with SKC; PHY-511 – Astrophysics PhD course work with SKC; 3. PHY-191 – Basic Laboratory 1 optics part with AKR.

Other Publications

1. Dutta, Somanth, Mondal, Soumen, Das, Ramkrishna et al. "A census of variable stars in the young cluster NGC 2282", 41st Cospar Assembly Abstract.

Lectures Delivered

1. "Understanding of variability properties in very low mass stars (VLMs) and Brown dwarfs" at 1st BINA International workshop held in Nainital, 15 – 18 Nov 2016.
2. "Understanding of Rapid Rotation in Very Low Mass stars (VLMs) and Brown Dwarfs" at Star and Planet Formation: Insights and Intricacies, held at IIST, Trivandram, 5-7 Dec 2016.

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.

Sponsored Projects

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

Significant research output / development during last one year

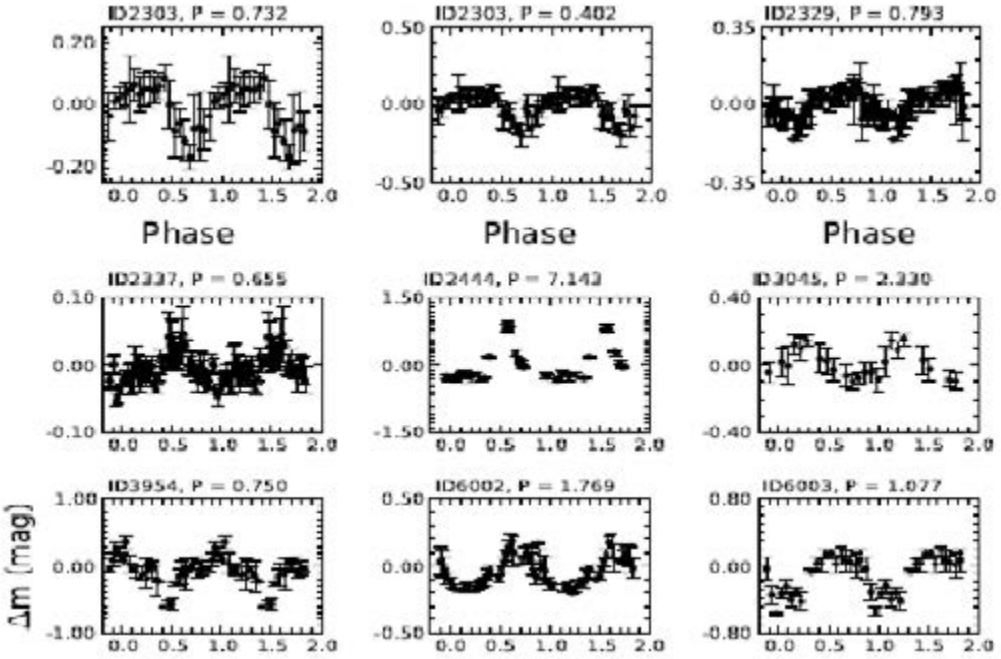
General research areas and problems worked on

- 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

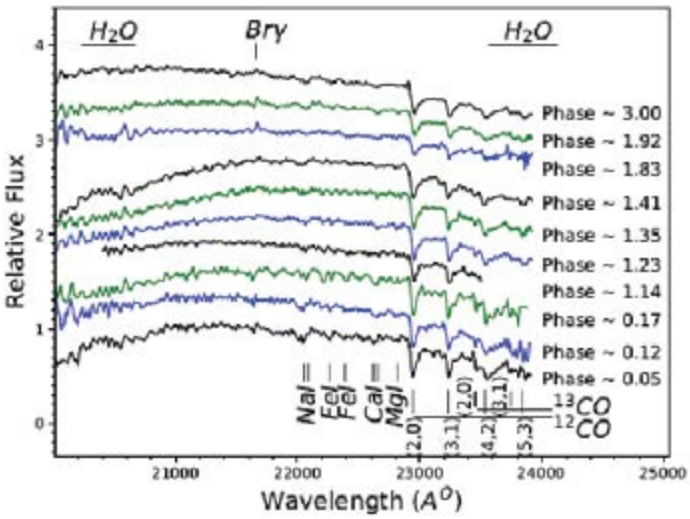
1. Optical Photometric Variable Stars towards Galactic Hill region NGC 2282

From CCD I-band time series photometry of a young (2-5 Myr) cluster NGC 2282 using 1.3m Devasthal Optical Telescope and 2m Himalayan Chandra Telescope (HCT) we have identified and characterized the variability of Pre-main sequence (PMS) stars. The deep I-band photometry, down to ~20.5 mag, enables us to probe variability towards low-mass end of PMS stars. From the light curves of 1627 stars, we have identified 63 new photometric variable candidates. Their association with the region were established from Halpha emission and infrared excess using JHK UKIRT and mid-IR Spitzer data. Out of 63 variables, 47 are periodic variables, and show the rotation rate from 0.2 to 7 days. Period distribution shows peak around ~1.5 days as seen in other young clusters (e.g. NGC~2264, Orion etc.), but it shows uni-modal distribution unlike others few young clusters having bi-modal distribution with slow rotators peaking at 6- 8 days. Slow rotation due to disk-locking are lacking here. To understand correlation between disk and rotation periods, we have checked infrared excess, mass and age of individual periodic member candidates, we do not have any conclusive evidence on such analyses. Below figure, the light curves of few new young variables are shown. (Dutta et al. 2015; 2017)



2. Phase dependent spectroscopy of a new Mira variable and fundamental parameters of M-giants from optical/IR spectra

We have discovered a new Mira variable from MASTER Optical Transient (OT) alert on J212444.87+321738.3 (J2124+32) toward the Cygnus. We have performed long-term optical/near-IR photometric and spectroscopic observations to characterize that object. From optical light curves, we find that the object has a variability period of about 465 days with amplitude exceeding, I ~ 4 mag in I-band,, which is nature of pulsating Mira variable. The Near-IR variability amplitudes are seen in J ~ 2.2, H ~1.9 and K ~1.5 mag respectively with similar optical period but have a phase lag of ~ 60 days as seen in Miras. Our optical/near-IR spectra shows molecular features of TiO, VO, CO overtone and water bands, which is a signature of typical cool M-type stars. The Optical/NIR spectra indicates the likely O-rich nature. All these observations confirm that the source is a new O-rich Mira variable. Near-IR spectra of Mira variable J2124+32 is shown here taken TIRSPEC instrument on HCT telescope (Ghosh et al. 2017A; 2017b).



Proposed research activities for the coming year

1. Astronomical Observing facilities of S. N. Bose Centre

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. 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. Our project is of relatively low-cost and will focus on a few primary science programs. Scientific motivations for our telescope 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, 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.

(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 with Planewave optical tube assembly (OTA) on German equatorial mount from paramount ME-II. The 8 inch telescope are used to train the students, e.g., IPhD students, project students and public outreach programs. The 14 inch telescope will be used for scientific observations of bright objects and seeing measurement at the new site.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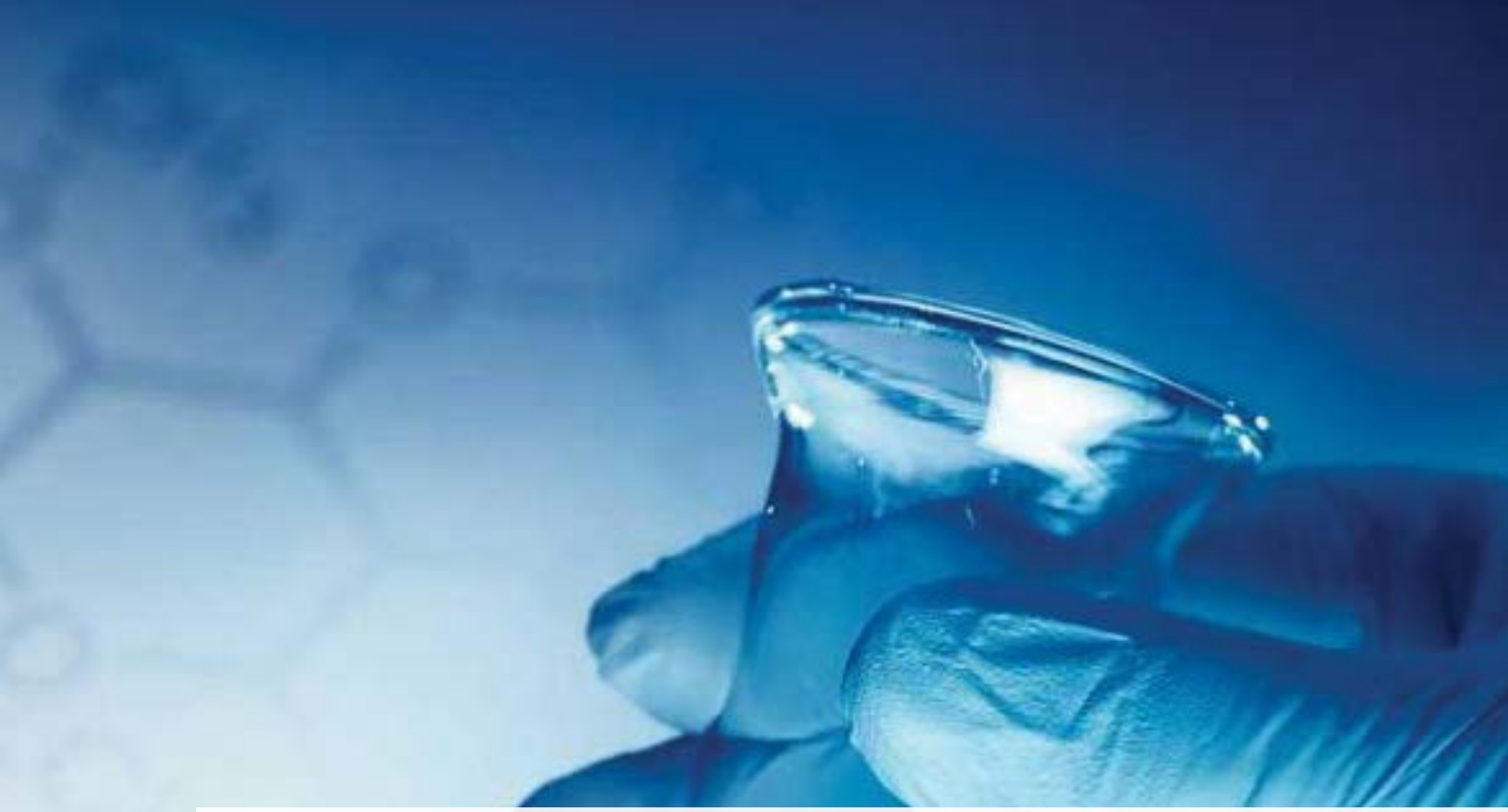


Department of
CHEMICAL, BIOLOGICAL & MACRO-MOLECULAR SCIENCES

Department of Chemical, Biological & Macro-Molecular Sciences

Ranjit Biswas

Department profile indicators

Table A : Manpower and resources

Number of faculties	6+1
Number of Post –doctoral research associate (centre+project)	4
Number of Ph.D students	43
Number of other project staff	2
Number of summer students	2
Projects (ongoing)	17

Table B: Research Activities indicators

Number of research papers in Journals	52
Number of Book-chapters/books	0
Number of other publications	2
Number of Ph.D students graduated (submitted+degree awarded)	17
Number of M.Tech/M.Sc projects	2

Table C: Academic activities and linkage

Number of courses taught by faculties	8	
Number of Visitors (non –associates)	0	
Number of associates	0	
Number of Seminars organized	20	
Number of Conference/Symposia/Advanced Schools organized	0	
Number of talks delivered by members of department in conferences/Symposia	National	14
	International	7

Most important research highlights

- Inactivation pathway of sodium ion channel studied
- Isochronicity for different chemical oscillators studied
- Responses in driven systems studied
- Spatio-temporal correlations among functional protein residues explored
- High resolution laser spectroscopic system and protocol established for tracer gas detection
- Human breath analyses for non-invasive disease detection established
- Hydrophobic hydration by THz spectroscopy investigated
- New material characterization done via THz spectroscopy
- Ultrafast dynamics of materials and nano-bio interactions explored
- Structure and dynamics of deep eutectics studied
- Biomedical instruments for non-invasive medical diagnosis developed
- New nanomaterials, intermetalics, etc. synthesized, and their interactions studied.

Summary of research activities

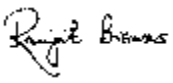
Our research has revealed that oxygen-18 (^{18}O) in human breath CO_2 regulated by the carbonic anhydrase (CA) activity is a potential diagnostic biomarker that can selectively and precisely distinguish type 1 and type 2 diabetes patients. Studies on patients in collaboration with appropriate medical practitioners have led to development of methodology for this non-invasive diagnosis for large scale application. We have also developed a high-resolution cw-CRDS system coupled with an external-cavity quantum cascade laser (EC-QCL) for real-time detection of several trace molecular species such as nitric oxide (NO), nitrous oxide (N_2O), carbonyl sulphide (OCS) and acetylene (C_2H_2) from parts-per-billion (ppb) to parts-per-trillion (ppt) levels. Quest for biomedical application has led to development of an integrated yet low-cost device that can simultaneously detect anemia, jaundice and oxygen deficiency in a given human body.

Ultrafast femtosecond measurements have opened up possibilities for choosing an appropriate material either for solar energy harvesting or for use as a drug delivery vehicle. Terahertz measurements performed in the department have made significant contribution to the understanding of DNA hydration and impact on it of electrolyte or urea. Self-aggregated systems have been studied to find out the possibilities for using them as transporter of chemicals with biological importance. Picosecond resolved measurements shed light on the inherent timescales of molecular movements in systems that are molten mixtures at room temperatures. The structure of these systems, which are known as deep eutectic solvent systems, has been found to be micro-heterogeneous. An attempt has been made to connect medium heterogeneity to bio-protection of tissues in cryoprotectant systems.

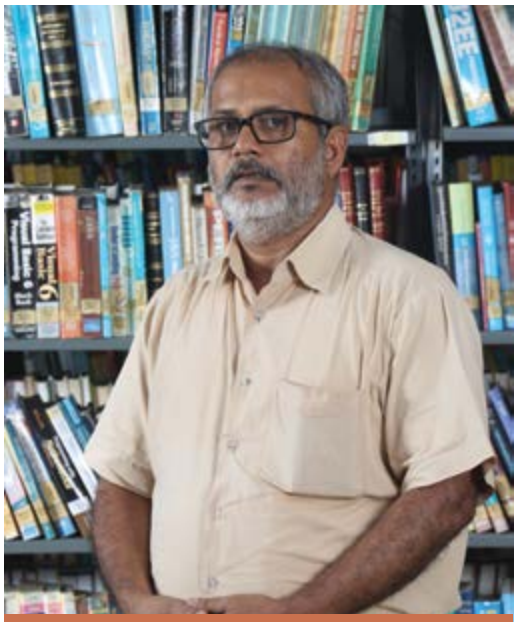
An attempt has been initiated to understand the interplay between structure and dynamics in non-equilibrium steady-state by tracking Brownian Dynamics trajectories of particles in a binary colloid of opposite charges in an external electric field. The length scale of structural correlations in such systems has been found to control the heterogeneity in diffusion and consequent anomalous dynamic responses, like the exponential tail in probability distributions of particle displacements and stretched exponential structural relaxation. The microscopic basis of communication among the functional sites in bio-macromolecules is a fundamental challenge in uncovering their functions. This communication has been explored through temporal cross-correlation among the binding site via Molecular Dynamics simulations of the temporal cross-correlation between the dihedrals of a small protein, ubiquitin which participates in protein degradation in eukaryotes. The existence of path for temporally correlated degrees of freedom among the functional residues is stressed. The qualitative features of the cross-correlations through a general mathematical model have been revealed. The generality of this analysis suggests that temporal cross-correlation functions may provide convenient theoretical framework to understand bio-molecular functions on microscopic basis.

Inactivation path of voltage gated sodium ion channel has been studied under various voltage protocols as it is the main governing factor for the periodic occurrence and shape of the action potential.The kinetic flux as well as energetic contribution of the closed and open- state inactivation path is compared here for voltage protocols, namely constant, pulsed and oscillating. It is shown that an efficient CSI and OSI dynamical profile in principle can characterize the open-state drug blocking phenomena. Chemical oscillation is an interesting nonlinear dynamical phenomenon which arises due to complex stability condition of the steady state of a reaction far away from equilibrium which is usually characterised by a periodic attractor or a limit cycle around an interior stationary point. In conjunction with the property of limit cycle oscillation, our research has shown the condition for isochronicity for different chemical oscillators with the help of renormalization group method.

Our research has demonstrated the use of inner lumen of clay nanotubes as nanoconfined reactor for the synthesis of nanoscale inorganic materials. Selective modification of the lumen using a chelating ligand facilitates the adsorption of iron and subsequently formation of nanoscale iron oxide within the lumen of the clay nanotubes. Halloysite nanotubes (HNTs) with immobilized silver (Ag) nanoparticles (NPs) were prepared by methods of wet chemistry and were characterized by using the transmission electron microscopy, x-ray diffraction, optical spectroscopy and experiments with *E. coli* bacteria *in-vitro*. It was found that Ag NPs with almost perfect crystalline structure and sizes from ~ 9 nm were mainly attached over the external surface of HNTs. The optical absorption measurement revealed a broad plasmonic resonance in the region of 400-600 nm for HNTs with Ag NPs.



Ranjit Biswas
Head, Department of Chemical, Biological and Macromolecular Sciences



Gautam Gangopadhyay

Professor
CBMS
gautam@bose.res.in

Prof. Gautam Gangopadhyay is working in the broad area of Chemical Physics. It includes statistical mechanical modeling 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 (to be submitted).
2. Sandip Saha; Nonlinear dynamical studies on Isochronous oscillators in Chemistry and Biology; Ongoing (2015-).

Teaching activities at the Centre

1. Chemical Physics; PHY-404 for Int. PhD students.

Publications in Journals

1. Krishnendu Pal, **Gautam Gangopadhyay;** *Dynamical characterization of inactivation path in voltage-gated Na+ ion channel by non-equilibrium response spectroscopy; Channels;* 2016; **10** (6); 478-497.
2. Krishnendu Pal, Biswajit Das and **Gautam Gangopadhyay;** *Nonequilibrium response of a voltage gated sodium ion channel and biophysical characterization of dynamic hysteresis;* J.Theor. Bio.; 2017; **415;** 113-124.
3. Sandip Saha and **Gautam Gangopadhyay;** *Isochronicity and limit cycle oscillation in chemical systems;* J. Math. Chem.; 2017; **55** (3); 887-910.

Lectures Delivered

1. An Introduction to Nonequilibrium processes at C. K. MAJUMDAR MEMORIAL SUMMER WORKSHOP IN PHYSICS 2016; SNBNCBS; 20.06.2016; One.

Membership of Committees

External Committee

Theoretical Chemistry Symposium-2016, member of National Advisory Committee.

Internal Committee

Member SCRE, EVLP, Patent and Project Cell.

Fellow / Member of Professional Body

1. Life Member of IACS

Conference / Symposia / Workshops / Seminars etc. organized

1. Member National advisory committee; 15th Indian Theoretical Chemistry Symposium; 14-17 December; Hyderabad; Session Chairman.

Significant research output / development during last one year

General research areas and problems worked on

We have done a series of works on sodium and potassium ion channels. 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 the nonequilibrium response of a voltage gated sodium ion channel and biophysical characterization of dynamic hysteresis. In a different context we have found the condition of Isochronicity and limit cycle oscillation in several biochemical system.

Interesting results obtained

Inactivation path of voltage gated sodium ion channel has been studied here under various voltage protocols as it is the main governing factor for the periodic occurrence and shape of the action potential. In contrast to a lot of effort in finding the crystal structure based molecular mechanism of closed-state(CSI) and open-state inactivation(OSI) here our approach is to understand inactivation process through dynamical characterization. The kinetic flux as well as energetic contribution of the closed and open- state inactivation path is compared here for voltage protocols, namely constant, pulsed and oscillating. It is shown that an efficient CSI and OSI dynamical profile in principle can characterize the open-state drug blocking phenomena.

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 frequency and amplitude but it also depends sensitively on the mean of the oscillating voltage and here we have shown how the system optimize the dynamic memory itself in the biophysical range of field parameters.

Chemical oscillation is an interesting nonlinear dynamical phenomenon which arises due to complex stability condition of the steady state of a reaction far away from equilibrium which is usually characterised by a periodic attractor or a limit cycle around an interior stationary point. In conjunction with the property of limit cycle oscillation, here we have shown the condition for isochronicity for different chemical oscillators with the help of renormalisation group method.

Proposed research activities for the coming year

1. Role of Patch Size in Synchronization and Metabolic Energy Consumption in Coupled Neurons which is a first step to signal transduction and the effect on synchronization due to Drug Blocking of Sodium and Potassium Channels.
2. Staring from the microscopic study of the Effect of single Sodium And Potassium channels due to drug blocking we have estimated the macroscopic effect on Action Potential.

Any other matter

1. Vigilance Officer of the Centre from Dec'2014.

Jaydeb Chakrabarti

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

Supervision of Research / Students

Ph.D. Students

1. Samapan Sikdar; 'Microiscopic description of protein-ligand and protein-protein interaction (completed)
2. Suman Dutta (ongoing)
3. Sutapa Dutta (ongoing)
4. Arunava Adhikary (ongoing)
5. Piya Patra (external, ongoing)

Post Doctoral Research Scientists

1. Manas Mandal
2. Lakshmi Maganti

Teaching activities at the Centre

1. Phy 201: Basic Statistical Mechanics

Publications in Journals

1. Paramita Saha, Samapan Sikdar, Camelia Manna, **Jaydeb Chakrabarti** and Mahua Ghosh; *SDS induced dissociation of STY3178 oligomer: experimental and molecular dynamics studies;* RSC advances; 2017; **7**; 6209-6214.
2. Sutapa Dutta, Mahua Ghosh and **J. Chakrabarti;** *Spatio-temporal coordination among functional residues in protein*; Sci Rep.; 2017; **7**; 40439; doi:10.1038/srep40439.
3. Paramita Saha, Samapan Sikdar, **Jaydeb Chakrabarti** and Mahua Ghosh; *Response to chemical induced changes and their implication in yfdX proteins;* RSC advances; 2016; **6;** 91256-91264.
4. P. Saha, C. Manna, **Jaydeb Chakrabarti** and Mahua Ghosh; *Reversible thermal unfolding of a yfdX protein with chaperone-like activity*; Sci Rep.; 2016, **6**; 29541; doi:10.1038/srep29541.
5. S Sikdar, M Ghosh, M De Raychaudhury and **J Chakrabarti;** *Quantum chemical studies on nucleophilic sites in calcium ion bound Zwitterionic calmodulin loops*, RSC. Adv.; 2016; **6**; 54608-54614.
6. S. Dutta and **J. Chakrabarti;** *Anomalous dynamical responses in a driven system;* Europhys. Lett.; 2016; **116**; 38001.
7. B. Ash, **J. Chakrabarti** and A. Ghosal; *Spatio-temporal correlations in Coulomb clusters;* Europhys. Lett; 2016; **114;** 46001.

Lectures Delivered

1. Presented Poster by Sutapa Dutta in "Statphys Kolkata IX" at SINP, Kolkata during December, 2016.
2. Presented Poster by Sutapa Dutta in International Conference on "Advances in Biological System and Material Science in NanoWorld" at IIT BHU, during February 2017.
3. Oral presentation by Sutapa Dutta in "Mini Conference on Statistical Physics" at University of Calcutta during March, 2017.
4. Oral presentation by Sutapa Dutta in Bose Fest organized by SNBNCBS, March 2017.
5. C. K. Majumdar Summer workshop, May 2016, two lectures.

Sponsored Projects

1. Microscopic calculations of metal ion binding to proteins, DST, 2013-2016.

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

National

1. 2 (Sl. No. 5 and 7)

Significant research output / development during last one year

General research areas and problems worked on

- Statistical mechanics of soft matter systems
- Computational physics of bio-molecular systems

Interesting results obtained

1. **Anomalous Dynamical Responses in a Driven System**

   The interplay between structure and dynamics in non-equilibrium steady-state is far from understood. We address this issue by tracking Brownian Dynamics trajectories of particles in a binary colloid of opposite charges in an external electric field. The particles show cross-over from homogeneous to lane state, a prototype of heterogeneous structure formation in non-equilibrium systems. We show that the length scale of structural correlations controls heterogeneity in diffusion and consequent anomalous dynamic responses, like the exponential tail in probability distributions of particle displacements and stretched exponential structural relaxation. We generalize our observations using equations for steady state density which may help to understand microscopic basis of heterogeneous diffusion in condensed matter systems.

2. **Spatio-temporal correlations among functional residues of protein**

   The microscopic basis of communication among the functional sites in bio-macromolecules is a fundamental challenge in uncovering their functions. We study the communication through temporal cross-correlation among the binding sites. We illustrate via Molecular Dynamics simulations the properties of the temporal cross-correlation between the dihedrals of a small protein, ubiquitin which participates in protein degradation in eukaryotes. We show that the dihedral angles of the residues possess non-trivial temporal cross-correlations with asymmetry with respect to exchange of the dihedrals, having peaks at low frequencies with time scales in nano-seconds and an algebraic tail with a universal exponent for large frequencies. We show the existence of path for temporally correlated degrees of freedom among the functional residues. We explain the qualitative features of the cross-correlations through a general mathematical model. The generality of our analysis suggests that temporal cross-correlation functions may provide convenient theoretical framework to understand bio-molecular functions on microscopic basis.

Proposed research activities for the coming year

The primary focus of my research would be as follows:

a) **Kinetics of bio-molecular processes:** We shall look into coarse-grained model of proteins to calculate factors affecting rates of folding of proteins into native structures and that of aggregation of misfolded proteins. Such calculations would be based on Brownian dynamics simulations. These results are expected to throw lights on energy landscapes governing folding and aggregation in systems having large number of degrees of freedom.

b) **Microscopic theory of aggregation in driven systems:** Recent experiments suggest that thermo-phoretic motion of nanometer sized particles often drive their aggregation. We shall try to understand the mechanism of such cluster formation through Brownian Dynamics simulations and mean field calculations.

c) **Microscopic description of metal ion coordination to proteins:** This project involves ab-initio simulation of metal ion and peptide fragments. The main objective is to understand how ion induced polarization affect the stability of peptides in an aqueous medium.

Manik Pradhan

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Dr. Pradhan received his PhD from the University of Bristol, UK (2008), having been awarded a prestigious Dorothy Hodgkin Fellowship. He did his postdoctoral works at University of Cambridge, UK (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 and Associate Nodal Officers of the Technical Research Centre (TRC) at S. N. Bose Centre.

Supervision of Research / Students

Ph.D. Students

1. Gourab Dutta Banik
2. Abhijit Maity
3. Suman Som
4. Chiranjit Ghosh
5. Mithun Pal
6. Sanchi Maithani
7. Santanu Mandal
8. Akash Das
9. Sasthi Charan Mandal
10. Ikbal Ahmed

Teaching activities at the Centre

1. PHY 391 (METHODS OF EXPERIMENTAL PHYSICS) (shared)

Publications in Journals

1. G. Dutta Banik, S. Som, A. Maity, M. Pal, S. Maithani, S. Mandal, **M. Pradhan;** *An EC-QCL based N_2O sensor at 5.2 μm using cavity ring-down spectroscopy for environmental applications;* Analytical Methods; 2017; **9;** 2315.
2. A. Maity, M. Pal, S. Som, S. Maithani, S. Chaudhuri, **M. Pradhan;** *Natural ^{18}O and ^{13}C-urea in gastric juice: a new route for non-invasive detection of ulcer;* Anal. and Bioanal. Chem.; 2017; **409**(1); 193-200.
3. C. Ghosh, S. Mandal, G. D Banik, A. Maity, P. Mukhopadhyay, S. Ghosh, **M. Pradhan;** *Targeting erythrocyte carbonic anhydrase and ^{18}O-isotope of breath CO_2 for sorting out type 1 and type 2 diabetes;* Scientific Reports (Nature Publishing Groups); 2016; **6;** 35836.
4. A. Maity, M. Pal, S. Maithani, B. Ghosh, S. Chaudhuri, **M. Pradhan;** *Molecular hydrogen in human breath: a new strategy for selectively diagnosing peptic ulcer disease, non-ulcerous dyspepsia and Helicobacter pylori infection;* J. Breath. Res.; 2016; **10;** 036007.
5. G. D. Banik, A. De, S. Som, S. Jana, S. B. Daschakraborty, S. Chaudhuri and **M. Pradhan;** *Hydrogen sulphide in exhaled breath: a potential biomarker for small intestinal bacterial overgrowth in IBS;* J. Breath. Res.; 2016; **10;** 026010.
6. A. De, G. Banik, A. Maity, M. Pal and **M. Pradhan;** *Continuous wave external-cavity quantum cascade laser-based high-resolution cavity ring-down spectrometer for ultrasensitive trace gas detection;* Optics Letters; 2016; **41**(9); 1949.

Lectures Delivered

1. Invited Speaker: International Conference on Perspectives in Vibrational Spectroscopy; ICOPVS 2016; Lucknow, India.

Patent/s submitted / granted

1. **File No:** 201631038296; **Title on the invention:** "Dioxo vanadium (V) complex as carbonic anhydrase inhibitor".

Awards / Recognitions

1. WIDF-Innovation Award by World India Diabetes Foundation (WIDF), USA: (2017)

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) Department of Biotechnology (DBT), RGYI Scheme: 2013-2016

Title: "Cavity Ring-Down Spectroscopy for Real-Time Breath Analysis: a Next-Generation Diagnostics in Modern Medicine".

(3) 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"

(4) 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".

Member of Editorial Board

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

Significant research output / development during last one year

General research areas and problems worked on

- Cavity Ring-Down Spectroscopy (CRDS)
- High-Resolution Quantum Cascade Laser (QCL) Spectroscopy
- Evanescent wave and Nano-Biophotonics
- Biomedical Optics and Clinical Diagnostics
- Human Breath Analysis
- Trace gas sensing and isotope ratio measurements

Interesting results obtained

(1) We have developed a high-resolution cw-CRDS system coupled with an external-cavity quantum cascade laser (EC-QCL) as shown in Fig.1 for ultra-sensitive trace gas detection for environmental monitoring and biomedical science applications. The CRDS system has been utilized for simultaneous and molecule-specific real-time detection of several trace molecular species such as nitric oxide (NO), nitrous oxide (N_2O), carbonyl sulphide (OCS) and acetylene (C_2H_2) from parts-per-billion (ppb) to parts-per-trillion (ppt) levels by probing numerous rotationally resolved ro-vibronic transitions in the mid-IR spectral region.

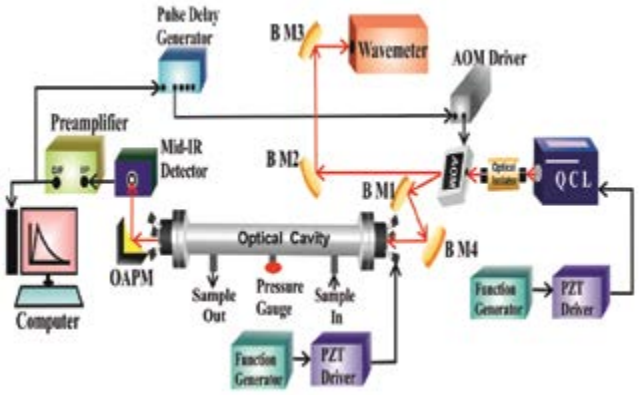

Fig.1 The quantum cascade laser based CRDS system developed in my laboratory

(2) We have shown that oxygen-18 (^{18}O) in human breath CO_2 regulated by the carbonic anhydrase (CA) activity is a potential diagnostic biomarker that can selectively and precisely distinguish type 1 and type 2 diabetes patients. The potential metabolic pathways involving the alternation of 18O isotopes in breath CO_2 is depicted in Fig.2

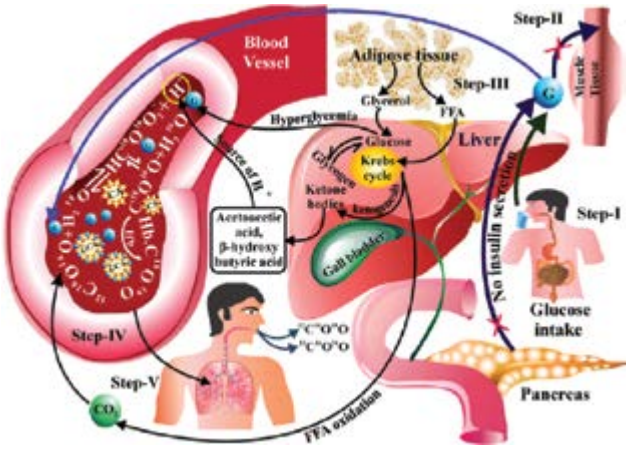

Fig.2 Proposed physiological pathways of oxygen-18 isotopic fractionation in diabetes.

Proposed research activities for the coming year

We are currently developing some novel spectroscopic techniques using diode and QC lasers for fundamental understanding of high-resolution molecular spectroscopy and hyper-fine structures of the molecular species.

Rajib Kumar Mitra

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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. Animesh Patra; "Structure Dynamics and Activity of Water in Restricted Environments"; Ph.D. degree awarded in December, 2016
2. Arindam Das; "Structure and Dynamics of Mixed Microemulsions/ Reverse Micellar Systems"; Ph.D. degree awarded in April, 2017
3. Debanjan Polley; "Manipulating THz Radiation Using Nanostructures"; Ph.D. thesis submitted in July, 2016
4. Nirnay Samanta; "Studying the Effects of Different Cosolutes on Protein Conformational Stability, Hydration Dynamics and Activity"; to submit Ph.D. thesis in July, 2017
5. Debasish Das Mahanta; "Investigation of the Collective H-bonded network and Hydration Dynamics around Electrolytes and Bio-molecules"; likely to submit Ph.D. thesis in July, 2018
6. Amit Barh; working since July, 2016 on generation of THz radiation from oxide materials
7. Sk. Imadul Islam; working since July, 2016
8. Saikat Pal; working since January, 2017

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Anupam Gorai, Post B.Sc. student, SNBNCBS, Jan-May, 2017, 4th Semester, "Application of THz Radiation on Materials", project completed.
2. Swarnali Hait, Post B.Sc. student, SNBNCBS, Jan-May, 2017, 4th Semester, "THz Spectroscopy – Generation and Application", project completed.

Post Doctoral Research Scientists

1. Dipak K. Das

Teaching activities at the Centre

1. 3rd Semester (Aug-Dec 2016), PHY 301: Atomic and Molecular Physics (Post B.Sc. course), jointly with Prof. Anjan Barman
2. 4th Semester (Jan-May, 2017), PHY 405: Biological Physics (post B.Sc. course), jointly with Prof. Samir K. Pal

Publications in Journals

1. N. Samanta, D. Das Mahanta, S. Choudhury, A. Barman, and **R. K. Mitra;** *Collective Hydration Dynamics in Some Amino Acid Solutions: A Combined GHz-THz Spectroscopic Study;* J. Chem. Phys.; 2017; **146;** 125101.
2. A. Patra, N. Samanta, D. K. Das, and **R. K. Mitra;** *Enhanced Catalytic Activity of α-Chymotrypsin in Cationic Surfactant Solutions: The Component Specificity Revisited;* J. Phys. Chem. B; 2017; **121**; 1457–1465.
3. D. Polley, A. Patra, A. Barman and **R. K. Mitra;** *Terahertz conductivity engineering in surface decorated carbon nanotube films by gold nanoparticles;* Applied Optics; 2017; **56;** 1107-1112.
4. D. Das Mahanta, A. Patra, N. Samanta, T. Q. Luong, B. Mukherjee and **R. K. Mitra;** *Non-monotonic dynamics of water in its binary mixture with 1,2-dimethoxy ethane: A combined THz spectroscopic and MD simulation study;* J. Chem. Phys.; 2016; **145;** 164501.
5. D. Polley, K. Neeraj, A. Barman and **R. K. Mitra;** *Diameter-dependent shielding effectiveness and terahertz conductivity of multiwalled carbon nanotubes;* J. Opt. Soc. Am. B; 2016; **33;** 2430-2436.
6. D. K. Das, A. Patra and **R. K. Mitra;** *Preferential solvation of lysozyme in dimethyl sulfoxide/water binary mixture probed by terahertz spectroscopy;* Biophys. Chem.; 2016; **216**; 31-36.
7. K. Kundu, A. Das, S. Bardhan, G. Chakraborty, D. Ghosh, B. Kar, S. K. Saha, S. Senapati, **R. K. Mitra** and B. K. Paul; *The mixing behaviour of anionic and nonionic surfactant blends in aqueous environment correlates*

in fatty acid ester medium; Colloids and Surfaces A: Physicochemical and Engineering Aspects; 2016; **504;** 331–342.

Lectures Delivered

1. "Collective Dynamics of Water Around Solutes: Terahertz Time Domain Spectroscopic Studies" in Photonics-2016, at IIT Kanpur during 5-8 December, 2016
2. "Application of Terahertz Spectroscopy in Chemistry and Biology" in QIP Short Term Course on 'Industrial applications of Terahertz Radiation' at IIT Kharagpur during 27th March-2nd April, 2017

Membership of Committees

Internal Committee

Admission Committee; Technical Cell Advisory Committee; Technical Cell Working Group etc.

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)

National

1. 01 (Sl. No. 7)

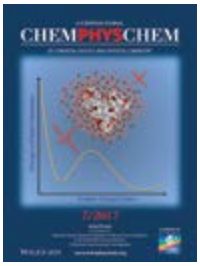
Significant research output / development during last one year

General research areas and problems worked on

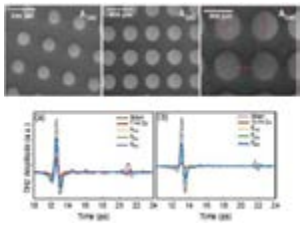
Terahertz Spectroscopy, Time resolved fluorescence spectroscopy, Hydration dynamics, Biophysics, Protein folding, Self-assembled systems (micelles, reverse micelles, lamellae, vesicles etc.), Nanomaterials.

Interesting results obtained

1. Our study shows the unusual concentration induced behavior of alcohols on proteins and we conclude that this behavior is driven by an intricate balance between different counter-interacting interactions.



2. We have made a systematic investigation on the broad notion of hydrophobic hydration using THz time domain spectroscopy. We have found a very systematic change in the hydration dynamics depending upon the hydrophobic scale of the solute (be it amino acids or alkyl ammonium salts or nonpolar solvents).
3. We have performed two-photon absorption experiment to understand the binding of fluorophores on the surface of a model protein. The study could be found helpful for imaging applications.
4. We have shown that Cu anti dots can be used as efficient anti reflection agent in the THz frequency region.



5. We have investigated the change in the enzyme activity of lysozyme in presence of polyethyle glycol and we conclude that at low concentration region of PEG the protein dehydration phenomenon predominates while at higher concentrations the PEGs directly interact with the proteins.
6. We have investigated the effect of PEGs on DNA-ligand intercalation and found that the quenching of ligand fluorescence, which is due to the intercalation in DNA, is released in presence of PEGs.

Proposed research activities for the coming year

1. Development of a broadband THz facility (~10 THz) using optical rectification (OR) technique. We plan to couple this facility with a 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 will investigate in more details hydrophobic hydration. We plan to couple spectroscopic results with thermodynamic outputs (in the form of enthalpy and entropy of the process) which would enable us to obtain the corresponding energetic cost of destruction or formation of water structure around hydrophobic molecules. We would like to include complex molecules like small peptides, self aggregating proteins etc. in order to understand their hydration behavior.
3. 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.
4. 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.).
5. We would collaborate with industries regarding application of THz spectroscopy in pharmaceutical and biomedical applications.

Ranjit Biswas

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In the research group of Prof. Ranjit Biswas, they perform experiments, develop theory and employ computer simulations to generate an integrated understanding of chemical events in complex systems. Their research has led to significant insights into the (i) structure and dynamics of deep eutectic solvents, (ii) relaxation mechanism in ionic liquids and (ionic liquid + polar solvent) binary mixtures, (iii) aggregation in aqueous solutions (iv) slow dynamics in confined aqueous environments and (v) mechanism that decouples solute rotation from electrostatic interactions.

Supervision of Research / Students

Ph.D. Students

1. Kajal Kumbhakar, Experiments, Chemical Dynamics in Complex Systems, Ongoing.
2. Atanu Bakshi, Theoretical Studies of Relaxation Dynamics in Confinements and Ionic Systems, Theory & Simulations, Ongoing
3. Juriti Rajbangshi, Studies of Glassy Signatures in High Temperature Systems, Simulations, Ongoing
4. Ejaj Tarif, Experiments Relaxation Dynamics in Complex Chemical Systems, Ongoing.

Teaching activities at the Centre

1. CB524 Physical Chemistry: Experiments & Theory

Publications in Journals

1. S. Rajkhowa, S. Mahiuddin, J. Dey, S. Kumar, V. K. Aswal, **R. Biswas,** J. Kohlbrechere and K. Ismail; *The Effect of Temperature, Composition and Alcohols on the Microstructures of Catanionic Mixtures of Sodium Dodecylsulfate and Cetyltrimethylammonium Bromide in Water;* Soft Matter; 2017; **13;** 3556-3567; DOI: 10.1039/c7sm00342k.
2. Kallol Mukherjee, Ejaj Tarif, Anjan Barman and **Ranjit Biswas;** *Dynamics of a PEG Based Non-Ionic Deep Eutectic Solvent: Temperature Dependence;* Fluid Phase Equilibria; 2017; **448;** 22-29; Invited Article for the Special Issue on Deep Eutectic Solvents; DOI: 10.1016/j.fluid.2017.05.003.
3. Suman, Das, Biswaroop Mukherjee and **Ranjit Biswas;** *Microstructures and Their Lifetimes in Acetamide/Electrolyte Deep Eutectics: Anion Dependence;* Journal of Chemical Sciences; 2017; **129** (7); 939-951; Invited Article for Charusita Chakrabarti special issue; DOI: 10.1007/s12039-017-1263-9.
4. Sandipa Indra and **Ranjit Biswas;** *How Heterogeneous Are Trehalose/Glycerol Cryoprotectant Mixtures? A Combined Time-Resolved Fluorescence and Computer Simulation Investigation;* Journal of Physical Chemistry B; 2016; **120;** 11214-11228.
5. Sandipa Indra and **Ranjit Biswas;** *Is Dynamic Heterogeneity of Water in Presence of a Protein Denaturing Agent Different from that in Presence of a Protein Stabilizer? A Molecular Dynamics Simulation Study;* Journal of Chemical Sciences; 2016; **128;** 1943-1954.
6. Suman Das, **Ranjit Biswas** and Biswaroop Mukherjee; *Collective Dynamic Dipole Moment and Orientation Fluctuations, Cooperative Hydrogen Bond Relaxations, and Their Connections to Dielectric Relaxation in Ionic Acetamide Deep Eutectics: Microscopic Insight from Simulations;* Journal of Chemical Physics; 2016; **145;** 084504.
7. Kallol Mukherjee, Anjan Barman and **Ranjit Biswas;** *Impact of the Aggregation Behaviour of Sodium Cholate and Sodium Deoxycholate on Aqueous Solution Structure and Dynamics: A Combined Time Resolved Fluorescence and Dielectric Relaxation Spectroscopic Study;* Journal of Molecular Liquids – Special Issue (Invited Article); 2016; **222;** 495-502.

Lectures Delivered

1. Invited Talk in the Indo-Japan Meeting, Department of Chemistry, IIT-Kanpur on November 15, 2016, entitled 'Dielectric Relaxation in Ionic and Non-Ionic Deep Euetctics: Polarity and Origin of Relaxation Timescales'.

Membership of Committees

Internal Committee

HoD/CBMS; Convener, SCOLP-EVLP

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

National

1. Sl. No. 1

International

1. Sl. No. 1

Significant research output / development during last one year

General research areas and problems worked on

- Structure & Dynamics of Deep Eutectics
- Understanding glass dynamics of coulomb systems/ fluids
- Small molecule relaxation in a wide variety of environments

Interesting results obtained

The research works of R. Biswas and his students/ collaborators are concerned with the central theme of developing a molecular level understanding of the structure and dynamics of complex media and their relationship to simple chemical events occurring in them. For this, Dr. Biswas performs experiments, and carries out computer simulations and theoretical studies in his own group. This approach constitutes a rather interesting example where results obtained by one method are analyzed and complemented with the data provided by the other two.

The above trend is reflected in various research papers published by Biswas et al in the last few years. For example, the first molecular theory for experimental Stokes shift dynamics in ionic liquids (ILs) emerged from this research group. These works have successfully explained the experimental results obtained via ultrafast fluorescence measurements of ILs. Temperature-dependent studies have explained why hydrodynamics nearly holds for diffusive relaxations in these highly viscous and heterogeneous media. The prediction 4 that the motion of a large solute can influence the relaxation in these Coulomb fluids has been validated by subsequent simulation works. Further study reveals a strong interconnection between the measured sub-picosecond fluorescence response in ILs and rotation of dipolar ions in a collective potential created by the ionic neighbors.

The first semi-molecular theory for understanding experimental Stokes shift dynamics in (IL + common polar solvent) mixtures has also originated from this research group. An extremely slow (just a few nanoseconds) time-scale in the collective orientational relaxation appears in an all-atom simulation study of (ionic liquid + real solute). These works constitute a fundamental contribution to the overall understanding of relaxation processes in ILs.

Interaction and dynamics in deep eutectic solvents have been explored by using fluorescence experiments, simulations and theory by this group. These studies are novel in the sense that these works for the first time focused on the chemical physics of deep eutectics. These mixtures resemble ionic liquids (interaction-wise) yet show diffusion-viscosity decoupling at a much higher temperature. A combined fluorescence and all-atom simulation study provides emphatic evidences for the existence of ultra-slow water in confined aqueous systems, and explains numerous experimental results including theirs. Picosecond fluorescence dynamics studies of (alcohol + water) binary mixtures are well-cited works as these have made important contributions in understanding the hydrophobic interaction induced water agglomeration in aqueous solutions. In a very recent work, the first evidence for electrolyte-induced arrest of polymer segmental motion in polymer-electrolyte composites has been observed. Other simulation studies and analytical works depict microscopic picture of interaction and dynamics in liquid mixtures, electrolyte solutions and super-critical fluids.

Very recently, presence of jump reorientations in molten acetamide has been established, and extended to ionic acetamide deep eutectics. High frequency response in ionic and non-ionic deep eutectics has been measured and their impact on a chemical reaction studied. Experimental study exploring competition between hydrophobic interaction and critical fluctuations in producing microheterogeneity in binary mixtures with solubility gap has been performed and heterogeneity length- and timescales in binary mixtures explored. Furthermore, aggregation behavior of a variety of molecules has been studied and impact on dynamics explained via carrying out simulations and measurements. In summary, these works are of a high quality and have provided a critical understanding of several longstanding fundamental questions in solution-phase physical chemistry.

Proposed research activities for the coming year

Generating better understanding of deep eutectic solvents.

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Prof. Samir Kumar Pal's group 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 220 research papers published in various international peer-reviewed journals, 17 patent applications, 5 extramural research funding and 5 book chapters resulting more than 8366 citations, 47 h-index, 151 i10 index, to describe their activities concisely.

Supervision of Research / Students

Ph.D. Students

1. Siddhi Chaudhuri "Spectroscopic Studies On The Medicinally Important Molecules With Various Nanoparticles And Their Interaction With Different Cell Lines" University of Calcutta (2016). Completed.
2. Samim Sardar "Spectroscopic Studies on Light Harvesting Materials Toward Enhanced Solar Energy Conversion" University of Calcutta (2016). Completed.
3. Nabarun Polley "Exploration of Biomedically Relevant Spectroscopic Techniques for Potential Clinical Diagnostic and Therapeutic Procedures" University of Calcutta (2017). Completed.
4. Susobhan Chaudhury "Study on Conformation and Ultrafast Dynamics in Biomolecular Recognition with Optical Laser Spectroscopy" University of Calcutta (Submitted) (2017).
5. Prasenjit Kar, "Spectroscopic Studies on Nanomaterials for Solar Energy Harvesting Application" University of Calcutta (Ongoing).
6. Damayanti Bagchi "Spectroscopic and Microscopic Studies on Nanohybrids of Inorganic Metal-oxides with Medicinally Important Organic Ligands" University of Calcutta (Ongoing).
7. Priya Singh "Spectroscopic Studies on Structure, Function and Dynamics of Biological Macromolecules in Physiologically Relevant and Engineered Environments" University of Calcutta (Ongoing).
8. Probir Sarkar "Spectroscopic Studies on Molecules and Nanomaterials for Potential Applications in Medical Diagnosis and Environmental Pollution Monitoring" University of Calcutta (Ongoing).
9. Tuhin Maji "Combined experimental and computational investigation on optical and catalytic properties of functionalized metal oxides" University of Calcutta (Ongoing).
10. Aniruddha Adhikari "Studies on Therapeutic Potential of Various Nanomaterials and Ethnobotanical Ingredients in Preclinical Disease Model" University of Calcutta (Ongoing).
11. Jayita Patwari "Photophysical Studies on Light Harvesting Nanomaterials for Improved Solar Energy Conversion" University of Calcutta (Ongoing).
12. Soumendra Singh "Development of Spectroscopic Techniques for Potential Environmental and Biomedical Applications" University of Calcutta (Ongoing).

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Sounak Banerjee (MSC Biochemistry)

Post Doctoral Research Scientists

1. Shreyasi Dutta

Teaching activities at the Centre

1. PHY 405, CB 526

Publications in Journals

1. P. Singh, S. Choudhury, S. Dutta, A. Adhikari, S. Bhattacharya, D. Pal and **S. K. Pal;** *Ultrafast Spectroscopy on DNA-Cleavage by Endonuclease in Molecular Crowding;* Int. J. Biol. Macromolecules; 2017; **103;** 395.
2. P. K. Sarkar, S. Pal, N. Polley, R. Aich, A. Adhikari, A. Halder, S. Chakrabarti, P. Chakrabarti and **S. K. Pal;** *Development and Validation of a Noncontact Spectroscopic Device for Hemoglobin Estimation at Point-of-Care;* J. Biomed. Optics; 2017; **22;** 055006.
3. P. Singh, S. Choudhury, S. Singha, Y. Jun, S. Chakraborty, J. Sengupta, R. Das, K-Han Ahn and **S. K. Pal;** *A Sensitive Fluorescent Probe for the Polar Solvation Dynamics at Protein- Surfactant Interfaces;* Phys. Chem. Chem. Phys.; 2017; **19;** 12237.
4. D. Bagchi, S. Dutta, P. Singh, S. Chaudhuri and **S. K. Pal;** *Essential Dynamics of an Effective Phototherapeutic Drug in a Nanoscopic Delivery*

Vehicle: Psoralen in Ethosomes for Biofilm Treatment; ACS Omega; 2017; **2;** 1850.

5. S. Mondal, A. Giri, Y. Zhang, **S. K. Pal,** W. Zhou and L-ping Wen; *Caspase mediated beclin-1 dependent autophagy tuning activity and apoptosis promotion by surface modified hausmannite nanoparticle;* J. Biomed. Mat. Res.: A; 2017; **105;** 1299.
6. S. Ghosh, P. Kar, N. Bhandary, S. Basu, T. Maiyalagan, S. Sardar and **S. K. Pal;** *Reduced graphene oxide supported hierarchical flower like manganese oxide as efficient electrocatalysts toward reduction and evolution of oxygen;* Int. J. Hydrogen Energy; 2017; **42;** 4111.
7. A. Adhikari, N. Polley, S. Darbar and **S. K. Pal;** *Therapeutic Potential of Surface Functionalized Mn_3O_4 Nanoparticles against Chronic Liver Diseases in Murine Model;* Materials Focus; 2017; **6;** 280.
8. Z. S. Seddigi, S. A. Ahmed, S. Sardar, N. H. Yarkandi, M. Abdulaziz and **S. K. Pal;** *Combating Fuel-driven Aqua-Pollution using "BenzoMagnets"; RSC Advances;* 2017; **7;** 12277.
9. D. Bagchi, T. K. Maji, S. Sardar, P. Lemmens, C. Bhattacharya, D. Karmakar and **S. K. Pal;** *Sensitized ZnO Nanorod assemblies to detect heavy metal contaminated phytomedicines: Spectroscopic and Simulation Studies;* Phys. Chem. Chem. Phys.; 2017; **19**; 2503.
10. J. Patwari, H. Ghadi, S. Sardar, J. Singhal, B. Tongbram, S. Shyamal, C. Bhattacharya, S. Chakrabarti and **S. K. Pal;** *Photo-induced electronic properties in single quantum well system: Effect of excitonic lifetime;* Materials Res. Express; 2017; **4;** 016301.
11. P. Kar, T. K. Maji, R. Nandi, P. Lemmens and **S. K. Pal;** *In-situ hydrothermal synthesis of Bi-$Bi_2O_2CO_3$ heterojunction photocatalyst with enhanced visible light photocatalytic activity;* Nano-Micro Letters; 2017; **9;** 18.
12. A. Adhikari, N. Polley, S. Darbar, D. Bagchi and **S. K. Pal;** *Citrate Functionalized Mn_3O_4 in Nanotherapy of Hepatic Fibrosis by Oral Administration;* Future Science (OA); 2016; **2;** FSO146.
13. M. Khatun, S. Choudhury, B. Liu, P. Lemmens, **S. K. Pal** and S. Mazumder; *Resveratrol-ZnO Nanohybrid Enhanced Anti-cancerous Effect in Ovarian Cancer Cells through ROS;* RSC Advances; 2016; **6;** 105607.
14. S. Ghosh, C-L Yu, D. Ferraro, S. Sudha, **S. K. Pal,** W. Schaefer, D. T. Gibson, and S. Ramaswamy; *Blue protein with Red Fluorescence; Proceedings of the National Academy of Sciences (PNAS, USA);* 2016; **113;** 11513.
15. P. Kar, T. K. Maji, P. K. Sarkar, S. Sardar and **S. K. Pal;** *Direct Observation of Electronic Transition-Plasmon Coupling for Enhanced Electron Injection in Dye-sensitized Solar Cells;* RSC Advances; 2016; **6;** 98753.
16. T. K. Maji, D. Bagchi, P. Kar, D. Karmakar, and **S. K. Pal;** *Enhanced Charge Separation through Modulation of Defect-state in Wide Band-gap Semiconductor for Potential Photocatalysis Application: Ultrafast Spectroscopy and Computational Studies;* J. Photochem. Photobiol. A; 2017; **332;** 391.
17. D. Bagchi, A. Ghosh, P. Singh, S. Dutta, N. Polley, I. I. Althagafi, R. S. Jassas, S. A. Ahmed and **S. K. Pal;** *Allosteric Inhibitory Molecular Recognition of a Photochromic Dye by a Digestive Enzyme: Dihydroindolizine makes Alpha-chymotrypsin Photo-responsive;* Scientific Reports (Nature Publications); 2016; **6;** 34399.
18. G. Naiya, P. Raha, M. K. Mondal, U. Pal, R. Saha, S. Choudhury, S. Batabyal, **S. K. Pal,** D. Bhattacharyya, N. C. Maiti and S. Roy; *Conformational Selection Underpins Recognition of Multiple DNA sequences by Proteins and Consequent Functional Actions;* Phys. Chem. Chem. Phys.; 2016; **18;** 21618.
19. P. Kar, S. Sardar, B. Liu, M. Sreemany, P. Lemmens, Srabanti Ghosh and **S. K. Pal;** *Facile Synthesis of Reduced Graphene Oxide-gold Nanohybrid for Potential Use in Industrial Waste-water Treatment;* Sci. Tech. Adv. Mat.; 2016; **17;** 375.
20. N. Polley, P. K. Sarkar, S. Chakrabarty, P. Lemmens, and **S. K. Pal;** *DNA Biomaterial Based Fiber Optic Sensor: Characterization and Application for Monitoring in situ Mercury Pollution;* ChemistrySelect; 2016; **1;** 2916.

Other Publications

1. D. Panda, A. Balgarkashi, S. Sardar, S. K. Pal, S. Hubbard and S. Chakrabarti, "Comparison of InAs/GaAs and InGaAs/GaAs quantum dot solar cells and effect of post-growth annealing on their optical properties" Photovoltaic Specialists Conference (PVSC), 2016 IEEE 43rd (pp. 2105-2107).

Lectures Delivered

1. Invited Speaker at National Conference on Ultrafast Sciences (UFS-2016). Held on 24-26th November 2016 at BARC Mumbai, India.
2. Invited Speaker at International Conference on Nanobiotechnology (NanoBioCon). Held on 3-5th October 2016 at MAKAUT, India.
3. Invited Speaker at Indo-Japan Discussion meeting. Held on 13-16th November 2016 at IIT-K, India.
4. Invited Speaker at National conference on Transcription Assembly 2016. Held on 8-9th November 2016 at Bose Institute, India.
5. Invited Speaker at International Conference on Advances in Biological Systems and Materials Science in NanoWorld (ABSMSNW-2017). Held on 19 23th February 2017 at IIT-Varanasi, India.

6. Invited Speaker at International Conference on Advances in Nanotechnology, iCAN 2017. Held on 9-11th January 2017 at Assam Don Bosco University, India.
7. Invited Speaker at National Symposium on Recent Advances in Chemistry & Industry 2016, with special emphasis on Pharmaceutical Industry). Held on 2-3 August 2016 at Indian Chemical Society, University of Calcutta.
8. Participant at a one-day symposium in memory of Dr. Ahmed Zewail on19th January 2017 at Califonia Institute of Technology (CALTECH), USA.

Membership of Committees

Internal Committee

Chairman, Pest Control

Patent/s submitted / granted

1. Bio-Templated Nanosensor for Mercury Detection in PPB Level. Indian Pat. Appl. (2016), 201621004916.
2. Development of DetecTEA, a low cost easy to use instrument for Quick Validation of Geographical Indication, Darjeeling Tea Indian Pat. Appl. (2017), 201721014138.

Sponsored Projects

1. Title: "Study on the role of biomolecular conformation and environmental dynamics in the process of molecular recognition with optical spectroscopy" (Award No. SB/S1/PC-011/2013), Agency: Department of Science and Technology (DST), Completed on 2016.
2. 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.
3. 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, Continuing.
4. 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, Continuing
5. Title: "Nanogels: Biophysical Characterization and Potential Biomedical Applications in Drug Delivery" Department of Biotechnology (DBT), Approved in 2015, Continuing.
6. 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.
7. 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, Continuing.

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

National

Sl. No. 1, 2, 3, 6, 7, 9, 10, 12, 13, 14, 16, 18, 19, 20

International

Sl. No. 3, 5, 8, 9, 11, 13, 14, 17, 19, 20

Member of Editorial Board

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

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 quantum dots (QD) to various biological macromolecules is the key feature of the nano-conjugates.

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.

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 ZnO for the better dye sensitized solar cell 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 nano-materials 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 technology is the motivation.

Subhra Jana

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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. She was awarded SERB Women Excellence Award and Young Associate of Indian Academy of Sciences, Bangalore. Her multi-disciplinary research involves solution phase synthesis and potential application of alloys, intermetallics and hybrid nanocomposites.

Supervision of Research / Students

Ph.D. Students

1. Sankar Das
2. Arnab Samanta

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. C.V.K.L Ramya

Publications in Journals

1. S. Das, **S. Jana**; *A tubular Nanoreactor Directing the Formation of In Situ Iron Oxide Nanorods with Superior Photocatalytic Activity*; Environmental Science: Nano; 2017; **4;** 596–603.
2. **S. Jana,** A. V. Kondakova, S. N. Shevchenko, E. V. Sheval, K. A. Gonchar, V. U. Timoshenko, A. N. Vasilev; *Halloysite Nanotubes with Immobilized Silver Nanoparticles for Anti-Bacterial Application;* Colloids and Surfaces B: Biointerfaces; 2017; **151;** 249-254.
3. G. Dutta Banik, A. De, S. Som, **S. Jana,** S. B. Daschakraborty, S. Chaudhuri, M. Pradhan; Hydrogen Sulphide in Exhaled Breath: *A Potential Biomarker for Small Intestinal Bacterial Overgrowth in IBS;* Journal of Breath Research; 2016; **10;** 026010.

Other Publications

1. S. Jana, Moisture Induced Isotopic Carbon Dioxide Trapping from Ambient Air Using Low-Cost Clay Based Nanocomposites, Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016, 3, 302.

Lectures Delivered

1. International Conference on Advances in Nanotechnology (ICAN 2017), January 9-13, 2017 held at Assam Don Bosco University (Jointly organized by Assam Don Bosco University and Sustainable Nanotechnology Organization, USA).
2. Networking-Cum-Discussion Meeting, January 16-17, 2017 held at KIIT University, Bhubaneswar.
3. 82nd Annual Meeting of Indian Academy of Sciences, Bangalore, November 4-6, 2016 held at IISER Bhopal.
4. International Conference on Nanotechnology for Better Living (ICNBL 2016), May 25-29, 2016 held at NIT Srinagar (Joint initiative of IIT Kanpur and NIT Srinagar).

Membership of Committees

External Committee

Editorial Board Member of Scientific Reports (*Nature Publishing Group*) from 2015 onward

Internal Committee

Member of Seminar and Colloquia Programme (SCOLP) committees; Member of interview committees; Member of organizing committee of Bose Fest; Member of Local Management Committee (LMC) of Technical Research Centre, SNBNCBS

Patent/s submitted / granted

Title: A Method to Direct the Growth and Formation of Nanorods, Inventors: Sankar Das and Subhra Jana

Awards / Recognitions

1. SERB Women Excellence Award, 2017.
2. Young Associate of Indian Academy of Sciences, Bangalore, 2015-2018.

Fellow / Member of Professional Body

1. Life Member of Chemical Research Society of India
2. Life Member of Materials Research Society of India

Sponsored Projects

1. SERB Women Excellence Research Grant, DST, India, Sanctioned for 3 years.
2. Extramural Research Grant as a PI funded by Nano Mission, DST, India from June 2016-June 2019.
3. Technical Research Centre (TRC) funded by DST, India from January 2016-December 2020. (One of the Activity Leaders, PIs)

4. INSPIRE Research Grant funded by DST, India from November 2012-October 2017.

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

International

1. Sl. No. 2

Member of Editorial Board

1. Editorial Board Member of Scientific Reports (*Nature Publishing Group*) from 2015 onward.

Significant research output / development during last one year

General research areas and problems worked on

Experimental Materials Chemistry

- Solution Phase Conversion of Nanoscale Metals into Intermetallics: Efficient Catalysts for Chemoselective Organic Transformations
- Synthesis of Hybrid Nanocomposites for Use as Efficient Carbon Dioxide Capture Materials

Interesting results obtained

1. We have demonstrated the use of inner lumen of clay nanotubes as nanoconfined reactor for the synthesis of nanoscale inorganic materials. Selective modification of the lumen using a chelating ligand facilitates the adsorption of iron and subsequently formation of nanoscale iron oxide within the lumen of the clay nanotubes (Figure 1). Lumen modification followed by the formation of iron oxide in the clay nanotubes has been evidenced by several physical methods, authenticating the presence of chelating ligand as well as formation of α-Fe_2O_3 nanorods inside the lumen and thus originating α-Fe_2O_3 nanocomposite that exhibits solar light induced enhanced photocatalytic activity. This study represents the first demonstration of the selective modification of clay lumen using a chelating ligand to direct the in situ synthesis of iron oxide nanorods. Thus, the selective lumen modification under mild condition to produce novel inorganic-organic hybrid nanocomposites may open up a new direction in the frontier area of nanoconfined reactions and hence may impart a broader impact in the field of catalysis and environmental remediation.

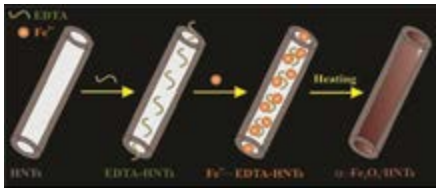


Figure 1. Schematic illustration of clay lumen (HNTs) modification with EDTA to entrap iron(III) via the formation of iron-EDTA complex followed by the decomposition to produce iron oxide nanorods within the lumen and subsequently achieved α-Fe_2O_3 nanocomposites.

2. Halloysite nanotubes (HNTs) with immobilized silver (Ag) nanoparticles (NPs) were prepared by methods of wet chemistry and were characterized by using the transmission electron microscopy, x-ray diffraction, optical spectroscopy and experiments with *E. coli* bacteria *in-vitro*. It was found that Ag NPs with almost perfect crystalline structure and sizes from ~ 9 nm were mainly attached over the external surface of HNTs. The optical absorption measurement revealed a broad plasmonic resonance in the region of 400-600 nm for HNTs with Ag NPs (Figure 2). The later samples exhibit bactericidal effect, which is more pronounced under illumination. A role of the plasmonic excitation of Ag NPs for their bioactive properties is discussed. The obtained results show that Ag NPs–decorated HNTs are promising agents for antibacterial treatments of liquids and surfaces stimulated by visible light exposure.

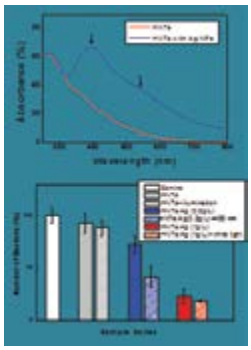


Figure 2. (A) Absorption spectra of the bare HNTs (red line) and those with Ag NPs (blue line) deposited on quartz substrate. Vertical arrows indicate features of the plasmon resonance in Ag NPs. (B) Relative number of *E. coli* bacteria after incubation without (control) and with bare HNTs (1 g/L) in darkness (grey bars) and under illumination (pattern grey bars) as well as with HNTs (0.2 g/L) covered by Ag NPs (blue bars) in darkness and under illumination at 488 nm (blue pattern bars), and HNTs (1 g/L) covered by Ag NPs (red bars) in darkness and under illumination with white light (red pattern bars).

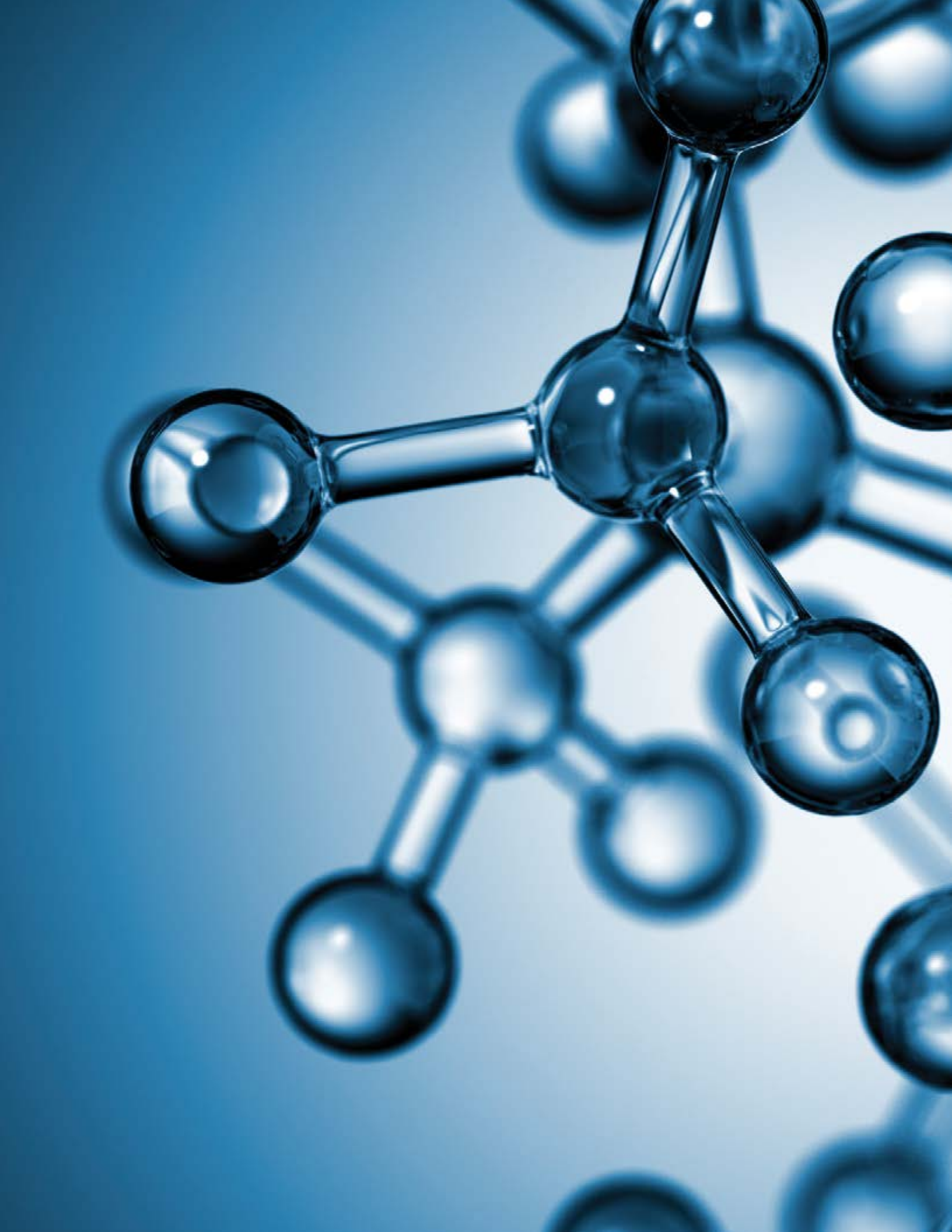
Proposed research activities for the coming year

Proposed research plan has been summarized below:

- Using solution chemistry route fabrication of inorganic-organic hybrid nanocomposites for environmental remediation.
- Synthesis of size- and shape-tunable nanoscale alloys for surface-enhanced Raman spectroscopy.
- Utilize these nanocomposites and nanoscale alloys as heterogeneous catalysts for chemical and photochemical reactions.

Any other matter

1. Reviewer of several ACS, RSC, Elsevier and Wiley Journals.



Department of
CONDENSED MATTER PHYSICS AND MATERIAL SCIENCES

Department of Condensed Matter Physics and Material Sciences

Pratip Kumar Mukhopadhyay

Department profile indicators

Table A : Manpower and resources

Number of faculties	9
Number of Post –doctoral research associate (centre+project)	9
Number of Ph.D students	58+9 (External Ph.D. Students)
Number of other project staff	6 (including Project Fellow/Asst.)
Number of summer students	4
Projects (ongoing)	

Table B: Research Activities indicators

Number of research papers in Journals	84
Number of Book-chapters/books	0
Number of other publications	7
Number of Ph.D students graduated (submitted+degree awarded)	16
Number of M.Tech/M.Sc projects	4

Table C: Academic activities and likeage

Number of courses taught by faculties	13	
Number of Visitors (non –associates)	6	
Number of associates	3	
Number of Seminars organized	5	
Number of Conference/Symposia/Advanced Schools organized	4	
Number of talks delivered by members of department in conferences/Symposia	National	21
	International	4

Most important research highlights

- Simulation of elastic behavior of crystalline-amorphous Si-nanocomposites found that the easltic moduli increased with crystalline volume fraction.
- Interfacial Dzyaloshinskii-Moriya Interaction was directly observed using Brillouin Light Scattering on W/CoFeB interface in W/CoFeB/SiO_2 heterostructures.
- Optical response in a single strand of a branched Y-junction CNT composed of multiwalled CNTs was investigated in and around the junction area.
- Stable and enhanced visible-light water electrolysis for clean and sustainable energy by using Highly oriented arrays of C, N and S surface functionalized/surface doped ZnO Nanorods.
- Development of Efficient Density Matrix Renormalization Group technique for one dimensional periodic boundary condition system, through Matrix Product State algorithm.
- For the first time a metallic antiferromagnetic system was found that had simulteneously enhanced disordered induced weak localization, so that the magnetic transitions occur concomitantly with resistivity minima.
- A smart fluid was found that showed bullet stopping ability, for use in the body armours of defense and peace keeping persons.
- The long standing problem of only non stoichiometric ferromagnetic shape memory alloys of type Ni-Mn-Sn exhibiting transition from the high symmetric cubic phase, was investigated from first principle calculations.

- Detailed theoretical investigation of generalized spin stiffness constant for doped quantum antiferromagnet with strong electronic correlations on low dimensional lattices was carried out
- ZnO nanorod array hybrid photodetectors on Au nanoparticle-embedded silk protein that was used as a biopolymer substrate for flexible photonic devices, has been demonstrated as useful UV and visible range photodetectors.
- To find topological phases in thin films of correlated oxide and heterostructures, a quantum anomalous Hall insulator in ultrathin films of double perovskites based on mixed 3d–5d or 3d–4d transition-metal ions, grown along the [111] direction was proposed and modelled.

Summary of research activities

This large and vibrant department is engaged in exploring various aspects of condensed matter physics, to understand the properties theoretically and experimentally. The following is a gist of some outstanding work from the department.

In the theoretical side, bandstructure based calculations were carried to solve very interesting and long stading problems, and also predict new structures. For example, why the Full Heusler alloy systems like Ni_2MnSn needs non stoichiometric composition to undergo Austanite – Martensite transition is explored through band structure calculations. Similarly, prediction of High-temperature large-gap quantum anomalous Hall insulating state in ultrathin double perovskite film was made through Ab-Initio calculations, as well as another similar problem of pressure driven cooperativity of hybrid perovskites were solved. In a similar way, bimetallic nano-alloyed clusters of silver and transition metal atoms were explored for their mixing, catatlytic and optical properties.

Further, molecular dynamic simulations were carried out to find the elastic properties of metallic and semiconducting nano pillers and other such structures. Another group developed an efficient DMRG technique one dimensional periodic boundary condition system, with Matrix Product State (MPS) algorithm gives a new approach to find accurate results for the one dimensional PBC system that is very difficult to solve otherwise. Another group looked into the origin of superconductivity with anisotropic nature in multi-layered systems with inclusion of various intra-layer, inter-layer and inter-band processes, relevant to cuprates and Fe-pnictides. Theoretical and microscopic investigation of superconductivity with anisotropic nature in multi-layered systems with inclusion of various intra-layer, inter-layer and inter-band processes, relevant to cuprates and Fe-pnictides. A detailed theoretical investigation of generalized spin stiffness constant for doped quantum antiferromagnet with strong electronic correlations on low dimensional lattices was also looked at by them. The last group worked on a mesoscopic system that was coupled to leads with the help of which it exchanges electrons with external reservoirs. Solving this problem helps to determine very accurately the partial density of states at the Fano resonances.

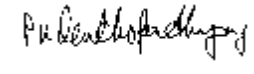
In the experimental side, the major focus was on nano structures and magnetism. One group showed, for the first time, a remarkable concomitant antiferromagnetic transition and disorder-induced weak localization in a material. It was thought that disorder destroyed the insulating antiferromagnetic state originating from electron correlation in its weak limit, leading to a metallic paramagnetic phase. But in the limit of strong disorder–strong e-e interaction regime, nothing was so far known. This is the first time demonstration of what happens when both effects are simulteneously present.

In the group working on ultrafast spectroscopy on nanoscale magnetic devices, development of all-magnetic transistor with favorable properties is going on. It is an important step towards a new paradigm of all-magnetic computation. Another group worked on room temperature ferromagnetic and ferroelectric properties of double perovskite Y_2NiMnO_6 nanowires, demonstrating the unusual room temperature ferromagnetism, ferroelectricity and strong magnetoelectric coupling of these nanowires, due to surface charge effects.

A group studied the low-temperature electronic transport properties of single germanium nanowires (NWs) with diameters down to 45 nm to investigate the weak localization (WL) behavior and approach to metal–insulator transition (MIT) within them. Similarly, another one Theoretical and experimental investigated the hybrid heterostructure interfaces between atomically thin MoS_2 nanocrystals (NCs) on Si platform for their potential applications towards next-generation electrical and optical devices, these have a great potential for hybrid electronic and optoelectronic devices in the near future. In the same vein, another group was busy fabricating a thin film transistor (TFT) on a flexible substrate using polymer electrolyte as gate dielectric with oxide semiconductor channel, this is a step towards future flexible electronics.

Finally, a group is developing hollow nano particles of various morphologies for targeted drug deliveries, especially for treatment against cancer cells.

One of the above groups has developed a smart fluid that is ordinarily liquid like, but on contact with a fast projectile like a bullet, turns solid like and offers a stiff resostance to its path. It is to be used as a material for use in body armours. This is expected to be used by military and police forces for saving lives.



Pratip Kumar Mukhopadhyay

Head, Department of Condensed Matter Physics and Material Sciences

Amlan Dutta

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Major research interests of Dr. Amlan Dutta are theoretical and computational material science. He employs the tools of molecular dynamics simulations to investigate the elasto-plastic properties of solids. Presently, he is studying systems like metallic glasses, heteroepitaxial semiconductors and nanocrystalline solids. He is also performing studies on data mining methods in material science.

Supervision of Research / Students

Ph.D. Students

1. Suvankar Das, Atomistic simulations of semiconductor nanocomposites (Ongoing)

Teaching activities at the Centre

1. PHY 291, Basic Laboratory – II, 2nd Semester IPhD, 9 students (Shared with Prof. Kalyan Mandal)

Publications in Journals

1. **A. Dutta;** *Compressive deformation of Fe nanopillar at high strain rate: Modalities of dislocation dynamics;* Acta Mater.; 2017; **125;** 219.
2. S. Das and **A. Dutta;** *Elastic behavior of amorphous-crystalline silicon nanocomposite: An atomistic view;* Physica E; 2017; **85;** 180.

Lectures Delivered

1. Elastic behavior of crystalline/amorphous core/shell silicon nanowires, Devices for Integrated Circuit (DevIC), Kolkata, India (2017).
2. Unveiling the mechanism of compressive deformation of bcc nanopillar through atomistic simulations, EMN Prague Meeting, Czech Republic (2016).

Sponsored Projects

1. INSPIRE project, DST, May 2013 – May 2018

Conference / Symposia / Workshops / Seminars etc. organized

1. Ramanujan Conclave, 22-23 Dec., 2016, SNBNCBS (co-organizer)

Significant research output / development during last one year

General research areas and problems worked on

Molecular dynamics simulations, Elastic behavior of silicon nanocomposite, Deformation behavior of metallic nanostructures, Data mining applications in materials science

Interesting results obtained

By means of molecular dynamics simulations, we have investigated the elastic behavior of crystalline-amorphous Si-nanocomposites. It is found that the Young's and shear moduli of such materials increase with increase in volume fraction of the crystalline phase. By comparing the simulation results with mathematical micromechanical models, we he found that the crystal-amorphous interphase plays a key role in this regard. Moreover, the bulk modulus behaves in an anomalous non-monotonic way. The simulations reveal that this anomaly is due to the internal relaxation of atomic structures at the interphase (Fig. 1).

In a separate study, the deformation behavior of bcc Fe-nanopillar was investigated (Fig. 2). MD simulations revealed that during the compressive deformation, screw dislocation become active and act as carriers of plastic slip. If the load is high, a screw dislocation may also split into a twin fault. Furthermore, the mechanism of deformation was found to be sensitive to the temperature. Finally, the statistics of load-drop was studied, which unveiled the signature of self-organized criticality in the underlying dynamics.

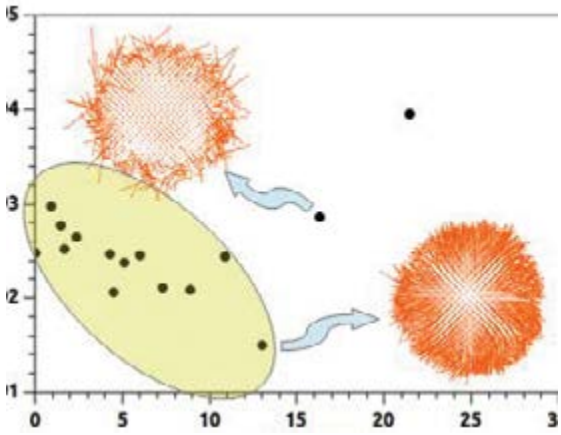

Fig. 1 Anomalous trend of bulk modulus due to atomic relaxation.

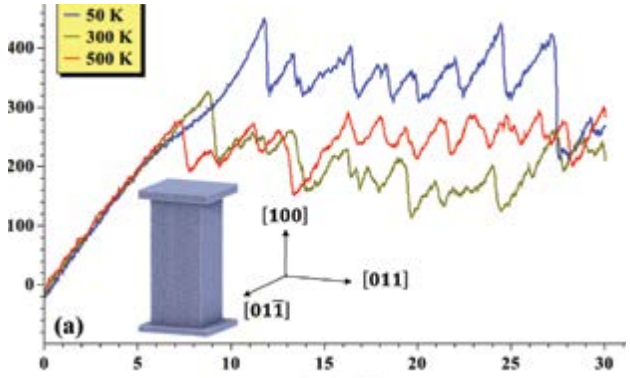

Fig. 2 Stress-strain behavior of Fe-nanopillar during compressive deformation at different temperatures.

Proposed research activities for the coming year

1. Development of a highly optimized algorithm for time series to network transform.
2. Use of visibility network algorithm to study the phenomenon of serrated yielding in dilute alloys.
3. Studying inverse Hall-Petch behavior of nanocrystalline metals by using MD simulations.
4. Studying Ballistic deformation of bulk metallic glass.

Anjan Barman

Professor
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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 Magnonics and Spintronics, including ultrafast magnetization dynamics, nanomagnetism, spin Hall effect and interface magnetism.

Supervision of Research / Students

Ph.D. Students

1. Arnab Ganguly: Investigation and Control of Magnetization Dynamics in Ferromagnetic/ Nonmagnetic Bi-Layer Systems (completed)
2. Debanjan Polley: Manipulating THz Radiation Using nanostructures (completed)
3. Kallol Mukherjee: Interactions and Dynamics in Complex Systems (completed)
4. Chandrima Banerjee: Experimental Study of Spin Waves in Magnetic Thin Films and Nanostructures (ongoing)
5. Santanu Pan: Ultrafast Spin Dynamics in Ferromagnetic Thin Films (ongoing)
6. Samiran Choudhury: Spin Waves in Two-Dimensional Magnonic Crystals (ongoing)
7. Sucheta Mondal: Spin Dynamics and Spin Hall Effect in Metallic Thin Films and Nanostructures (ongoing)
8. Anulekha De: Spectroscopic Studies of Metallic Nano and Microstructures (ongoing)
9. Avinash Kumar Chaurasiya: Brillouin Light Scattering Studies of Interfacial Dzyaloshinskii-Moriya Interaction (ongoing)
10. Kartik Adhikari: Ferromagnetic Resonance of Patterned Magnetic Nanostructures (ongoing)
11. Sourav Sahoo: Spin Dynamics in 3D Magnonic crystal and 2D Spin Ice Systems (ongoing)

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Suryanarayan Panda (IPhD student, SNBNCBS); Project 1: Investigation of Magnetic Anisotropy in W/CoFeB/SiO2 Thin Films; completed; Project 2: Investigation of Spin Pumping Effect in Heavy Metal/ Ferromagnetic Bilayer System Using Time Resolved Magneto-optical Kerr Effect Technique; completed; Project 3: All Optical Detection of Spin Diffusion Length of a Heavy Metal; completed.
2. Sudip Majumdar (IPhD student, SNBNCBS); Project 1: Investigation of Spin Wave Dynamics in Ferromagnetic Nanostructures - I; completed; Project 2: Investigation of Spin Wave Dynamics in Ferromagnetic Nanostructures - II; completed.
3. Tanwistha Chakrabarti (Presidency University, Kolkata); Project 1: The Effect of Variation in the Diameter of Antidots on the Spin Wave Spectra using VNA-FMR Technique; completed.
4. Neha Jha (IPhD Student, SNBNCBS); Project 1: Time-Domain Study of Spin Hall Effect in Nonmagnet/Ferromagnet Bilayer Thin Films; completed.
5. Sourav Sahoo (IPhD Student, SNBNCBS); Project 1: Spin Waves in Nonmagnet/Ferromagnet/Oxide Heterostructures; completed.

Post Doctoral Research Scientists

1. Jaivardhan Sinha
2. Sumona Sinha
3. Rakhi Acharya

Teaching activities at the Centre

1. PHY301: Atomic and Molecular Physics, IPhD, No. of students: 07, Co-Teacher: Dr. Rajib Kumar Mitra.
2. CB527: Molecular Physics and Spectroscopy, Post MSc, No. of students: 07, Co-Teacher: Dr. Rajib Kumar Mitra.
3. PHY292: Summer Project Research, IPhD, No. of Students: 01.
4. PHY304: Project Research, IPhD, No. of students: 02.
5. PHY401: Project Research III, IPhD, No. of students: 04; Independent: 02, Shared with Dr. Rajib K. Mitra: 02.

Publications in Journals

1. K. Neeraj, S. Choudhury, D. Polley, R. Acharya, J. Sinha, **A. Barman,** and R. K. Mitra; *Efficient Terahertz Anti-Reflection Properties of Metallic Anti-Dot Structures;* Optics Letters; 2017; **42;** 1764.
2. N. Samanta, D. Das Mahanta, S. Choudhury, **A. Barman** and R. K. Mitra; *Collective Hydration Dynamics in Some Amino Acid Solutions: A Combined GHz-THz Spectroscopic Study;* J. Chem. Phys.; 2017; **146;** 125101.
3. D. Polley, A. Patra, **A. Barman** and R. K. Mitra; *Terahertz Conductivity Engineering in Surface Decorated Carbon Nanotube Films by Gold Nanoparticles;* Applied Optics; 2017; **56;** 1107.
4. K. Adhikari, S. Choudhury, R. Mandal, S. Barman, Y. Otani and **A. Barman;** *Bias Field Tunable Magnetic Configuration and Magnetization Dynamics in $Ni_{80}Fe_{20}$ Nano-cross Structures with Varying Arm Length;* J. Appl. Phys.; 2017; **121;** 043909.
5. S. Bhardwaj, A. Pal, K. Chatterjee, P. Chowdhury, S. Saha, **A. Barman,** T. Rana, G. D. Sharma and S. Biswas; *Electrophoretic deposition of plasmonic nanocomposite for the fabrication of dye-sensitized solar cells;* Indian Journal of Pure & Applied Physics; 2017; **55;** 73.
6. D. Polley, **A. Barman** and R. K. Mitra; *Diameter-Dependent Shielding Effectiveness and Terahertz Conductivity of Multiwalled Carbon Nanotubes;* Journal of the Optical Society of America B; 2016; **33,** 2430.
7. S. Mondal, S. Choudhury, S. Barman, Y. Otani and **A. Barman;** *Transition from Strongly Collective to Completely Isolated Ultrafast Magnetization Dynamics in Two-Dimensional Hexagonal Arrays of Nanodots with Varying Inter-dot Separation;* RSC Advances; 2016; **6;** 110393.
8. S. Pan, S. Mondal, T. Seki, K. Takanashi, and **A. Barman;** *Influence of thickness-dependent structural evolution on ultrafast magnetization dynamics in $Co_2Fe_{0.4}Mn_{0.6}Si$ Heusler alloy thin films;* Phys. Rev. B; 2016; **94;** 184417.
9. S. Barman, S. Saha, S. Mondal, D. Kumar and **A. Barman;** *Enhanced Amplification and Fan-Out Operation in an All-Magnetic Transistor;* Scientific Reports; 2016; **6;** 33360.
10. A. K. Chaurasiya, C. Banerjee, S. Pan, S. Sahoo, S. Choudhury, J. Sinha and **A. Barman;** *Direct Observation of Interfacial Dzyaloshinskii-Moriya Interaction from Asymmetric Spin-wave Propagation in W/CoFeB/ SiO_2 Heterostructures Down to Sub-nanometer CoFeB Thickness;* Scientific Reports; 2016; **6;** 32592.
11. C. Banerjee, S. Pal, M. Ahlberg, T. N. Anh Nguyen, J. Åkerman, and **A. Barman;** *All-optical Study of Tunable Ultrafast Spin Dynamics in [Co/Pd]/NiFe Systems: The Role of Spin-Twist Structure on Gilbert Damping;* RSC Advances; 2016; **6;** 80168.
12. C. Banerjee, L. Ming Loong, S. Pal, X. Qiu, Y. Hyunsoo, and **A. Barman;** *Improvement of Chemical Ordering and Magnetization Dynamics of Co-Fe-Al-Si Heusler Alloy Thin Films by Changing Adjacent Layers;* RSC Advances; 2016; **6;** 77811.
13. K. Mukherjee, **A. Barman** and R. Biswas; *Impact of the Aggregation Behaviour of Sodium Cholate and Sodium Deoxycholate on Aqueous Solution Structure and Dynamics: A Combined Time Resolved Fluorescence and Dielectric Relaxation Spectroscopic Study;* J. Mol. Liq.; 2016; **222;** 495.
14. S. Choudhury, S. Saha, R. Mandal, S. Barman, Y. Otani, and **A. Barman;** *Shape- and Interface-Induced Control of Spin Dynamics of Two-dimensional Bicomponent Magnonic Crystals;* ACS Appl. Mater. Interfaces; 2016; **8;** 18339.
15. N. Hasegawa, S. Sugimoto, D. Kumar, S. Barman, **A. Barman,** K. Kondou, and Y. Otani; *Observation of anisotropic energy transfer in magnetically coupled magnetic vortex pair;* Appl. Phys. Lett.; 2016; **108;** 242402.
16. R. K. Upadhyay, S. Pan, **A. Barman,** J. A. Mclaughlin, and S. S. Roy; *Oil swollen surfactant gel based synthesis of metal oxides nanoparticles: An attractive alternative for the conventional Sol gel synthesis;* Ceramics International; 2016; **42;** 12119.
17. B. Samantaray, A. K. Singh, C. Banerjee, **A. Barman,** A. Perumal, and P. Mandal; *Perpendicular standing spin wave and magnetic anisotropic study on amorphous FeTaC films;* IEEE Trans. Magn.; 2016; **52;** 2003104.

Lectures Delivered

1. Ultrafast Magnetization Dynamics in Artificially Structured Ferromagnetic Nanomaterials for Applications in Spintronics and Magnonics, **A. Barman,** MRSI Medal Lecture, IIT Bombay, 13-15 Feb, 2017.
2. Magnetization Dynamics: From Theory to Experiment, **A. Barman,** Science Academies' Lecture Workshop "Recent Trends in Physics", St. Xaviers College, Kolkata, 10-11 Feb, 2017.
3. Interface Controlled magnetization Dynamics in ferromagnetic/Nonmagnetic Bilayer Thin Films, **A. Barman,** 61st DAE Solid State Physics Symposium, Bhubaneswar, 26-30 Dec, 2016.
4. Seeing and Tailoring Spin Dynamics on Ultrafast Time Scale, **A. Barman,** Institute Seminar, NISER, Bhubaneswar, 8 Dec, 2016.
5. Interface Controlled Magnetization Dynamics in Ferromagnet/Nonmagnet Bilayer Thin Films, **A. Barman,** Indo-Japan Workshop on Magnetism at the Nanoscale, Sendai, Japan, 1-2 Dec, 2016.
6. Femto- and Picosecond Spin Dynamics in Ferromagnetic Thin Films, Multilayers and Nanostructures, **A. Barman,**

Ultrafast Science 2016 (UFS-2016), BARC, Mumbai, 24-26 Nov, 2016.

7. Optical, Thermal and Spin Torque Induced Magnetization Dynamics in Ferromagnetic Nanostructures and FM/NM Bilayers, **A. Barman,** IUMRS-ICEM 2016 Conference, Suntec City, Singapore, 4-8 July, 2016.
8. Optical, Thermal and Spin Torque Induced Magnetization Dynamics in Ferromagnetic Nanostructures and Multilayers, **A. Barman,** Inhouse Meeting, Physics Department, University of Calcutta, 20-21 Jun, 2016.

Membership of Committees

External Committee

Member of Faculty Selection Committee of Jadavpur University; Member of Executive Committee of MRSI- Kolkata Chapter; Expert for PhD Thesis Examination Committee at NISER Bhubaneswar and LNMIIT Jaipur.

Internal Committee

Member of Admission Committee; Member of Works Committee; Member of Faculty Search Committee; Member of Technical Cell Advisory Committee; Convener of the Thematic Unit of Excellence on Nanodevice Technology at the S. N. Bose Centre; Convener of the Advanced Spectro-Microscopy Unit at the S. N. Bose Centre.

Awards / Recognitions

1. MRSI Medal, 2017

Fellow / Member of Professional Body

1. Life Member of MRSI.
2. Member of IEEE.

Sponsored Projects

1. Project Title: 3D Nanomagnetic Crystal Fabrication for Advanced Microwave Devices and Water Treatment

   Funding Agency: EPSRC Global Challenges Research Fund jointly with Cardiff University, UK.

   Principal Investigator: Sam Ladak and Anjan Barman 2016

2. Project Title: Nanoscale Modifications and Active Control of Magnonic Crystals for On-Chip Microwave Communication

   Funding agency: DST under India-Poland Collaborative Research Project

   Principal Investigator: Anjan Barman. 2015-18.

3. Project Title: Advanced Spectro-Microscopy for Novel Materials

   Funding agency: S. N. Bose National Centre for Basic Sciences

   Principal Investigator: Anjan Barman, Co-PI, Ranjit Biswas, Rajib K. Mitra, Manik Pradhan. 2012-17

4. Project Title: Thematic Unit of Excellence on Nanodevice Technology

   Funding Agency: Nano Mission, DST

   Convener: Anjan Barman, Members: A. K. Raychaudhuri, Rajib K. Mitra, Manik Pradhan 2011-17

Conference / Symposia / Workshops / Seminars etc. organized

1. Indo-Japan Workshop on Magnetism at the Nanoscale under DST-JSPS S&T Programme at Tohoku University, Sendai, Japan 1-2 Dec, 2016

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

National

1. Prof. Prabhat Mandal (Sl. No. 17)
2. Dr. Susanta SinhaRoy (Sl. No. 16)
3. Dr. Subhayan Biswas (Sl. No. 5)

International

1. Prof. Yoshichika Otani (Sl. No. 4, 7, 14, 15)
2. Prof. Johan Akerman (Sl. No. 11)
3. Prof. Koki Takanashi (Sl. No. 8)
4. Prof. Takeshi Seki (Sl. No. 8)
5. Prof. Hyunsoo Yang (Sl. No. 12)

Member of Editorial Board

1. Editorial Board member of Scientific Reports

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; 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. Shape and Interface Induced Control of Spin Dynamics of Two-dimensional Bi-component Magnonic Crystals: We have fabricated two-dimensional bi-component magnonic crystals (BMCs) in form of embedded $Ni_{80}Fe_{20}$ nanostructures in $Co_{50}Fe_{50}$ thin films by nanolithography.

The spin-wave spectra showed significant variation as the shape of the embedded nanostructure changes from circular to square. Significantly, in both shapes, a minimum in frequency is obtained at a negative value of bias field during the field hysteresis **(Fig. 1)** confirming the presence of a strong exchange coupling at the interface between the two materials, which increases the spin-wave propagation velocity in such structures leading to faster GHz frequency magnetic communication and logic devices. The spin-wave frequencies and bandgaps show bias-field tunability, which is important for above device applications.

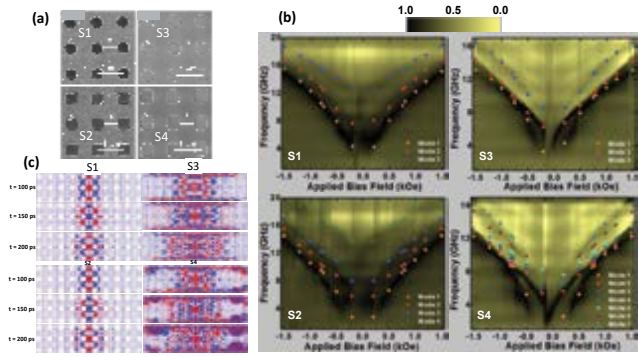

Fig. 1. (a) Scanning Electron Micrographs of antidot lattices (S1, S2) and bicomponent magnonic crystals (S3, S4) of two different shapes. Dispersion of spin-wave frequency with applied bias-field for all four lattices. (c) Simulation results of spin-wave propagation in S1 and S3.

b. Ultrafast Magnetization Dynamics of Heusler Alloy Thin Films: We experimentally investigated thickness (t) dependent evolution of structural and magnetic properties in $Co_2Fe_{0.4}Mn_{0.6}Si$ (CFMS) thin films and correlate them with ultrafast demagnetization time, relaxation time and Gilbert damping coefficient (α). Structural ordering and magnetic parameters, including α, exhibit a non-monotonic variation with increasing *t*. A remarkably low value of α of 0.009 is obtained for the CFMS film with t = 20 nm without any buffer layers, which helps to avoid possible diffusion of buffer layer into CFMS. Highest saturation magnetization, lowest coercivity and α value imply CFMS film with t = 20 nm is most suitable for integrated spintronics devices. Finally, unique band structure controlled demagnetization and fast relaxation in half-metallic CFMS is correlated to α.

We also demonstrated an improvement of chemical ordering and magnetic properties of $Co_2FeAl_{0.5}Si_{0.5}$ (CFAS) Heusler alloy thin films, and investigated the correlation between these two, to elucidate the influence of different capping-layers and under-layers. The structural characterization reveals a variation in the surface roughness, grain size and the chemical ordering. The Gilbert damping constants show a broad tunability with the chemical order. A Gilbert damping constant as low as about 0.002 has been found. The observed effects can be attributed to the different melting points of the under-layers and thermal expansion stress between the adjacent layers and CFAS thin films.

c. Direct Observation of Interfacial Dzyaloshinskii-Moriya Interaction Using Brillouin Light Scattering: Interfacial Dzyaloshinskii-Moriya interaction (IDMI) is important for its roles in stabilizing the skyrmionic lattice as well as soliton-like domain-wall motion leading towards new generation spintronic devices. However, achievement and detection of IDMI is often hindered by various spurious effects. We have demonstrated pure IDMI originating from W/CoFeB interface in W/CoFeB/SiO_2 heterostructures using Brillouin light scattering technique **(Fig. 2)**. The DMI constant is found to scale as the inverse of CoFeB thickness, over the whole studied thickness range, confirming the presence of pure IDMI in our system without any extrinsic effects. The W/CoFeB interface shows no degradation down to sub-nanometer CoFeB thickness, which would be useful for devices.

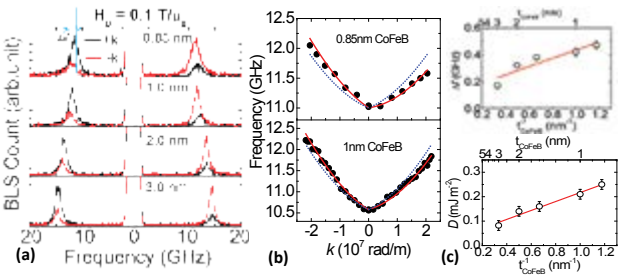

Fig. 2. (a): Asymmetric spin-wave propagation in the Damon-Eshbach geometry for W(2 nm)/CoFeB(*t*) /SiO2 heterostructures with varying CoFeB thickness. Asymmetric spin-wave dispersion for two values of CoFeB thickness (symbols: experimental data; solid red line: theoretical fit with DMI term; dotted line: theoretical fit without the DMI term in the effective field. (c) Frequency difference between two counter-propagating spin wave (top panel) and the extracted DMI constant *D* as a function of CoFeB thickness.

d. Experimental and Numerical Studies of Magnetic Vortex Transistor: Development of all-magnetic transistor with favorable properties is an important step towards a new paradigm of all-magnetic computation. Recently, we showed such possibility in a Magnetic Vortex Transistor (MVT). We further demonstrated enhanced amplification in MVT achieved by introducing geometrical asymmetry in a three vortex sequence. The resulting asymmetry in core-to-core distance in the three vortex sequence led to enhanced amplification of the MVT output. A cascade of antivortices travelling in different trajectories including a nearly elliptical trajectory through the dynamic stray field is found to be responsible for this amplification. This is further used for a successful fan-out operation.

Further, we have experimentally investigated the energy transfer and storage in the magnetostatically coupled vortices in a pair of disks. We observed a specific gyrating motion due to anomalous energy storage at the off-resonance frequency. Micromagnetic simulations revealed that the behavior arises from the modulation of effective damping constant of the pair disks, originating from the phase difference between coupled vortex cores. The above observations promote the magnetic vortex transistors to be used in complex circuits and logic operations.

Proposed research activities for the coming year

a. Investigation of Magnonic Band Structure in Co/Pd Stripe Domain System for Energy Efficient Spin Wave Propagation:

By combining Brillouin Light Scattering and numerical simulations we will investigate the spin-wave dynamics of a Co/Pd thin film multilayer, featuring stripe domain structure at remanence. The domain walls can cause scattering of bulk and surface spin-wave modes similar to one dimensional magnonic crystal towards development of energy efficient magnonic crystal.

b. Development of Pseudo One-Dimensional Magnonic Crystal for High Frequency Nanoscale Devices:

We will develop array of asymmetric sawtooth shaped width modulated nanoscale ferromagnetic waveguides forming a pseudo one-dimensional magnonic crystal. Control over the internal field distribution as well as the dispersion properties would find potential applications in dynamic spin wave filters and magnonic waveguides.

c. All-optical Detection of Spin Hall Angle in W/CoFeB/SiO2 Heterostructures by Varying Tungsten Layer Thickness:

We will employ a novel all-optical time-resolved magneto-optical Kerr microscope for unambiguous determination of SHA in W/CoFeB/SiO_2 heterostructures using the principle of modulation of Gilbert damping of the adjacent ferromagnetic layer by the spin-orbit torque from the W layer. The effects of structural phase transition of W with varying thickness and spin diffusion length in W will be thoroughly studied.

d. Spin Waves in Two-Dimensional Quasi-Periodic Magnonic Crystal:

We will develop two-dimensional ferromagnetic antidot lattices arranged in the octagonal lattice which can be considered as quasi-periodic magnonic crystals. A rich variation in the spin wave spectra is expected with the variation of lattice constant as well as the strength and orientation of the bias magnetic field. In addition to this, possibility of observation of eight-fold anisotropy will be investigated.

e. Observation of Skyrmions at Room Temperature in Heusler Alloy Ultrathin Films:

Magnetic skyrmions are topological spin structure having immense potential for energy efficient spintronic devices. However, observation of skyrmions at room temperature is limited to patterned nanostructures. We will investigate stable skyrmions at room temperature and zero external magnetic field in unpatterned Heusler alloy based thin film heterostructures with strong interfacial Dzyaloshinskii-Moriya interaction employing the magnetic force microscopy.

Arup Kumar Raychaudhuri

Distinguished Professor Emeritus
CMPMS
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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. Rishiram Ghimire, "Investigation of opto-electronic phenomena in nanostructured ZnO with electric double layer gate", Completed.
2. Ravindra Singh Bisht, "Investigation of metal-insulator transition in 3d and 5d transition Metal Oxides", Ongoing.
3. Shaili Seth, "Investigation of transport properties in Germanium Nanowires", Ongoing.
4. Vibhuti Narayan Rai, "Electrical Transport and Phase Transitions in nanowires of Charge transfer complex nanowire CuTCNQ", Ongoing.
5. Subhamita Sengupta, "Physical Properties of interface of Ferroelectric and Ferromagnetic films", Ongoing.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Sumit Kumar Singh, IIT/Kharagpur, "Fabrication and Photoconductivity of Si Nanowires fabricated on SOI wafers", Completed.

Post Doctoral Research Scientists

1. Pabitra Mandal
2. Jashashree Ray

Teaching activities at the Centre

1. 1st semester. PH 191 Basic Laboratory-I I.PhD Year 1, 9, Dr. Soumen Mondal
2. 3rd semester , PH 391 Methods of Experimental Physics , IPHD Year 2, 7, Dr. Barnali Ghosh, Dr.Kalyan Mandal and others

Publications in Journals

1. Sudeshna Samanta, Deepika Saini, Achintya Singha, Kaustuv Das, Prabhakar R. Bandaru, Apparao M. Rao, and **Arup Kumar Raychaudhuri;** *Photoresponse of a Single Y Junction Carbon Nanotube;* ACS Applied Materials and Interfaces; 2016; **8**; 19024.
2. Rabaya Basori, Manoranjan Kumar and **Arup K. Raychaudhuri;** *Sustained Resistive Switching in a Single Cu:7,7,8,8-tetracyanoquinodimethane Nanowire: A Promising Material for Resistive Random Access Memory;* Scientific Reports; 2016; **6;** 26764.
3. Aveek Bid and **A.K Raychaudhuri;** *Structural instability and phase co-existence driven non-Gaussian resistance fluctuations in metal nanowires at low temperatures;* 2016; Nanotechnology; **27;** 455701.
4. Rajesh Kumar Neogy, Rajib Nath, **A.K. Raychaudhuri;** *Thermal transport enhancement in gold nanofluid containing network like structure;* Materials Chemistry and Physics; 2017; **186;** 478.
5. Rishi Ram Ghimire, **A.K. Raychaudhuri;** *High performance thin film transistor (flex-TFT) with textured nanostructure ZnO film channel fabricated by exploiting electric double layer gate insulator;* Appl. Phys. Lett.; 2017; **110;** 052105.
6. Samt K Ray, Ajit K Katiyar and **A. K Raychaudhuri;** *One-dimensional Si/Ge nanowires and their heterostructures for multifunctional applications - a review;* Nanotechnology; 2017; **28;** 092001.
7. Shaili Sett, K Das and **A K Raychaudhuri;** *Weak localization and the approach to metal–insulator transition in single crystalline germanium nanowires;* J. Phys.: Condens. Matter.; 2017; **29;** 115301.
8. Soumen Dhara and **A. K. Raychaudhuri;** *Enhancement in red emission at room temperature from europium doped ZnO nanowires by 1,10 phenanthroline-europium interface induced resonant excitations;* AIP Advances; 2017; **7;** 025306.
9. Ravindra Singh Bisht, Sudeshna Samanta and **A. K. Raychaudhuri;** *Phase coexistence near the metal-insulator transition in a compressively strained $NdNiO_3$ film grown on $LaAlO_3$: Scanning tunneling, noise, and*

impedance spectroscopy studies; Physical Review B; 2017; **95;** 115147.

10. Shaili Sett, K. Das, and **A. K. Raychaudhuri;** *Investigation of factors affecting electrical contacts on single germanium nanowires;* Journal of Applied Physics; 2017; **121;** 124503.

Lectures Delivered

1. Metal Insulator Transition Revisited; Cornell University; May 2016 -1.
2. An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide films; SNBNCBS International Conference; January 2017-1.
3. Experimenting with Single nanowires: A new paradigm to do materials science; University of Southern Florida, USA; June 2016 -1.
4. Experimenting with Single nanowires: Physics and Applications; IGCAR, Kalpakkam; August 2016-1.
5. Synthesis of Charge transfer complex nanowires and its application in ultra-sensitive electronic devices; 12th IUPAC Conference, Changsha, China; October 2016-1.
6. Experimenting with single nanowires: Physics and application issues; International Workshop on Advanced Materials and Nanotechnology, Hanoi, Vietnam; November 2016-1.
7. A lonely nanowire and its broad vision; Annual Day Lecture, UGC-DAE Consortium of Research; December 2016.
8. Experimenting with single nanowires: A new paradigm of doing nanoscience and technology; International Conference on Emerging Trends in Nanomaterials Science & Technology, NIT, Dimapur; January 2017-1.
9. Photodetectors Switches and Nanowires: A single nanowire Paradigm; Nano India 2017, IIT,Delhi; March 2017-1.
10. Endless surprises of Metal Insulator Transition: Physics and Application Potentials; IIT, Kharagpur; March 2017-3.

Membership of Committees

External Committee

1. Member of Board , Science and Engineering Research Board
2. Chairman, Scientific Advisory Committee, UGC-DAE Consortium of Research, Indore
3. Member, Governing Board and Governing Council, UGC-DAE Consortium of Research, Indore
4. Convenor, Sectional committee VI- INSA;
5. Chairman, PAC of Physics , International Division (DST)
6. Programme Advisory Committee , Solar Energy Research Initiative (DST);
7. Programme Management Committee , SERIUS, Indo-US Science and Technology Forum;
8. Member Faculty Selection Committee at IISER and IIT's.
9. Member expert committee on different topics in DST
10. Member delegation to Indo-US Joint Commission on S&T.

Internal Committee

Nodal officer, Technical Research Centre, SNBNCBS

Patent/s submitted / granted

1. Ammonia Gas Sensor and A Method for Manufacturing The Same; Avisek Maity, Barnali Ghosh, A.K.Raychaudhuri; Submitted on 03/01/2017

Awards / Recognitions

1. J.C. Bose fellowship 2nd renewal

Fellow / Member of Professional Body

Fellow: Indian National Science Academy, New Delhi; Indian Academy of Sciences, Bangalore; National Academy of Sciences, Allahabad; Asia Pacific Academy of Materials;

Members: American Physical Society; Materials Society of India; Indian Physics Association; Indian Association of Physics Teachers; Instrumentation Society of India

Sponsored Projects

1. Unit for Nanoscience, Nanomission, March 2011-October 2016
2. Theme Unit of Excellence in Nanodevice ,Nanomission, Technology, October 2011-April 2017
3. J.C Bose Fellowship, SERB, June 2006- February 2020,
4. An investigation on certain emerging aspects of Metal-Insulator Transition in thin oxide films, SERB, March 2017-March 2020
5. 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)

National

1. Dr. Aveek Bid, IISC (Sl. No. 3)
2. Dr. Achintya Singha (Sl. No. 1)

International

1. Dr. Deepika Saini, Prof. Prabhakar R. Bandaru, Prof. Apparao M. Rao (Sl. No. 1)

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 2016-17, include electronic and optoelectronic properties of Ge nanowires, Y-Jn CNT and Au functionalized ZnO nanowires, Fluctuations in metal nanowires, Phase -coexistence near metal-insulator transition in correlated oxides
- Research Keywords: Nanomaterials, Nanolithography, Correlated electron systems, Optoelectronics

Interesting results obtained

1. We report an observation of phase coexistence near the metal-insulator transition (MIT) in a film of NdNiO3 grown on crystalline substrate LaAlO3. This was established through a combination of three techniques, namely, scanning tunneling spectroscopy, 1/f noise spectroscopy, and impedance spectroscopy experiments. The spatially resolved scanning tunneling spectroscopy showed that the two coexisting phases have different types of density of states (DOS) at the Fermi level. One phase showed a depleted DOS close to EF with a small yet finite correlation gap, while the other coexisting phase showed a metal-like DOS that had no depletion. The existence of the phase separation leads to a jump in the resistance fluctuation (as seen through 1/f noise spectroscopy) at the transition, and, notably, the fluctuation becomes non-Gaussian. This was corroborated by the impedance spectroscopy, which showed a broad hump in capacitance at the transition region as a signature of the existence of two phases. The phase separation starts well within the metallic phase much above the transition temperature and makes the sample electronically "inhomogeneous" in nanoscopic scale.
2. We study the low-temperature electronic transport properties of single germanium nanowires (NWs) with diameters down to 45 nm to investigate the weak localization (WL) behavior and approach to metal–insulator transition (MIT) within them. The NWs (single crystalline) we investigate lie on the metallic side of the MIT with an extrapolated zero temperature Conductivity $\sigma 0$ in the range 23 to 1790 (Ohm cm)−1 and show a temperature-dependent conductivity which below 30 K can be described by a 3D WL behavior. From the observed value of $\sigma 0$ and the value of the critical carrier concentration nc, it is observed that the approach to MIT can be described by the scaling equation $\sigma 0 \sim (n - nc)^{\nu}$ with $\nu \approx 0.6$, which is a value expected for an uncompensated system. The investigation establishes a NW size limit for the applicability of 3D scaling theories.
3. We investigated optical response in a single strand of a branched a Y-junction CNT composed of multiwalled CNTs. The experiment was performed by connecting a pair of branches while grounding the remaining one. Of the three branch combinations, only one combination is optically active which also shows a nonlinear semiconductor-like I–V curve, while the other two branch combinations are optically inactive and show linear ohmic I–V curves. The photoresponse includes a zero-bias photocurrent from the active branch combination. The photoresponse experiment allows us to understand the nature of internal connections in the Y-CNT. Analysis of data locates the region of photoactivity at the junction of only two branches and only the combination of these two branches (and not individual branches) exhibits photoresponse upon illumination. A model calculation based on back-to-back Schottky-type junctions at the branch connection explains the I–V data in the dark and shows that under illumination the barriers at the contacts become lowered due to the presence of photogenerated carriers.

Proposed research activities for the coming year

In the year to come we will investigate the metal insulator transition in correlated oxide films (preferably very thin within few unit cells) using such tools as low temperature measurements down to 0.3K, 1/f noise spectroscopy , Scanning Tunneling Microscopy as well as impedance spectroscopy.

We will also investigate single nanowire photo-detectors using vapor phase grown Ge nanowires and in particular, investigate their very large responsivity in the near IR region upto 1600nm. This work will also couple to investigation of weak localization phenomena in Ge nanowire through low temperature conductivity and magnetoresistance measurements.

In an attempt to understand the interface of ferroelectric and ferromagnetic materials, we will grow 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). The challenge of making a sharp interface and growing film of proper stoichiometry will be addressed to.

We will also study functionalization of ZnO nanowires with Au nanoparticles and will explore whether their performance as a photo-detector can be extended to visible range of the spectrum.

We will also investigate likely occurrence of Bose –Einstein Condensation of Magnons in Gd nanostructured films.

We will also investigate whether current induced magnetization reversal can be observed in nanoconstrictions of few hundred nanometer in Gd nanowires, nanofabricated by nanolithography tools and will also explore whether this can be used for making measurements of anisotropy energy.

We will also would do deliverable specific research in TRC projects.

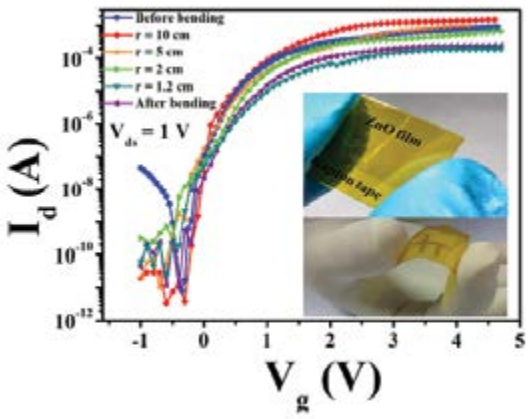

Fig.1: Flexible Thin Film Transistor High performance flexible thin film transistor (flex-TFT) with textured nanostructure ZnO film channel fabricated on Kapton using electric double layer gate insulator

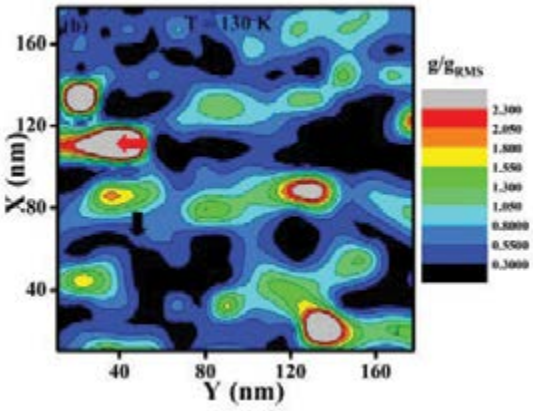

Fig.2: Nanoscopic phase separation on $NdNiO_3$ film grown on $LaAlO_3$ near MI transition Local tunneling conductance map at 130 K taken in UV The data are plotted as normalized conductance g /grms .. The red and black arrows show the highest and lowest g regions, respectively.

Barnali Ghosh (Saha)

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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 Scineces 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 associate Nodal Officer. Her research interest is Physics of Complex oxide systems and in nano materials.

Supervision of Research / Students

Ph.D. Students

1. Subarna Datta (submitting July 2017)
2. Samik Roy Moulik (part time) (will submit soon)
3. Chandan Samanta (Ongoing)
4. Avisek Maity (Ongoing)

Post Doctoral Research Scientists

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, Ankita Ghatak and **Barnali Ghosh;** *Manganite ($La_{1-x}A_xMnO_3$; A = Sr, Ca) nanowires with adaptable stoichiometry grown by hydrothermal method: understanding of growth mechanism using spatially resolved techniques;* J Mater Sci.; 2016; **51;** 9679.
2. Samik Roy Moulik, Ankita Ghatak, **Barnali Ghosh;** *Study of surface chemistry and microstructure of TiO_2 nanostructures on Pt(111)/Si wafer and FTO glass substrates: A comparative approach;* Surface Science; 2016; **651;** 175-181.
3. Abhijit Maity, Mithun Pal, Sanchi Maithani, **Barnali Ghosh,** Sujit Chaudhuri and Manik Pradhan; *Molecular hydrogen in human breath: a new strategy for selectively diagnosing peptic ulcer disease, non-ulcerous dyspepsia and Helicobacter pylori infection;* Journal of Breath Research; 2016; **10;** 036007.

Lectures Delivered

1. Special seminars organized by the Department of Physics, Lady Brabourne College in April 8, 2016, two lectures.
2. BIT's 5th Annual World Congress of Advanced Materials-2016 (WCAM-2016), on 6-8, June, 2016 in Chongqing, China, one lecture.
3. National Conference on Condensed Matter Physics-2017, Indian Statistical Institute, Kolkata, 1 -3 February, 2017, two lectures.

Other Academic / Educational Activities

1. National Science day program: On 28.2.17, National Science Day celebration, total 120 number of students from various Colleges and University visited our sophisticated instruments like, X-Ray Diffractometer, Scanning Electron Microscope, VSM, Atomic Force Microscope, 1000 class clean room along with various lithographic facilities, under Central Equipment Facilities, Technical Cell. Students from Lady Brabourne College, Presidency University, Narendrapur Ramkrishna Mission, Serampore Girls college visited laboratories.
2. C.K. Majumdar Workshop: 30 number of participants in C. K. Majumdar Memorial Summer Workshop (during 23 May-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 4 days, during 29 May-01 June, 2017. They have performed experiments successfully.
3. Special lecture on fabrication of nanostructures and various lithographic techniques using various sophisticated tools was delivered at Lady Brabourne College, Kolkata (during April 2016), 40 students (graduate and post graduate) attended the seminar.
4. Special lectures on tuning of size and shape, morphology tailoring issues of different nanostructures and making of devices with single nanowires using different lithographic techniques and their measurements was

given in the Laboratory for Manufacturing System Engineering School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, China, June 2016.

Membership of Committees

Internal Committee

Various committees related to Technical cell; Various purchase committees; Associate Nodal Officer, Technical Research Centre.

Patent/s submitted / granted

1. Ammonia Gas Sensor and a method for manufacturing the same; Avisek Maity, Arup Kumar Raychaudhuri, Barnali Ghosh; Application no: 201731000270; Patent filed: 3/01/2017; Published online: 10/02/17.

Fellow / Member of Professional Body

1. Indian Physics Association
2. Indian Association for the Cultivation of Science

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

Significant research output / development during last one year

General research areas and problems worked on

Part A: Technology development based research

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

Part B: Basic Research:

- Growth of high performance thin film transistors (TFT) and physical property study
- Growth and physical property study of perovskite lead hallide
- Synchrotron X-ray and Neutron diffraction study in complex oxides.
- Growth of binary and complex oxide nanowires and thin films by using different techniques like; wet chemistry and pulsed laser deposition methods.
- Fabrication of single nanowire device of complex oxide systems by using different lithographic techniques and transport measurement on single nanowire.
- cross-sectional TEM study in binary and complex oxide nanowires, nanocrystals and thin films
- Study of Photoresponse and gas sensing property in binary oxide systems.

Interesting results obtained

The nature of work has two distinct regions:

a) Academic nature: Research activities along with 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

a) Academic work:

Part A: Technology development based Research:

1. Hazardas Gas like Ammonia detection down <10ppm level from atmosphere based on visual colour change without any other peripherals. Test system developed for proof of concept (Patent filed, Ref. "Patent/s submitted / granted" section)

Part B: Basic Research:

1. Fabrication thin film transistor (TFT) on a flexible substrate using polymer electrolyte as gate dielectric with oxide semiconductor channel: Present work is related to the field of flexible semiconductor devices using electrolyte as gate dielectric. More specifically, the present invention is directed towards development of flexible thin Film Transistor (Flex-TFT) with nanostructure/ polycrystalline/amorphous oxide semiconductors as a channel material, which has been fabricated at low temperature retaining high channel mobility. The flexible Thin Film Transistor (Flex-TFT) that uses electrolyte as gate dielectric is adapted to operate at very low voltage, which will allow its operation to be supported by any low voltage source such as a battery. This would make it particularly suitable for use in any mobile and wireless electronic platforms having limited power/voltage source. Fabrication of oxide semiconductor channel was done by using wet chemistry and by pulsed laser Deposition technique and making the device done by optical lithography technique. (patent filed and paper submitted)
2. Surface chemistry and microstructural study of binary oxide vertically aligned nanostructures on different substrates: study of surface and interfaces: The thin film and nanowire of complex and binary oxides grown by Pulsed laser deposition and wet chemistry route. The cross section of the film has been done by focused ion beam assisted lithography technique. A precise electron microscopy analysis i.e, structural simulation by Java Electron Microscopy Software (JEMS) which provides knowledge on growth direction, epitaxy of the materials with respect to the substrate and simulation of the data for understanding the physical property at the interface.

Finally, the physical properties in terms of the interface of the multilayered materials be done (paper published).

3. Understanding of growth mechanism in provskite oxide nanostructures and size, shape tailoring issues: We report an investigation to understand the basic growth mechanism of family of perovskite oxide manganite nanostructures in cost-effective hydrothermal route, which adds a new dimension in the low-temperature range (230–300°C) synthesis route of complex oxide system. We adapt size, shape, and composition control issues, the general principle of growth of nanocrystals and its controllable length scale tailoring are explained and most importantly, how the amount of mineralizer tunes the shape and size of the nanostructures has been discussed. Mechanism of shape and size tuning followed by a phase diagram has been proposed. Understanding of detailed interaction mechanisms of perovskite oxide manganite is definitely promising for rationally designing various kinds of inorganic materials in controllable length scale via wet chemistry route. (paper published)
4. Electrical transport measurement of single nanowire based devices of complex oxides: Along with the study on ensemble of nanowires where size dispersion issues may arise, we have explored single nanowire based transport measurement to resolve the size dispersion issues and also performed single nanowire 1/f noise spectroscopy study with the aim to understand magnetic phase separation in manganite system. The single nanowire based device of complex oxide nanowires was be made by using electron beam and ion beam lithography and transport measurement by using four probe technique.

b) Administrative work:

Work done other than research activities: As a Scientist in-change of Technical cell, I have to be actively involved in the instrumental facility management and equipment installation. (Ref. "Any Other matter" section below)

Proposed research activities for the coming year

Part A: Technology development based Research:

1. Development of the visual hazarders gas senor into a proof of concept demonstration product; Making design of low cost product
2. Use of ion beam for inspection of faulty VLSI: Work has already been initiated. It has potential as a revenue earner

Part B: Basic Research

1. Regeneration of ferroelectric phase by surface and sub-surface engineering of perovskite oxide thin films: Details growth and surface and interfacing properties of complex oxide thins films would be done to understand the exact cause of degradation of ferroelectric and dielectric properties of a ferroelectric materials by complete analysis by number of tolls , the work will provide in-depth knowledge about the tuning of physical properties of a dielectric system.
2. Crystallographic structural study using synchrotron and Neutron diffraction experiments: Size reduction induced modification of magnetic property leading to phase separation and its correlation with crystallographic structure in 1D nanostructures of complex oxide systems would be studied by synchrotron and Neutron diffraction experiments
3. Growth and physical property study of perovskite lead halide thin films and nanostructures: Growth of perovskite halide is being done by using wet chemistry route, understanding of physical properties will be done in details.
4. Size induced transport properties in complex oxide nanostructures: The transport properties of single nanowires of different diameters will be measured by making devices using ion beam and e-beam lithographic techniques.

Any other matter

50% of time spent 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:

1. Maintenance of equipments;
2. Purchase and installation of new instruments;
3. Up-gradation of existing instruments under Technical cell;
4. Have to supervise smooth inflow of consumables and supplies that is needed for smooth running of the facility;
5. 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.

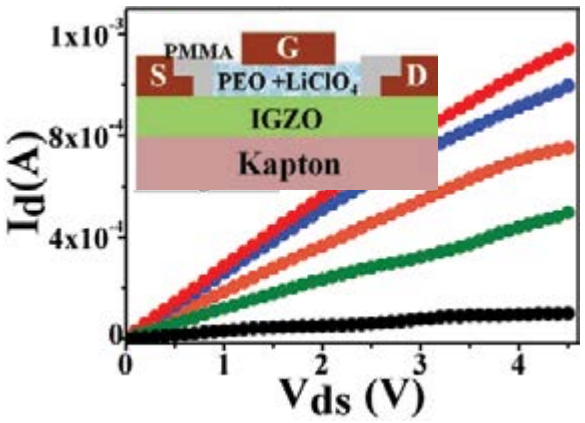

Fig 1. Schematic diagram of the cross section of a flexible TFT device (inset), Typical output characteristics of the device.

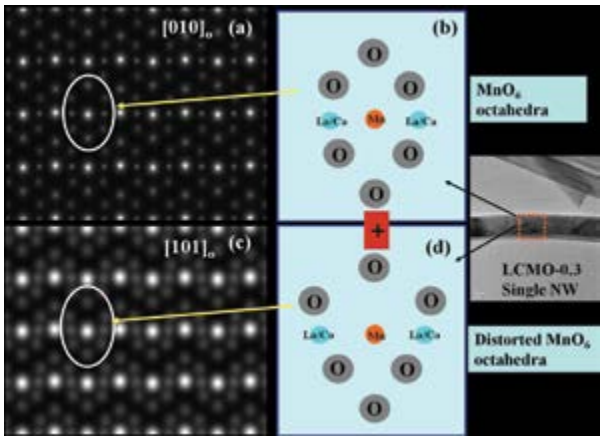

Figure 2. Generated HREM maps of manganite nanowire along the zone axis [010]0 and [101]0;respectively, showing the atomic co-ordinations. b and d, showing distortions in the MnO6 octahedra confirming the presence of twins.

Kalyan Mandal

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Professor Kalyan Mandal is a former student of Ramkrishna Mission (Asansol), Presidency College (Calcutta) 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. Arup Ghosh: "Magnetic, magnetocaloric and magnetotransport properties of Heusler alloys", awarded Ph.D. degree in August 2016
2. Rupali Rakshit: "Tuning of magnetic and electromagnetic response of 3d-transition metal oxide based magnetic nanostructures", Ph.D. thesis submitted in July 2016
3. Souvanik Talukdar: "Magnetic and optical properties of oxide nanomaterials", on-going
4. Indranil Chackraborty: "Bio-medical applications of oxide nanostructures", on-going
5. Mahebub Alam: "Multiferroic materials", on-going
6. Keshab Karmakar:"Energy materials", on-going

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Anupam Gorai, SNBNCBS: "Study of exchange-coupled core-shell nanostructures"
2. Shashank Gupta, SNBNCBS: "Study of multiferroic materials"
3. Priya Maity, Indian School of Mines: "Preperation and study of Co/ MnFe2O4 core-shell structure"

Post Doctoral Research Scientists

1. Madhuri Mandal

Teaching activities at the Centre

1. PHY 291, Basic experiments, second semester
2. PHY 391, Advanced experiments, third semester
3. PHY 409, Magnetism and superconductivity, fourth semester
4. PHY 601, Advanced Condensed Matter Physics-II, fourth semester

Publications in Journals

1. R. Das, S. Sharma and **K. Mandal;** *Aliovalent Ba^{2+} doping: A way to reduce oxygen vacancy in multiferroic $BiFeO_3$;* Journal of Magnetism and Magnetic Materials; 2016; **401**; 129-137.
2. A Sarkar, GG Khan, A Chaudhuri, A Das, **K Mandal;** *Multifunctional $BiFeO_3$/ TiO_2 nano-heterostructure: Photo-ferroelectricity, rectifying transport, and nonvolatile resistive switching property;* Applied Physics Letters; 2016; **108;** 033112.
3. M Alam, **K Mandal,** GG Khan; *Double perovskite Y_2NiMnO_6 nanowires: high temperature ferromagnetic-ferroelectric multiferroic;* RSC Advances; 2016; **6**; 62545-62549.
4. A. K. Singh, D. Sarkar, K. Karmakar, **K. Mandal,** and G. G. Khan; *High-Performance Supercapacitor Electrode Based on Cobalt Oxide-Manganese Dioxide-Nickel Oxide Ternary 1D Hybrid Nanotubes;* ACS Applied Materials and Interfaces; 2016; **8;** 20786-20792.
5. M Pal, R Rakshit, AK Singh, **K Mandal;** *Ultra high supercapacitance of ultra small Co_3O_4 nanocubes;* Energy; 2016; **103;** 481-486.
6. R. Rakshit, K. Serita, M. Tonouchi, **K. Mandal;** *THz conductivity of semi-insulating and magnetic $CoFe_2O_4$ nano-hollow structures through thermally activated polaron;* Journal of Applied Physics; 2016; **120;** 203901.
7. A. Sarkar, K. Karmakar, A. K. Singh, **K. Mandal** and G. G. Khan; *Surface functionalized $H_2Ti_3O_7$ nanowires engineered for visible-light photoswitching, electrochemical water splitting, and photocatalysis;* Physical Chemistry Chemical Physics; 2016; **18;** 26900-26912.
8. K. Karmakar, A. Sarkar, **K. Mandal** and G. G. Khan; *Stable and Enhanced Visible-Light Water Electrolysis Using C, N, and S Surface Functionalized ZnO Nanorod Photoanodes: Engineering the Absorption and Electronic Structure;* ACS Sustainable Chemistry & Engineering; 2016; **4;** 5693-

5702.

9. A. Ghosh, P. Sen and **K. Mandal;** *Measurement protocol dependent magnetocaloric properties in a Si-doped Mn-rich Mn-Ni-Sn-Si off-stoichiometric Heusler alloy;* Journal of Applied Physics; 2016; **119;** 183902.
10. A. K. Singh and **K. Mandal;** *Growth and Magnetic Characterization of 1D Permalloy Nanowires Using Self Developed Anodic Aluminium Oxide Templates;* Journal of Nanoscience and Nanotechnology; 2016; **16;** 994-997.
11. M. Alam, K. Karmakar, M. Pal and **K. Mandal**; *Electrochemical supercapacitor based on double perovskite Y_2NiMnO_6 nanowires;* RSC Advances; 2016; **6;** 114722.

Lectures Delivered

1. "Magnetism in nanostructured materials", in C. K. Majumdar Memorial Workshop-2016 held in SNBNCBS, on 22 June 2016.

Membership of Committees

External Committee

Member of Executive Committee, Magnetics Society of India; Member, Executive Committee of Material Research Society of India (Kolkata Chapter); Ph.D. Viva-Voce examiner of many students

Internal Committee

Library Committee; Visitors Associates and Students Programme Committee; SCRE Committee and many other committees of SNBNCBS

Awards / Recognitions

1. Material Research Society of India Medal - 2016

Sponsored Projects

1. "Functionalization of transition metal oxide nanoparticles for biomedical applications" funded by SNBNCBS (2016-2018).

Conference / Symposia / Workshops / Seminars etc. organized

1. "Young Scientist Colloquium - 2016" of MRSI on 16 September 2016 at SNBNCBS. Role: Convener

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

National

1. Dr. G. G. Khan, University of Calcutta (Sl. No. 2, 3, 7, 8)

International

1. Professor M. Tonouchi, Osaka University, Japan (Sl. No.6)

Member of Editorial Board

1. Transaction of Indian Ceramic Society, a Tailor Francis Journal.

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, magnetoicaloric effect, Use of nanostructured oxide magnetic materials in THz frequency, Supercapacitor, stable and enhanced Visible-Light Water Electrolysis

Interesting results obtained

1. Stable and enhanced visible-light water electrolysis for clean and sustainable energy :

The successful implementation of photoelectrochemical (PEC) cell to produce the Hydrogen fuel by water splitting and the fixation of CO_2 into hydrocarbons by using the clean and abundant sun light are promising approaches to face this energy challenge.

We prepared Highly oriented arrays of C, N and S surface functionalized/surface doped ZnO Nanorods (NRs) by a simple chemical bath deposition followed by wet chemical method as shown in Fig.1(a). Surface functionalization significantly improved both the photocurrent and photostability of the ZnO NRs electrodes under visible-light irradiation along with the reduction in onset-potential for water oxidation (Fig.1(b)). Surface engineered ZnO NRs also exhibited enhanced visible light harvesting efficiency and significantly quenched electron-hole recombination due to the presence of surface states leading to greatly efficient carrier separation.

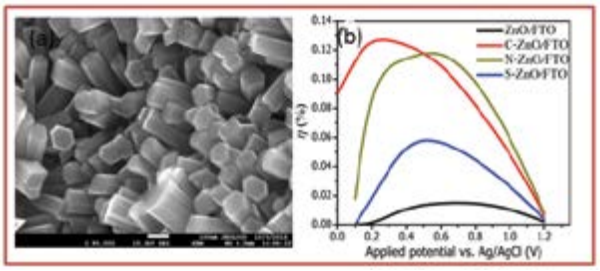

Fig: 1 (a) FESEM image of ZnO NRs,
(b) Photoconversion efficiency.

2. Room temperature ferromagnetic and ferroelectric properties of double perovskite Y_2NiMnO_6 nanowires:

This work demonstrates the unusual room temperature ferromagnetism, ferroelectricity and strong magnetoelectric coupling of the double perovskite multiferroic Y_2NiMnO_6 nanowires (Fig.2), fabricated using a facile solvothermal route. The studies indicate that the large concentration of surface spin and the surface charge polarization associated with the surface

electrons of the unique one dimensional high aspect ratio nanowires are responsible for the ferromagnetism and ferroelectricity, respectively at room temperature.

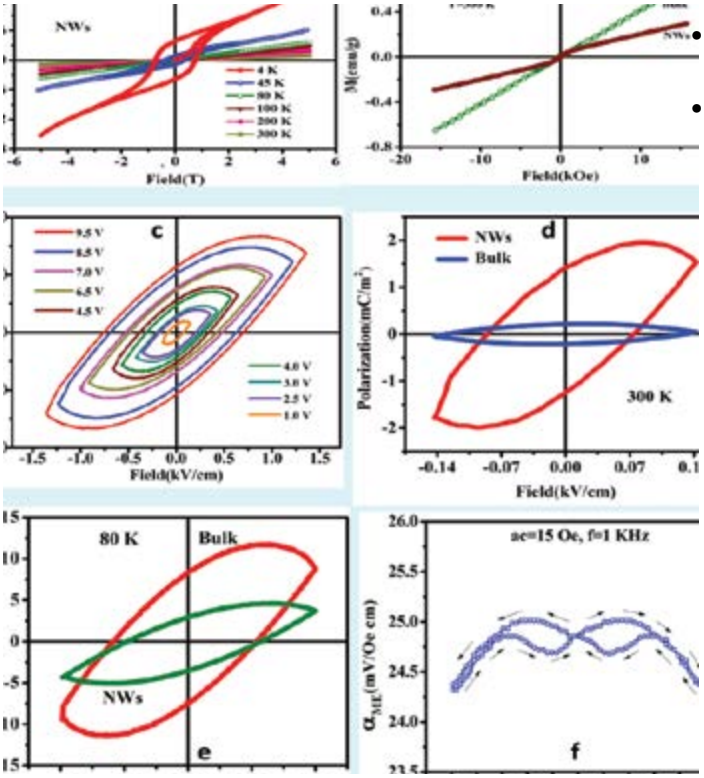

Fig: 2. (a) Magnetization versus magnetic field hysteresis loops for the Y_2NiMnO_6 NWs at 4, 50, 80, 100, 200 and 300 K and (b) Y_2NiMnO_6 NWs and bulk samples at 300 K. (c) Variation of the room temperature (300 K) P–E hysteresis loops with applied voltage for the Y_2NiMnO_6 NWs, Variation of the P–E hysteresis loops for the Y_2NiMnO_6 NWs and bulk at (d) 300 K and (e) 80 K, (f) DC bias magnetic field dependence of longitudinal magnetoelectric coefficients (α_{ME}) for Y_2NiMnO_6NPs in ac magnetic field of frequency f = 1 kHz.

Proposed research activities for the coming year

- To develop electrodes with nanostructured materials for stable and enhanced visible-light water electrolysis for clean and sustainable energy
- To find better multiferroic materials with stronger magnetoelectric coupling.
- To prepare water soluble magnetic nanoparticles with good magnetic as well as fluorescent properties due to surface functionalization.

Madhuri Mandal (Goswami)

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Dr. Madhuri Mandal (Goswami) did her Ph.D from IIT Kharagpur and 6 years post doctoral research in the University of Alabama, USA, at SINP, Kolkata and then in SNBNCBS, Kolkata. Then Visiting Faculty Fellow in SNBNCBS, Kolkata. Research mainly focuses on the synthesis, characterization and applications of magnetic nanoparticles including hyperthermia therapy, drug release, biosensor etc.

Supervision of Research / Students

Ph.D. Students

1. Chaitali Dey, Title: Synthesis of transition metal based magnetic nanoparticles for drug delivery and catalytic activity, Ongoing
2. Debarati De, Title: Design of biocompatible fluorescent magnetic nanoparticles for imaging of cancer cells and possible theranostic use, Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Arpita Das, Calcutta University, DNA Engineered Cobalt Ferrite Nanoparticles: Magnetic And Optical Studies For Hyperthermia Application, Completed.
2. Madhumanti Neogi, Calcutta University, Title: Synthesis of magnetic nanoparticles and their characterization for biological application, Completed.

Teaching activities at the Centre

1. Fall, PHY-391, I.Ph.D students, UV-visible spectroscopy practical, seven students

Publications in Journals

1. Chaitali Dey, Arka Chaudhuri, Ajay Ghosh, **Madhuri Mandal Goswami;** *Magnetic cube-shaped $NiFe_2O_4$ nanoparticles: An effective model catalyst for nitro compound reduction;* ChemCatChem; 2017; **9;** 1953.
2. Debarati De and **Madhuri Mandal Goswami;** *Shape induced acid responsive heat triggered highly facilitated drug release by cube shaped magnetite nanoparticles;* Biomicrofluidics; 2016; **10;** 064112.
3. Chaitali Dey, Kaushik Baishya, Arup Ghosh, **Madhuri Mandal Goswami,** Ajay Ghosh, Kalyan Mandal; *Improvement of drug delivery by hyperthermia treatment using magnetic cubic cobalt ferrite nanoparticles;* J. Mag. Mag. Mater.; 2017; **427;** 168-174.
4. **Madhuri Mandal Goswami;** *Synthesis of Micelles Guided Magnetite (Fe_3O_4) Hollow Spheres and Their Application for AC Magnetic Field Responsive Drug Release;* Scientific Reports; 2016; **6;** 35721.

Lectures Delivered

1. Synthesis of Magnetite (Fe_3O_4) Hollow Spheres and their Size Dependent Stimulated Cancer Drug Release Study, Haldia Institute of Technology, Haldia, March, 2017.

Sponsored Projects

1. **Title:** Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release, **Sponsor:** DST, New Delhi, **Period of funding:** For 3 years, from June 2014- June-2017.
2. **Title:** Synthesis and Engineering of Magnetic Nanoparticles for their in-vitro Application in Hyperthermia Therapy, **Sponsor:** S. N. Bose National Centre for Basic Sciences, Salt Lake Kolkata, **Period of funding:** For 3 years, from March 2016- March-2019.

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

National

1. Prof. Ajay Ghosh, University of Calcutta (Sl. No.1 and 3)

Significant research output / development during last one year

General research areas and problems worked on

- Synthesis, characterization and application of various types of magnetic nanoparticles with change of size, shape and physical properties.
- Drug loading and AC magnetic field, pH, temperature etc. stimuli driven drug release studies
- Theranostics by cancer cell imaging and cell death study using hyperthermia therapy

- Biosensor development

Interesting results obtained

Many types of magnetic hollow like particles can be synthesized by our method by co-precipitating the precursor salts using solvothermal technique. Using precursor salts, Urea, Ethylene Glycol (EG) mixture and micelles under prolonged heat treatment for 15 hrs produce hollow like particles. Micelles here play an important role in synthesis of hollow like particles. The mechanism is shown below.

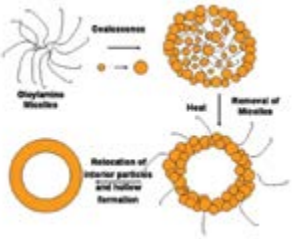
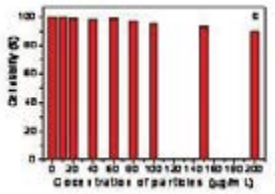


Fig: Mechanism of formation of hollow particle

Initially smaller particles and micelles coalesce to each other and bigger particles are formed which is known as Oswald ripening. Then during prolonged heat treatment the micelles from interior portion of the bigger particles are come out and an out ward force make the particles hollow like particles as shown above.

Not only hollow shaped, other shaped particles are also prepared by using different micelles in different manners such as cube, sphere atc. are also formed. Magnetic properties are studied for the functionalized and nonfunctionalized particles. Difference in magnetic properties is observed for functionalized particles from the nonfunctionalized one. The AC magnetic field dependent studies are made for all types of particles. Here we see cube shaped particles differ from the hollow like particles. In case of magnetic measurements we see that co-ferrite particles are more hard in magnetic nature so their hysteresis loss is higher. So they produce higher loss power compare to the same shaped magnetite one. Hence this way by changing from material to material we can change the magnetic properties and can produce the particles of our desired quality.

Then those particles are functionalized with different bio-molecules like DNA, folic acid, to make them biocompatible and to attach them selectively to cancer cells. Then these particles are treated with normal as well as cancer cells and effects of these particles are seen. Cytotoxicity studies are made on these functionalized particles. Particles are seen to be non toxic in nature. The cytotoxicity study made is presented in following histogram. More than 90 % of cells remain alive after treatment of upto 200 micro gm/mL of particle dispersion which is depicted by the following histogram.



Drug loading and release studies are done by these particles under different stimuli like, AC magnetic field, heat, pH etc. Then these particles are loaded with cancer drugs DOX, and drug release study is done at different temperatures and pH. We have measured drug loading efficiency for both the cube and hollow particles and have seen that loading efficiency for hollow like particles is higher. In case of drug release at lower pH and higher temperature better release takes place. At lower pH the drug molecules detached from the particles with more ease due to slight dissolution of the particles at lower pH and at higher temperature due to thermal agitation bonding between particles and drugs are broken and drug release is favored. Among cube shaped and hollow like particles the release rate for hollow shaped particles are better at same condition. It is because the hollow like particles can load more amount of the drug. Hence release rate also become better for these particles.

Proposed research activities for the coming year

Currently cancer is one of the harmful diseases in the world and taking the shape of epidemic disease. In present cancer therapies several side effects can occur and many normal cells of body are affected. In case of chemotherapy cancer drug some time become so toxic it causes death to the cancer patient. Detection of cancer in early stage and therapy of cancer by selected drug delivery systems without hampering the whole body may reduce the adverse side effects originated due to present therapies. The magnetic nanoparticles having suitable magnetic properties with the attachment of bio-friendly fluorescent reagents may provide a new direction for such therapeutic purpose. We have seen in our previous studies that the magnetic nanoparticles after tagging with some non-fluorescent molecules show highly fluorescent properties and after tagging with some organic molecules (some specific DNA molecules and some natural products) selectively attach with cancer cells. 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 tuneable magnetic properties, biocompatibility, stability etc. are very useful in such application, where hyperthermia technique is considered. From these properties we are motivated to utilize these functionalised particles for such theranostic use. 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

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Dr. Manoranjan Kumar completed his MSc in Physics from School of Physical Sciences JNU New Delhi (2003) and PhD from IISc Bangalore (2009). He joined Princeton University New Jersey USA as Postdoctoral Research Associate in 2009. He joined as Assistant Professor at SNBNCBS in 2012.

Supervision of Research / Students

Ph.D. Students

1. Aslam Parvej, Exotic Phases in Frustrated Low Dimensional Spin Systems (Ongoing).
2. Hrishit Benerjee, Study of Electronic Structure of Organic and Inorganic Complexes, (Ongoing) in Collaboration with Professor Tanusri Saha-Dasgupta.
3. Rakesh Das, Non-equilibrium phenomena in nematic systems, (Ongoing) With Dr. S Mishra (IIT BHU).
4. Sudipta Pattanayak, Collective Behaviour of Polar Self-Propelled Particles (Ongoing), With Dr. S Mishra (IIT BHU).
5. Monalisa Singh Roy, Edge Modes in 1D Chains of Correlated Electrons and Their Junctions (Ongoing).
6. Debasmita Maiti, Frustrated Magnetic Ladders: A DMRG Study (Ongoing).
7. Sudip Kumar Saha, Search of Majorana Modes in low dimensional Topological systems (Ongoing).

Post Doctoral Research Scientists

1. Dayasindhu Dey

Teaching activities at the Centre

1. Spring 2017, Computational Methods in Physics II, PHY 204, No of students 9, Shared with Prof. S S Manna.

Publications in Journals

1. D. Dey and **Manoranjan Kumar** and Zolt'an G Soos; *Boundary-induced spin-density waves in linear Heisenberg antiferromagnetic spin chains with S≥ 1;* Physical Review B; 2016; **94;**144417.
2. Dayasindhu Dey, Debasmita Maiti and **Manoranjan Kumar;** *An Efficient Density Matrix Renormalization Group Algorithm for chains with Periodic Boundary condition;* Papers in Physics; 2016; **8;** 080006.
3. Rabaya Basori, **M. Kumar** and Arup Kumar Raychaudhuri; *Sustained Resistive Switching in a Single Cu:7,7,8,8-tetracyanoquinodimethane Nanowire: A Promising Material for Resistive Random Access Memory;* Scientific Reports; 2016; **6;** 26764.

Independent publications of students

1. S. Pattanayak and S Mishra; Boundary induced convection in a collection of polar self-propelled particles; Physica A: Statistical Mechanics and its Applications; 2017; **477;** 128.

Lectures Delivered

Speaker in Conference & Meeting -

1. International conference on Frustrated Magnets IMSc Chennai India (2017)
2. Ramanujan Conclave Dec 2016

Sponsored Projects

1. Ramanujan Fellowship (DST) 5 years

Conference / Symposia / Workshops / Seminars etc. organized

1. Ramanujan conclave Dec 2016.

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

International

Sl. No. 1

National

Sl. No. 3

Significant research output / development during last one year

General research areas and problems worked on

Frustrated magnets, Topological Insulators, Majorana Fermions, Electronic properties of fermionic wire Junctions, Exotic phases in low Dimension.

Interesting results obtained

1. Quantum phase Diagram of Frustrated J1-J2 model The spin-1/2 chain with isotropic exchange J1, J2 > 0 between first and second neighbors is frustrated for either sign of J1 and has a singlet ground state (GS) for J1/J2 ≥ − 4. The J1-J2 model has rich quantum phase diagram supports gapless, gapped, commensurate (C), incommensurate (IC) and other phases. Critical points J1/J2 are evaluated using exact diagonalization (ED) and density matrix renormalization group (DMRG) calculations. The wave vector qG of spin correlations is related to GS degeneracy and obtained as the peak of the spin structure factor S(q). Variable qG indicates IC phases in two J1/J2 intervals, [− 4, −1.24] and [0.44, 2], and a C-IC point at J1/J2 = 2. The decoupled C phase in [−1.24, 0.44] has constant qG = π/2, nondegenerate GS, and a lowest triplet state with broken spin density on sublattices of odd and even numbered sites. The lowest triplet and singlet excitations, E m and Eσ , are degenerate in finite systems at specific frustration J1/J2. Level crossing extrapolates in the thermodynamic limit to the same critical points as q G. The S(q) peak diverges at q G = π in the gapless phase with J1/J2 > 4.148 and quasi-long-range order (QLRO(π)). S(q) diverges at ± π/2 in the decoupled phase with QLRO(π/2), but is finite in gapped phases with finiterange correlations. Numerical results and field theory agree at small J2/J1 but disagree for the decoupled phase with weak exchange J1 between sublattices. Two related models are summarized: one has an exact gapless decoupled phase with QLRO(π/2) and no IC phases; the other has a single IC phase without a decoupled phase in between. We have constructed a new phase diagram of J1-J2 model shown in Fig. 1

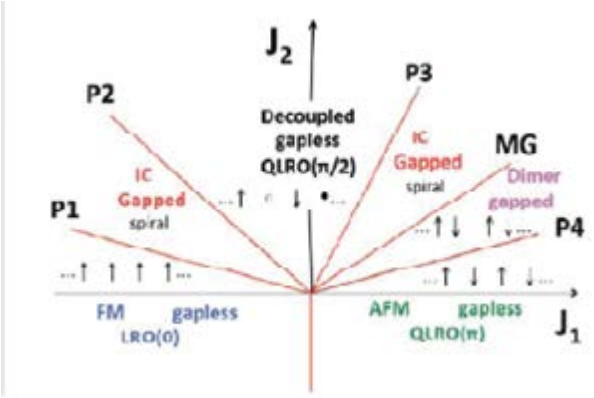

Fig.1 Quantum phase diagram of H(J1,J2), equation (1). The J1/J2 values at the critical points are P1 = −4, P2 = −1.24, P3 = 0.44 and P4 = 4.148. The exact point P1 is between a gapless FM phase and a gapped incommensurate (IC) phase. The gapless decoupled phase is between P2 and P3; open and closed circle denote spins pointing in and out of the plane. The gapped IC phase extends to the MG point, J1 = 2J2, and the dimer phase to P4 = 4.148, beyond which lies a gapless AFM phase.

2. Development of Efficient DMRG technique one dimensional periodic boundary condition system The Density Matrix Renormalization Group (DMRG) is a state-of-the-art numerical technique for a one dimensional quantum many-body system; but calculating accurate results for a system with Periodic Boundary Condition (PBC) from the conventional DMRG has been a challenging job from the inception of DMRG. The recent development of the Matrix Product State (MPS) algorithm gives a new approach to find accurate results for the one dimensional PBC system. The most efficient implementation of the MPS algorithm can scale as O(p × m3), where p can vary from 4 to m2 . In this paper, we propose a new DMRG algorithm, which is very similar to the conventional DMRG and gives comparable accuracy to that of MPS. The computation effort of the new algorithm goes as O(m3) and the conventional DMRG code can be easily modified for the new algorithm .

Proposed research activities for the coming year

1. Currently we are working on XYZ Heisenberg model and attractive Hubbard model to search the Majorana like modes in low dimensional systems.
2. We are also trying to understand the two dimensional frustrated magnetic systems and various magnetic phases.
3. Our group is also interested in the non-equilibrium phenomenon in active systems where we are focusing on the effect of obstacles on the phase kinetics and steady state. We are also trying to apply these studies to some realistic system.

Pratip Kumar Mukhopadhyay

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Professor Pratip Kumar Mukhopadhyay is an experimental condensed matter physicist who works on magnetic properties of matter in solid and fluid forms. The present focus is on smart materials. These are at the cutting edge of technology. His lab was the first one in Eastern India to start working on FSMA materials and magnetorheological fluids. He is also working a little bit of ferroelectric properties.

Supervision of Research / Students

Ph.D. Students

1. Injamamul Arief – Ph. D. – Completed and defended, January 2017
2. Tanmoy Ghosh – Ph. D. – Completed & Submitted, March 2017
3. Sarowar Hossain – Ph. D. – Ongoing
4. Abhishek Bagchi – Ph. D. – Ongoing
5. Chayan Mitra (External)- Ph. D. – Ongoing

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Animesh Basak - Extra mural project student - completed
2. Kartik Panda, Ramakrishna Mission Vivekananda University, Belur Math, Howrah - Summer semester
3. Chirantan Deb, Tushar Ajitsaria & Jinesh Surana; VNIT, Nagpur - Fall semester

Post Doctoral Research Scientists

1. Alo Dutta (Young Scientist)
2. T. Paramanik (resigned on 31/12/16)
3. S. Vinoth (Selected in February 2017, joined in April 2017)

Teaching activities at the Centre

1. Fall 2016; Research Methodology; 50; Sanjoy Choudhury

Publications in Journals

1. 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. Injamamul Arief, **P.K. Mukhopadhyay;** *Yielding behavior and temperature-induced on-field oscillatory rheological studies in a novel MR suspension containing polymer-capped Fe_3Ni alloy microspheres;* J. Magn. Magn. Mater; 2017; **429;** 236.
3. Alo Dutta, Sanjay Mandal, Premlata Kumari, **P. K. Mukhopadhyay,** S. K. Biswas and T. P. Sinha; *Crystal Structure and Dielectric Properties of Microwave Ceramics $CaLa(CaM)O_6$ [M = Nb, Sb];* Journal of Electronic Materials; 2017; **46;** 1889.
4. Injamamul Arief and **P.K. Mukhopadhyay;** *Magnetorheological Payne effect in bidisperse MR fluids containing Fe nanorods and Fe_3O_4 nanospheres: A dynamic rheological study;* J. Alloy. Compd; 2017; **696;** 1053.
5. B. Rajini Kanth, **P.K. Mukhopadhyay;** *Magnetic field and stress Induced strain in CoNiAl Ferromagnetic Shapememory Alloy;* Materials Today: Proceedings; 2016; **3;** 3960.
6. Tanmoy Ghosh, Sandeep Agarwal and **P. K. Mukhopadhyay;** *Structural and magnetic properties of $Mn_{50}Fe_{50-x}Sn_x$ (x=10, 15 and 20) alloys;* J. Magn. Magn. Mater; 2016; **418;** 260.
7. Alo Dutta, **P.K. Mukhopadhyay,** T.P. Sinha, Dipankar Das, Santiranjan Shannigrahi; *Structural and magnetic properties of double perovskite oxide Ba_2CeSbO_6;* Solid State Sciences; 2016; **58;** 64.
8. Alo Dutta, **P.K. Mukhopadhyay,** T.P. Sinha, Santiranjan Shannigrahi, A.K. Himanshu, Pintu Sen and S.K. Bandyopadhyay; *Sr_2SmNbO_6 perovskite: Synthesis, characterization and density functional theory calculations;* Mater. Chem. Phys.; 2016; **179;** 55.

Other Publications

1. A. Bagchi, B. R. Kanth and **P. K. Mukhopadhyay**, Investigations on Photo Induced Microactuation of FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016

2. S. Hossain, B. R. Kanth and **P. K. Mukhopadhyay**, Effect of Annealing on Elastic Moduli for a FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016
3. Md Sarowar Hossain, Tanmoy Ghosh, B. Rajini Kanth and **P.K. Mukhopadhyay**, Effect of annealing on the structural transformations and magnetic properties of CoNiAl FSMA, ICMAGMA '17 Proceedings, Hyderabad, 2017
4. Kartik Panda, Md. Sarowar Hossain, and **P. K. Mukhopadhyay**, "Structural anomaly and shape memory effect in a CoNiAl FSMA system due to heat treatment.", ICMAGMA '17 Proceedings, Hyderabad, 2017

Lectures Delivered

1. Effect of Composition on Elastic Moduli for a CoNiAl System - B. R. Kanth, S. Hossain and P. K. Mukhopadhyay, ICFSMA'16, Tohoku University, Japan, September 2016.
2. Magnetic field induced Elastic behaviour of FINEMET Melt spun ribbon – (invited) S. Hossain, A. K. Hakim & P. K. Mukhopadhyay, ICMAGMA 2017, Hyderabad, Feb 1- 3, 2017.

Membership of Committees

External Committee

Member, APS; Life Member, Indian Science Congress; Member of governing body of Magnetic Society of India; International advisory board member of ICFSMA international conference series.

Internal Committee

Convenor, Project and Patent Cell; Convenor, Technical Committee; Chairman, Internal Standing Committee; Ex officio Chairman, Departmental Purchase Committee; member of various thesis committees; Ex officio member, SCRE; Ex officio member, CAC; Ex officio member, AC and BoS for CU-Ph.D. course; Ex officio member, APMP; Convenor and chairman, NPEP/EVLP; Incharge, Mechanical Workshop; Chairman, Liquid Helium Plant Committee; Member, Technical Research Project.

Awards / Recognitions

1. Chairman for a session of FSMA materials, in ICFSMA'16, Tohoku University, Sendai
2. Referee for various international peer reviewed journals

Fellow / Member of Professional Body

1. Member of APS, Indian Science; GB member of Indian Physical Association, Magnetic Society of India.

Sponsored Projects

1. "Feasibility study of development of synthetic body armour based on smart fluids" – DRDO – Concluded on September 2016
2. TRC project – DST – 2016

Conference / Symposia / Workshops / Seminars etc. organized

1. National Symposium on Ultrasonics, NSU-16; 08; 10/11/2016; SNBNCBS; Convener.
2. International Conference on Ferro magnetic Shape Memory Alloys (ICFSMA'16); 05; 09/09/2016; Sendai, Japan; Organizing Committee member.

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

National

1. S .N. Kaul (Sl. No. 1)
2. T.P. Sinha (Sl. No. 3, 7, 8)
3. Santiranjan Shannigrahi (Sl. No. 7, 8)
4. A.K. Himanshu, Pintu Sen, S.K. Bandyopadhyay (Sl. No. 8)
5. Dipankar Das (Sl. No. 7)
6. Sanjay Mandal, Premlata Kumari, S. K. Biswas (Sl. No. 3)
7. B. Rajinikanth (Sl. No. 5)
8. I. Arief (Sl. No. 2, 4)

International

1. T. Fukuda, T. Kakeshita (Sl. No. 1)
2. S. Agarwal (Sl. No. 6)

Significant research output / development during last one year

General research areas and problems worked on

1. Magnetic and other properties of metallic alloys –
   a) Functional properties, like magnetocaloric effects, Elastic moduli etc. of FSMA systems
   b) Theory and experiments on various interesting disordered alloys
2. Properties of Magnetic Rheological fluids
3. Development of body armors with smart fluids

Interesting results obtained

While the main interest of the lab is still magnetic properties of materials, we also diversified a bit on ferroelectric and rheological properties. Some of the highlights are as follows –

In case of a simple system like $FeAl_2$, we showed that addition of isoelectronic Ga in the system ($FeAl_{2-x}Ga_x$, $0 \leq x \leq 0.5$), antiferromagnetic transition in these intermetallic

compounds occurred concomitantly with a disorder-induced weak localization of electrons; the temperatures TN and Tm, at which antiferromagnetic transition and the weak localization respectively occurred closely track each other as the Ga concentration was varied. The antiferromagnetic transition was confirmed from the magnetic and specific heat measurements, and the occurrence of weak localization was confirmed from the temperature variation of resistivity and magnetoresistance measurements. With increasing Ga concentration, substitutional disorder in the system increases, and the consequent disorder-enhanced magnetic exchange interaction and disorder-induced fluctuations simultaneously drive antiferromagnetic transition and weak localization, respectively, to higher temperatures. This is the first reported case of such occurrence of simultaneous presence of AFM and disordered induced localization in the same system. We did both the experiments as well as ab initio theoretical calculations to explain the phenomenon. Figure 1 shows the correlations among two different measurements.

Another noteworthy work was on the DRDO sanctioned project on development of smart fluids for body armour. It was planned to have a smart fluid that would be light weight and free flowing like an ordinary liquid in quiescent state. This will be therefore easy to wear and carry, and will offer minimum resistance to maneuverability to the wearer. However, on contact with a fast moving object, like a fired bullet, it will instantly (in µsec) turn into a solid, thereby offering enhanced protection against the projectile. Upon passing of the impacting object, the sold will turn to ordinary liquid once again, in the same time scale.

This was tested in PXE firing grounds in Chandipore. One of the tested liquid was so good that it could damage a bullet fired upon by an INSAS rifle, and deflect it out of its incoming path. However, this is a classified item, so I can not divulge more on this. Only I can inform that the state level peacekeeping force is interested in this material and will be testing soon with their weapons.

We are also working on the photomicroactuation effect. While the basic understanding of the effect is still unknown, we are making a prototype for a microgripper to using this effect. This will be a self-activated and self-propelled system that requires no power source. This will be for the first time in the world.

Proposed research activities for the coming year

As stated in the previous entry, we are vigorously pursuing work on various smart materials. We are trying to develop materials which will be actually useful for everyday use. This will continue, and more and more avenues will be explored.

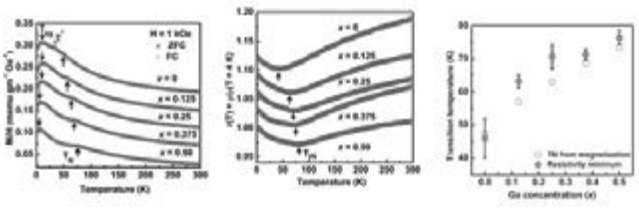

Fig. 1 (a, b, c) Temperature dependence of ZFC and FC magnetizations of $FeAl_{2-x}Ga_x$. Upward (wine) and downward (olive) vertical arrows indicate the antiferromagnetic transition temperature *TN* and spin-glass transition temperature *Tsg* , respectively. Downward gray arrow indicates the second magnetic transition at *T** observed only in the composition x = 0. (b) Temperature dependence of resistivity in FeAl2−xGax. Upward red arrows indicate the position of resistivity minimum. (c) Variation with Ga composition of the antiferromagnetic transition temperature (*TN*) and the temperature at which the resistivity minimum occurs (*Tm*).

Priya Mahadevan

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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; Unusual magnetic ground states in transition metal oxides; Ongoing
2. Sagar Sarkar; Role of structure in determing the properties of transition metal oxides; Ongoing
3. Poonam Kumari; Spin orbit effects in the properties of low-dimensional semiconductors; Ongoing
4. Joydeep Chatterjee; Electronic structure of low dimensional semiconductors; Ongoing
5. Sumanti Patra; Optical properties of layered transition metal dichalcogenides; Ongoing

Publications in Journals

1. Soumyadipta Pal, Sagar Sarkar, Shishir Kumar Pandey, Chhayabrota Maji and **Priya Mahadevan;** *Driving force for martensitic transformation in* $Ni_2Mn_{1+x}Sn_{1-x}$; Phys. Rev B; 2016; **94;** 115143.
2. M. Mittal, A. Jana, S. Sarkar, **Priya Mahadevan** and Sameer Sapra; *Size of the organic cation tunes the band gap of colloidal organolead bromide perovskite nanocrystals;* J. Phys. Chem. Lett.; 2016; **7;** 3270.
3. S. Middey, J. Chakhalian, **Priya Mahadevan,** JW. Freeland, AJ Millis and D.D. Sarma; *Physics of ultrathin films and heterostructures of rare-earth nickelates;* Ann Rev of Mat. Res.; 2016; **46;** 305.
4. S. Middey, P, Aich, C. Meneghini, K. Mukherjee, E.V. Sampathkumaran, V. Siriguri, **Priya Mahadevan** and Sugata Ray; *Metal-insulator transition in* $Ba_3Fe_{1-x}Ru_{2+x}O_9$*: Interplay between site disorder, chemical percolation, and electronic structure;* Phys. Rev. B; 2016; **94;** 184424.

Lectures Delivered

1. 2nd Lakshmi Raman memorial lecture, IIT Madras, April 2016.
2. ICAMMP VI, IIT Kharagpur, November 2016.
3. AESET 2016, Puri, December 2016.
4. PCOTE 2017, Kolkata, January 2017.
5. ICAFM 2017, Chennai, January 2017.
6. WCMP 2017, IIT Kharagpur, February 2017.
7. JNU March meeting, JNU Delhi, March 2017.

Membership of Committees

External Committee

IUPAP National Committee; IUPAP C20 Commission on Computational Physics; various SERB review committees

Internal Committee

Various thesis committees, SCOLP, CWEP

Fellow / Member of Professional Body

1. Fellow of Indian Academy of Science

Sponsored Projects

1. Functional transition metal oxides, DAE-BRNS, 2014-2017

Conference / Symposia / Workshops / Seminars etc. organized

1. MRSI Young scientist meet, September 2016, SN Bose centre, Co-convener

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

National

Sl. No. 1, 2, 4

International

Sl. No. 3

Significant research output / development during last one year

General research areas and problems worked on

Understanding the martensitic transition in shape memory alloys; Role of the cation at the A site of a perovskite of the form ABX_3 in determining the structure and properties of the perovsite

Interesting results obtained

The ideas of how the ionic size of the atom at the A site of a perovskite of the form ABX_3 are well understood. However, a recent class of materials that have been of interest for photovoltaic applications have a molecule at the A site. The question is how does the size of the molecule determine the structure and consequently the electronic properties of these materials. A part of this question has been addressed in JPCL 7, 3270 (2016).As in the inorganic perovskites the atom/molecule at the A site of the perovskite lattice ABX3 plays an important role in determining the size of the unit cell as well as the structural distortions. What we go on to show is that these two have differing effects on the band gap of the system. The literature so far has not distinguished the various contributions such as volume, structural distortions etc and this has led to ambiguity in the role of the cation at the A site which we clarify for the first time in these systems.

The shape memory alloys of the form Ni-Mn-Sn exhibit a transition from the high symmetric cubic phase only for non-stoichiometric compositions. Our first principle electronic structure calculations are able to capture the transition that takes place for only certain compositions. We are therefore able to discuss what are the microscopic considerations that drive the transition. This has appeared in Phys. Rev. B 94, 115143 (2016).

Proposed research activities for the coming year

We had presented a heuristic model in 2004 to understand the magnetism in dilute magnetic semiconductors based on an analysis of various features and trends that we had found in the electronic structure and magnetic properties calculated within an ab-initio framework. We are now developing a microscopic model within a model Hamiltonian framework to extend the purview of these results and examine various limits.

Another unusual feature that we are trying to understand are the glassy dynamics of hybrid perovskites seen in the low temperature orthorhombic phase where one expects the molecular dipoles to be frozen in and no other form of crystallographic disorder is believed to be present.

Prosenjit Singha Deo

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Professor Prosenjit Singha Deo did his PhD in 1996 from IOP, BBSR and a couple of post docs in Europe. He joined S.N. Bose Centre in 1999.

Supervision of Research / Students

Ph.D. Students

1. U. Satpathy

Publications in Journals

1. U. Satpathi and **P. Singha Deo;** *Negative partial density of states in mesoscopic systems; Annals of physics;* 2016; **375;** 491.

Lectures Delivered

1. National Conference on Condensed Matter Physics at ISI, during 2-3 February, 2017; Delivered talk on "Scattering phase shifts in low dimensions".

Significant research output / development during last one year

General research areas and problems worked on

We have developed a new method to experimentally determine the electronic partial density of states of a non-ergodic mesoscopic system.

Interesting results obtained

A mesoscopic system is a small system coupled to leads with the help of which it exchanges electrons with external reservoirs. The nature and position of these leads crucially determine the states inside the system that are accessed in a particular experiment and ensamble averaging is not allowed. All the known methods of statistical mechanics fails in these systems. Partial density of states determine its thermodynamic and transport properties. Our method helps to determine very accurately the partial density of states at the Fano resonances of such systems.

Proposed research activities for the coming year

Inclusion of Coulomb interaction and their effect on partial density of states.

Ranjan Chaudhury

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Dr. Ranjan Chaudhury received his PhD (Science) from TIFR , Mumbai (Bombay University) in 1988 ; he was a Post-doctoral & 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; Completed.
2. Soumi Roy Chowdhury; Studies on Superconducting Pairing Mechanism in Low Dimensional Materials; Ongoing.
3. Suraka Bhattacharjee; Study of generalized spin and charge stiffness constants of doped quantum antiferromagnets on low dimensional lattices based on t-J model; Ongoing.
4. Koushik Mandal; Superconducting Pairing in Strongly Correlated Systems (tentative); Ongoing.

Teaching activities at the Centre

1. 4th semester; Magnetism & Superconductivity; IPhD, Elective, PHY 409; 4; K. Mandal
2. 2nd semester; Advanced Condensed Matter Physics Magnetism & Superconductivity with normal state excitations; PMSC-PhD, PHY 601; 5; K. Mandal

Publications in Journals

1. Suraka Bhattacharjee and **Ranjan Chaudhury;** *Calculation of generalized spin stiffness constant of strongly correlated doped quantum antiferromagnet on two-dimensional lattice and its application to effective exchange constant for semi-itinerant systems;* Physica B; 2016; **500;** 133-141.
2. Subhajit Sarkar, **Ranjan Chaudhury** and Samir K. Paul; *Semi-phenomenological analysis of neutron scattering results for quasi-two dimensional quantum anti-ferromagnet;* Journal of Magnetism and Magnetic Materials; 2017; **421;** 207-215.
3. Timothy Chibueze and **Ranjan Chaudhury;** *Synthesis of conventional phenomenological theory of superconductivity with Marginal Fermi Liquid model;* Journal of Ovonic Research; 2016; **12**(3); 121-127.

Other Publications

1. Ranjan Chaudhury; Microscopic understanding of high temperature superconductivity and its possible role towards enhancement of critical temperature; Journal of Material Science and Engineering (special issue as Proceedings of CMP 2016); 2016; 5; 85.

Independent publications of students

1. Suraka Bhattacharjee; Investigation of the magnetic behavior of doped quantum antiferromagnets on low-dimensional lattices; Journal of Material Science and Engineering (special issue as Proceedings of CMP 2016); 2016; **5**; 75.

Lectures Delivered

1. Microscopic understanding of high temperature superconductivity and its possible role towards enhancement of critical temperature; CMP 2016 (OMICS Conference) held in Chicago (USA); October; 2016; sent a shortened version of my scheduled invited talk to the organizers due to late arrival of Visa for going to US.

Membership of Committees

Internal Committee

Chairman of Space Reallocation Committee (Visitors' and Students' sitting arrangement) (SNBNCBS)

Awards / Recognitions

1. Selected as an Active Member of Physics Unit of Athens Institute For Education And Research (Athens, Greece) in May 2016.

Fellow / Member of Professional Body

1. Continued as the Member of Physical Chemistry Division of American Chemical Society (USA).

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

International

1. With T. Chibueze (Univ. of Nigeria, Nigeria (Sl. No.3).
2. With M.P. Das (ANU, Canberra, Australia); manuscript under preparation.

Member of Editorial Board

1. Continued as the Editor-in-Chief of Journal of Opinion in Condensed matter Physics (Singapore) till December 2016.

Significant research output / development during last one year

General research areas and problems worked on

1. Theoretical and microscopic investigation of superconductivity with anisotropic nature in multi-layered systems with inclusion of various intra-layer, inter-layer and inter-band processes, relevant to cuprates and Fe-pnictides.
2. Detailed theoretical investigation of generalized spin stiffness constant for doped quantum antiferromagnet with strong electronic correlations on low dimensional lattices.
3. Extension and application of our calculational results and analysis for spin dynamics of quasi-two dimensional XY-anisotropic antiferromagnetic models to both small and large spin layered materials.

Interesting results obtained

1. The consequences of intra-layer s-wave pairing combined with the coherent inter-layer pair hopping processes were examined within mean field approximation. The two distinct order parameters viz. In-plane superconducting gap and out-of-plane superconducting gap were properly identified and expressions for the quasi-particle operators were explicitly determined. The results obtained are shown to be very different from those obtained from a similar approach of H. Suhl et al carried out in another context much earlier. The formulation for taking care of inter-band mixing and its effect on the phases of the two kinds of superconducting gap functions were also initiated.
2. The magnetic correlation in doped quantum Heisenberg antiferromagnetic system on one-dimensional lattice is investigated theoretically on the basis of the single band strongly correlated t-J model. The presence of a maximum in the plot of our theoretically obtained generalized spin stiffness constant as a function of doping concentration, occurring at a finite doping, suggests the emergence of a tendency to form a new magnetic ordering of itinerant nature in the system in the low doping regime and its disappearance as the doping is increased further. This prediction of ours is quite novel and awaits direct verification by independent experiments in future. Besides, the comparison between our theoretical results for spin stiffness constant and those for the effective exchange constant extracted from the available experimental results obtained so far from the chains of $YBa_2Cu_3O_{6+x}$ at low temperature show very similar behaviour as a function of doping concentration. This firmly establishes the role of spin stiffness constant as effective exchange constant for strongly correlated semi-itinerant systems in one-dimension. Our results also receive good support from those based on other theoretical approaches appropriate to 1D.
3. Our conjecture involving the limitations of the conventional Berezinskii-Kosterlitz-Thouless (BKT) scenario with semi-classical treatments for quasi-two dimensional XY-anisotropic antiferromagnets involving topological excitations, relating to the magnitude of spin, found further support from the inelastic neutron scattering experiments performed on high spin XXZ systems like $MnPS_3$ (with S = 5/2) . In this material, the conventional theoretical treatment was found to be adequate and no quantum approach was required for quantitative agreement with the experimental results. This is in sharp contrast to our earlier investigation involving La_2CuO_4 (with S = ½).

Proposed research activities for the coming year

1. Completion of the ongoing calculation for full quantum magnetic dynamical structure function in the case of quantum BKT scenario. This would help resolve the disagreement between theory and experiments for low spin systems of both ferromagnetic and antiferromagnetic in nature.
2. Completion of the ongoing charge stiffness calculations for strongly correlated doped quantum antiferromagnet on low-dimensional lattices.
3. Understanding the microscopics of superconducting pairing in the pesudo-gap region of the cuprates.
4. Extension of my quantum modelling developed earlier, to explore various other processes involving DNA.

Any other matter

The manuscript draft for my proposed book on condensed matter physics is nearing completion and I hope to submit it soon.

Samit Kumar Ray

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Professor Samit Kumar Ray is involved in the research and development of semiconductor quantum and heterostructures for nanoscale devices in collaboration with IIT Kharagpur. Plasmonic semiconductor nanostructures are being studied for use in multifunctional sensing and detector applications. The group is also working on the integration of 2D materials on Si platforms for photonic devices.

Supervision of Research / Students

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Sumit Kr. Singh jointly with prof. A. K. Raychaudhuri, M.Tech. Project, IIT Kharagpur, Nanowire based Devices – completed.

Publications in Journals

1. **S. K. Ray,** A. K. Katiyar and A.K. Raychaudhuri; *Topical Review: One-dimensional Si/Ge nanowires and their heterostructures for multifunctional applications-A review;* Nanotechnology; 2017; **28;** 092001.
2. A. Sarkar, A. K. Katiyar, S. Mukherjee and **S. K Ray;** *Enhanced UV–visible photodetection characteristics of a flexible Si membrane-ZnO heterojunction utilizing piezo-phototronic effect;* J. Phys. D: Appl. Phys.; 2017; **50;** 145104.
3. R.K. Singha, S. Manna, R.Bar, S. Das and **S.K. Ray;** *Surface potential, charging and local current transport of individual Ge quantum dots grown by molecular beam epitaxy;* Applied Surface Science; 2017; **407;** 418.
4. N. Gogurla, S. C. Kundu and **S. K Ray;** *Gold nanoparticle-embedded silk protein-ZnO nanorod hybrids for flexible bio-photonic devices;* Nanotechnology; 2017; **28;** 145202.
5. S. Mukherjee, S. Biswas, S. Das, and **S. K. Ray;** *Solution-processed, hybrid 2D/3D MoS_2/Si heterostructures with superior junction characteristics;* Nanotechnology; 2017; **28;** 135203.

Lectures Delivered

1. 2-D Materials based Optoelectronic Devices on Silicon Platforms – Intl. Conference on Fiber Optics & Photonics (Photonics-2016), IIT Kanpur, Dec. 2016.
2. Silicon Based Multifunctional and Green Photonic Devices – Intl. Conf. on Functional Materials, IIT Kharagpur, Dec. 2016.
3. Low Dimensional Structures for Silicon Photonic Devices – DAE Solid State Physics Symposium, Bhubaneswar, Dec. 2016.
4. Heterostructure Devices using 2D Materials on Silicon Platforms – IACS, Kolkata, Feb. 2017.
5. Silicon based Nanostructures for Photonic Devices - 4th Intl. Symp. Semiconductor Materials and Devices, Jadavpur Univ., 8-10 March, 2017.
6. Semiconductor Quantum Structures : Recent Trends – Bose Colloquium, S.N.Bose National Centre for Basic Sciences, Jan. 2017.
7. Strain and Band Engineering for Si/Ge based Heterostructure Devices, Synchrotron Techniques in Material Research, *Dooars,* 2nd – 5th February, 2017.
8. Excitements with Materials in Nanoscale - DST-JBNSTS INSPIRE Science Camp, March, 2017.

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

National

Sl. Nos. 3, 4, 5

Member of Editorial Board

1. Editorial Board member, Nanotechnology, IOP, UK

Significant research output / development during last one year

General research areas and problems worked on

- Heterostructure and quantum devices
- Semiconductor and Oxide Nanostructures
- Nanoelectronic & Nano-photonic devices
- 2D/3D heterostructures

- Photovoltaic Materials and Devices
- Silicon Alloy Heterostructures
- Thin Film Technology

Interesting results obtained

1. Silk protein based biophotonic devices

Silk protein has been used as a biopolymer substrate for flexible photonic devices. We have demonstrated ZnO nanorod array hybrid photodetectors on Au nanoparticle-embedded silk protein for flexible optoelectronics. Hybrid samples exhibited optical absorption at the band edge of ZnO as well as plasmonic energy due to Au nanoparticles, making them attractive for selective UV and visible wavelength detection. The device prepared on Au-silk protein shows a much lower dark current and a higher photo to dark current ratio of ~10^5 as compared to the control sample without Au nanoparticles. The hybrid device has also exhibited a higher specific detectivity due to higher responsivity arising from the photo-generated hole trapping by Au nanoparticles. Sharp pulses in the transient photocurrent have been observed in devices prepared on glass and Au-silk protein substrates due to the light induced pyroelectric effect of ZnO, enabling the demonstration of self-powered photodetectors at zero bias. Flexible hybrid detectors have been demonstrated on Au-silk/polyethylene terephthalate substrates, exhibiting characteristics similar to those fabricated on rigid glass substrates. A study of the performance of photodetectors with different bending angles indicates very good mechanical stability of silk protein based flexible devices. This novel concept of ZnO nanorod array photodetectors on a natural silk protein platform provides an opportunity to realize integrated flexible and self-powered bio-photonic devices for medical applications in near future.

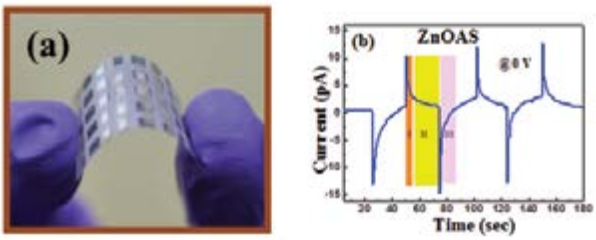

Fig.1 (a) Optical image of flexible biophotonic device fabricated on plastic substrate, (b) Transient photocurrent of the device due to light induced pyroelectric effect.

2. Hybrid 2D/3D MoS_2/Si heterostructures

Theoretical and experimental investigations of the hybrid heterostructure interfaces between atomically thin MoS_2 nanocrystals (NCs) on Si platform for their potential applications towards next-generation electrical and optical devices have been made. Mie theory-based numerical analysis and COMSOL simulations based on the finite element method have been utilized to study the optical absorption characteristics and light–matter interactions in variable-sized MoS_2 NCs. The size dependent absorption characteristics and the enhancement of electric field of the heterojunction in the UV-visible spectral range agree well with the experimental results. A lithography-free, wafer-scale, 2D material on a 3D substrate hybrid vertical heterostructure has been fabricated using colloidal n-MoS_2 NCs on p-Si. The fabricated p-n heterojunction exhibited excellent junction characteristics with a high rectification ratio suitable for voltage clipper and rectifier applications. The current–voltage characteristics of the devices under illumination have been performed in the temperature range of 10–300 K. The device exhibits a high photo-to-dark current ratio of ~3×10^3 and a responsivity comparable to a commercial Si photodetector. The excellent heterojunction characteristics demonstrate the great potential of MoS_2 NC-based hybrid electronic and optoelectronic devices in the near future.

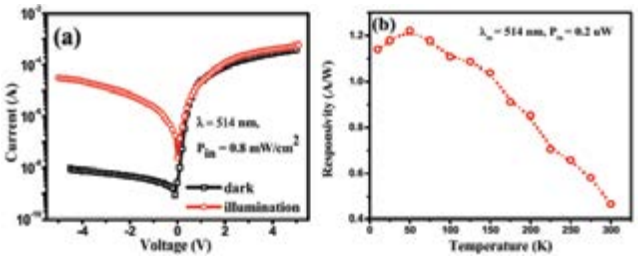

Figure 2: (a) Typical current-voltage characteristics of fabricated device, using ~3 nm MoS_2 NCs on Si, under dark and illumination condition, recorded at 300 K. (b) Photoresponse behavior of the as-fabricated device as a function of operating temperature for 514 nm illumination.

Soumendu Datta

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CMPMS
soumendu@bose.res.in

Dr. Soumendu Datta's research focuses on the study and understanding of material properties from microscopic electronic structure calculations using DFT-based first principles analysis. The materials which he deals with in his research include both the crystalline bulk as well as finite nano-sized systems. His present research involves mainly three kinds of materials, namely organic-inorganic hybrid perovskites for photocatalytic hydrogen fuel production, bimetallic nano-alloys for catalytic applications and exploring the possibility of graphene systems as suaitable hydrogen storage medium.

Supervision of Research / Students

Ph.D. Students

Sangita Dutta; Electronic structure calculaions for (a) bimetallic nano-clusters for catalytic application; (b) Semi-conducting nano-particles for photocatalytic water-splitting; Ongoing.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Lalit Kumar Sahoo from ISM, Dhanbad completed his summer project titled "An overview of some promising materials for photocatalytic water-splitting".

Teaching activities at the Centre

I conducted the IphD course PHY202 titled "Quantum Mechanics II" along with Prof. Rabin Banerjee . The batch had total 9 students.

Publications in Journals

1. **S. Datta,** A. K. Raychaudhuri, T. Saha-Dasgupta; *First principles study of bimetallic $Ni_{13-n}Ag_n$ nano-clusters (n = 0–13): Structural, mixing, electronic, and magnetic properties;* J. Chem. Phys.; 2017; **146;** 164301.

Other Publications

1. Soumendu Datta, "Properties of nano-clusters involving 3d late transition metal elements : Role of magnetization versus hybridization interplay", accepted in Advanced Scinence Letter (as conference proceeding for ICMST2016)

Lectures Delivered

1. Gave an invited talk in "ICMST2016" conference at St. Thomas College Pala, Kerala during 5-8 June, 2016

Membership of Committees

Internal Committee

Included in the selection committee for selecting IPhD and PhD students admission-2017

Fellow / Member of Professional Body

1. Regular member of Material Research Society, USA

Sponsored Projects

1. INSPIRE Faculty

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

National

1. Dr. Tilak Das, IISER-Pune

International

1. Prof. Karsten W. Jacobsen, DTU - Copnhagen, Denmark

Significant research output / development during last one year

General research areas and problems worked on

During this period, I have worked on two main projects: (I) study of equilibrium structure and mixing behavior of the bimetallic nanoalloyed clusters involving silver and transition metal atoms, and (II) study of the materials for photocatalytic watersplitting for the production of hydrogen fuel. I performed density functional theory (DFT) based electronic structure calculations for these systems.

Interesting results obtained

I. Bimetallic nano-alloyed clusters of silver and transition metal atoms: The Ag-related bimetallic alloyed nano-clusters are promising for their catatlytic and optical properties. Being of finite sized nano-systems, they are usually associated with highly size-dependent properties which render them for various applications including catalysis. The properties of the bimetallic nano-alloys can be tuned further by varying their composition and chemical ordering. During the period, I have worked on the bimetallic NiAg and CuAg nano-clusters. The challenging issues for bimetallic nano-clusters are the determination for their globally optimized structures, trend in the mixing versus segregation pattern and understanding it from their electronic properties.

   For the NiAg nano-clusters of 13 atoms, the adopted equilibrium structural patterns show the tendency towards the formation of *core-shell* like structural patterns, favorable mixing for all compositions with the magic composition of the highest mixing for the $NiAg_{12}$ alloy cluster. I studied the microscopic origin of the favorable mixing, in which the Ni-Ag inter-facial interaction is found to play role. This work is published in JCP (2017) The bimetallic CuAg nano-clusters with 13 atoms cluster size, also show favorable mixing for all compositions with the magic composition for the Cu_5Ag_8 cluster. The binary CuAg nano-clusters show weak mixing due to small degree of charge transfer between the two species of atoms. In order to enhance the mixing property of the Cu-Ag nano-clusters, I performed substitutional doping with Cd atom and Cr atom separately in place of Ag atom of the Cu-Ag clusters. It shows that both the Cd-doping as well as the Cr-doping have enhanced the mixing of Cu with Ag with the magic compositions for the $CdCu_5Ag_7$ cluster and $CrCu_{12}$ clusters.

II. Study of stability, electronic structure and optical properties of Bismuth oxyhalides for photo-catalytic water-splitting: Materials of photo-catalytic water-splitting for hydrogen fuel production using the sunlight is another part of my project. The overall merits of the water-splitting reaction relies on light collection in semiconducting materials with appropriate bandgaps that match the solar spectrum in order to obtain high energy conversion efficiency. High stability, optimal bandgap and suitable band edges positions are the desired criteria for a good photocatalyst. Band structure engineering of semiconducting materials is very demanding in this respect.

   Bismuth Oxy-halide (BiOX ; X = F, Cl, Br, I) is a new class of promising layered materials with outstanding photo-catalytic activity. The bulk BiOX with tetragonal crystal structure consists of [X-Bi-O-Bi-X] slices stacked together by van der Waals interaction through halogen atoms along the c-axis. The strong intra-layer covalent interaction and weak inter-layer van der Waal's interaction give rise to unique physico-chemical properties. The band-structure of this materials is also interesting. The band-edges are highly dispersive as they are consist of s and p orbitals of the constituent atoms and it results in

   lower effective mass of the carriers. However, a detailed microscopic understanding about the enhanced photo-activity of this system is lacking.

   Using DFT calculations, I have studied the effects of compressive strain (on the in-plane lattice parameters) on the energy landscapes, bandgaps, bandedges and optical properties of BiOX systems. The effects of quasi-particle self-energy correction, spin-orbit interaction, van der Waal's dispersion correction have been considered in the calculations. It is to be noted that the effects of the compressive strain is significant for the BiOF. We find that the unstrained BiOF with the experimental lattice parameters is unstable, while compressive strain of 4% for the in-plane lattice parameters, converts the BiOF system into a thermodynamically stable phase. Furthermore, the compressive strain of 2% is also sustainable for the other BiOX systems, which is confirmed by the phonon band structure analysis. As expected, band gap increases with the compressive stain. **Figure 1** shows the plots of calculated joint density of states and comparison with related electronic projected density of states of the BiOX (X: F, Cl, Br, I), and hence estimation of optical conductivity (σ).

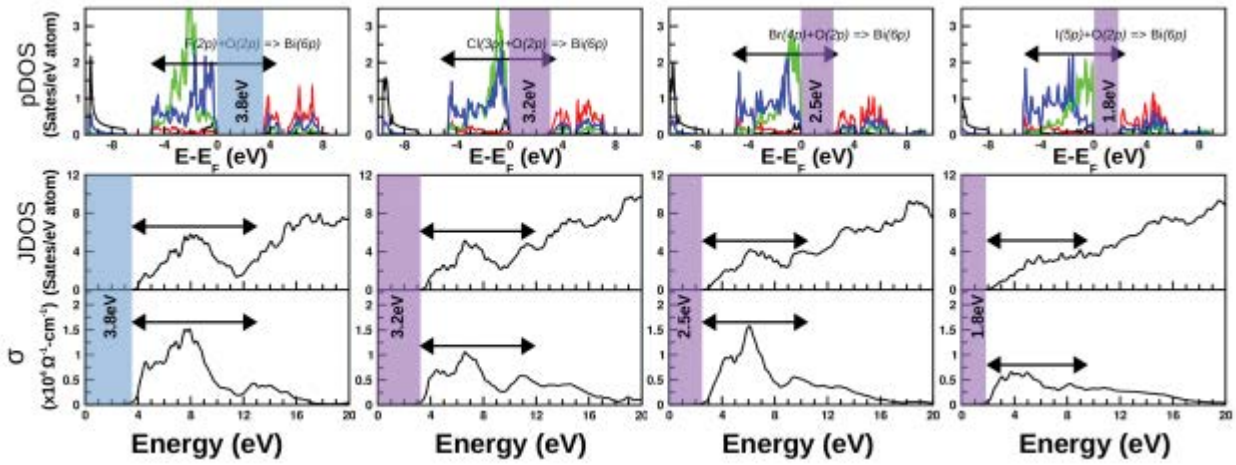


Figure 1 : Calculated joint density of states (JDOS) [middle panels] and comparison with related electronic projected density of states (pDOS) [top panels] of BiOX (X: f, Cl, Br, I), and hence estimation of optical conductivity (σ) [bottom panels]. In the pDOS plot, the Bi(s), Bi(p), X(p) and O(p) are denoted with black, red, green and blue solid lines. The electronic and optical band-gap is marked with color shaded (blue for direct and magenta for indirect transitions) in the top and bottom panels. Possible low energy optical transition is marked with both sides headed black solid line arrow.

Proposed research activities for the coming year

My future research activity will focus mainly on three categories of materials as mentioned below. Organic-inorganic halide perovskites have emerged in recent time as promising solar-cell materials for their low-cost, flexible, solution-based synthesis and unique opto-electronic properties. The challenges for practical application of these materials are stability under experimental conditions, detailed structural analysis, synthesis of toxic-lead free environment friendly analogues. Therefore, more DFT analysis on the structure-property relationship for this class of materials will be useful. The second one is related to ultra-thin 2D nano-materials. The past decade has seen an enormous increase in research progress on ultra-thin two-dimensional nano-materials after the ex-foliation of graphene from graphite in 2004. The unprecedented physical, electronic, chemical and optical properties of the ultra-thin 2D nano-materials arising from their unique structural features offer great potential for numerous applications. Various 2D layered structures possessing versatile properties have been explored. Further exploration and identification of 2D nano-systems is very desirable for new promising applications. The last but not the least area of my future research is related to functionalized nano-structures as hydrogen storage materials. The primary requirement for a good hydrogen storage material is that it can store hydrogen reversibly with high gravimetric and volumetric density and operate under moderate temperature and pressure. An ideal storage system would be one where hydrogen binds molecularly but with a binding energy that is intermediate between physisorbed and chemisorbed states. Much research is still needed to identify appropriate catalyst, study the existence of stable intermediate phases, their crystal structures and understand the kinetics.

Tanusri Saha-Dasgupta

Senior Professor
CMPMS
tanusri@bose.res.in

Professor 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); Completed, to be submitted in July 2017.
2. Hrishit Banerjee; Electronic Structure Study of Organic and Inorganic complexes; Ongoing.
3. Dhani Nafday; Electronic Structure of graphene and related materials; Ongoing.
4. Ransell D'souza; First-principles Study of 2D materials; Ongoing.
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.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Mitrajyoti Ghosh; St. Stephen's College, Delhi, Summer Student sponsored by Indian Academy of Sciences.

Post Doctoral Research Scientists

1. Tilak Das
2. Shamik Chakrabarti

Teaching activities at the Centre

1. Post-BSc; PHY302 course; 7 students; co-teacher: Dr. Shreemoyee Ganguly.

Publications in journals

1. R D'Souza, S Mukherjee, **T Saha-Dasgupta;** *Influence of interface geometry on phase stability and bandgap engineering in boron nitride substituted graphene: A combined first-principles and Monte Carlo study;* Journal of Alloys and Compounds; 2017; **708**; 437.
2. K Samanta, **T Saha-Dasgupta;** *Rocksalt versus layered ordering in double perovskites: A case study with La_2CuSnO_6 and La_2CuIrO_6;* Physical Review B; 2017; **95;** 235102.
3. P Chakraborty, T Das, D Nafday, L Boeri, **T Saha-Dasgupta;** *Manipulating the mechanical properties of Ti_2C MXene: Effect of substitutional doping;* Physical Review B; 2017; **95;** 184106.
4. S Ganguly, M Kabir, **T Saha-Dasgupta;** *Magnetic and electronic crossovers in graphene nanoflakes;* Physical Review B; 2017; **95;** 174419.
5. S Datta, AK Raychaudhuri, **T 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; 2017; **146;** 164301.
6. Hajime Hojo, Ryo Kawabe, Keisuke Shimizu, Hajime Yamamoto, Ko Mibu, Kartik Samanta, **Tanusri Saha-Dasgupta,** Masaki Azuma; *Ferromagnetism at Room Temperature Induced by Spin Structure Change in $BiFe_{1-x}Co_xO_3$ Thin Films;* Advanced Materials; 2017; **29;** 1603131.
7. A Valli, A Amaricci, A Toschi, **T Saha-Dasgupta,** K Held, M Capone; *Effective magnetic correlations in hole-doped graphene nanoflakes;* Physical Review B; 2016; **94;** 245146.
8. H Banerjee, S Chakraborty, **T Saha-Dasgupta;** *Cationic Effect on Pressure Driven Spin-State Transition and Cooperativity in Hybrid Perovskites;* Chemistry of Materials; 2016; **28;** 8379.
9. Santu Baidya, Umesh V. Waghmare, Arun Paramekanti, and **Tanusri Saha-Dasgupta;** *High-temperature large-gap quantum anomalous Hall insulating state in ultrathin double perovskite films;* Physical Review B; 2016; **94;** 155405.

10. Olga S Volkova, Larisa V Shvanskaya, Evgeny A Ovchenkov, Elena A Zvereva, Anatoly S Volkov, Dmitriy A Chareev, Kaimujjaman Molla, Badiur Rahaman, **Tanusri Saha-Dasgupta,** Alexander N Vasiliev; *Structure–Property Relationships in* α-, β'–, *and* γ-*Modifications of* $Mn_3(PO_4)_2$; Inorganic Chemistry; 2016; **55;** 10692.
11. Nagamalleswararao Dasari, SRKC Sharma Yamijala, Manish Jain, **T Saha Dasgupta,** Juana Moreno, Mark Jarrell, NS Vidhyadhiraja; *First-principles investigation of cubic* $BaRuO_3$*: A Hund's metal;* Physical Review B; 2016; **94;** 085143.
12. KV Zakharov, EA Zvereva, MM Markina, MI Stratan, ES Kuznetsova, SF Dunaev, PS Berdonosov, VA Dolgikh, AV Olenev, SA Klimin, LS Mazaev, MA Kashchenko, Md A Ahmed, A Banerjee, S Bandyopadhyay, A Iqbal, B Rahaman, **T Saha-Dasgupta,** AN Vasiliev; *Magnetic, resonance, and optical properties of* $Cu_3Sm(SeO_3)_2O_2Cl$*: A rare-earth francisite compound;* Physical Review B; 2016; **94;** 054401.

Other Publications

1. P Das, **T Saha-Dasgupta,** S Puri; Kinetics of Order-Disorder Transitions in Binary Mixtures: A Monte Carlo Study; Journal of Physics: Conference series; 2016; 759; 012010.

Lectures Delivered

1. Oxide Heterostructures; Max-Planck-Partnergroup workshop, IOP; Bhubaneswar; March; 2017.
2. Heterostructures based on double perovskites; Indo-US conference; Kolkata; January; 2017.
3. A site cations in oxides; Solid State Chemistry Symposium, JNCASR; December; 2016.
4. Modeling of strongly correlated electron materials; Indian Academy of Sciences meeting, special session on Walter Kohn; December; 2016.
5. Designing Anomalous Quantum Hall Effect; APCTP; Pohang, South Korea; December; 2016.
6. Materials modeling through first-principles; IISER; Pune; October; 2016.
7. First-principles way of understanding Physical and Chemical processes; RSC-CRSI joint symposium; Edinburg; May; 2016.

Membership of Committees

External Committee

Member, PAC under Physical Sciences; Member, Sectional Committee (Physics), Indian Academy of Sciences, Bangalore; Member, Sectional Committee (Physics), National Academy of Sciences India, Allahabad; Member, International Advisory Committee, CIMTEC conference, Italy.

Internal Committee

Associate Dean (Faculty); Convener, Advanced Post Doctoral Manpower Program; Convener, Faculty search committee; Chairperson, Computer Services Cell Advisory Committee & Working Group Committee.

Awards / Recognitions

1. "Outstanding Referees" recognition of American Physical Society (2017).

Sponsored Projects

1. Thematic Unit on Computational Materials Science; DST-Nanomission; 2012-2017 (PI).
2. Indo-Austrian; DST bilateral program; 2015-2017 (PI).
3. Indo-Russian; DST bilaterial program; 2014-2016 (PI).
4. Technical Research Centre; DST; 2016-- (Co-PI).

Conference / Symposia / Workshops / Seminars etc. organized

1. Indo-US conference on Physics and Chemistry of Oxide Materials; January 2017.

Collaborations including publications (Sl. No. of the paper listed in 'Publications in journals' jointly published with collaborators)

National

1. M. Kabir (IISER, Pune) (Sl No. 4)
2. U. Waghmare (JNCASR, Bangalore) (Sl No. 8)

International

1. L. Boeri, Technical Uni , Graz, Indo-Austrian project (Sl No 3)
2. M. Azuma, Tokyo Tec, Collaboration sponsored by Visiting Professorship at Tokyo Inst of Technology (Sl no 6)
3. A. Vasiliev, Moscow State Univ, Indo-Russian (Sl no. 10, 12)
4. K Held, Techinal Univ Vienna, Indo-EU project (Sl no. 7)

Member of Editorial Board

1. Pramana

Significant research output / development during last one year

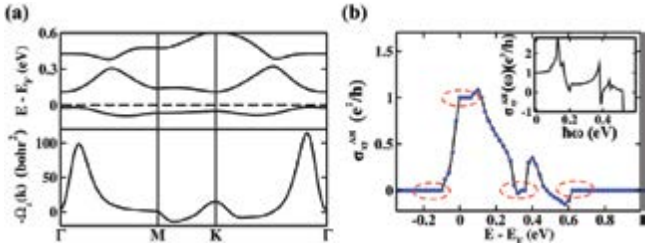
General research areas and problems worked on

Oxide heterostructures; 2D materials; Double perovskites; Organic-inorganic hybrid materials; Quantum Spin Systems

Interesting results obtained

Prediction of High-temperature large-gap quantum anomalous Hall insulating state in ultrathin double perovskite films (Santu Baidya, Umesh V. Waghmare, Arun Paramekanti, and Tanusri Saha-Dasgupta, Phys. Rev. B 94, 155405 , 2016)

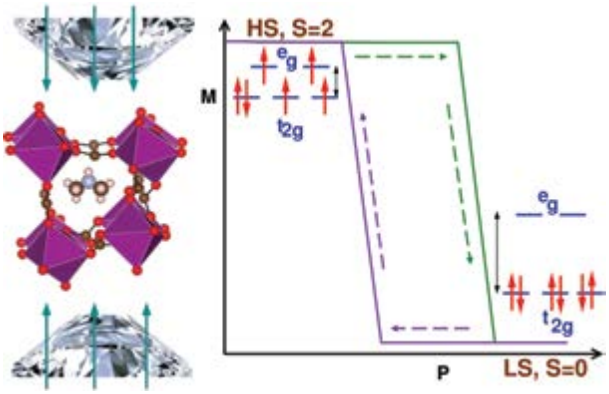
Towards the goal of realizing topological phases in thin films of correlated oxide and heterostructures, we propose here a quantum anomalous Hall insulator (QAHI) in ultrathin films of double perovskites based on mixed 3d–5d or 3d–4d transition-metal ions, grown along the [111] direction. Our finding of the QAHI state in ultrathin Ba_2FeReO_6 is expected to stimulate experimental verification along with possible practical applications of its dissipationless edge currents.



(a): The band structure in minority spin channel (top panel) and calculated Berry curvature (bottom panel) plotted along the high symmetry directions in the BZ. (b): Anomalous Hall conductivity of the band structure in (a), in units of e^2/h. Quantized plateaus are highlighted. Inset: Frequency dependence of the real part of the antisymmetric optical conductivity.

Cationic Effect on Pressure driven Spin-State Transition and cooperativity in Hybrid Perovskites (H Banerjee, S Chakraborty, T Saha-Dasgupta, Chemistry of Materials 28, 8379, 2017)

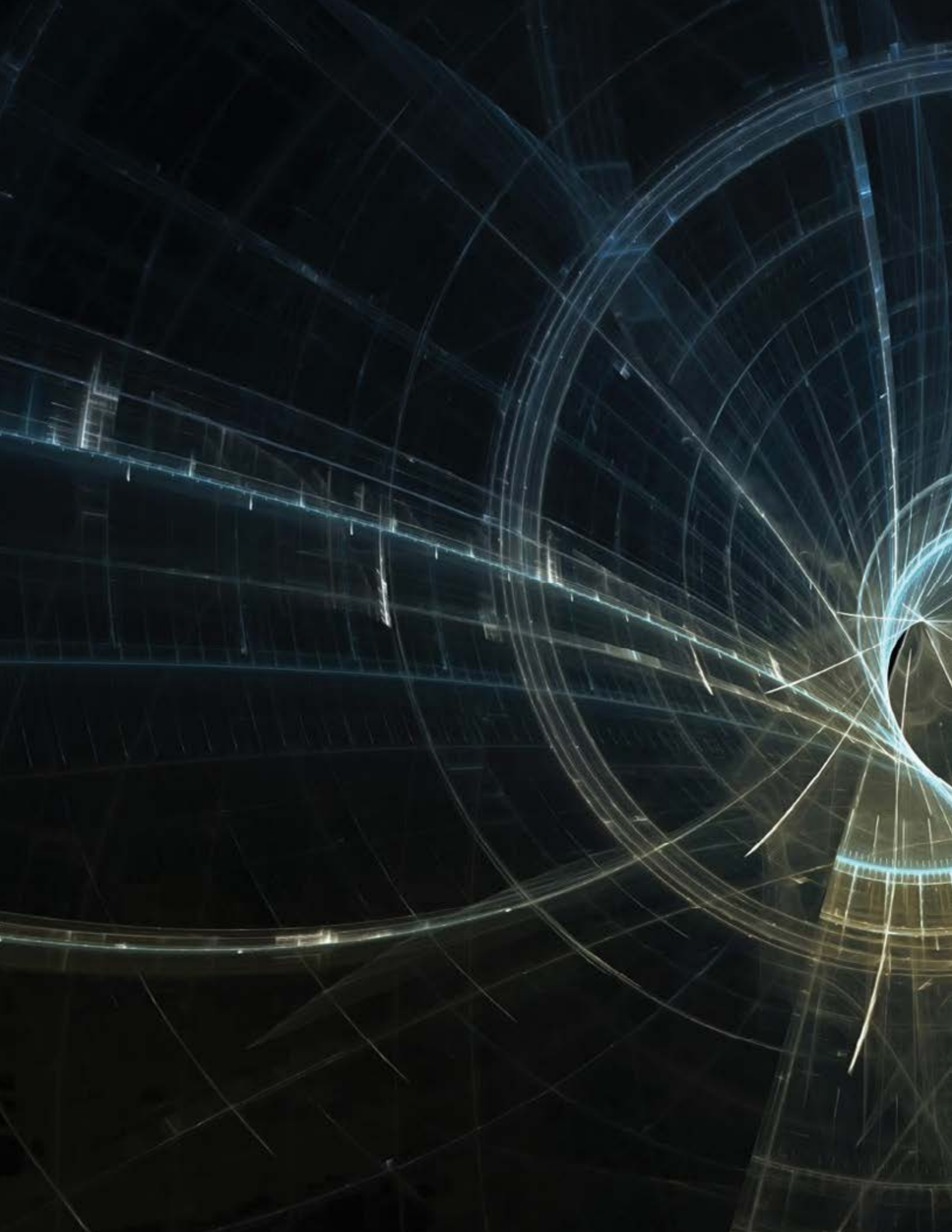
Hybrid or metal organic framework (MOF) perovskites of general composition, ABX_3, are known to show interesting properties which can lead to a variety of technological applications. Our first principles study shows they are also potential candidates for exhibiting cooperative spin-state transitions upon application of external stimuli.

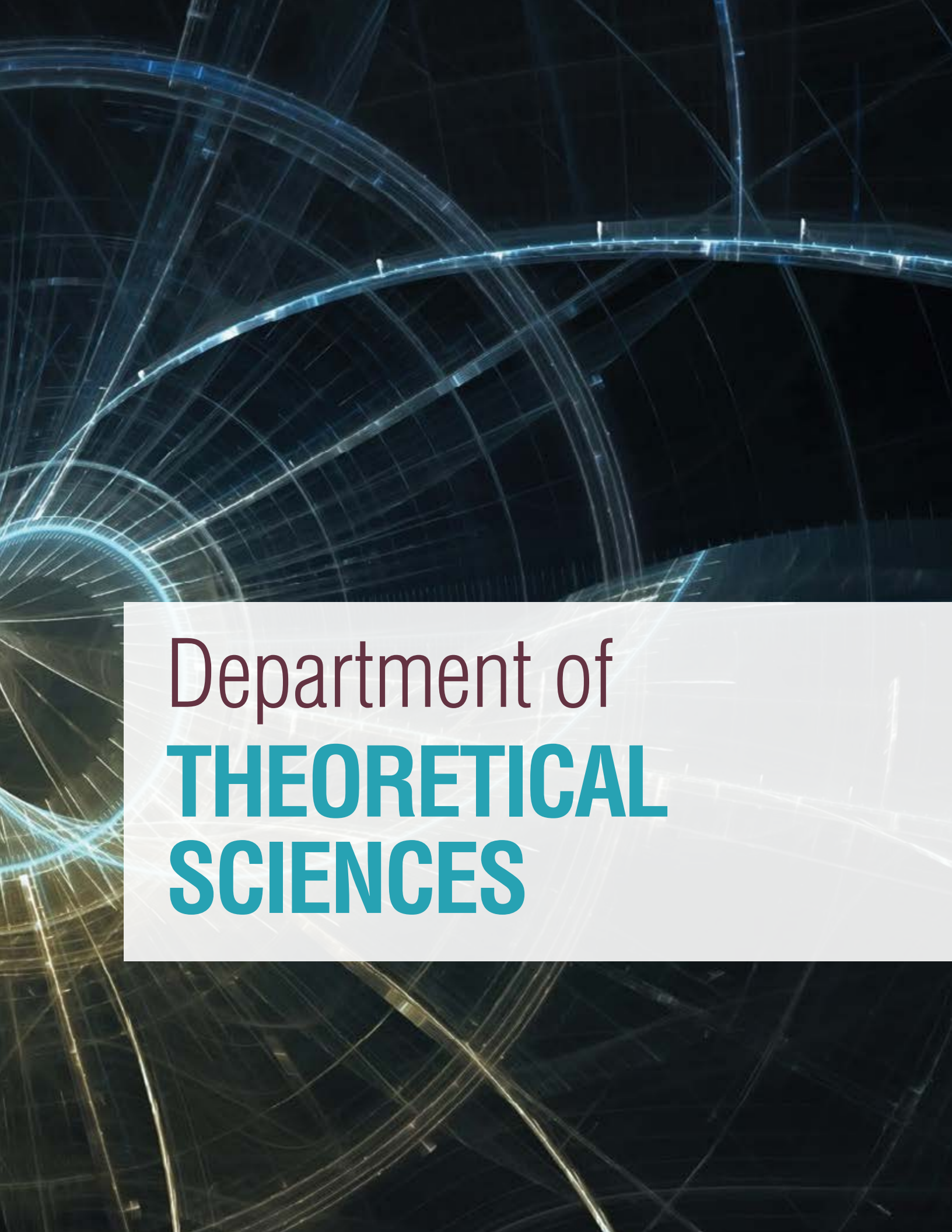


Hybrid perovskites and cooperativity, manifested as hysteresis in spin-state transition under pressure.

Proposed research activities for the coming year

1. High-throughput Computational Materials Design
2. Problems of geological interest
3. Light induced Spin-Cross Transition in Metalorganic Complexes





Department of **THEORETICAL SCIENCES**

Department of Theoretical Sciences

Manu Mathur

Department profile indicators

Table A : Manpower and resources

Number of faculties	9
Number of Post –doctoral research associate (centre+project)	3
Number of Ph.D students	25+1 External (Part-time) + 1 Proj. JRF
Number of other project staff	1
Number of summer students	3
Projects (ongoing)	1

Table B: Research Activities indicators

Number of research papers in Journals	26
Number of Book-chapters/books	1
Number of other publications	1
Number of Ph.D students graduated (submitted+degree awarded)	2+2=4
Number of M.Tech/M.Sc projects	0

Table C: Academic activities and likeage

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

Most important research highlights

- Study of two Higgs doublet models with softly broken U(1) symmetry, Gauge theories in the presence of Black holes, Categorical fiber bundles and connection on path spaces
- Schrodinger equation in non-commutative space time, spevtral distance in doubled Moyal plane.
- Gauging non relativistic diffeomorphism and its application, Fluid dynamics in non commutative space, new results in the context of Newton Cartan geometry.
- Canonical transformations and Duality in SU(N) lattice gauge theories leading to new disorder operators.
- Regularization of kappa deformed Keppler problem, Poisson structures of dynamical systems with three degrees of freedom having chaotic properties.
- Entanglement of quantum optical states and squeezing
- Study of fiber bundle model with non-linear fibers, study of lattice percolation model and a model of 'Colored percolation' has been introduced.
- Characterization of steady state spatial structures in a broad class of conserved mass transport processes, study of active Brownian particles.
- Phase ordering in coupled systems, Actin filaments, Bacterial chemotaxis, Periodically driven systems.
- Study of light scattering methods for biomedical tissue characterization.

Summary of research activities

The 2 Higgs doublet models (2HDMs) with softly broken U(1) symmetry are studied leading to testable signals for 2DHMs in ongoing and future LHC experiments.

Gauge theories in the presence of charged black holes are studied under less restrictive and more physical assumptions on gauge transformations than before. This leads to a remarkable result that for a charged black hole the horizons has equal and opposite charge not visible from outside.

Study and formulation of Schrodinger equations in a non-commutative space-time and computation of spectral distance in doubled Moyal plane.

Torsional Newton Carton geometry is formulated in a consistent manner. An explicit expression for the contorsion tensor is derived for the first time.

Fluid dynamics is formulated in non-commutative space time. The Euler equation receives a correction and the continuity equation remains form invariant.

Exact duality transformations in the SU(N) lattice gauge theories were constructed using a series of Canonical transformations. This led to a novel disorder operator for SU(N) lattice gauge theories. The well known Kramers-Wannier and Wegner dualities are similarly obtained.

The Moser method is extended and used to regularize Kepler problem in kappa space time. The mapping of geodesic motion on a sphere to the Kepler problem in deformed space time has dependence on the deformation parameter.

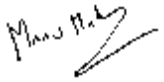
A counter intuitive result of non-monotonic dependence of entanglement generated by beam splitter with photon added squeezed state on the squeezing parameter was found and explained.

The fibre bundle model with nonlinear fibers is studied showing brittle and quasi-brittle phase transition. This transition has weak power law modulated logarithmic (brittle) and logarithmic (quasi-brittle) dependence of the relaxation times.

Characterization of steady state spatial structure by exactly calculating the spatial correlation functions in a broad class of conserved-mass transport processes. The spatial correlation functions are in general short ranged and therefore these transport processes possess remarkable thermodynamic structures in steady states.

The importance of considering shape fluctuations of a barrier against which actin filaments exert force while polymerizing is shown.

Development of theoretical light scattering methods for biomedical tissues characterization, study of interstellar medium from analysis of extinction spectrum and X ray halos around stars.



Manu Mathur
Head, Department of Theoretical Sciences

Amitabha Lahiri

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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

(All `ongoing' as of 31/03/2017)

1. Debmalya Mukhopadhyay (External)
2. Subhasish Chakrabarty
3. Ishita Dutta Choudhury
4. Ambalika Biswas
5. Karan Fernandes
6. Ritam Basu

Teaching activities at the Centre

1. Spring 2016; Electromagnetic Theory; PHY 203; 7
2. Autumn 2016; Classical Dynamics; PHY 101; 9

Publications in Journals

1. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta; *Construction of categorical bundles from local data;* Theory and Applications of Categories; 2016; **31;** 388.
2. Ambalika Biswas and **Amitabha Lahiri;** *Alignment, reverse alignment, and wrong sign Yukawa couplings in two Higgs doublet models;* Phys. Rev. D; 2016; **93;** 115017.
3. Saikat Chatterjee, **Amitabha Lahiri** and Ambar N. Sengupta; *Connections on decorated path space bundles;* J. Geom. Phys.; 2017; **112;** 147.
4. Karan Fernandes, Suman Ghosh and **Amitabha Lahiri;** *Constrained field theories on spherically symmetric spacetimes with horizons;* Phys. Rev. D; 2017; **95;** 045012 .

Other Publications

1. Ambalika Biswas and **Amitabha Lahiri,** *Various perspectives of Two Higgs Doublet models and Naturalness criteria,* (talk delivered by A. Biswas) in the Proceedings of the 38th International Conference on High Energy Physics (ICHEP 2016), Chicago, USA 3-10 Aug, 2016, Published in **PoS (ICHEP 2016)** 710.

Lectures Delivered

1. Topological mass generation and confining potential, Keio University, Hiyoshi, Kanagawa, Japan, Nov 2016
2. Quark confinement and magnetic monopoles, Presidency University, Kolkata, Mar 2017.

Membership of Committees

Internal Committee

Director's Advisory Board; Consultative Advisory Committee; Admission Committee; Students' Curriculum and Research Evaluation Committee; Students Advisory Committee ***(ex officio as Dean (AP) till 31st January, 2017);*** Complaints Committee (till Aug 2016); Computer Services Cell (Working Group & Advisory Committee); Conferences, Workshops and Extension Programmes Committee; Medical Committee.

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

National

1. Sl. No. 1, 3, 4

International

1. Sl. No. 1, 3

Significant research output / development during last one year

General research areas and problems worked on

Quantum Field Theory and Particle Physics:

Two Higgs doublet models (2HDM) as a possible source of Dark Matter;

General Relativity:

Gauge systems near a horizon;

Mathematical Physics:

Construction of fiber bundles on the path space of a manifold, and of connections on those bundles.

Interesting results obtained

1. and 3. The space of paths on a manifold is a mathematical object called a category. We are interested in dynamics on this space because that can describe the dynamics of charged strings on ordinary spacetime. We constructed a fiber bundle on this space, and found that it required a novel way of describing the action of a categorical group on the categorical bundle. Later we also constructed a connection on this bundle, i.e.,a derivative operator compatible with the category structure. These constructions should be useful, in the long run, in finding a description of QCD strings for example.

2. 2HDMs with a softly broken U(1) symmetry have two uncharged CP-even scalars. We imposed a very basic criterion that infinities coming from quadratic divergences cancel at the lowest order, and calculated the masses of the new scalar particles which arise in the model. We have shown that the heavier CP-even scalar in these 2HDMs cannot be the observed Higgs particle. For the case when the lighter CP-even scalar is the observed Higgs particle, and fermions couple to it with the wrong sign Yukawa coupling, we have calculated the rate of decay of the Higgs to two photons (Fig.1). This may be a way to test 2HDMs in ongoing and future LHC experiments.

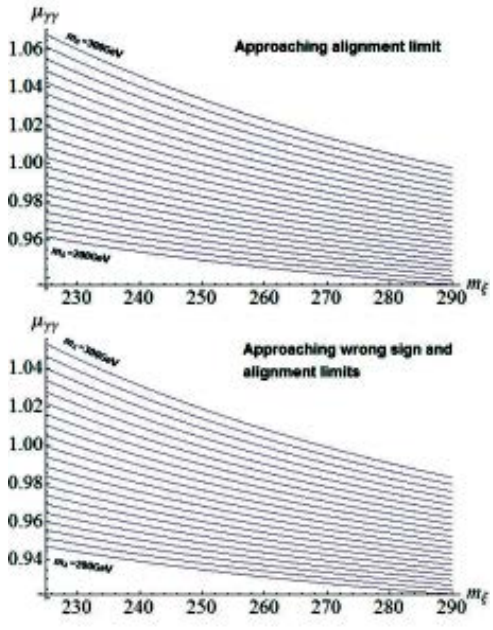

Fig.1: Diphoton decay width of the SM-like Higgs particle (normalized to SM) as a function of the charged Higgs mass in GeV for (a) the same sign and (b) the wrong sign, of down-type Yukawa couplings.

4. We studied gauge theories on spacetimes with a black hole under less restrictive, and more physical, assumptions about gauge transformations than have been done before, and found that gauge constraints are modified in previously unknown ways. In particular, we found the remarkable and counterintuitive result that for a charged black hole, the horizon carries an equal and opposite charge which is not visible from outside. This will clearly have a significant impact on our understanding of dynamics on black hole spacetimes, and also on quantization of gauge fields near black holes.

Proposed research activities for the coming year

i) Mathematical Physics: I plan to investigate the local description of the connection on categorical fiber bundle, in particular, how to relate it to gauge fields on the base manifold, and to investigate gauge transformations of these fields. These fields may be expected to mediate interactions between charged strings.

ii) Quantum Field Theory: I plan to work on a followup of an earlier work, in which a non-local interaction between fermions and a 2-form field was proposed. Since a 2-form field typically arises in string theory, I plan to investigate if stringlike obejcts are present in the non-local model in question.

iii) Particle Physics: I plan to look into the possibility of Higgs-Higgs bound states in 2HDMs. These, being uncharged and weakly interacting with other fields, may provide viable candidates for Dark Matter.

iv) General Relativity: I plan to follow up on the problem of gauge theories on black hole spacetimes, and try to extend it to stationary black holes and to quantum gauge theories.

Any other matter

He was Dean (Academic Programme) till Jan 31, 2017.

Biswajit Chakraborty

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After his schooling from Shillong, Professor Biswajit Chakraborty did his B.Sc. and M.Sc. from Delhi University and eventually completed his Ph.D. from Institute of Mathematical Sciences, affiliated to Madras University in 1992. After a few years of Post Doctoral experience in IIT, Kanpur, HRI, Allahabad and SNBNCBS, he was finally absorbed in the faculty in SNBNCBS in 1997. Currently, he is a professor in SNBNCBS.

Supervision of Research / Students

Ph.D. Students

1. Yendrenbam Chaoba Devi, submitted her thesis on "Study in Noncommutative geometry inspired Physics" on Dec'2016 in Calcutta University.
2. Aritra N. Bose, Mr. Partha Nandi, Mr. Sayan Paul and Mr. Jaydeb Das are currently working on different aspects of Noncommutative Geometry. Besides, Mr. Debabrata Ghorai, who is also being co-supervised by Dr. Sunandan Gangopadhyay of IISER, Kolkata, is currently working on holographic superconductors-inspired by AdS-CFT correspondence.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. I have supervised the summer projects of Kaushlendra Kumar of IPhD batch, IISER, Kolkata and that of Atul Rathore of IPHD batch , SNBNCBS.

Post Doctoral Research Scientists

1. Ravi Kanth Verma worked on some aspects of Zitterbewegung in kappa-Minkowski type of Noncommutative spaces.

Teaching activities at the Centre

I have taught the following Courses in last two semesters under IPhD & PhD Curriculum of the Centre.

1. Advanced Quantum Mechanics & Applications (PHY 303) in Fall Semester 2016 jointly with Professor Archan S Majumdar.
2. Quantum Physics [Application] (PHY 604) in Spring Semester 2017.

Independent publications of students

1. Debabrata Ghorai, Sunandan Gangopadhyay; *Noncommutative effects of spacetime on holographic superconductors;* Phys.Lett. B; 2016; **758;** 106.
2. Debabrata Ghorai, Sunandan Gangopadhyay; *Holographic free energy and thermodynamic geometry;* Eur. Phys. J. C; 2016; **76;** 702.

Membership of Committees

External Committee

Member, Board of Research Studies, Physics Department, West Bengal State University, Barasat, West Bengal.

Internal Committee

1. CAC; 2. Admission Committee; 3. FSC; 4. CWEP.

Significant research output / development during last one year

General research areas and problems worked on

Noncommutative Geometry inspired Physics, Noncommutative Quantum Mechanics and Noncommutative Quantum Field Theory.

We continued with th computation of finite Connes distance on Noncommutative spaces like Moyal Plane and Fuzzy sphere. Besides we formulated Noncommutative Quantum Mechanics with space-time Noncommutativity.

Interesting results obtained

1. We have formulated an appropriate Schrodinger equation, where time is also an operator satisfying space-time noncommutativity. We start with a time re-parametrization invariant form of the action, where time and its conjugate variables are both counted as phase space variables. For this we make use of the Hilbert-Schmidt operatorial formulation of quantum mechanics, devised earlier by us. Our earlier application did not involve time operator; it was taken to be a c-number evolution parameter, as

in the case of usual commutative Quantum mechanics. But here the situation is drastically different and one needs to identify ``sub-Hilbert space", so to say, from the original Hilbert space, where the inner product for the former case can be thought of an induced one from the latter case, in the sense that the former involves integration over only spatial coordinates, in contrast to the former one, where integration over both spatial and temporal coordinates occur, when an appropriate coherent state basis is used (for Moyal type of noncommutativity). Although the energy spectrum of most of the bound state problems are not affected, the wave functions themselves undergo deformation and displays the distinctive features of parity violation. Finally in the presence of time-dependent potential we find a deformation, stemming from noncommutativity, in the transition probability, where the rate of transition probability is enhanced i.e. a deformed Fermi's Golden rule.

2. The computation of spectral distance in doubled Moyal plane is taken up, for the important role played by its counterpart in Almost-Commutative spaces like the models proposed by Chamseddine et. al. and Connes et.al. In the formulation of Standard model in Particle Physics. In this sense, the doubled Moyal plane is a natural toy model having an intrinsic space time noncommutativity and may be of relevance for quantum gravity scale. We compute, using our Dirac eigen spinor basis formulation, various distances here, like (i) transverse (the distance between a state in the Moyal plane and its "clone" in the other Moyal Plane), (ii) longitudinal (the distance between a pair of states in the same Moyal plane and finally (iii) the hypotenuse distance. We find remarkably that the Pythagoras theorem is satisfied here, provided certain quantization rule is satisfied by a dimensionless variable constructed out of Moyal space noncommutativity and inter-Moyal plane separation.

Proposed research activities for the coming year

1. We plan to take up the similar studies in kappa-Minkowski spaces and extension.

2. We plan to extend our formulation of the computation spectral distance from Riemannian to Pseudo-Riemannian spaces, where the metric is of Lorentzian signature.

Makhtedar Sanjay Kumar

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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'.

Publications in Journals

1. Soumyakanti Bose and **M. Sanjay Kumar;** *Quantitative study of beam-splitter-generated entanglement from input states with multiple nonclassicality-inducing operations;* Physical Review A; 2017; **95;** 012330.

Membership of Committees

Internal Committee

1. Member, Admissions Committee & Admissions Coordinator
2. Member, EVLP (VASP) Committee

Significant research output / development during last one year

General research areas and problems worked on

QUANTUM OPTICS & QUANTUM INFORMATION

Aspects of entangled states generated by a beam-splitter when various nonclassical states of light are input.

Interesting results obtained

Found that entanglement generated by a beam splitter with photon-added squeezed state at the input shows a nonmonotonic dependence on the squeezing parameter.

Have explained the above counter-intuitive phenomenon in terms of competition between the photon additon and squeezing operations as evidenced in the coutours of the Q function associated with this state.

Proposed research activities for the coming year

Detailed investigation of Issues relating to use of beam-splitter output entangled states as resources in quantum teleportation.

Manu Mathur

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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, Title of Thesis: "Canonical Transformations and Loops Formulation of Lattice Gauge Theories" Completed.
2. Atul Rathor, Title of Thesis: "Duality Transformations in SU(N) Lattice Gauge Theories", just started.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Atul Rathor; 'Duality in Ising Model'; Completed and 'Entanglement in SU(N) Lattice Gauge Theories'; Completed.

Teaching activities at the Centre

1. 3rd Semester, Electromagnetic Theory, Physics 203, 10, Prof. S. K. Sharma

Publications in Journals

1. **Manu Mathur,** T.P. Sreeraj; *Lattice Gauge Theories and Spin Models;* Phys. Rev. D; 2016; **94**(8); 085029.

Significant research output / development during last one year

General research areas and problems worked on

Lattice gauge Theories and Loop Formulation:

The Wegner Z_2 gauge theory-Z_2 Ising spin model duality in (2 + 1) dimensions is revisited and derived through a series of canonical transformations. The Kramers-Wannier duality is similarly obtained through Z_2 canonical transformations. The Wegner Z_2 gauge-spin duality is directly generalized to SU(N) lattice gauge theory in (2 + 1) dimensions to obtain the SU(N) spin model in terms of the SU(N) magnetic fields and their conjugate SU(N) electric scalar potentials. The exact & complete solutions of the Z2, U(1), SU(N) Gauss law constraints in terms of the corresponding spin or dual potential operators are given. The gauge-spin duality naturally leads to a new gauge invariant magnetic disorder operator for SU(N) lattice gauge theory which produces a magnetic vortex on the plaquette. A variational ground state of the SU(2) spin model with nearest neighbor interactions is constructed to analyze SU(2) gauge theory.

Interesting results obtained

As a natural consequence of the exact duality we are able to construct the the most general disorder operator for SU(2) lattice gauge theories in (2+1) dimension. This disorder operator creates magnetic vortex on a plaquette and reduces to the well known t'Hooft disorder operator in a special case.

Proposed research activities for the coming year

1) Generalization of exact duality in (3+1) dimensions.
2) Generalization of the disorder operator in (3+1) dimensions.

Partha Guha

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Professor Partha Guha's research interests are centered around integrable systems, integrability in curved and noncommutative spaces, nonlinear vibrations and delay differential equations, geometric thermodynamics and contact geometry, applications of cosymplectic and locally conformal symplectic geometry.

Supervision of Research / Students

Ph.D. Students

1. Sumanto Chanda
2. Ankan Pandey

Post Doctoral Research Scientists

1. Kumar Abhinav

Publications in journals

1. S. Chanda, G.W. Gibbons, **P. Guha;** *Jacobi-Maupertuis-Eisenhart metric and geodesic flows;* Journal of Mathematical Physics; 2017; **58;** 032503.
2. A. Ghose Choudhury and **P. Guha;** *An analytic technique for the solutions of nonlinear oscillators with damping using the Abel Equation;* Discontinuity, Nonlinearity and Complexity; 2017; **6**(1); 65-74.
3. A. Ghose-Choudhury, **Partha Guha**, Andronikos Paliathanasis, P. G. L. Leach; *Noetherian symmetries of noncentral forces with drag term;* International Journal of Geometric Methods in Modern Physics; 2017; **14**(2); 1750018.
4. O. Esen, A. Ghose Choudhury and **P. Guha;** *Bi-Hamiltonian Structures of 3D Chaotic Dynamical Systems;* International Journal of Bifurcation and Chaos; 2016; **26**(13); 1650215.
5. K. Abhinav and **P. Guha;** *Quasi-Integrability in Supersymmetric Sine-Gordon Models;* Euro Physics Letters; 2016; **116**(1); 10004.
6. S. Chanda, **P. Guha** and R. Roychowdhury; *Schwarzschild instanton in emergent gravity;* International Journal Geometric Methods in Modern Physics; 2017; **14**(1); 1750006.
7. S. Chanda, **P. Guha** and R. Roychowdhury; *Taub-NUT as Bertrand spacetime with magnetic fields;* Journal of Geometry and Symmetry in Physics; 2016; **41;** 33.
8. **P. Guha,** E. Harikumar and N.S. Zuhair; *Regularization of Kepler Problem in k-spacetime;* Journal of Mathematical Physics; 2016; **57;** 112501.

Lectures Delivered

1. Invited speaker at Discussion meeting on Geophysical Fluid Dynamics; International Center for Theoretical Sciences, Bangalore; 21-23 July 2016.
2. Poster presentation at XXV International Fall Workshop on Geometry and Physics; IEM-CSIC, Madrid; August 29-September 2, 2016.
3. Talk given at Department of Theoretical Physics; University of Zaragoza, Spain; 13 Sepember, 2016.
4. Lectures given at the 5th SERC school on Nonlinear Dynamics is being held in PSG College of Technology, Coimbatore, Tamil Nadu (1-21 December 2016).

Awards / Recognitions

1. Grant obtained from Brazil, FAFESP, Sao Paulo Research Foundation, for a project on Nonlinear dynamics and gravity.

Conference / Symposia / Workshops / Seminars etc. organized

1. Organized an activity on Dynamics of complex systems jointly with Professor Amit Apte; May 23- July 23, 2016.
2. Co-convenor of the C. K. Majumdar Memorial Workshop, June 2016.

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

National

1. Anindya Ghose Choudhury (Surendranath College, CU, Sl. No.2, 3, 4)
2. E. Harikumar (faculty, HCU, Sl. No.8)
3. M.Zuhair (student, HCU, Sl. No.8)

International

1. Ogul Esen (Gabze Technology,Turkey, Sl. No. 4)
2. Gary Gibbons (Cambridge, England, Sl. No.1)
3. Peter Leach (Kwazulu Natal, South Africa, Sl. No.3)
4. A. Palaithanasis (Valdivia, Chile, Sl. No.3)
5. Raju Roychowdhury (USP, Brazil, Sl. No.6, 7)

Member of Editorial Board

1. Advances in Mathematical Physics
2. International Journal of Physics and Mathematical Sciences

Significant research output / development during last one year

General research areas and problems worked on

Integrable systems, contact and metriplectic geometry, nonlinear dynamics and geometrical mechanics.

Interesting results obtained

Jacobi-metric has been mainly formulated only for autonomous systems, because for the autonomous systems the Hamiltonians are conserved quantity. However, such convenience is denied in the case of time-dependent systems. Under such circumstances, the Eisenhart-Duval lift proved to be a useful tool, by providing a dummy variable along an extra dimension, and thus, a conserved quantity.

This gives us a momentum equation from which we can define a metric for the unit momentum sphere, and thus, the Jacobi metric for time-dependent systems.

We have studied the regularization of kappa-deformed Kepler problem. We used an extension of Moser method to regularize Kepler problem in kappa-spacetime. The mapping of geodesic motion on a sphere to the Kepler problem in deformed-spacetime have dependence on the deformation parameter 'a'. We have studied the generalization of the Ligon-Schaaf map to the kappa-deformed case and it is established that the procedure of regularization can be carried out in a straightforward manner, as in the commutative situation. The key idea in our regularization is that we consider coordinates of kappa-deformed phase space in terms of functions of usual variables in Minkowski phase space.

We have studied Poisson structures of dynamical systems with three degrees of freedom which are known for their chaotic properties and all these flows admit bi-Hamiltonian structures depending on the values of their parameters.

We have carried forward the programme of analysis of curl forces initiated by Berry and Shukla. This is largely an unexplored area of nonlinear mechanics, though efforts at linearisation of planar systems subject to nonisotropic central forces

We have shown that the first integrals derived by Berry and Shukla are the Noetherian first integrals resulting from the symmetries of the Emden-Fowler equation.

Proposed research activities for the coming year

The non-standard Lagrangians are deformations of simpler standard Lagrangians for Lienard system.

We wish to exhibit its connection with contact Hamiltonian mechanics and thermostat problem. We wish to explore geometry of thermodynamics using contact mechanics, GENERIC or metriplectic structure and information geometry.

Exploring the Hamiltonian geometry of non-autonomous three dimensional dynamical systems using nambu cosymplectic geometry and nambu metriplectic geometry.

We wish to do qualitative analysis of quadratically and higher-order damped oscillators with non-linear restoring force. In particular, we wish obtain Hamiltonian structure and analytical form of the energy functions and other qualitative features.

We wish to carry out the inverse problem of dynamics in noncommutative kappa spacetime and we want to continue our mechanics on curved space-time.

Punyabrata Pradhan

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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 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. Sayani Chatterjee; Additivity property and mass fluctuation in conserved-mass transport processes (registered for Ph.D. in the University of Calcutta); ongoing (thesis to be submitted soon).
2. Arghya Das; Thermodynamic characterisation of nonequilibrium steady states and study of phase transitions (registered for Ph.D. in the University of Calcutta); ongoing (thesis to be submitted soon).
3. Subhodip Chakraborti; Studies of fluctuations in systems of self-propelled particles (registered for Ph.D. in the University of Calcutta); ongoing.
4. Amal Garai; Fluctuations in nonequilibrium steady states and single-file diffusion; ongoing.
5. Dhiraj Tapader (under SERB/DST project); Studies of higher dimensional mass transport processes; ongoing.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Dhiraj Tapader (M.Sc.); S. N. Bose National Centre for Basic Sciences (under SERB/DST project); Studies of higher dimensional mass transport processes (work report to be submitted soon); ongoing.

Post Doctoral Research Scientists

1. Subhashis Rana

Teaching activities at the Centre

1. 6th semester; Advanced statistical mechanics (PHY 603); advanced level (post M. Sc., designed for research); 10 students (credit 5 + audit 5).
2. 2nd semester; Computational methods in physics II (PHY 204); M. Sc. level (designed for research); 11 students (credit 7 + audit 4).

Publications in journals

1. Subhadip Chakraborti, Shradha Mishra, and **Punyabrata Pradhan;** *Additivity, density fluctuations, and nonequilibrium thermodynamics for active Brownian particles*; Physical Review E; 2016; **93**; 052606.
2. Rakesh Chatterjee, Sakuntala Chatterjee, and **Punyabrata Pradhan**; *Symmetric exclusion processes on a ring with moving defects;* Physical Review E; 2016; **93**; 062124.
3. Arghya Das, Sayani Chatterjee, and **Punyabrata Pradhan;** *Spatial correlations, additivity and fluctuations in conserved-mass transport processes*; Phys. Rev. E; 2016; **93**; 062135.

Lectures Delivered

1. Additivity and fluctuations in nonequilibrium; S. N. Bose National Centre for Basic Sciences; Kolkata; January; 2017; a talk delivered in a conference.
2. Additivity, hydrodynamics and mass distributions in nonequilibrium mass transport processes; Saha Institute of Nuclear Physics (SINP); Kolkata; December; 2016; an invited talk delivered in an international conference.
3. Hydrodynamics of mass transport processes and Einstein relation; Jawaharlal Nehru University (JNU); New Delhi; December; 2016; an invited talk delivered.
4. Sandpiles, ricepiles and other mass transport processes; Tata Institute of Fundamental Research (TIFR); Mumbai; November; 2016; an invited talk delivered in a meeting.
5. Additivity and mass fluctuations in mass transport processes; Presidency University; Kolkata; October; 2016; a colloquium delivered (designed mainly for students).
6. Additivity and mass fluctuation in nonequilibrium mass transport processes; TIFR Centre for Interdisciplinary Sciences (TCIS); Hyderabad; September; 2016; an invited talk delivered.

Membership of Committees

External Committee

Doctoral (Ph.D. thesis) committee for Ms. Karthika at the Indian Institute of Space Science and Technology, Thiruvananthapuram, India.

Internal Committee

Doctoral (Ph.D. thesis) committees; interview committees (doctoral and post-doctoral admissions); library committee; computer service cell advisory committee; short-listing committee (scientist-C); purchase committees; creche committee.

Sponsored Projects

1. "Additivity Principle and Thermodynamic Characterization of Mass Transport Processes" (EMR/2014/000719); SERB (DST, India); 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.

Conference / Symposia / Workshops / Seminars etc. organized

1. Discussion meeting on the occasion of 60 years of Broadbent and Hammersley (1957) paper on percolation phenomena; January 23 - 24, 2017; S.N. Bose National Centre for Basic Sciences, Kolkata; one of the conveners

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

National

1. Dr. Shradha Mishra, IIT - BHU (Sl. no. 1)

Significant research output / development during last one year

General research areas and problems worked on

Formulation of thermodynamics in various mass transport processes and active matters (self-propelled particles), having a nonequilibrium steady state, in terms of an equilibrium-like chemical potential. Studies of transport properties in systems having a time-periodic steady state.

Interesting results obtained

1. We have characterized the steady-state spatial structure, by exactly calculating the spatial correlation functions (related to structure factor), in a broad class of conserved-mass transport processes governed by chipping, diffusion, and coalescence of masses. We find that the spatial correlations are in general short-ranged in space, with correlation length being finite. Consequently, on a large length scale (much larger than the correlation length in the system), these transport processes possess a remarkable thermodynamic structure in the steady state: The processes have an equilibrium-like additivity property and, consequently, a fluctuation-response relation. Additivity property has been used to theoretically obtain subsystem mass distributions, which are described by gamma distribution. Our theoretical results have been verified to have an excellent agreement with simulations. Interestingly, gamma-like distributions have been observed in various experiments in the past (concerning self-assemblies in materials and force fluctuations in granular matter), which could be understood in the light of the results of this work. Moreover, our work could help us to formulate a unified thermodynamic framework for driven systems in general.
2. In this work, we study particle-number fluctuations in interacting self-propelled particles, in the context of a particular system, called active Brownian particles (ABPs), consisting of repulsive disks with random self-propulsion velocities. We demonstrate, in the regime of homogeneous phase, that an equilibrium-like additivity property leads to subsystem particle-number distributions in the system. The crucial ingredient of this theory is a nonequilibrium fluctuation-response relation (FR) between compressibility and number-fluctuation or variance, which is a direct consequence of additivity. We believe additivity could be the missing link, providing a unified characterization of a broad range of phenomena in the self-propelled particles observed in the past.
3. In this work, we have studied, motivated by the recent experiments on colloidal particles driven by moving lasers, the effect of a periodically moving external potential on a system of hard-core particles diffusing in a confined geometry (*e.g.*, a one-dimensional ring) in a setup of a very simple and paradigmatic model-system, called symmetric simple exclusion process (SSEP). We find that, depending on the structure of the external potential, spatial structures may be quite complex, *e.g.,* multiple peaks and troughs could develop in a traveling density-wave-like patterns. Consequently, the particle current is described by higher order spatial correlations (extending beyond neighbouring-particle correlations). Interestingly, irrespective of these details, the particle current does show polarity reversal and nonmonotonicity (appearance of peak as well as trough in the current) upon variation of particle density and velocity of the external potential. On a general ground, our results could be useful in the context of externally stirred fluids, such as micro-fluidic or micro-electromechanical devices and a driven assembly of nano-particles, etc.

Proposed research activities for the coming year

1. We would like to obtain hydrodynamic description in various conserved-mass transport processes, which could help one to understand various fluctuation relations, if any, in these systems in a dynamical setting and would certainly put our previous findings (see sl. no. 1 in 'Interesting results obtained') on a much stronger ground.
2. We would like to extend our previous work for active Brownian particles (see sl. no. 2 in 'Interesting results obtained') to other systems of self-propelled particles, which could help one to understand the general structure in many living systems, *e.g.*, bacterial colonies, fish schools, flocks of birds as well as in nonliving systems, *e.g.*, photo-activated or chemically powered colloids, etc.
3. We plan to explore if the striking features discovered in our previous work (see sl. no. 3 in 'Interesting results obtained'), *e.g.*, the polarity reversal of current upon tuning certain parameters, would persist in particle transport even in a more realistic system of particles, driven in a confined geometry.

Rabin Banerjee

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Professor Rabin Banerjee did his masters from IIT Kharagpur and Ph.D from Saha Institute of Nuclear Physics (Calcutta University). He joined S.N.Bose Centre as a research associate in 1988 and stayed here since then.

Supervision of Research / Students

Ph.D. Students

1. Arpita Mitra, Nonrelativistic diffeomorphism symmetry and its applications, Completed (Thesis to be submitted in July 2017).
2. Shirsendu Dey (external), Some aspects of anomalous hydrodynamics, Completed (Thesis to be submitted in July 2017).
3. Arpan Krishna Mitra, Fluid dynamics as Field theory, Ongoing.

Projects of M.Sc./ M.Tech./ B.Tech./ Post B.Sc. students

1. Poulami Mondal (IIT KGP), PT symmetric quantum theory, Completed.

Teaching activities at the Centre

1. Second semester (Jan. - Apr. 2017), Quantum mechanics II, IPHD, 9 students, Soumendu Dutta

Publications in Journals

1. **Rabin Banerjee,** Bibhas Ranjan Majhi and Saurav Samanta; *Thermogeometric phase transition in a unified framework;* Phys. Letters B, 2017, **767**, 25.
2. **Rabin Banerjee** and Pradip Mukherjee; *Torsional Newton-Cartan geometry from Galilean gauge theory;* Class. Quant. Grav.; 2016, **33,** 225013.

Lectures Delivered

1. Nonrelativistic diffeomorphism invariance and its applications, Ben Gurion University, Israel, March 2017 (invited lecture)
2. Gauging nonrelativistic diffeomorphism invariance and applications, ISI, Kolkata, March 2017 (colloquium)

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

National

1. Sl. No. 1 and 2

Significant research output / development during last one year

General research areas and problems worked on

Nonrelativistic diffeomorphism symmetry and its applications in field theory, condensed matter systems and gravity.

Newton Cartan geometry, with or without torsion, from Galilean gauge theory.

Shift symmetric galileon field theory in curved background and its cosmological implications.

Noncommutative fluid dynamics.

Interesting results obtained

We have found new results in the context of Newton Cartan geometry which is the mathematical foundation of Newton's gravity. Specifically, torsional Newton Cartan geometry could be formulated in a consistent manner. An explicit expression for the contorsion tensor was derived for the first time. An exact parallel with the general relativistic result was shown.

Recently, galileon field theories are in vogue. A problem is that they cannot be consistently defined in a curved background because they lose their original shift symmetry. Using our techniques developed in formulating Galilean gauge theory, we have solved this problem.

Fluid dynamics in noncommutative space was developed. It was shown that while the continuity equation remained form invariant, the Euler equation received a correction. This noncommutativity was shown to have a direct connection with the Moyal product used to define a noncommutative algebra.

Proposed research activities for the coming year

We wish to use our results for noncommutative fluid dynamics in the context of cosmology. Specifically, the role of the modified Euler equation is expected to yield nontrivial consequences.

Renewed interest has surfaced in discussing knotted solutions in electrodynamics and their mapping with fluid dynamics. We wish to investigate these issues in the context of noncommutative spacetime.

Sakuntala Chatterjee

Assistant 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; Ongoing.
2. Shauri Chakraborty; Dynamics of propagating modes and characterization of ordering in coupled non equilibrium systems; Ongoing.
3. Rajkumar Sadhu; Force generation by actin filaments growing against a barrier; Ongoing.

Teaching activities at the Centre

1. Fall semester, 2016, Quantum Mechanics 1, IPhD level, 9 students

Publications in Journals

1. Raj Kumar Sadhu and **Sakuntala Chatterjee;** *Actin filaments growing against a barrier with fluctuating shape*; Physical Review E; 2016; **93**; 062414.
2. Rakesh Chatterjee, **Sakuntala Chatterjee,** and Punyabrata Pradhan; *Symmetric exclusion processes on a ring with moving defects*; Phys. Rev. E; 2016; **93**; 062124.
3. Shauri Chakraborty, Sukla Pal, **Sakuntala Chatterjee**, and Mustansir Barma; *Large compact clusters and fast dynamics in coupled nonequilibrium systems*; Phys. Rev. E; 2016; **93**, 050102(R).

Lectures Delivered

1. Ordering and dynamics in coupled driven systems; S.N. Bose Centre; Kolkata; January; 2017; 1.
2. Equilibrium Statistical Mechanics; S. N. Bose Centre (C.K. Majumder Memorial Summer Workshop); Kolkata; May; 2016; 2.
3. Coupled non-equilibrium systems: ordering and dynamics; Presidency University; Kolkata; March; 2017; 1.
4. Actin filaments growing against a barrier with fluctuating shape; Calcutta University; Kolkata March; 2017; 1.

Membership of Committees

External Committee

Acted as reviewer for Phys Rev E, Phys Rev Lett, Physica A; Served in KVPY interview board.

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

Significant research output / development during last one year

General research areas and problems worked on

Phase-ordering in coupled systems; Actin filaments; Bacterial chemotaxis; Periodically driven systems.

Interesting results obtained

We show the importance of considering the shape fluctuations of a barrier against which actin filaments exert force while polymerizing. The shape of the force velocity curve has been measured as convex or concave, depending on the experimental set-up or modeling details. We show that the relative time-scale between the shape fluctuations of the barrier and polymerization of the filaments decide the shape of the force-velocity characteristic and by tuning this time-scale, it is possible to go over from a convex to a concave characteristic.

We obtain interesting phase diagram showing novel ordered phases on varying the coupling parameters between two coupled driven systems. These novel phases are characterized by presence of pure domains, along with fast dynamics of the domain boundaries over algebraic time-scale. The existence of fast dynamics also gives rise to an algebraic relaxation during the coarsening phase, which was not seen earlier in systems with pure domains.

Proposed research activities for the coming year

1. Characterization of propagating dynamical modes in coupled driven systems.
2. Bacterial chemotaxis with signaling noise.

Subhrangshu Sekhar Manna

Senior 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 Melbourne University, Australia; Forschungzentrum, Germany; St. Francis Xavier University, Canada and Yale University, USA. He joined the Physics department in Indian Institute of Technology, 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, about to submit shortly.
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. PHY104; Fall 2016; Full course
2. PHY204; Winter 2017; Half course

Publications in Journals

1. Biplab Bhattacherjee, Amitava Datta, **S. S. Manna**; *Asymptotic properties of restricted naming games;* Physica A; 2017; **478**; 177.
2. Sumanta Kundu and **S. S. Manna**; *Percolation model with an additional source of disorder*; Phys. Rev. E; 2016; **93**; 062133.
3. Chandreyee Roy and **S. S. Manna**; *Brittle-to-quasibrittle transition in bundles of nonlinear elastic fibers*; Phys. Rev. E; 2016; **94;** 032126.

Conference / Symposia / Workshops / Seminars etc. organized

1. Discussion meeting on the occasion of 60 years of Broadbent and Hammersley (1957) paper on percolation phenomena, 23-24 January, 2017, S. N. Bose National Centre for Basic Sciences, Convener.

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

International

1. Sl. No. 1

Member of Editorial Board

1. Fractals

Significant research output / development during last one year

General research areas and problems worked on

- Introduced a generalized model of lattice percolation
- Introduced a model of colored percolation
- Introduced a model of oscillating percolation
- Studied effect non-linear fiber bundle model.
- Restricted naming games

Interesting results obtained

The fiber bundle model has been studied with nonlinear fibers. This model exhibits a brittle to quasi-brittle phase transition. This transition has weak power law modulated logarithmic (brittle) and logarithmic (quasi-brittle) dependence of the relaxation times.

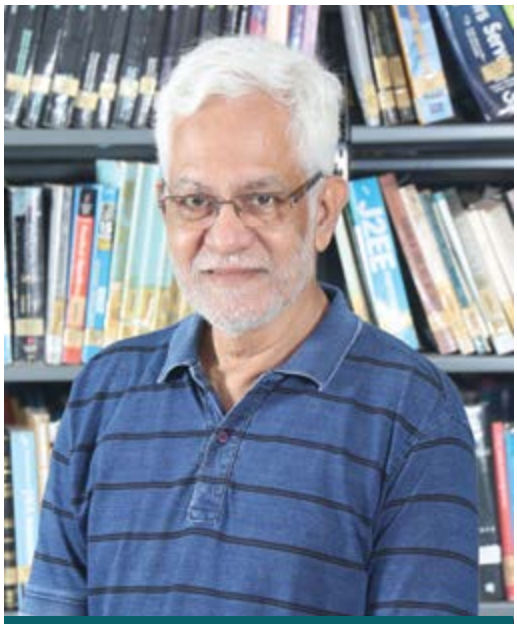
Symmetric and asymmetric naming games have been studied where the vocabulary sizes of the agents are restricted to finite capacities. The power law exponents are different from the original naming game.

The model of `Colored Percolation' has been introduced where 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. Here, only those lattice bonds having two different colored atoms at the ends are defined as connected. Biased and unbiased versions of this model has been studied.

The model of lattice percolation has been studied using a system of pulsating discs. Here, every site i of a square lattice has been assigned a circular disc of radius R_i(t) that varies sinusoidally with time. A bond is occupied when two end discs overlap. Interestingly, for R_0 < R_{0c} when there exists no spanning cluster, information can still be transmitted across the system by propagating through different finite size clusters that appear in different instants of time. Consequently, the average transmission time increases as R_0 decreases and it diverges as R_0 approaches to its second critical value.

Proposed research activities for the coming year

- Models of percolation problems
- Collective behavior of self-propelled agents
- Self-organized critical models



Subodh Kumar Sharma

Emeritus Professor
Theoretical Sciences
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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. He co-authored a book (with Dr. D. J. Somerford of UWCC, "Light scattering by optically soft particles: Theory and applications" published by Springer Praxis.

Teaching activities at the Centre

1. 2nd Semester; Electromagnetic theory; M.Sc.; 10; Prof. Manu Mathur

Books / Book Chapter / Monographs Published / Edited

1. A monograph entitled 'Elastic scattering of electromagnetic radiation: Analytic solutions in diverse backgrounds' is under preparation.

Fellow / Member of Professional Body

1. Member, Optical Society of America
2. Member, SPIE

Significant research output / development during last one year

General research areas and problems worked on

1. Development of theoretical light scattering methods for biomedical tissue characterization.
2. Study of interstellar medium from analysis of extinction spectrum and X-ray halos around stars.

Interesting results obtained

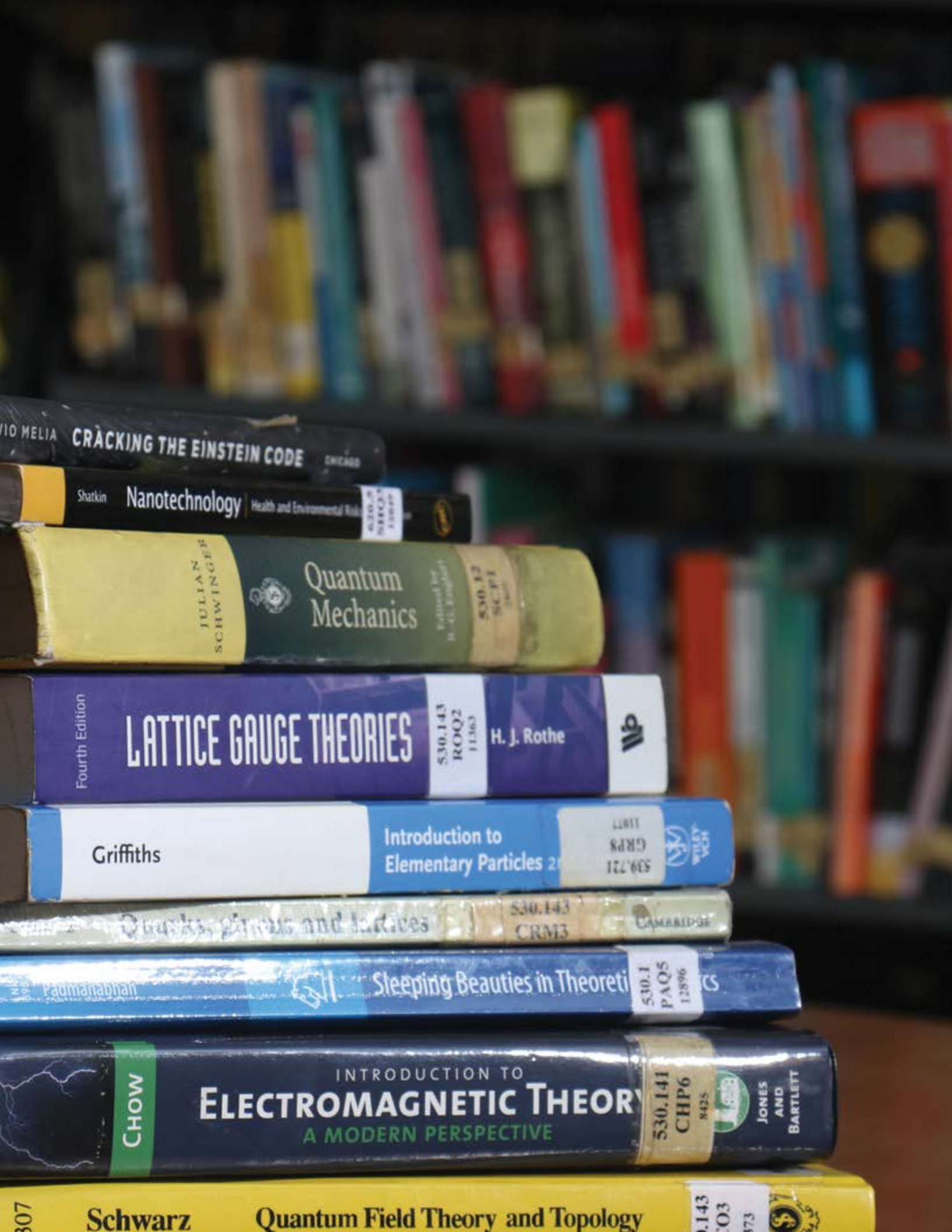
1. Some time back we had suggested a method for distinguishing plasmodium falciparum infected red blood cells from normal cells. We returned to this problem and have done further studies in this direction. Some progress has been made but more work remains to be done to establish the usefulness of this method over other methods.
2. Our work towards obtaining analytic formulas for constituents of interstellar dust continued. We obtained analytic formulas for extinction by ultrasmall silicate particles. This, in conjunction with our earlier works on larger silicate and graphite components, almost completes the work we proposed in our ISRO-RESPND project, which ended about a year ago. We hope to publish the results soon.

Proposed research activities for the coming year

Both the areas of research mentioned above are of significant importance. Our studies in both the area of interest will continue.

Any other matter

1. Examined Ph. D thesis "Multifractal models and inverse light scattering methods for biological tissue characterization and diagnosis" by Mr. N K Das of IISER, Mohanpur (Also Viva).
2. Examined M.S. thesis entitled "Full-field spatial mapping of spectral polarization information: Experimental schemes, instrument, development and caliberation" of Mr. B. S. Athira, IISER, Mohanpur.
3. Participated in "21st National Symposium on Ultrasonics, 8-10 Nov. 2016.


VIO MELIA
CRACKING THE EINSTEIN CODE
Shatkin
Nanotechnology
Health and Environmental
JULIAN SCHWINGER
Quantum Mechanics
Fourth Edition
LATTICE GAUGE THEORIES
530.143 ROQ2 1136
H. J. Rothe
Griffiths
Introduction to Elementary Particles
530.143 CRM3
Quarks, Gluons and Lattices
Padmanabhan
Sleeping Beauties in Theoreti
530.1 PAQ5 12896
CHOW
INTRODUCTION TO
ELECTROMAGNETIC THEORY
A MODERN PERSPECTIVE
530.141 CHP6 8425
JONES AND BARTLETT
Schwarz
Quantum Field Theory and Topology

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 15000 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. 2016-17

1 Approximately 342 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 2015, 2004 and 2003 have been uploaded in the repository.

3. In the Financial Year 2016-17, the Fiction Section has been enriched by procuring 52 books of classic literature, novel, short story, biography and books of general interests.

4. 36 Hindi books are added in the Library collection the mentioned financial year.

5. Ph.D. collection has been displayed with systematic arrangement procedure for convenient searching of desired Ph.D. thesis.

6. Institutional membership in the American Library, Kolkata has been taken in this financial year.

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:

The construction activities started on 16th February, 2015. This was a deposit work for a contract value of Rs 13.03 crores awarded to M/s. Bridge and Roof Co. (India) Ltd. after observing GFR Rule. M/s. Ghosh, Bose & Associates was selected as Consultant Architect for this Project. With all round efforts of M/s Bridge and Roof and the Engineering Section, the First phase of work for G + 3 Floors have been completed in July, 2016 which was within due time schedule and after carrying out certain additional works, the building has been made ready for taking over. 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.

IHB&TQC Building Front View

IHB&TQC Building Side view

Hall for proposed Bose Archive in IHB&TQC Building

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 Civil Superstructure and Structural erection works have been almost completed.

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 modern-type of Stainless Steel Cycle sheds at different locations and the first one of the same has been erected near the North Security gate.

SS Cycle Shed

iv) Flag Hoisting Stand

To commemorate the Independence Day and Republic Day celebrations in the Centre, a permanent flag pole hoisting stand has been installed.

Flag Hoisting Stand

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 ESQ 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 lt.) 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.

RCC Overhead Water Tank

Campus Garden

Winter Blossom

One of the Pomelo Trees in Campus Garden

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. The entire system has been made ready for the inspection of Regional Inspecting Organization (RIO) (Central Electricity Authority).

Electrical Panels in New Sub Station

(b) IHB&TQC Building :

The entire electrical work including cable laying, internal electrical installation work has been carried out by M/s Bridge & Roof Co. (India) Ltd for which arrangement of Air-conditioning, Illumination and Fire-fighting facilities are being taken up.

(c) Electrical facilities for Computer Centre Servers :

Supply, Installation, Testing & Commissioning of New Electrical Panel Boards & Additional Power Cable was completed, keeping in mind the future expansion and probable additional power demand at Computer Centre Servers.

(d) Other Activities related to Electrical and Air-conditioning works :

i) Modification and renewal of electrical installation work for various laboratories at the Centre were carried out.

ii) Dedicated earthing system was installed at various laboratories to protect the sophisticated research equipments/instruments and also for the proper electrical installation.

(iii) Annual Maintenance, Preventive Maintenance and daily requirement of electrical support for all the Buildings and Campus of SNBNCBS

(e) Maintenance of DG Sets :

The Centre is having Two 500 KVA and one 320 KVA DG sets are maintained to provide energey power for back up which are being maintained to provide emergency power requirement in the event of main power failure.

(f) Air-conditioning work and Lifts:

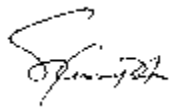
The Centre is having approximately 450 Nos of Air-conditioners of various capacities and various makes which need to be maintained periodically and systematically to take care of the requirement of various labs as well as offices. Upkeep and maintenance work for 4 nos of 8-passenger lifts in the Centre are also looked after by the Engineering Section.

(g) 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 for maintaining water supply of the Campus, 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 whice are being regularly maintained. In additiona to that there is an Iron removal unit and Pump house, the operation and maintenance for which is looked after by the Engineering Section.

(h) Elementary Training for Fire Fighting and Fire Prevention at West Bengal Fire & Emergency Services (WBFES) Training Institute at Shilpara, Behala, Kolkata.

A three day basic training on 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, for a batch of seventeen (17) incumbents from different verticals of the Centre was organized by the highly experienced instructors of West Bengal Fire Training institute at Shilpara (Behala). The training was imparted to. The training was held from 28th November 2016 to 30th November 2016.



Sujit Kr. Dasgupta

Superintending Engineer

COMPUTER SERVICES CELL

Sanjoy Choudhury

Scientist – C

Sanjoy Choudhury, Postgraduated in Master of Computer Application and contribute to the research and development community in the areas of CPU & GPU Computing and parallel programming domain with **09** years experienced in HPC using Fortran/C/C++, CUDA. OpenACC, OpenCL, OpenMp, MPI and Linux professional with highly deadline sensitive and ability to contribute alone and as a team player from conception through implementation and maintenance of System Administration, Cluster managements and overall a data center management. Previously I was worked in the various Government and private organizations like NAL(CSIR Lab), RRSC-E(ISRO), Wipro, Intel etc.

Teaching activities at the Centre

PHY 501 Research Methodology Fall 2016 – Prof. P. K. Mukhopadhyay

Membership of Internal Committees

Computer Centre in-charge, members of CSC-Working Group (CSC-WG), CSC –Advisory Committee, members of internal E-procurement Committee, Nodal officer of Central Public Procurement Portal, Govt. of India, member of Procurement of New Laptop/Desktop Committee, members of Procurement of New Generation Firewall Technical Committee, members of Procurement of Video Conferencing facility Committee, members of Fire-Safety Technical Committee, members of Student Advisory Committee(SAC), Development and Implementation of Asset Tracking Application Committee.

Fellow / Member of Professional Body

Computer Society of India(CSI) – Life Membership

Significant research output / development during last one year

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:

i) Hybrid Computing (CPU and GPU, Collaborative Research Work with- Institute of Bioinformatics and Applied Biotechnology (IBAB)): High-throughput DNA sequencers are becoming indispensable in our understanding of diseases at molecular level, in marker-assisted selection in agriculture 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.

ii) Fastest way to compute Massive Human Genome Raw Data Processing and Analysis using data pipeline through Multiscale parallel Hybrid Programming

b) Administrative Work:

Work done other than research activities:

As a Scientist in-change of Computer Services Cell, I have to be actively involved in the Computational facility management and equipment installation.

Computer Services Cell:

As a Scientist in-charge of Computer Services Cell (CSC), I have to be actively involved in the Central Computational facility management and supported all kind of day-to-day activities associated to the cell. All the Central Computational facilities at our Center are under CSC, which looks after overall smooth running of the facilities.

1. Maintenance, proper utilization and up gradation of the central computational facility and associated services.
2. Up gradation of existing software under CSC.
3. Have to supervise smooth inflow consumables and supplies that is need for smooth running of the facility.
4. Make fair share policy for internal academic members for utilization of HPC system.
5. Involved in jobs allotment of CSC staffs associated with CSC.

As the major computational facilities are central facility of the S N Bose National Centre for Basic Sciences, the users are mainly internal users but we have 10% of the available time for external users (Academic/Research) also on payment basis

Proposed research activities for the coming year

Molecular Computing:

Using Molecular Dynamics (GROMACS, NAMD, and Quantum WISE) simulation to explore the modalities of Carbon Nanotubes.

Any other matter

Perusing PhD in Computer Science and Engineering

The Computer Services Cell (CSC) enables to extend all computational facilities and computer related services of the centre. 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. Abhijit Roy, and Mr. Sagar S. De) and Jr. Assistant (Mr. Bijay Pramanik) had supported all day-to-day activities associated to the cell.

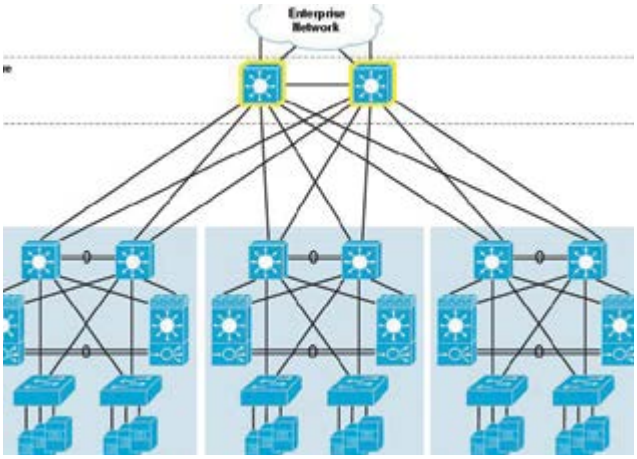
At the end of the academic year 2016-17, there were more than 500 users including faculty members, administrative staffs, PDRAs, and students. The Centre is backboned with a fibre optic based internal network capable to support up to 1Gbps. Internet facility had been pulled up to support up to 1Gbps 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 (partial)	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
UNANST (partial)	480	12 TB	25
CRAY	7808	255	50



CSC-AC Members:

Sr. Prof. Tanusri Saha Dasgupta, Prof. Priya Mahadevan, Prof. Amitabha Lahiri, Prof. Ranjit Biswas, Dr. Soumen Mondal, Ms. Shohini Majumder, Mr. A. K. Sarkar, , Dr. Punyabrata Pradhan, Mr. Sanjoy Choudhury.

CSC-WG Members:

Sr. Prof. Tanusri Saha Dasgupta, Prof. Amitabha Lahiri, Dr. Manoranjan Kumar, Mr. S. K. Singh, Ms. Nibedita Konar, Mr. Soumen Adhikari, Mr. Sanjoy Choudhury, Mr. Abhijit Ghosh, Mr. Abhijit Roy, Mr. Sagar S. De.

Central Computational Resources (2016-17):

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 Committee blog had been developed as per the recommendations of Faculty Search Committee.

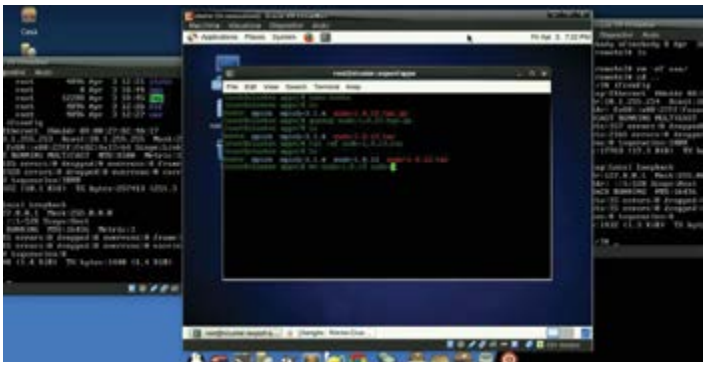
14. Ticketing system for the Engineering and Estate Office Complaints had been introduced.
15. Hall booking application had been developed for reliable and sophisticated use with new feature.
16. Backup systems had been configured for any unusual accidental breakdown.
17. Govt. of India Central Public Procurement Portal (CPPP) E-Procurement Portal has been implemented for the transparency of every new procurements through Centre.
18. Initiate Computational Training/Workshop for the Scientists and Researchers for the better way of utilizing Central Computational Resources.
19. 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.
20. Network racks had been rearranged for better arrangement and maintenance concern.
21. CSC configured Linux based new personal firewall, gateway for the centre.
22. Web applications such as Radhachura booking, Guesthouse Billing, Visitor pass, Asset Manager, Online Confreg had been developed and deployed in the intranet server.
23. Admission application has been modified to fulfil 2017 admission criteria.
24. BCRC blog has been created & upgraded.
25. 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.
26. Old CO_2 and Dry Powder based fire extinguishers had been replaced with safer clean agent based fire extinguishers in the cell.
27. Comprehensive fire safety solution had been design and proposed for the entire computer centre, which will be implemented very soon.
28. We 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 we 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.
- Procurement of centralised SAN based storage solution for the Centre.
- Procurement of redundant core switch with Next Generation IP Infrastructure features and enhanced back plane and uplink.
- Procurement of Multipoint-to-Multipoint Video Conferencing Solution.
- WiMax base secure wireless Internet Access in Campus
- 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
In-charge, Computer Services Cell



PROJECT AND PATENT CELL

The project cell, was formed with the objective of setting up of a central record keeping cell of the various projects applied for extramural funding as well as internal funding. Later, the functionality of the cell was further extended and the cell was also assigned the responsibility of maintaining the patent applications. The Cell was renamed as "Project & Patent Cell".

The present members of the Cell are:

Prof. Pratip Kr. Mukhopadhyay, Convenor

Prof. Gautam Gangopadhyay

Prof. Jaydeb Chakrabarti

Dr. Soumen Mondal

Dr. Sakuntala Chatterjee

Dr. Manoranjan Kumar

Two representatives from the Office of Dean(Faculty) and Dean(AP) are also members of the Cell. Mr. Rupam Porel represents the Office of Dean(Faculty) and Ms. Chandrakana Chatterjee represents the Office of Dean(AP).

Mr. Sukanta Mukherjee represents the Accounts Section and Mr. Achyut Saha is the secretory to the Cell.

The relevant forms for use of the cell are available in appropriate parts in the webpage of the centre, namely http://bose.res.in/~prjcell and in intranet.

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.)
2012-2013	36	5,94,78,715=00
2013-2014	31	10,10,54,463=00
2014-2015	32	4,72,26,394=00
2015-2016	38	4,71,50,347=00
2016-2017	35	4,05,49,788=00

Apart from this, the Centre has also received the first installment of Technical Research Cell project grant during January 2016. This grant was allowed by the Govt. of India for selected five among all DST institutes in the country.

Running projects during 2016-17

Project Title	PI / Co – PI	Funding Agency
"Setting up of Technical Research Centre (TRC) at S. N Bose National Centre for Basic Sciences, Kolkata."	Prof. A. K. Raychaudhuri, Prof. Tanusri Saha-Dasgupta, Prof. P. K. Mukhopadhyay, Prof. Ranjit Biswas, Dr. Barnali Ghosh (Saha), Dr. Manik Pradhan, Dr. Soumen Mondal and Dr. Subhra Jana	DST AI/1/64/SNB/2014
"J.C.Bose Fellowship"	Prof. A.K. Raychaudhuri	DST SR/S2/JCB-17/2006
DST/KD/09-10/28 - "Investigation of the intrinsic conductivity of undoped single Si nanorod/nanowire grown by vapor transport and chemical method"	Dr. Kaustuv Das	DST (SERB) SR/FTP/PS-60/2009
DST/AKR/09-10/40 - "Unit on Nanoscience at SNBNCBS, Kolkata (UNANST – II)	Prof. A.K. Raychaudhuri	DST SR/NM/NS-53/2010
DST/AKR/11-12/63 – "Thematic Unit for Excellence on Nanodevice Technology"	Prof. A.K. Raychaudhuri / Dr. Anjan Barman (Coordinator)	DST SR/NM/NS-09/2011

Project Title	PI / Co – PI	Funding Agency
"Thematic Unit of Excellence on Computational Materials Science at the SNBNCBS, Kolkata"	Prof. Tanusri Saha Dasgupta	DST SR/NM/NS-29/2011
"Ramanujan Fellowship"	Dr. Manoranjan Kumar	DST (SERB) SR/S2/RJN-69/2012
DBT(RGYI)/MP/11-12/80 – "Cavity Ring-down Spectroscopy for Real Time Breath Analysis: A Next Generation Diagnostics in Modern Medicine"	Dr. Manik Pradhan	DBT (RGYI) BT/PR6683/GBD/27/ 477/2012
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-18/2013 dated 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/JC/12-13/91 – "Microscopic calculations of metal ion binding to proteins"	Dr. Jaydeb Chakrabarti	DST (SERB) SR/S2/CMP-100/2012
DBT/AM/12-13/92 – "Development of nanomaterial based dual mode contrast agent and their surface mediated conjugation study from first principles"	Prof. Abhijit Mookerjee, Dr. Ranjit Biswas (From SNBNCBS)	Biotech Consortium India Ltd. (DBT) BCIL/NER-BPMC/2013-367
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/SKP/12-13/105 – "Study on the role of biomolecular conformation and environmental dynamics in the process of molecular recognition with Time-resolved optical spectroscopy"	Dr. S.K. Pal	DST (SERB) SB/S1/PC-011/2013
DRDO/PKM/12-13/108 – "Development of synthetic body armour based on smart fluids"	Dr. P.K. Mukhopadhyay	(DRDO) PXE/TE/CARS PXE/CARS/01/2013
BRNS/SKP/13-14/111 – "Science and application of organic ligand-transition metal oxide hybrids as new functional materials"	Dr. S.K. Pal	DAE – BRNS 2013/37P/73/BRNS
DST/ASM/13-14/112 – "Fundamental aspects of Quantum Theory and Quantum Information Science"	Prof. Archan S. Majumdar	SERB SB/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	DST SR/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-BRNS 1466 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
DST/TSD/13-14/124 – "Magnetism in low dimensional quantum spin systems"	Dr. Tanusri Saha - Dasgupta	(DST-RFBR) INT/RUS/RFBR/P-166

Project Title	PI / Co – PI	Funding Agency
DBT/SKP/13-14/126-2 – "Nanogels: Biophysical characterization and Potential Biomedical Applications in Drug Delivery"	Prof. S.K. Pal	DBT BT/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	DST DST/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	DST SR/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	ICMR 5/3/8/247/2014-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)	DST DST/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
RSSDI/MP/15-16/162 – "Non-invasive detection of diabetes mellitus from breath analysis using cavity enhanced absorption spectroscopy"	Dr. Manik Pradhan	RSSDI (Research Society for the Study of Diabetes in India)
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

Post doctorates and scientists in various projects –

Dr. Madhuri Mandal	Visiting Faculty Fellow	Preparation of magnetic nanoparticles and proper biofunctionalization for their use in drug delivery and release
Dr. Kaustuv Das	Scientist - D	TUE on Nano Device Technology
Dr. Biswaroop Mukherjee	Scientist D	TUE on Computational Materials Science
Dr. Jaivardhan Sinha	Scientist D	TUE on Nano Device Technology
Dr. Alo Dutta	Young Scientist of SERB Fast Track Scheme of DST	Microwave Dielectric properties and collective vibrational modes of double perovskite oxides
Ms. Jashashree Ray	Research Associate - I	UNANST
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

Mr. Bhushan Omprakash Awasarmol	Scientist D Computer Engineer	TUE on Computational Materials Science
Dr. Shreemoyee Ganguly	Scientist D	TUE on Computational Materials Science
Dr. Rakhi Acharyya	Research Associate - I	TUE on Nano Device Technology
Dr. Rabaya Basori	Research Associate – I	UNANST
Dr. Tanumoy Pramanik	Research Associate – I	Fundamental Aspects of Quantum Theory and Quantum Information
Dr. C. Jebarathinam	Research Associate – I	Fundamental Aspects of Quantum Theory and Quantum Information
Mr. Animesh Halder	Research Associate – I	Study on the role of Biomolecular conformation and environmental dynamics in the process of molecular recognition with optical spectroscopy

Project students during this time:

NAME OF THE STUDENT	PROJECT INSTRUCTOR	DEPT.	NAME OF THE PROJECT	JOINED ON	NO. OF STUDENTS
Shishir Kumar Pandey	Priya Mahadevan	CMPMS	DAE-BRNS Project: Functional transition metal oxides	12.03.2015	
Animesh Basak	P K Mukhopadhayay	CMPMS	Feasibility study of development of synthetic body armour based on smart fluids	29.02.2016	
Suvankar Das	Amlan Dutta	CMPMS	DST INSPIRE Faculty Award	18.12.2013	
Shubham Agarwal	Soumendu Datta	CMPMS	DST INSPIRE Faculty Award Materials for photocatalytic water spliting for hydrogen production	05.01.2016	
Sangita Dutta	Soumendu Datta	CMPMS	DST INSPIRE Faculty Award Materials for photocatalytic water spliting for hydrogen production	06.07.2016	
DEPT. TOTAL					**5**
Camelia Manna	Jaydeb Chakrabarti	CBMS	Microscopic Calculation of Metal Binding to Proteins	29.01.2014	
Ramesh Nandi	Samir Kumar Pal	CBMS	Science and Application of Organic Ligand-transition Metal Oxide Hybrids as New Functional Materials (BRNS Funded Project)	01.12.2015	
Partha Pyne	Rajib Kumar Mitra	CBMS	Real Time Structure and Solvation Dynamics of Proteins during Folding / Unfolding in Crowded Environment	09.08.2016	
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					**5**

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	24.02.2016	
Dhiraj Tapader	Punyabrata Pradhan	TS	Additivity Principle and Thermodynamic Characterization of Mass Transport Processes	06.06.2016	
					1
	TOTAL				**13**

Patents:

Patent Granted during 2016-17:

(1)

Patent No.: 273114
Application No.: 546/KOL/2009
Date of Filing: 27/03/2009
Date of Grant: 18/05/2016
A method for non-destructive detection of genuineness of Gemstones and a system for carrying out the same

(2)

Patent No.: 273369
Application No.: 465/KOL/2009
Date of Filing: 17/03/2009
Date of Grant: 31/05/2016
A method and system for non-invasive quantitative estimation of oxygen content in human blood.

Patents Applied during 2016-17:

(1)

Dioxo Vanadium (V) complex as carbonic anhydrase inhibitor
(Dr. Manik Pradhan & others)
Patent Application No: 201631038296 dated 09/11/2016

(2)

Ammonia gas sensor and a method for manufacturing the same
(Dr. Barnali Ghosh & others)
Patent Application No: 201731000270 dated 03/01/2017

Pratip Kumar Mukhopadhyay
Convenor, Project Cell

TECHNICAL RESEARCH CENTRE

Activity Report (1st April 2016- 31st March 2017)

Making us innovative in the Innovation Space

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 in 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 on innovations with delivery in the areas of (a) health care, (b) environment (c) material and alloy industry (d) food and agro sector.

National Advisory committee

Dr. Srikumar Bannerjee Chairman, G0verning 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 Advisor DST or nominee	Ex-officio
Prof. S.K.Ray	Director, SNBNCBS (Ex-officio)
Prof. A.K.Raychaudhuri	Nodal officer TRC (Ex-officio)

Local Management Committee

Director, SNBNCBS (Chair), Nodal Officer (Convenor), All Project Investigators, Registrar, Deputy Registrar (Finance and Accounts), Invitees as required.

Project Investigators:

Prof. A.K.Raychaudhuri (Nodal Officer)

Prof. Tanusri Saha Dasgupta, Prof. P.K.Mukhopadhyay, Prof. Ranjit Biswas, Dr. Barnali Ghosh Saha, Dr.Manik Pradhan, Dr.Soumen Mandal, Dr. Subhra Jana

Approved Principal Activities

Innovation/Deliverable	Sector
1. A simple diagnostic methodology for non-invasive detection of infection in real-time using human breath analysis.	Health care
2. High-throughput Computation for Materials Design for value addition and Software development.	Metal and alloy industry
3. Use of silver nanoparticles to enhance the properties of natural fiber like Jute.	Value added material for an existing sector of economy
4. Pico-calorimeter for biochemical and small volume analyzer for DSC/ microscope attachment	Value added product to an existing sector of economy
5. Prototyping thin film devices using functional oxide patterned films.	Value added product for an existing sector of economy

Innovation/Deliverable	Sector
6. Development of light operated micro-actuator using photomechanical actuation of ferromagnetic shape memory alloys and related materials.	Health care: Engineering Applications
7. Application of (a) Hybrid Nanocomposites and (b) porous metal-organic framework compounds for CO2 and toxic gases removal from closed space.	Environment
8. Enzyme Catalyzed Biodegradation of Xenobiotic Compounds: Treatment of Industrial Effluents.	Environment
9. NIR Optical instrumentation for application.	Value added product for an existing sector of economy

Patents Submitted, Technical Reports Generated and Documents prepared (As on 31.3.2017)

Patents Filed

1. "A system and kit for non-invasive detection of peptic ulcer disease, non-ulcerous dyspepsia and *Helicobacter pylori* infection" by *Abhijit Maity* and *Manik Pradhan.*
2. "System and kit for monitoring blood glucose profile based on breath analysis" by *Chiranjit Ghosh* and *Manik Pradhan*.
3. "Ammonia Gas Sensor and A Method for Manufacturing the Same" by *Avisek Maity*, *A.K.Raychaudhuri* and *Barnali Ghosh*

Patents Cleared for submission

1. "A New Strategy to Control Isotopic Fractionations in Gases" by *Samik Roy Moulik*, *Abhijit Maity*, *Mithun Pal*, *Manik Pradhan* and *Barnali Ghosh*
2. "A flexible thin film transistor with Electrolyte double layer gate dielectric" by *Rishi Ram Ghimire*, *Chandan Samanta*, *Barnali Ghosh* and *A.K. Raychaudhuri*

Patents Submitted to committee for consideration for submission

1. "A Method to Direct the Growth and Formation of Nanorods" by *Shankar Das* and *Subhra Jana*

Technical Reports Generated

Fabrication of Lamellar samples of VLSI circuits for inspection under electron microscopes for faliure and fault analysis.

by *Ankita Ghatak* and *Barnali Ghosh*

Documents prepared

The LMC prepared a document entitled "Rules and guidelines for Services under TRC project" for the following revenue generation linked activities to be undertaken by TRC (as approved by the 50th GB):

(a) Knowledge based and value added service (*Short form: Knowledge services*).

(b) Scientific and Technical Consultancy (*Short form-Consultancy Project*).

(c) Contract research

The document was subsequently approved by the Finance Committee and Governing Body of the Centre.

Arup Kumar Raychaudhuri
Nodal officer
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/

Current experimental facilities and infrastructure under Technical Cell in the Centre

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	Thermmo Gravimetry/Differential Thermal aanalyzer (**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

Maintenance:

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.

Upcoming facility: Up-gradation of TEM facility under Technical Cell (cross sectional sample preparation), is under process from Technology Research Centre (TRC) project.

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 (hr)	Up time %
XRD (Panalytical)	445hr	67%
Mini XRD	210hr	80%
AFM	251hr	34%
VSM	1450hr	80%
PLD	1472hr	80%
FESEM	835hr	90%
TGA/DTA	423hr	80%

Note: AFM and TEM machine was under maintenance for some time. Other equipment s are not included in the list, the users are less but uptime is 95%

Our users:

External users:

There are external users from 35 institutes, universities, colleges from different parts of our country.

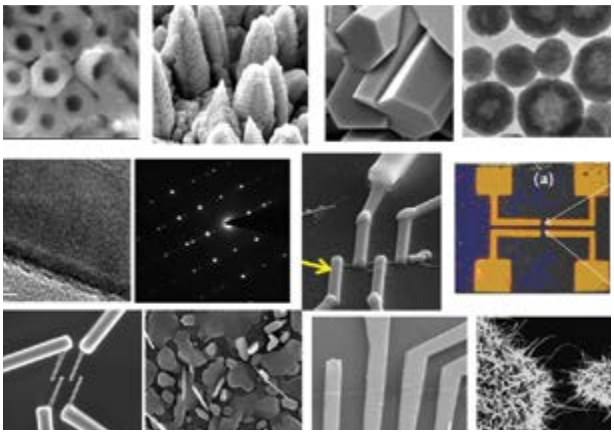
Internal users:

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.

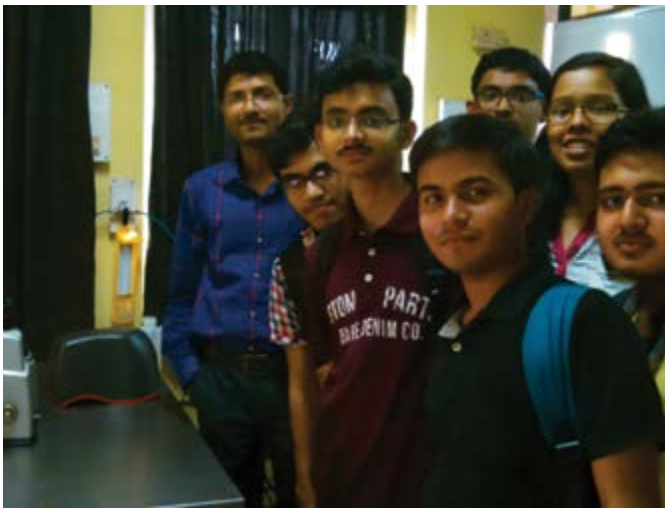
Few images taken by using the instruments under Technical Cell:



Some images taken using our central equipment facilities

1) National Science day program:

On 28.2.17, National Science Day celebration, total 120 number of students from various Colleges and University visited our sophisticated instruments like , X-Ray Diffractometer, Scanning Electron Microscope, VSM, Atomic Force Microscope , 1000 class clean room along with various lithographic facilities, under Central Equipment Facilities, Technical Cell. Students from Lady Brabourne College, Presidency university, Narendrapur Ramkrishna Mission, Serampore Girls college visited laboratories.



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.



Visits during C.K. Memorial workshop

3) Visit of students from different institutes:

Several visits are 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.

Barnali Ghosh (Saha)
Scientist in-charge,
Technical Cell

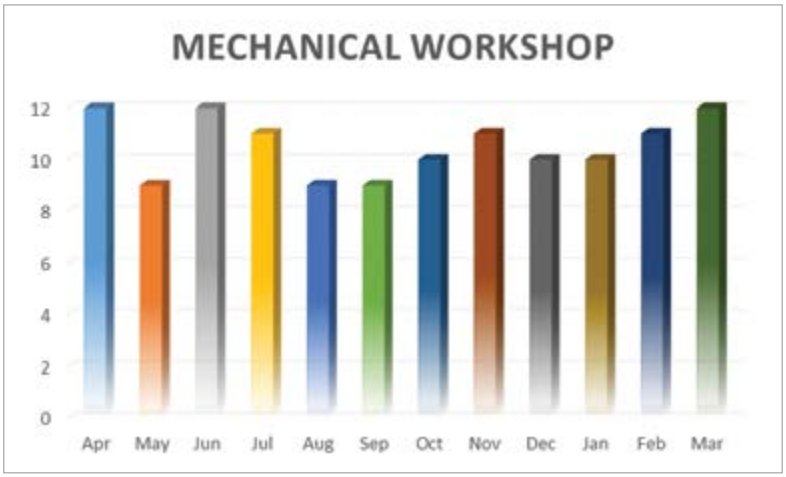
MECHANICAL WORKSHOP AND GLASS BLOWING UNIT

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. 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 – 126, glass blowing section – 32 inside and 31 jobs for outside.

Month wise breakups are given below: (2016 – 2017)



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 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.

Smajumder

Shohini Majumder
Registrar

CRÈCHE

'Kishlay' is a home away from home for the children of staff and students of S. N. Bose National Centre for Basic Sciences.

The purpose of 'Kishlay' is to meet, to the best of ability, the child's basic needs (social, intellectual, physical and emotional) with love, integrity, hard work and self-discipline. '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. There were 2 (two) children in 'Kishlay' as on 31st March 2017.

Sonajumder

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 68th Republic Day on 26th January 2017 and 70th Independence Day on 15th August 2016, 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.

The Sports Activity Group of 'Muktangan' organised the following events :-

- "Friendly Cricket Match", between Student vs Staff of the Centre twice on 14th April 2016 (Poila Boisakh) and 3rd February 2017. On both the occasions the events were a grand success.
    - The screening of the final of Women's Singles of Badminton in Rio Olympic 2016 on 19.08.2016 as P V Sindhu was the first woman from India to reach the final of any Olympic event.
    - A Carrom Tournament for the first time at the Centre on 29th August to 31st August 2016 with pre-knockout and knockout matches of full 29 point format.
    - A Self –Defence Workshop for the staff and students of the Centre on 1st September, 7th September, 9th September, 13th September & 14th September 2016.
    - An Intra-Institute Table Tennis Tournament from 28th – 30th November 2016.
    - 3rd Inter Institute Badminton tournament 2017 from 11th to 13th February 2017.
- The Centre organised International Day of Yoga on 21st June 2016 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.
- The Fresher's Welcome - 2016 was organised by 'Muktangan' on 15th September 2016.

Like previous years, the Centre organised number of programmes in September 2016 to celebrate the Hindi Mahina, viz:

- Signing of Attendance Register in Hindi.
- Everyday one new Hindi word with its English meaning displayed in the Reception area.
- Showing of Hindi Feature Film 'CHUPKE CHUPKE'.
- In house Hindi Cultural Programme 'BY MISTAKE GALTI HO GAYE' was staged by staff members of the Centre.
- Hindi play 'TAJ MAHAL KA TENDER' performed by 'Ognam' group.
- A Hindi quiz session.
- A Hindi Essay competition on '"Olympic – 2016 me Bharat ka Safar" was organised during the Hindi Mahina.
- A Hindi Extempore was also organised.

- The Centre organised Cleanliness Oath/Pledge [Swachh Shapath] on 2nd October 2016 at the Centre's premises as part of the Swachh Bharat Mission campaign introduced by Government of India. All the staff and students of the Centre were present on the said date to take the Cleanliness Oath.
- The Centre celebrated Satyendra Nath Bose's 123rd birthday on 2nd January 2017. The bust of Satyendra Nath Bose was garlanded by the Director and other senior faculties and high tea was arranged for the occasion.
- On the occasion of 'BOSE FEST 2017' held during 9th February 2017 – 10th February 2017, Family Day was celebrated in the evening of 9th February 2017. On 9th February 2017, the Performing Arts Group of 'Muktangan' organised an in-house programme comprising of individual and group performances of singing, recitation and Nrityalekha – Dance Programme 'Bhanusingher Padabali'. 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 10th February 2017, renowned singer Smt. Lopamudra Mitra entertained the audience with her popular numbers.

Shohini Majumder

Shohini Majumder
Registrar

Publications

LIST OF PUBLICATIONS 2016-17

Journal Publications

Department of Astrophysics and Cosmology

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4. S. Datta, S. Goswami, T. Pramanik, **A. S. Majumdar;** *Preservation of a lower bound of quantum secret key rate in the presence of decoherence*; Phys. Lett. A; 2017; **381**; 897.
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13. Aslam Ali Molla, **Sandip K. Chakrabarti**, Dipak Debnath, Santanu Mondal; *Estimation of Mass of Compact Object in H 1743-322 from 2010 and 2011 Outbursts using TCAF Solution and Spectral Index-QPO Frequency Correlation;* ApJ; 2017; **834**; 88.
14. Emmanuel E. Etim, Prasanta Gorai, Ankan Das, **Sandip K. Chakrabarti,** Elangannan Arunan; *Systematic Theoretical Study on the Interstellar Carbon Chain Molecules*; ApJ; 2016; **832**; 144.
15. Arnab Deb, Kinsuk Giri, **Sandip K. Chakrabarti;** *Numerical simulation of vertical oscillations in an axisymmetric thick accretion flow around a black hole;* MNRAS; 2016; **462**; 3502.
16. Shreeram Nagarkoti, **Sandip K. Chakrabarti;** *Viscosity parameter in dissipative accretion flows with mass outflow around black holes;* MNRAS; 2016; **462**; 850.
17. Broja G. Dutta, **Sandip K. Chakrabarti**; *Temporal Variability from the Two-Component Advective Flow Solution and Its Observational Evidence*; ApJ; 2016; **828**; 101.
18. A. Ghosh, **Sandip K. Chakrabarti**; *Smearing of mass accretion rate variation by viscous processes in accretion disks in compact binary systems*; Ap&SS; 2016; **361**; 310.
19. Santanu Mondal, **Sandip K. Chakrabarti**, Dipak Debnath; *Spectral study of GX 339-4 with TCAF using Swift and NuSTAR observation*; Ap&SS; 2016; **361**; 309.
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2. Krishnendu Pal, Biswajit Das and **Gautam Gangopadhyay**; *Nonequilibrium response of a voltage gated sodium ion channel and biophysical characterization of dynamic hysteresis*; J.Theor. Bio.; 2017; **415**; 113-124.
3. Sandip Saha and **Gautam Gangopadhyay**; *Isochronicity and limit cycle oscillation in chemical systems*; J. Math. Chem.; 2017; **55** (3); 887-910.
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10. B. Ash, **J. Chakrabarti** and A. Ghosal; *Spatio-temporal correlations in Coulomb clusters*; Europhys. Lett; 2016; **114**; 46001.
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12. A. Maity, M. Pal, S. Som, S. Maithani, S. Chaudhuri, **M. Pradhan;** *Natural ^{18}O and ^{13}C-urea in gastric juice: a new route for non-invasive detection of ulcer*, Anal. and Bioanal. Chem.; 2017; **409**(1); 193-200.
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4. Dutta, Somanth, Mondal, Soumen, Das, Ramkrishna et al. "A census of variable stars in the young cluster NGC 2282", 41st Cospar Assembly Abstract.

Department of Chemical, Biological & Macro-Molecular Sciences

1. D. Panda, A. Balgarkashi, S. Sardar, S. K. Pal, S. Hubbard and S. Chakrabarti, "Comparison of InAs/GaAs and InGaAs/GaAs quantum dot solar cells and effect of post-growth annealing on their optical properties" Photovoltaic Specialists Conference (PVSC), 2016 IEEE 43rd (pp. 2105-2107).
2. S. Jana, Moisture Induced Isotopic Carbon Dioxide Trapping from Ambient Air Using Low-Cost Clay Based Nanocomposites, Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016, 3, 302.

Department of Condensed Matter Physics and Material Sciences

1. A. Bagchi, B. R. Kanth and P. K. Mukhopadhyay, Investigations on Photo Induced Microactuation of FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016
2. S. Hossain, B. R. Kanth and P. K. Mukhopadhyay, Effect of Annealing on Elastic Moduli for a FSMA, Proceedings of ICFSMA '16, Tohoku University, Japan, 2016
3. Md Sarowar Hossain, Tanmoy Ghosh, B. Rajini Kanth and P.K. Mukhopadhyay, Effect of annealing on the structural transformations and magnetic properties of CoNiAl FSMA, ICMAGMA '17 Proceedings, Hyderabad, 2017
4. Kartik Panda, Md. Sarowar Hossain,and P K Mukhopadhyay, "Structural anomaly and shape memory effect in a CoNiAl FSMA system due to heat treatment.", ICMAGMA '17 Proceedings, Hyderabad, 2017
5. Ranjan Chaudhury; Microscopic understanding of high temperature superconductivity and its possible role towards enhancement of critical temperature; Journal of Material Science and Engineering (special issue as Proceedings of CMP 2016); 2016; 5; 85.
6. Soumendu Datta, "Properties of nano-clusters involving 3d late transition metal elements : Role of magnetization versus hybridization interplay", accepted in *Advanced Scinence Letter* (as conference proceeding for ICMST2016)
7. P Das, **T Saha-Dasgupta**, S Puri; Kinetics of Order-Disorder Transitions in Binary Mixtures: A Monte Carlo Study; Journal of Physics: Conference series; 2016; 759; 012010.

Department of Theoretical Sciences

1. Ambalika Biswas and **Amitabha Lahiri**, *Various perspectives of Two Higgs Doublet models and Naturalness criteria*, (talk delivered by A. Biswas) in the Proceedings of the 38th International Conference on High Energy Physics (ICHEP 2016), Chicago, USA 3-10 Aug, 2016, Published in **PoS (ICHEP 2016)** 710.

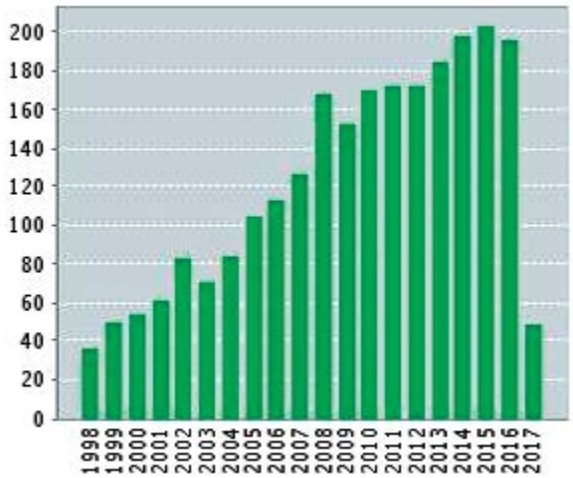
Total No. of other publications: 14

RESEARCH PUBLICATION STATUS

Citation Report (On 25th April, 2017)

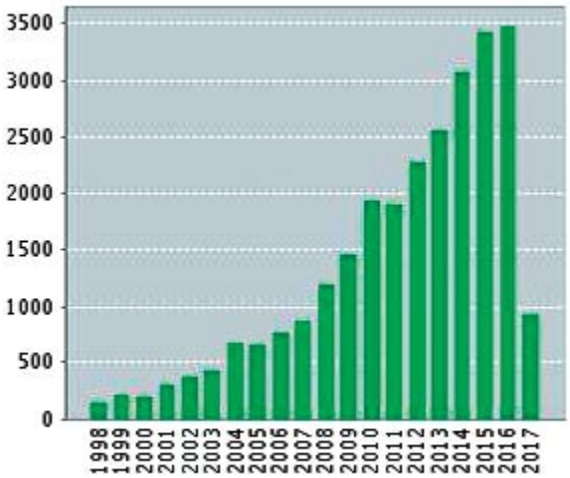
Time span = All years. Database =SCI-EXPANDED, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC.

Published Items in Each Year



The latest 20 years are displayed.

Citations in Each Year



The latest 20 years are displayed.

Results found (No. of Publication)	:	2653
Sum of the Times Cited	:	27510
Sum of Times Cited without self-citations	:	21212
Citing Articles	:	17519
Citing Articles without self-citations	:	15728
Average Citations per Item	:	10.37
h-index	:	60

Total no. of Papers published	Total no. of Citation received	Citations per paper	Citation per year*	h-index
2653	27510	27510 / 2653 = 10.37	27510 / 30 = 917.00	60

* Year of establishment of the Centre is 1986. Citations received from 1987 to 2017 = 30 years

Source : web of science
Address : (SN Bose Natl Ctr Basic Sci OR Satyendra Nath Bose Natl Ctr Basic Sci OR SNBNCBS)

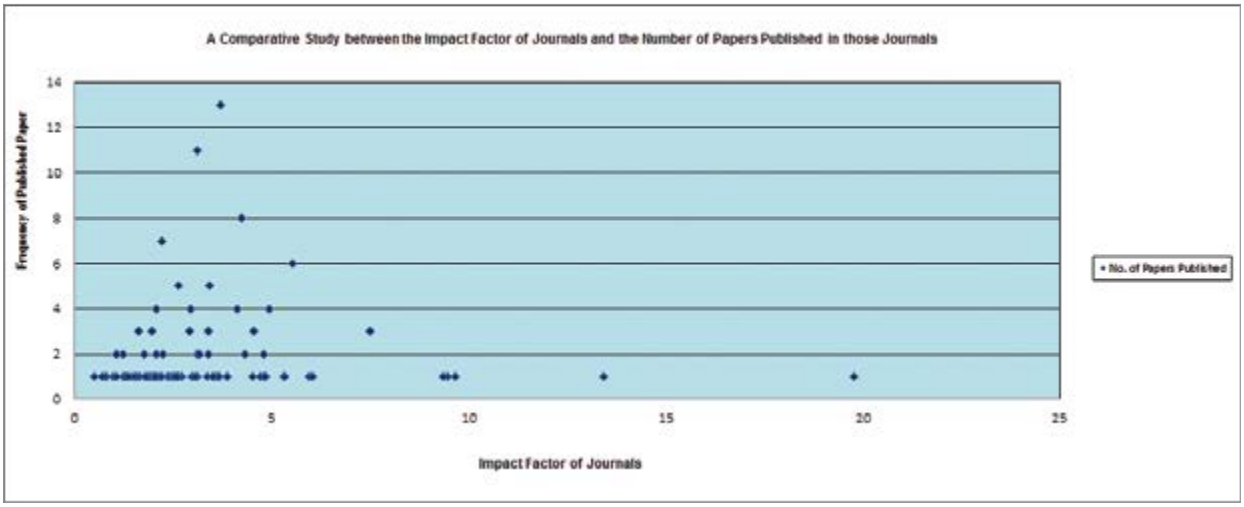
Prepared by : Saumen Adhikari, Librarian – cum – Information Officer

IMPACT FACTOR FOR PUBLICATIONS IN THE FINANCIAL YEAR 2016-17

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
1	ACS Applied Materials & Interfaces	7.504	3	22.512
2	ACS Omega	New Journal	1	New Journal
3	ACS Sustainable Chemistry & Engineering	5.951	1	5.951
4	Acta Materialia	5.301	1	5.301
5	Advanced Materials	19.791	1	19.791
6	AIP Advances	1.568	1	1.568
7	Analytical and Bioanalytical Chemistry	3.578	1	3.578
8	Analytical Methods	1.9	1	1.9
9	Annals of physics	2.375	1	2.375
10	Annual Review of Materials Research	13.432	1	13.432
11	Applied Optics	1.65	1	1.65
12	Applied Physics Letters	3.411	3	10.233
13	Applied Surface Science	3.387	1	3.387
14	Astrophysical Journal	5.533	6	33.198
15	Astrophysics and Space Science	1.622	3	4.866
16	Biomicrofluidics	2.535	1	2.535
17	Biophysical Chemistry	2.402	1	2.402
18	Ceramics International	2.986	1	2.986
19	Channels	2.042	1	2.042
20	ChemCatChem	4.803	1	4.803
21	ChemistrySelect	New Journal	1	New Journal
22	Chemistry of Materials	9.466	1	9.466
23	Classical and Quantum Gravity	3.119	1	3.119
24	Colloids and Surfaces A: Physicochemical and Engineering Aspects	2.714	1	2.714
25	Colloids and Surfaces B: Biointerfaces	3.887	1	3.887
26	Discontinuity, Nonlinearity and Complexity		1	
27	Energy	4.52	1	4.52
28	Environmental Science: Nano	6.047	1	6.047
29	European Physical Journal C	5.331	1	5.331
30	European Physical Journal D	1.288	1	1.288
31	Europhysics letters	1.957	3	5.871
32	Fluid Phase Equilibria	2.473	1	2.473
33	Future Science		1	
34	IEEE Transactions on Magnetics	1.243	1	1.243
35	Indian Journal of Pure & Applied Physics	0.521	1	0.521
36	Inorganic Chemistry	4.857	1	4.857
37	International Journal of Bifurcation and Chaos	1.329	1	1.329
38	International Journal of Biological Macromolecules	3.671	1	3.671
39	International Journal of Geometric Methods in Modern Physics	1.068	2	2.136
40	International Journal of Hydrogen Energy	3.582	1	3.582

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
41	International Journal of Modern Physics D	1.96	1	1.96
42	International Journal of Quantum Information	0.992	1	0.992
43	Journal of Alloys and Compounds	3.133	2	6.266
44	Journal of Applied Physics	2.068	4	8.272
45	Journal of Biomedical Materials Research Part A	3.076	1	3.076
46	Journal of Biomedical Optics	2.53	1	2.53
47	Journal of Breath Research	4.318	2	8.636
48	Journal of Chemical Physics	2.965	4	11.86
49	Journal of Chemical Sciences	1.235	2	2.47
50	Journal of Cosmology and Astroparticle Physics	4.734	1	4.734
51	Journal of Electronic Materials	1.579	1	1.579
52	Journal of Geometry and Physics	0.819	1	0.819
53	Journal of Geometry and Symmetry in Physics	0.79	1	0.79
54	Journal of Magnetism and Magnetic Materials	2.63	5	13.15
55	Journal of Materials Science: Materials in Electronics	2.019	1	2.019
56	Journal of Mathematical Chemistry	1.308	1	1.308
57	Journal of Mathematical Physics	1.077	2	2.154
58	Journal of Molecular Liquids	3.648	1	3.648
59	Journal of Nanoscience and Nanotechnology	1.483	1	1.483
60	Journal of the Optical Society of America B	1.843	1	1.843
61	Journal of Ovonic Research	0.698	1	0.698
62	Journal of Photochemistry and Photobiology A	2.625	1	2.625
63	Journal of Physical Chemistry B	3.177	2	6.354
64	Journal of Physical Chemistry Letters	9.353	1	9.353
65	Journal of Physics: Condensed Matter	2.649	1	2.649
66	"Journal of Physics D: Applied Physics"	2.588	1	2.588
67	Journal of Theoretical Biology	2.113	1	2.113
68	Materials Chemistry and Physics	2.084	2	4.168
69	Materials Focus		1	
70	Materials Research Express	1.068	1	1.068
71	Materials Today: Proceedings		1	
72	Monthly Notices of the Royal Astronomical Society	4.961	4	19.844
73	Nano-Micro Letters	4.849	1	4.849
74	Nanotechnology	3.44	5	17.2
75	Optics Letters	3.416	2	6.832
76	Papers in Physics		1	
77	Physica A: Statistical Mechanics and its Applications	2.243	2	4.486
78	Physica B: Condensed Matter	1.386	1	1.386
79	Physica E	2.221	1	2.221
80	Physical Chemistry Chemical Physics	4.123	4	16.492
81	Physical Review A	2.925	3	8.775
82	Physical Review B	3.718	13	48.334
83	Physical Review D	4.568	3	13.704
84	Physical Review E	2.22	7	15.54

Sl No.	Name of Journal	Journal Impact Factor	No. of Papers Published	Total of Impact Factor in the Journal
85	Physics Letters A	1.772	2	3.544
86	Physics Letters B	4.807	2	9.614
87	Proceedings of the National Academy of Sciences	9.661	1	9.661
88	Quantum Information Processing	2.192	1	2.192
89	RSC Advances	3.108	11	34.188
90	Science and Technology of Advanced Materials	3.513	1	3.513
91	Scientific Reports (Nature Publishing Group)	4.259	8	34.072
92	Soft Matter	3.889	1	3.889
93	Solid State Sciences	1.811	1	1.811
94	Surface Science	2.062	1	2.062
95	Theory and Applications of Categories	0.61	1	0.61
	Total		**178**	**581.979**



ACCOUNTS

Satyendra Nath Bose National Centre for Basic Sciences
Block JD, Sector-III, Salt Lake, Kolkata – 700 106

BUDGET SUMMARY 2016-2017

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2016-2017.

(Figure in Lakhs)

	Actuals 2015-2016	Budget Estimate 2016-2017	Revised Estimate 2016-2017
Non-Plan	52.17	30.92	36.20*
Plan	3115.05	3427.92	3612.45*
TOTAL	3167.22	3458.84	3648.65*

* Sanctioned by DST Plan **Rs.** 3410.01 Non-Plan **Rs.** 10.00 lakhs and released as under:

Non-Plan

Sl no.	Sanction Letter No.	Dated	Amount (Rs.)
1	AI/SNB/NP/003/2016/1	22.02.2017	1000000.00
(A) TOTAL (NON-PLAN)			**Rs.10,00,000.00**

Plan

Sl no.	Sanction Letter No.	Dated	Amount (Rs.)
1	AI/SNB/SAL/003/2015/1	10.05.2016	30592000.00
2	AI/SNB/SAL/003/2016/3	21.09.2016	73146000.00
3	AI/SNB/SAL/003/2016/2	23.06.2016	50421000.00
4	AI/SNB/SAL/003/2016/2	22.02.2017	31575000.00
5	AI/SNB/SC/003/2016/2	21.09.2016	3642000.00
6	AI/SNB/SC/003/2016/1	23.06.2016	1770000.00
7	AI/SNB/SC/003/2016/3	22.02.2017	1108000.00
8	AI/SNB/GEN/003/2016/1	10.05.2016	14121000.00
9	AI/SNB/GEN/003/2016/2	23.06.2016	22535000.00
10	AI/SNB/GEN/003/2016/3	21.09.2016	32242000.00
11	AI/SNB/GEN/003/2016/4	22.02.2017	29112000.00
12	AI/SNB/CAP/003/20161	10.05.2016	18255000.00
13	AI/SNB/CAP/003/2016/2	23.06.2016	13774000.00
14	AI/SNB/CAP/003/2016/3	21.09.2016	10083000.00
15	AI/SNB/CAP/003/2016/4	22.02.2017	8625000.00
(B) TOTAL (PLAN)			**Rs. 34,10,01,000.00**
TOTAL (A+B)			**Rs. 34,20,01,000.00**

ROY & BAGCHI
Chartered Accountants

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3rd Floor, Kolkata – 700 013
Phone No. (033) 2236 8172
Fax No. (033) 2225 2338
E-mail: roybagchi@gmail.com
Website: www.roybagchi-ca.com

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, 2017, 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, 2017.

(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 Note No.2.5 of schedule 25 regarding interest earned on Fixed Deposits and Savings Bank Deposits.

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 comply with the appropriate Accounting Standard.

For Roy & Bagchi
Chartered Accountants
FRN No . 301053E

(Amit Mitra)
Partner
Membership No. 060694

Place: Kolkata
Date: 01.08.2017

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

BALANCE SHEET AS AT 31ST MARCH 2017

Amount (₹)

	Schedule	Current Year	Previous Year
FUNDS AND LIABILITIES			
CAPITAL / CORPUS FUND	1	1018592287.34	939414831.36
RESERVES AND SURPLUS	2	-	
EARMARKED/ENDOWMENT FUNDS	3	511238579.43	398675295.79
SECURED LOANS AND BORROWINGS	4		
UNSECURED LOANS AND BORROWINGS	5		
DEFERRED CREDIT LIABILITIES	6		
CURRENT LIABILITIES AND PROVISIONS	7	42302504.31	42545812.31
TOTAL		**1572133371.08**	**1380635939.46**
ASSETS			
FIXED ASSETS	8	738252385.67	758132456.80
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	9	123424415.38	126371330.38
INVESTMENTS - OTHERS	10	568248614.00	362531415.00
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	142207956.03	133600737.28
MISCELLANEOUS EXPENDITURE			
(to the extent not written off or adjusted)			
TOTAL		**1572133371.08**	**1380635939.46**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

As Per our report of even date

Date: 01.08.2017
Place: Kolkata

For Roy & Bagchi
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
Membership no:060694

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2017

Amount (₹)

	Schedule	Current Year	Previous Year
INCOME			
Income from Sales/Services	12	7432761.00	6722569.00
Grants/Subsidies	13	291264000.00	254088000.00
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	10898186.00	11617691.00
Other Income	18	363045.00	407331.00
Increase/(decrease) in stock of finished goods and	19		
works-in-progress			
TOTAL (A)		**309957992.00**	**272835591.00**
EXPENDITURE			
Establishment Expenses	20	100513232.00	94194800.00
Other Administrative Expenses etc.	21	133243468.89	150485526.14
Expenditure on Grants, Subsidies etc.	22		
Interest earned on fixed deposit and savings bank (payable)		10529332.00	11455120.00
TOTAL (B)		**244286032.89**	**256135446.14**
Balance being excess of Income over Expenditure(A-B)		65671959.11	16700144.86
Prior period adjustments (Debit)		(531241.00)	3374419.10
Transfer to/from Capital Fund			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**65140718.11**	**20074563.96**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

As Per our report of even date

Date: 01.08.2017
Place: Kolkata

For Roy & Bagchi
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
Membership no:060694

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

RECEIPTS AND PAYMENTS ACCOUNTS For the year ended 31st March 2017

Amount (₹)

RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
I. Opening Balances			**I. Expenses :**		
a) Cash in hand	53541.00	12001.00	a) Establishment Expenses	119275705.00	114936354.00
b) Bank Balances :			b) Administrative Expenses	93660698.00	100945389.77
I. In current accounts(Schd 11A)	11003610.72	18469564.66	c) Maintenance	24862761.00	31766605.00
ii. In deposit accounts			**II. Payments made against funds for**		
Schedule - 10	362531415.00	210248304.00	various Projects		
Schedule - 11A	22589916.00	54651909.00			
iii. Savings accounts (Schd 11A)	34734802.44	13907339.37			
iv. Remittance-in-Transit					
II. Grants Received			**III. Investments and deposits made**		
a) From Government of India			a) Out of Earmarked/Endowment	140612227.00	213114234.00
-For the year	505965164.00	553501889.00	b) CPWD Deposit and NBCC Deposit		0.00
-For the previous year			c) Bank Gurantee & LC A/C	1596487.00	1060000.00
b) From State Government			d) Out of Own Fund	77043032.00	68918450.00
c) From Other sources (details)			e) Bridge&Roof Deposit Account	0.00	0.00
(Grants for capital & revenue exp.					
To be shown separately)					
			IV. Expenditure on Fixed Assets &		
			Capital Work-in-Progress		
			a) Purchase of Fixed Assets	20533199.00	82775238.93
III. Income on Investments from			b) Expenditure on Capital Work-in-Progress	18792343.00	69011595.00
a) Earmarked/Endow Funds		-			
b) Own Funds (Oth. Investment)			**V. Refund of surplus money/Loans**		
			a) To the Government of India		
IV. Interest Received			b) To the State Government		
a) On Bank deposits	3635082.00	8160947.00	c) To other providers of funds		
V. Other Income	10839306.72	5282542.00	**VI. Finance Charges (Interest)**		
`			**VII. Other Payments**	59567857.17	66082801.27
			VIII. Amount transferred from Fixed Deposit		-
			account to Savings Account Account/Current	0.00	85857589.00
			Account		
VI Amount Borrowed		-			
			IX. Closing Balances		
VII. Any other receipts	2097326.00	25203154.10	a) Cash in hand	36760.00	53541.00
			b) Bank Balances :		
VIII. Amount transferred from Current Account/	242202426	375943892.00	I. In current accounts(Schd 11A)	36822075.95	11003610.72
Savings Account to Deposit Account.			ii. In deposit accounts		
			Schedule - 10	568248614.00	362531415.00
			Schedule - 11A	16134692.00	22589916.00
			iii. Savings accounts(Schd.11A)	18466138.76	34734802.44
			iv. Remittance-in-Transit		
	1195652589.88	**1265381542.13**		**1195652589.88**	**1265381542.13**

As Per our report of even date

Date: 01.08.2017
Place: Kolkata

For Roy & Bagchi
Chartered Accountants
FRN: 301053E

(Amit Mitra)
Partner
Membership no:060694

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year		Previous Year	
SCHEDULE 1-CAPITAL FUND:				
Balance as at the beginning of the year	958290018.36		1043226974.35	
Add:Interest earned on FD and savings bank(payable) for last year	11455120.00		0	
Add : Contributions towards Corpus/Capital Fund	50737000.00		45912000.00	
Less:Depreciation for the year	67030569.13		150923519.95	
Add : Surplus during the year	65140718.11		20074563.96	
		1018592287.34		958290018.36
BALANCE AS AT THE YEAR - END		**1018592287.34**		**958290018.36**
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, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	FUND-WISE BREAK UP					TOTAL	
SCHEDULE 3 - EARMARKED/ ENDOWMENT FUNDS	**Project Fund**	**Technical Research Centre**	**Retirement Benefits Fund**	**Medical Fund**	**Corpus Fund**	**Current Year**	**Prev. Year**
a) Opening balance of the funds	69620643.41	223310750.00	72127545.00	4988972.00	9752198.38	379800108.79	190436956.05
b) Additions to the Funds							
I) Donations/grants/ Contributions	44374164.00	120000000.00	2103983.00	594013.00	832500.00	167904660.00	271748405.00
ii) Income from investments made on account of funds	2564198.00	16226317.00	6377520.00	350282.00	650426.00	26168743.00	14431527.00
iii) Other additions -Provision during the year							
TOTAL (a + b)	**116559005.41**	**359537067.00**	**80609048.00**	**5933267.00**	**11235124.38**	**573873511.79**	**476616888.05**
c) Utilisation/Expenditure towards objectives of funds							
i) Capital Expenditure							
Fixed Assets	17424119.00	4,08,637.00	-	-		17832756.00	56665735.93
Others							
Total							
ii) Revenue Expenditure							
Salaries, Wages and	27148853.00	-	-	-		27148853.00	25484114.00
allowances etc.							
Rent							
Other Administrative							
expenses							
Other Payments	9161236.36	3348191.00	4793614.00	350282.00		17653323.36	14666929.33
iii) Adjustment (Interest)							
TOTAL (c)	**53734208.36**	**3756828.00**	**4793614.00**	**350282.00**	**-**	**62634932.36**	**96816779.26**
NET BALANCE AS AT THE YEAR-END (a+b-c)	**62824797.05**	**355780239.00**	**75815434.00**	**5582985.00**	**11235124.38**	**511238579.43**	**379800108.79**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	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

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	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
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 31.03.2017

Amount (₹)

	Current Year		Previous Year	
SCHEDULE 7 - CURRENT LIABILITIES AND PROVISIONS				
A. CURRENT LIABILITIES				
1. Acceptances				
2. Sundry Creditors:				
a) For Capital expenditure	725558.00			3516855.00
b) Others - Revenue expend.(including Project Rs.32000.00)	10282456.00			10112138.00
3. Othert Liabilities	4158843.00			2599419.00
4. Deposit from Contractors (including Project & TRC)	7680615.88			7017928.88
5. Deposit from Students	1387900.00			1242100.00
6. Deposit from Contractual Employees	1710256.00			1572265.00
7. Provident Fund Account (Payable)	425390.00			0.00
8. Project Overhead Fund	5298141.43			4974330.43
9. Interest earned on fixed deposit and savings bank (payable)	10529332.00			11455120.00
TOTAL (A)	**42198492.31**			**42490156.31**
B. PROVISIONS				
1. For Taxation				
2. Gratuity				
3. Superannuation/Pension				
4. Accumulated Leave Encashment				
5. Trade Warranties/Claims				
6. Others - Adhoc Bonus	104012.00			55656.00
TOTAL (B)	**104012.00**	**-**		**55656.00**
TOTAL (A + B)	**42302504.31**			**42545812.31**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

SCHEDULE 8 - FIXED ASSETS

Amount (₹)

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	0.00		306451448.86	43369090.49	4852147.96		48221238.45	258230210.41	263082358.37
b) On Freehold Land										
c) Ownership Flats/ Premises										
d) Superstructures on Land										
not belonging to the entity										
3. PLANT MACHIENRY & EQUIPMENT	448184023.22	15312635.00		463496658.22	224950750.02	53287271.56		278238021.58	185258636.64	223233273.20
4. VEHICLES	321013.00	0.00		321013.00	321011.00	0.00		321011.00	2.00	2.00
5. FURNITURE, FIXTURES	38838395.22	129613.00		38968008.22	22936691.14	2611329.45		25548020.59	13419987.63	15901704.08
6. OFFICE EQUIPMENT	4417150.29	799210.00		5216360.29	2139639.87	611630.59		2751270.46	2465089.83	2277510.42
7. COMPUTER & LAN INSTALLATION	69576100.44	1412129.00		70988229.44	56271063.08	4668413.36		60939476.44	10048753.00	13305037.36
8. ELECTRIC INSTALLATIONS	11699040.00	0.00		11699040.00	3540141.58	999776.20		4539917.78	7159122.22	8158898.42
9. LIBRARY BOOKS	215680643.11	5293889.00		220974532.11	69586478.05	0.00		69586478.05	151388054.06	146094165.06
10. TUBEWELLS & W.SUPPLY	-	-		0.00	-	-		0.00	0.00	-
11. OTHER FIXED ASSETS	84225.55	0.00		84225.55	80014.26	0.01		80014.27	4211.28	4211.29
TOTAL OF CURRENT YEAR	**1106202694.29**	**22947476.00**	**0.00**	**1129150170.29**	**423194879.49**	**67030569.13**	**0.00**	**490225448.62**	**638924721.67**	**683007814.80**
PREVIOUS YEAR	**1064201172.29**	**42001522.00**	**-**	**1106202694.29**	**272271359.54**	**150923519.95**	**-**	**423194879.49**	**683007814.80**	**791929812.75**
B. CAPITAL WORK IN PROGRESS	**75124642.00**	**24203022.00**	**0.00**	**99327664.00**					**99327664.00**	**12992443.00**
TOTAL (A + B)	**1181327336.29**	**47150498.00**	**0.00**	**1228477834.29**	**423194879.49**	**67030569.13**	**0.00**	**490225448.62**	**738252385.67**	**696000257.80**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year	Previous Year
SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS		
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		
Project Fund Investment	37009590.00	51013440.00
Retirement Benefit Fund Investment	74712036.00	64553448.00
Staff Medical Fund Investment	4227029.00	3694778.00
Corpus Fund Investment (Project Overhead)	7475760.38	7109664.38
TOTAL	**123424415.38**	**126371330.38**
SCHEDULE 10 - INVESTMENTS - OTHERS		
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)	193617915.00	104045250.00
Fixed Deposit with Union Bank of India including Project & TRC	374630699.00	258486165.00
TOTAL	**568248614.00**	**362531415.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year		Previous Year	
SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.				
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares		60524.32		73921.12
2) Cash balances in hand		36760.00		53541.00
3) Bank Balances:				
a) With Scheduled Banks:				
On Current Accoutns:				
Indian Overseas Bank (CA-089302000000220)	13919879.97		2884451.34	
Indian Overseas Bank (CA-089302000000273)	18041881.25		4311277.65	
Union Bank of India (CA-460901010034252)	4860314.73	36822075.95	3807881.73	11003610.72
On Deposit Accounts for LC&BG:				
Indian Overseas Bank (CA-089302000000220)	14034154.00		17410616.00	
Indian Overseas Bank (CA-089302000000273)	2100538.00	16134692.00	5179300.00	22589916.00
On Savings Accounts:				
Indian Overseas Bank(SB-089301000010662 UNAST)	1536914.94		919995.62	
Indian Overseas Bank(SB-089301000012029 SYNC.)	689644.00		662796.00	
Indian Overseas Bank(SB-089301000011479 NANO TECH)	489021.00		469983.00	
Union Bank of India (SB-460901110050013)	4290478.82		8281346.82	
Axis Bank (SB-775010100024408)	555867.00		511885.00	
Axis Bank (SB-775010100017860)	1566.00		1506.00	
Union Bank of India(SB-460902010097273 TRC)	2437696.00		23887290.00	
Indian Overseas Bank (SB- 089301000018598 TRC)	8464951.00	18466138.76	0.00	34734802.44
5. Remittance - in - Transit				
6. Post Office-Savings Accounts				
TOTAL (A)		**71520191.03**		**68455791.28**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year		Previous Year	
SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.(Contd.)				
B. LOANS, ADVACNES AND OTHER ASSETS				
1. Loans:				
a) Staff including HBA ,Vehicle &PC Advance(includes Project A/c)	1149476.00			1204625.00
b) Other Entitites engaged in activities/objectives similar to that of the Entity				
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	35261612.00			40438840.00
b) Prepayments				
c) Others (Security Deposits)	389048.00			126130.00
d) Contractors & Suppliers	1996635.00			91941.00
3. Income Accrued:				
a) On Investments from Earmarked/Endowment Funds(Including Project & TRC)	29157454.00			22346187.00
b) On investmetns - Others	2733540.00			937223.00
c) On Loans and Advances				
4. Claims Receivable - Grant -in- Aid Receivable				
TOTAL (B)		**70687765.00**		**65144946.00**
TOTAL (A + B)		**142207956.03**		**133600737.28**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year	Previous Year
SCHEDULE 12 - INCOME FROM SALES/SERVICES		
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	2320800.00	2184040.00
b) Hostel Charges (Recovery of HRA)	3217415.00	1835137.00
c) Equipment Utilisation Fees	506100.00	752100.00
d) Hostel Maintenance Fees	913436.00	1454942.00
e) Project Overhead	333000.00	304000.00
f) Income from BSNL	85360.00	60500.00
g) Course Fees	10000.00	10000.00
h) Seminer Hall Rent	44500.00	121100.00
i) Dining Hall Rent	2150.00	750.00
TOTAL	**7432761.00**	**6722569.00**
SCHEDULE 13 - GRANTS/SUBSIDIES (Irrevocable Grants & Subsidies Received)		
1) Central Government	291264000.00	254088000.00
2) State Government(s)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organsations		
6) Others		
TOTAL	**291264000.00**	**254088000.00**
SCHEDULE 14 - FEES/SUBSCRIPTIONS		
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

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Investment from Earmarked Fund		Investment - Others	
	Current Year	Previous Year	Current Year	Previous Year
SCHEDULE 15 - INCOME FROM INVESTMENTS (Income on Invest. From Earmarked/Endowment Funds transferred to Funds)				
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**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year	Previous Year
SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATION ETC.		
1. Income from Royalty		
2. Income from Publications		
3. Others		
TOTAL	**Nil**	**Nil**
SCHEDULE 17 - INTEREST EARNED		
1) On Term Deposits:		
a) With Scheduled Banks	10072086.00	11433983.00
b) With Institutions		
c) Others		
2) On Savings Accounts:		
a) With Scheduled Banks	457246.00	21137.00
b) Post Office Savings Accounts		
c) Others		
3) On Loans:		
a) Employees/Staff (Interest on HBA etc.)	368854.00	162571.00
b) Others		
4) Interest on Debtors and Other Receivables		
TOTAL	**10898186.00**	**11617691.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

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SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year	Previous Year
SCHEDULE 18 - OTHER INCOME		
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	363045.00	407331.00
TOTAL	**363045.00**	**407331.00**
SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS		
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		
a) Salaries and Wages	90479224.00	86664563.00
b) Other Allowances and Bonus	206193.00	55656.00
c) Contribution to Provident Fund	1915164.00	1975132.00
d) Contribution to Retirement Benefits Fund	2103983.00	1218713.00
e) Staff Welfare Expenses (Medical)	2663820.00	1540129.00
f) Contribution to NPS	1494557.00	1367721.00
f) Others (LTC, Leave Encashment on LTC, Re-imbursement of Tuition Fees etc.)	1650291.00	1372886.00
TOTAL	**100513232.00**	**94194800.00**

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BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

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Amount (₹)

	Current Year	Previous Year
SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.		
a) Extended Visitors Programme.(Including Seminars & Workshops)	9156132.00	10703764.00
b) Meeting Expenses	990195.00	1164353.00
c) Library General Expenses	108233.00	130128.00
d) Electricity and Power	37770037.00	36633061.77
e) Laboratory Expenses	8333674.00	11365113.00
f) Insurance	12492.00	10945.00
g) Repairs and Maintenance	31319066.80	36186941.43
h) TPSC Programme	807040.00	576149.00
i) Student Hostel Rent	180222.00	412985.00
j) Vehicles Hire Charges	1455728.00	1451550.00
k) Postage, Telephone and Communication Charges	1220429.00	1525738.00
l) Printing and Stationary	704067.00	1094078.00
m) Travelling and Conveyance Expenses	2602827.00	2118904.00
n) Contingency to Faculty	58339.00	41868.00
o) Auditors' Remuneration	47200.00	46000.00
p) Bank Charges	257511.09	336122.94
q) Professional Charges (Legal Charges)	455216.00	914907.00
r) Staff Training & Welfare	540751.00	196648.00
s) Patent & Trademark	346000.00	156950.00
t) Integrated Ph.D.	34790736.00	41121919.00
u) Hindi Programme	129577.00	366799.00
v) Advertisement and Publicity	615396.00	2505977.00
w) Others	1195632.00	1277657.00
x) Municipal Tax	146968.00	146968.00
TOTAL	**133243468.89**	**150485526.14**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2017

Amount (₹)

	Current Year	Previous Year
SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.		
a) Grants given to Institutions/Organisations		
b) Subsidies given to Institutions/Organisations		
TOTAL	**Nil**	**Nil**
SCHEDULE 23 - INTEREST		
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 BG/LC 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.

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

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.81,09,409.00).
- Letters of Credit opened by Bank on behalf of the Centre and Project– Rs. 74,61,034.00 (Previous year Rs.1,44,80,507.00) against 100% margin money by way of fixed deposit.
- 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. Nil (Previous year Rs. Nil).

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, 2016 was Rs.7,51,24,642/- addition during the year is Rs2,42,03,022/- ,totaling to Rs.9,93,27,664/- an amount of Rs.Nil has been capitalized, leaving balance of Rs.9,93,27,664/-00 which has been carried forward.

2.2.3 Current Assets, Loans and Advances

In the opinion of the Management, the current assets, loans and advances have a value on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet.

Unadjusted Travelling advances:-

Name	Amount	Remarks
Amrtya Sarkar	Rs. 63000/-	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) Expenditure in foreign currency:

a) Travel: Nil

b) Remittances and Interest payment to Financial Institutions/Banks in Foreign Currency : Nil

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

BLOCK JD, SECTOR-III, SALT LAKE, KOLKATA - 700 106

c) Other expenditure: Nil

- Commission on Sales
- Legal and Professional Expenses
- Miscellaneous Expenses
- Bank Charges

ii) Earnings:

Value of Exports on FOB basis: Nil

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 2015-16 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: 01.08.2017

Satyendra Nath Bose National Centre For Basic Sciences

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