

# Annual Report

## 2011-2012



Satyendra Nath Bose National Centre  
for Basic Sciences

# *Annual Report*

## 2011-2012



Satyendra Nath Bose National  
Centre for Basic Sciences



*Annual Report 2011-2012*

Satyendra Nath Bose National Centre  
for Basic Sciences

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Satyendra Nath Bose National Centre  
for Basic Sciences

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## *Acknowledgement*

**I**t's my immense pleasure to compile the Annual Report of 'Satyendra Nath Bose National Centre for Basic Sciences' for the second time. I would like to convey my gratitude to the Competent Authority of the Centre for providing this opportunity to me. To prepare the Annual Report we had to collect data from all the faculties and sections of the Centre. Thanks to them for submission of data in time. It is a time bound work to be completed within a short span of time. Thanks to the Annual Report Committee members – Dr. Rajib Kumar Mitra, Mr. Apurba K. Sarkar, Ms. Shohini Majumder, and Mr. Sunish Kumar Deb for their suggestions and coordination. I would like to acknowledge the good work done by Centre's Photo Club members - Mr. Suman Dutta (PBIR), Mr. Subhasish Chakrabarty (JRF), Md. Inzamamul Arief (SRF) and Mr. Soumyakanti Bose (PBIR) for shooting photos of the Annual Report. Thanks from the bottom of my heart to the beloved Photo Club members. I must acknowledge the continuous efforts and labour of my Library staffs - Mr. Gurudas Ghosh, Ms. Ananya Sarkar and Mr. Amit Roy without whom the work could not be completed within the stipulated time. Finally thanks to all the members of the Centre for their cooperation in preparing the Annual Report of the Centre.

**Saumen Adhikari**

Librarian – cum – Information Officer





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## Message from the Director

I am very happy to bring out the annual report of our Centre for the year 2011-2012. This is a chronicle of our growth in the last year and also is a document of our accountability. It not only brings out the scientific achievements, it also stock checks our governance and the transparency in our administrative and financial processes. Over the years, I am happy to see that the annual report is improving both in style and contents and I hope that the report brings out a correct perception of the Centre.

Our first priority is research in basic sciences and the activities of the Centre reflects on that. We are also keen to work on the basic science for some important areas of societal applications. The Centre in last few years have made investments to build scientific infrastructure for research, which is indeed the first priority of the Centre. We are also happy to welcome 5 new faculties to the Centre. It makes me happy to note that this year the Centre has made more than 145 publications in referred journals. This is around 4.7 papers per faculty which however is somewhat less than our output in last year. About 20% of our papers are published in journals with impact factor 4 or more. About 20% of the papers are in journals with impact factor between 2 and 3. This is encouraging that more than 40% of the papers are in Journals which are definitely very good. However, it will be desirable to do much better. We need not forget that enhancement of the output is collective yet an individual responsibility. For an institution engaged in basic research, the best way to ensure its accountability is to have large number of high quality publications.

In this year we have restructured the Extended Visitor Linkage Programme (EVLN), which is our outreach programme to make it more compatible with our original mandate and also to align with our new strengths. This programme also encompasses a vibrant Post-doctoral Programme.

I am deeply indebted to the members of our Governing Body, Academic and Research programme Advisory Committee, Finance Committee and Building Committee for their advice, proactive policy and guidance. In particular, this year we initiated the process to bring about important modifications/ amendments to our Bye-Laws to make it align with the activities and scope of the institute today and for years to come.

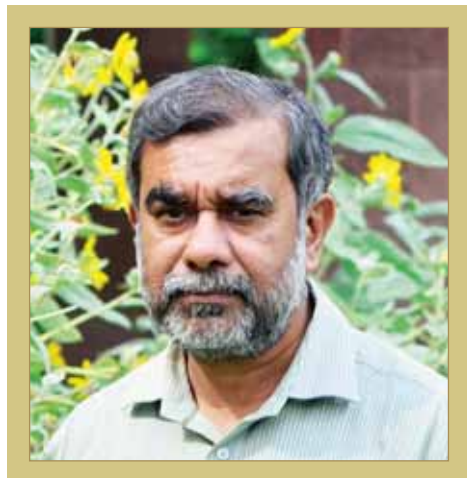
My thanks to a number of internal committees, in particular Consultative Advisory Committee (CAC) Deans, Head of the Departments and Registrar and his team of very able officers and staff for the hard work they have put to run the Centre. CAC is increasingly becoming a vehicle of collective decision making.

Thanks to the annual report committee for making the report and prepare it on time.

Arup Kumar Raychaudhuri  
Director and Senior Professor



# Dean Faculty



*Rabin Banerjee*

The last year was fruitful in terms of academic activities at the Centre. We have just celebrated the Silver Jubilee year of the Centre. We had plenty of good lectures throughout the year by eminent scientists from all over the world. The year gave an output of 147 publications and the Centre ran 41 sanctioned projects within the four departments amounting to Rs. 7,13,74,645/-.

Our continuous collaborations with various countries like Germany, South Africa, Sweden, Russia, Brazil, Taiwan, Korea, USA, France, Italy, Spain, UK, Australia, China, Vietnam, Hungary, Japan, Singapore, Thailand, Saudi Arabia, Turkey, Finland, Belgium, Austria etc. in terms of academic visits, exchange programmes, collaborations and conferences powered up the research activities of the Centre.

A conference on Advanced and Functional Materials and another on Statistical Physics and Nonlinear Dynamics celebrating the 60th Birthday of Prof. Arup Kumar Raychaudhuri and Prof. Jayanta Kumar Bhattacharjee respectively were organised at the Centre.

The DST "Unit on Nanoscience at S. N. Bose National Centre for Basic Sciences" and "Thematic Unit for Excellence on Nanodevice Technology" are running successfully from the beginning of this year. The second project significantly got a sanctioned amount of Rs.8.34 crores approximately.

During the last year several new appointments have been made including 5 at the regular faculty level.

**Rabin Banerjee**  
Dean, Faculty

# Dean Academic Programme



*Sandip Kumar Chakrabarti*

The academic activity at SNBNCBS has always been very vibrant and this year it was no exception. From this year, we started our own entrance test examination system named BOSETEST for screening students towards the Integrated PhD (IPhD) programme. We had seven examination centres throughout India. We are happy to report that all the ten IPhD students taken in this year are from the BOSETEST channel. Eighteen students have joined the PhD programme. All in all, we had a total 109 research scholars in PhD programme and a total of 37 students in the IPhD programme. This year ten students have received PhD degree and nine students have submitted their Thesis for the PhD degree. In 2011-2012 we also conducted our second BOSE TEST on March 4th, 2012 for the intake in the 2012-2013 academic year. This time, examinations in both PhD and IPhD programmes were taken. Altogether 12 centres throughout India conducted the examination simultaneously.

## **COURSES OFFERED**

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

**1st Semester:** PHY 101, Classical Dynamics, Biswajit Chakraborty; PHY 102, Mathematical Methods I, Manu Mathur; PHY 103, Quantum Mechanics I, Jayanta K Bhattacharjee; PHY 104, Computational Methods in Physics I, Subhrangshu S Manna; PHY 191, Basic

Laboratory I, Pratip Kumar Mukhopadhyay, Anjan Barman, Saikat Ghosh, B. Rajini Kanth.

**2nd Semester:** PHY 201, Statistical Mechanics, Punyabrata Pradhan; PHY 202, Mathematical Methods II, Jayanta K Bhattacharjee; PHY 203, Electromagnetic Theory, M Sanjay Kumar; PHY 204, Computational Methods in Physics II, Saswati Barman; PHY 291, Basic Laboratory II, Kalyan Mandal, Manik Pradhan.

**3rd Semester:** PHY 301, Quantum Mechanics III, M Sanjay Kumar; PHY 302, Condensed Matter Physics, Priya Mahadevan; PHY 303, Nuclear & Particle Physics, Ajit K Sinha, / Archan S Majumdar; PHY 304, Project Based Courses, Faculty Supervisors; PHY 391, Methods of Experimental Physics, Kalyan Mandal (Co-ordinator) & Faculty Supervisors (Experimental), Anjan Barman, Barnali Ghosh, Madhuri Mandal, Rajib Kumar Mitra.

**4th Semester:** PHY 401, Project Based Course, Faculty Supervisors; PHY 402, Seminar Course, Kinsuk Acharyya; PHY 404, Advanced Mathematical Methods, Samir Kumar Paul; PHY 405, Advanced Quantum Field Theory, Samir Kumar Paul; PHY 410, Advanced Techniques in Experimental Methods, Kalyan Mandal; PHY 413, Magnetism & Superconductivity, Ranjan Chaudhury; PHY 416, Optical Physics, M Sanjay Kumar.

### **Ph.D Programme**

#### **Course Work Programme**

**Common to all the departments:** PHY 501, Research

Methodology, Sandip Kumar Chakrabarti, Pratip Kumar Mukhopadhyay, Kinsuk Acharyya; PHY 502, Review of the Topical Research, Faculty Supervisors; PHY/CB 591, Project Research, Faculty Supervisors.

**Department of Astrophysics & Cosmology:** PHY 506, Quantum Physics, Archan S Majumdar; PHY 509, Relativity & Cosmology, Archan S Majumdar.

**Department of Condensed Matter Physics & Material Sciences:** PHY 503, Condensed Matter Physics, Priya Mahadevan; PHY 601, Advanced Condensed Matter Physics - Magnetism & Superconductivity, Ranjan Chaudhury.

**Department of Chemical, Biological and Macromolecular Sciences:** CB 533, Liquids, Jaydeb Chakrabarti; CB 540, Study of Bio-macromolecules, Mahua Ghosh.

**Department of Theoretical Sciences:** PHY 603, Statistical Physics, Punyabrata Pradhan.

## PROJECT RESEARCH

### Summer Projects

1. *Study of k-essence model and an approach to find the Lagrangian density*, Bijit Sinha, Indian Institute of Technology, Delhi, Supervisor: Debasish Gangopadhyay; *Analysis of the behaviour of spin stiffness and charge stiffness for the doped quantum antiferromagnet on low dimensional lattice*, Nimisha Kashyap, National Institute of Technology, Rourkela, Supervisor: Rabin Banerjee; *Cosmic Rays*, Bhupendra Mishra, Indian Institute of Technology, Guwahati, Supervisor: Sandip Kumar Chakrabarti; *Study of random graph theory and percolation theory*, Sukannya Bhattacharya, Indian Institute of Technology, Madras, Supervisor: Subhrangsu S Manna; *First principle calculation of electronic structure of  $\text{LaMnO}_3$  compound using TB-LMTO-ASA method*, Bubun Kar, Indian Institute of Technology, Bombay, Supervisor: Tanusri Saha Dasgupta; *Molecular Hydrogen formation on the grain surfaces*, Moumita Adhikari, Indian Institute of Technology, Madras, Supervisor: Kinsuk Acharyya; *The study of multiferroic properties of  $\text{BiFeO}_3$  ceramics co-doped by  $\text{Gd}^{3+}$  and  $\text{Ba}^{2+}$* , Tanushree Sarkar, University of Calcutta, Supervisor: Kalyan Mandal; *Synthesis One-Dimensional ZnO Nanowires by Chemical Method and vapor liquid solid growth and Analysis of their Size Distribution and Characterization*, Sumit

Sharma, University of Rajasthan, Supervisor: Kaustuv Das; *Synthesis of Zinc Oxide Nanostructures using different Solvents, Nanoflowers, Analysis of their Size Distribution and their Characterization*, Ishu Singhal, University of Rajasthan, Supervisor: Kaustuv Das; *Deposition and Characterization of  $\text{Ni}_{53}\text{Mn}_{24}\text{Ga}_{23}$  Alloy Thin Film*, Gopal Mapdar, Indian Institute of Technology, Kharagpur, Supervisor: Pratip Kumar Mukhopadhyay; *Preparation of Cobalt Nanowires in Presence of External Magnetic field*, Rajesh Dutta, Indian Institute of Technology, Madras, Supervisor: Anjan Barman; *Synthesis of LSMO ( $x=0.5$ ) Nanowires and Study of Magnetic and Electrical Properties*, Sayan Chandra, University of South Florida, Supervisor: Arup Kumar Raychaudhuri.

2. *Elementary Differential Geometry and its Physical Application*, Gopal Hazra, Indian Institute of Technology, Kharagpur, Supervisor: Biswajit Chakraborty; *A Study of Self-Adjoint Extensions of Operators in Quantum Mechanics and their Applications*, Ritam Sinha, St. Xavier's College, Kolkata, Supervisor: Biswajit Chakraborty; *Phase Space Quantisation and Noncommutative Quantum Mechanics*, Arvind Kumar, M. K. Institute of Engineering and Technology, Supervisor: Biswajit Chakraborty; *Brownian Dynamics of Colloids*, C. Ajina, National Institute of Technology, Calicut, Supervisor: Jaydeb Chakrabarti; *Solvation Phenomena In Ferro Fluid*, Krishna Kumari Swain, Ravenshaw University, Cuttack, Orissa, Supervisor: Ranjit Biswas; *Effects of Rippling on the Band Structure of Graphene*, Gurjeet Singh, Indian Institute of Technology (Banaras Hindu University), Supervisor: Priya Mahadevan.

3. *Foundations of Quantum Mechanics and Quantum Information Theory*, Siddhartha Das, Indian Institute of Science Education and Research, Pune, Supervisor: Archan S Majumdar; *Design and Fabrication of an Experimental Set-up for ac susceptibility measurement*, Rishi Maiti, Indian Institute of Technology, Kharagpur, Supervisor: Pratip Kumar Mukhopadhyay; *Making of Pulsed Magnetometer and Computerization of the Measurement*, Sougata Mallick, Indian Institute of Technology, Guwahati, Supervisor: Pratip Kumar Mukhopadhyay; *Fabrication and Characterization of  $\text{BaTiO}_3$  thin film*, Suman Karmakar, Indian Institute of Technology, Bombay, Supervisor: Pratip Kumar Mukhopadhyay.

4. *Hopf Algebraic Deformation and Non-commutative Quantum Mechanics*, Saikat Banerjee, St. Xavier's College, Supervisor: Biswajit Chakraborty.

1. FUNDED BY SNBNCBS;

2. FUNDED BY INDIAN ACADEMY OF SCIENCE;

3. FUNDED BY INSPIRE-SHE;

4. FUNDED BY KVPY.

### **M. Tech. / M. Sc. Projects**

*Formation and Magnetism on Rough Deposited Surfaces*, Pankaj Kumar, Sardar Vallabhbhai National Institute of Technology, Surat, Supervisor: Abhijit Mookerjee; *Fabrication of UV Detector Based on ZnO Thinfilms*, Niraj Desai, Sardar Vallabhbhai National Institute of Technology, Surat, Supervisor: Arup Kumar Raychaudhuri; *Synthesis of Nickel Nanorods in Alumina Templates*, Jitesh C Sharma, Sardar Vallabhbhai National Institute of Technology, Surat, Supervisor: Pratip Kumar Mukhopadhyay; *Synthesis Characterization and Analysis of Optical Properties, Photoconductivity and Photocatalysis of Different Shapes of Zinc Oxide Nanostructures*, Sumit Sharma, University of Rajasthan, Supervisor: Kaustuv Das.

### **Ph. D AWARDED**

*Some Aspects of Magnetic Properties of Amorphous Magnetic Materials*, Suman Sinha, Supervisor: Kalyan Mandal, in Jadavpur University, on December 24, 2010.

[Not included in Annual Report 2010-11]

*Study of Path Space, Gauge Theory and Holonomy*, Saikat Chatterjee, Supervisor: Amitabha Lahiri, in Jadavpur University, on March 1, 2011.

[Not included in Annual Report 2010-11]

*Elasto-Plastic Theories for Microstructure Selection in Solids*, Arya Paul, Supervisors: Surajit Sengupta & Jayanta K Bhattacharjee, in West Bengal University of Technology, on June 17, 2011.

*Bifurcations in Maps with Memory and Predator Prey Models with Modulated Control*, Debabrata Dutta, Supervisor: Jayanta K Bhattacharjee, in West Bengal University of Technology, on June 29, 2011.

*Quantum Tunneling in Black Holes*, Bibhas Ranjan Majhi, Supervisor: Rabin Banerjee, in University of Calcutta, on August 23, 2011.

*Theoretical Studies of Protein-Nucleic Acid Interactions*

*Related to Gene-Expression*, Navin Chandra, Supervisors: Siddhartha Roy, IICB and Surajit Sengupta, IACS, in West Bengal University of Technology, on September 14, 2011.

*Fluorescence Spectroscopic Studies of Charged Transfer and Dynamics in Solution Phase: Effects of Solvent, Electrolyte and Molten Salts*, Harun Ali Rashid Gazi, Supervisor: Ranjit Biswas, in Jadavpur University, on December 24, 2011

*Dynamical Heterogeneities and Non-Equilibrium Processes in Condensed Phase*, Tamoghna Kanti Das, Supervisors: Jayanta K Bhattacharjee & Surajit Sengupta, in West Bengal University of Technology, on March 6, 2012.

*A Study of the Effect of Disorder and Confinement on Binary Systems*, Shreemoyee Ganguly, Supervisor: Abhijit Mookerjee, in West Bengal University of Technology, on March 20, 2012.

*Studies of Magnetic and Transport Properties of Disordered Systems*, Mitali Banerjee, Supervisor: Abhijit Mookerjee & Alak K. Majumdar, in Jadavpur University, on March 21, 2012.

### **Ph. D THESES SUBMITTED**

*Studies of Magnetic and Transport Properties of Disordered Systems*, Mitali Banerjee, Supervisor: Abhijit Mookerjee & Alak K. Majumdar, in Jadavpur University, on April 19, 2011.

*Dynamical Heterogeneities and Non-Equilibrium Processes in Condensed Phase*, Tamoghna Kanti Das, Supervisors: Jayanta K Bhattacharjee & Surajit Sengupta, in West Bengal University of Technology, on June 8, 2011.

*Ultrafast Spectroscopic Studies on Chemically and Biologically Relevant Aqueous/Non-Aqueous Environments*, Pramod Kumar Verma, Supervisor: Samir K Pal, in Jadavpur University, on June 13, 2011.

*A Study of the Effect of Disorder and Confinement on Binary Systems*, Shreemoyee Ganguly, Supervisor: Abhijit Mookerjee, in West Bengal University of Technology, on July 26, 2011.

*Black Holes and the Positive Cosmological Constants*, Sourav Bhattacharya, Supervisor: Amitava Lahiri, in Jadavpur University, on September 9, 2011.

*Spectroscopic Characterization of Fluorescence Probes under Confinement*, Abhinandan Makhal, Supervisor:



Samir K Pal, in Jadavpur University, on November 15, 2011.

*Study of Wire-Shaped Ferromagnetic Materials*, Bipul Das, Supervisor: Kalyan Mandal, in West Bengal University of Technology, on December 13, 2011.

*Thermodynamics of Black Holes: Semi-Classical Approaches and Beyond*, Sujoy Kumar Modak, Supervisor: Rabin Banerjee, in University of Calcutta, on January 20, 2012.

*Monte Carlo Simulations of the Advective Inflow and Outflow around a Black Hole*, Himadri Ghosh, Supervisor: Sandip K Chakrabarti, in Jadavpur University, on March 28, 2012.

## Ph. D THESES COLLOQUIA

*Monte Carlo Simulations of the Advective Inflow and Outflow around a Black Hole*, Himadri Ghosh, May 20, 2011.

*Ultrafast Spectroscopic Studies on Chemically and Biologically Relevant Aqueous / Non-Aqueous Environments*, Pramod Kumar Verma, June 9, 2011.

*A Study of the Effect of Disorder and Confinement of Binary Systems*, Shreemoyee Ganguly, July 13, 2011.

*Study of Wire Shaped Ferromagnetic Materials*, Bipul Das, July 26, 2011.

*Black Holes and the Positive Cosmological Constant*, Sourav Bhattacharya, August 16, 2011.

*Spectroscopic Characterization of Fluorescence Probes under Confinement*, Abhinandan Makhil, November 14, 2011.

## RESEARCH SCHOLARS - Ph. D PROGRAMME

### Extended Senior Research Fellow

**2007–2008:** Sujoy Kumar Modak (CSIR)

### Senior Research Fellow

**2005–2006:** Mitali Banerjee (UGC) (Resigned on 23.05.2011), Sourav Bhattacharya (Resigned on 10.09.2011)

**2006–2007:** Rajesh Kumar Neogy, Raka Dasgupta, Himadri Ghosh

**2007–2008:** Kapil Gupta (CSIR), Prashant Singh, Soumyajit Sarkar (CSIR), Swastika Chatterjee, Kinshuk Banerjee (CSIR), Ambika Prasad Jena (CSIR), Biswajit

Das, Biswajit Guchhait (CSIR), Debraj Ray, Kinsuk Giri, Pramod Kumar Verma (CSIR), Abhinandan Makhil (CSIR)

**2008–2009:** Abhijit Chakraborty, Amit Das (CSIR), Debmalaya Mukhopadhyay, Manotosh Chakravorty (CSIR), Sandeep Agarwal (CSIR), Sandeep Singh, Shahnewaz Mondal (CSIR), Snehasis Das Chakraborty (CSIR), Sudipto Kanungo, Sujay Pal (CSIR), Tamal Basak (CSIR), Tanumoy Pramanik (UGC), Shyamsundar Ghosh (CSIR), Arka Choudhury, Rajib Nath (CSIR), Hirak Kumar Chandra (Indo-German Project)

**2009–2010:** Dibakar Raychaudhury (CSIR), Ashutosh Rai (DST Project), Dheeraj Kumar (CSIR)

### Junior Research Fellow

**2009–2010:** Anupam Giri (UGC), Ashutosh Kumar Yadav (Resigned on 29.12.2011), Bipul Kumar Mahato (CSIR), Biswajit Pal (CSIR), Bivas Rana (UGC), Dattatraya P Shinde, Debabrata Sinha (CSIR), Debashish Sarkar (CSIR), Deepak S Jalla (CSIR), Injamamul Arief (CSIR), Nirmal Goswami (CSIR), Putul Malla Chowdhury (CSIR), Rabaya Basori, Rajasree Das (CSIR), Ranajay Saha, Ruma Das (CSIR), Saikat Debnath (CSIR), Santu Baidya, Semanti Pal (UGC), Soma Banerjee (UGC), Soumi Roy Chowdhury, Soumik Sarkar (UGC), Sreemoyee Mukherjee, Subrata Batabyal (CSIR), Sudipta Kumar Bera (CSIR) (Resigned on 26.12.2011), Sujit Sarkar (UGC) (Resigned on 04.07.2011), Sumit Ghosh (CSIR), Surajit Rakshit (CSIR), Swarnakamal Mukherjee (CSIR), Tamisra Pal, Tanumoy Mondal, Thaneshwar Prasad Kaloni (Resigned on 01.02.2011), Urbashi Satpathi (INSPIRE), Wasim Iqbal, Priyanka Chowdhury (UGC), Subhadipa Das (DST Project), Arun Lakshmanan (DST Project), Shiladitya Mal (DST Project), Ruma Mandal (DST Project)

**2010–2011:** Anirban Karmakar, Anuradha Das (UGC), Arindam Lala (CSIR), Bandan Chakraborty (UGC), Sreeraj T P (CSIR), Subhajit Sarkar (CSIR), Susmita Saha (CSIR), Tanmoy Ghosh, Nandan Kumar Das (CSIR) (Resigned on 26.12.2011), Animesh Patra, Sandipa Indra (UGC), Y. Chaoba Devi, Sisir Chowdhury (UGC) (Resigned on 27.12.2011), Sabyasachi Ghosh, Sandeep Chakraborty (INSPIRE) (Resigned on 12.08.2011)

**2011–2012:** Arindam Das (UGC), Paramita Saha, Prithwish Sinha Roy (CSIR), Samapan Sikdar (UGC), Shantimoy Kar (CSIR), Soubhik Chakraborty (CSIR), Suman Das (CSIR), Sanjoy Kumar Routh, Nandini

Midya, Ishita Dutta Choudhury, Pratik Tarafdar (UGC), Shovon Pal (AMRU), Rishi Ram Ghimire (Twas-Bose Fellow), Kallol Mukherjee, Sayani Chatterjee, Siddhi Chaudhuri, Prasun Sarkar (DST Project), Subarna Dutta (DST Project)

## **RESEARCH SCHOLARS - INTEGRATED Ph.D PROGRAMME**

### **Extended Senior Research Fellow**

**2003–2004:** Arya Paul (Resigned on 01.09.2011)

**2004–2005:** Shreemoyee Ganguly

### **Senior Research Fellow**

**2003–2004:** Tamoghna Kanti Das (Resigned on 18.04.2011), Bipul Das (Resigned on 01.09.2011)

**2005–2006:** Abhinav Kumar (UGC)

**2007–2008:** Amartya Sarkar, Indrakshi Roychowdhury, Nilok Bose, Oindrila Ganguly, Rajiv Kumar Chouhan, Rudranil Basu (CSIR – SPM Fellow), Sudip Kumar Garain

### **Junior Research Fellow**

**2008–2009:** Arup Bhowmik, Sukla Pal

**2009–2010:** Arghya Das, Arijit Chatterjee, Arnab Ganguly, Ashutosh Kumar Singh, Bipul Battacharjee, Debanjan Polley, Kumar Jang Bahadur Ghosh, Subhasis Chakraborty

## **INTEGRATED Ph. D PROGRAMME**

**2010–2011:** Ankita Chakrabarti, Arpan Krishna Mitra, Soumyakanti Bose, Suman Duttta, Tejas Rathod

**2011–2012:** Anita Halder, Chandreyee Roy, Debasish Das Mahanta, Debolina Basu, Dilip Sao, Saheli Banerjee, Shauri Chakrabarty, Somnath Mukhopadhyay, Souvik Mondal, Sumanta Kundu

## **RESEARCH SCHOLARS - PART TIME Ph. D PROGRAMME**

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

Nirman Ganguly, Astrophysics & Cosmology, under Archan S Majumdar, Current Affiliation: Heritage Institute of Technology, Kolkata.

Pampa Pal, Condensed Matter Physics & Material Sciences, under Alak K Majumdar and Abhijit Mookerjee, Current Affiliation: Christopher Road Govt. Sponsored H. S. School for Girls, Kolkata.

Sarmistha Chaudhuri, Theoretical Sciences, under Rabin Banerjee, Current Affiliation: Camellia University of Technology, Kolkata.

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

Barun Khanra, Theoretical Science under Partha Guha, Current Affiliation: Sailendra Sircar Vidyalaya, Kolkata.



**Sandip Kumar Chakrabarti**  
Dean, Academic Programme

# Extended Visitors' Linkage Programme



Advanced School on High Resolution Techniques, Atomic Force Microscopy and their Applications, 14.12.11 - 15.12.11



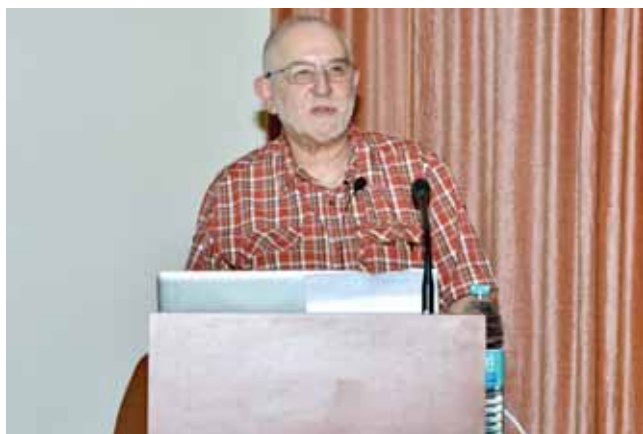
Prof. Kip S. Thorne interacting with students after delivering the Silver Jubilee Lecture, 27.12.11



Pt. Buddhadev Das Gupta, the sarod maestro paying tribute to the Late National Prof. S. N. Bose, Bose Fest 2012



Prof. Graham R. Fleming delivering the 22nd S.N. Bose Memorial Lecture, 05.12.11



Prof. Sir Michael Berry delivering the 10th C K Majumdar Memorial Lecture, 09.03.12



International Conference on Statistical Physics and Non-linear Dynamics, 12.03.12 - 16.03.12

The S. N. Bose National Centre for Basic Sciences fosters, encourages and promotes the growth of advanced studies and original research in basic sciences. One of the important mandates of the Centre is to have a vigorous Programme that would enhance the scientific activities and expand the science base in the country. The Centre's Visitor's Programme and its associated activities are coordinated by the EVLP Office.

### Seminar & Colloquia Programme (SCOLP)

#### Memorial Lectures

##### **The 22nd S. N. Bose Memorial Lecture, 5 December 2011**

*Speaker:*

Professor Graham R. Fleming, FRS, NAS, FAAAS Vice Chancellor for Research, University of California, Berkeley, USA

*Topic:*

Grand Challenges in Energy: Supply, Demand and Consequences

*Abstract:*

The provision of sustainable energy is the defining problem of the 21<sup>st</sup> century. The energy "problem" is a set of inter-related technological, scientific, economic, environmental and sociological challenges. In this talk, I will discuss these challenges and illustrate some potential solutions by means of examples of specific programs at UC Berkeley and Lawrence Berkeley National Laboratory.

*About the Speaker:*

**Graham Fleming** currently serves as UC Berkeley's Vice Chancellor for Research, a position which he assumed in April 2009. Fleming served as the Deputy Director of Lawrence Berkeley National Laboratory from 2005 through 2007. Through joint appointments as Melvin Calvin Distinguished Professor of Chemistry

at UC Berkeley, and Founding Director of both the Berkeley Lab's Physical Biosciences Division and UC Berkeley's California Institute for Quantitative Biosciences (QB3), he has re-shaped the intersection of physical and biological sciences, while maintaining his own investigations into ultrafast chemical and biological processes, in particular, the primary steps of photosynthesis. Throughout his administrative career, Fleming has remained a highly active scientific researcher. He has authored or co-authored more than 400 publications, and is widely considered to be one of the world's foremost authorities on ultrafast processes. In addition to his many other activities, Fleming has given numerous talks around the world on the inter-relation and inter-complexity of energy, climate and photosynthesis. In 2007, Fleming led the effort (with co-chair Mark Ratner) to define Grand Challenges in Basic Energy Science for DOE/BES, resulting in "Directing Matter and Energy: Five Challenges for Science and the Imagination."

#### **The Satyendra Nath Bose National Centre for Basic Sciences, Kolkata organizes the S N Bose Memorial Lectures as a tribute to the Late National Professor Satyendra Nath Bose.**

##### **Silver Jubilee Lecture, 27 December 2011**

*Speaker:*

Professor Kip S. Thorne, The Feynman Professor of Theoretical Physics, Emeritus California Institute of Technology, Pasadena, USA

*Topic:*

The Warped Side of our Universe

*Abstract:*

There is a Warped Side to our Universe: objects and phenomena that are made from warped space and warped time, instead of from matter. Three examples are black holes, the big-bang in which our Universe was born, and ripples in the fabric of space-time called gravitational waves. Numerical simulations





using supercomputers are making surprising predictions about the Warped Side – for example, that when two black holes collide, they create six vortexes of twisting space attached to the merged black hole, and as these vortexes slosh and whirl, they emit gravitational waves. LIGO (the Laser Interferometer Gravitational-Wave Observatory) and its international partners, will soon open the gravitational-wave window onto our Universe, enabling humans for the first time to explore its Warped Side.

*About the Speaker:*

Born in Logan Utah in 1940, **Kip Thorne** received his B.S. degree from Caltech in 1962 and his Ph.D. from Princeton University in 1965. He returned to Caltech as an Associate professor in 1967 and became Professor of Theoretical Physics in 1970, The William R. Kenan, Jr., Professor in 1981, The Feynman Professor of Theoretical Physics in 1991, and The Feynman Professor of Theoretical Physics, Emeritus, in 2009. Thorne's research has focused on Einstein's general theory of relativity and on astrophysics, with emphasis on relativistic stars, black holes and especially gravitational waves. He was co-founder (with R. Weiss and R.W.P. Drever) of the LIGO (Laser Interferometer Gravitational Wave Observatory) Project, with which he is still associated. He is a member of the LISA (Laser Interferometer Space Antenna) International Science Team.

Thorne was elected to the American Academy of Arts and Sciences in 1972, the National Academy of Sciences in 1973, the Russian Academy of Sciences and the American Philosophical Society in 1999. He has been awarded the Lilienfeld Prize of the American Physical Society, the Karl Schwarzschild Medal of the German Astronomical Society, the Albert Einstein Medal of the Albert Einstein Society in Berne, Switzerland, the UNESCO Niels Bohr Gold Medal from UNESCO, the Common Wealth Award for Science, and was named California Scientist of the Year in 2004.

**The Satyendra Nath Bose National Centre for Basic Sciences organized this Lecture as part of the**

**Silver Jubilee Celebrations commemorating the creation of the Bose Centre in the year 1986**

**The 10th C.K Majumdar Memorial Lecture, 9 March 2012**

*Speaker:*

Sir Michael Berry, *Melville Wills Professor of Physics (Emeritus), University of Bristol, UK*

*Topic:*

Making Light of Mathematics

*Abstract:*

Many 'mathematical phenomena' find application and sometimes spectacular physical illustration in the physics of light. Concepts such as fractals, catastrophe theory, knots, infinity, zero, and even when  $1+1$  fails to equal 2, are needed to understand rainbows, twinkling starlight, sparkling seas, oriental magic mirrors, and simple observations on interference, polarization and focusing. The lecture is intellectual but nontechnical, and strongly visual.

*About the Speaker:*

**Sir Michael Berry** is a mathematical physicist at the University of Bristol, England.

He was elected a fellow of the Royal Society of London in 1982 and knighted in 1996. From 2006 he has been Editor of the journal, *Proceedings of the Royal Society*. He is famous among other things for the Berry phase, a phenomenon observed e.g. in quantum mechanics and optics. He specializes in semi-classical physics (asymptotic physics, quantum chaos), applied to wave phenomena in quantum mechanics and other areas such as optics. Berry has a BSc in physics from the University of Exeter and a PhD from the University of St. Andrews. Since then, he has spent his whole career at the University of Bristol: Research Fellow, 1965-7; Lecturer, 1967-74; Reader, 1974-78; Professor of Physics, 1978-88; Royal Society Research Professor since 1988.

**The C. K. Majumdar Memorial Lectures are organized by the Satyendra Nath Bose National Centre for Basic Sciences, Kolkata as a tribute to the late Professor Chanchal Kumar Majumdar, Founder-Director of the Centre.**

### **Bose Colloquium**

- Arup K. Raychaudhuri, Professor and Director - SNBNCBS, Kolkata, *Metal, Insulators and Oxides*, 16.09.2011
- B. M. Deb, Emeritus Professor- IISER Kolkata, *Form, Colour and Movement: Glimpses Into Western Abstract Art*, 02.11.2011
- Yashwant Singh, Emeritus Professor- BHU, Varanasi, *Phase Transition*, 18.11.2011
- Benoy Chakraverty, Emeritus Professor- C.N.R.S, Grenoble, France, *Is Brain Bose Condensed*, 17.02.2012
- Peter Leach, Professor - Department of Mathematics and Statistics, University of Cyprus, Lefkosia, *The Mechanics of Finance*, 19.03.2012
- Bikram Grewal, Author, trustee WPSI- *Wildlife of India: An Overview*, 23.03.2012

### **Special Lecture**

- Animesh Chakravorty, IACS, Kolkata, *The Times, Life and Work of Acharya Prafulla Chandra*, 23.09.2011

### **Institute Colloquium / Seminar**

- Supriya Chakraborty, IACS, Kolkata, *Transmission Electron Microscopy, Philosophy and Techniques*, 26.09.2011
- Sudhansu Sekhar Mandal, Professor- IACS, Kolkata, *Novel Collective Modes in Fractional Quantum Hall Effect*, 30.09.2011
- Anunay Samanta, Professor - School of Chemistry, University of Hyderabad, *Photophysical Response of Molecular Systems in Room Temperature Ionic Liquids*, 14.10.2011
- Tanusri Saha-Dasgupta, Professor- SNBNCBS, Kolkata, *Correlation effects in Real Material*, 21.10.2011
- Charusita Chakrabarty, Professor -Department of

Chemistry, IIT Delhi, *Structure, Entropy and Mobility Relationships in Liquids*, 25.11.2011

- Aaron Lewis, CEO-Naninics Imaging Limited, *Evolution in SPM Technology*, 15.11.2011
- Srinivas Sridhar, Arts and Sciences Distinguished Professor of Physics, Director, IGERT Nanomedicine Science and Technology NCI/NSF Program, Director, Electronic Materials Research Institute, Northeastern University, Visiting Professor of Radiation Oncology at Harvard Medical School, *Controlling Light with Nanoscale Negative Metamaterials*, 12.12.2011
- Dipak K. Palit, Radiation & Photochemistry Division, Bhabha Atomic Research Centre, Mumbai, *Ultrafast Dynamics of the Excited States using Time-Resolved Absorption Spectroscopy*, 13.01.12
- Kasturi Saha, Department of Physics, Cornell University, *Frequency Comb Generation in Silicon-Nitride Resonators on-Chip*, 16.01.2012
- Pinaki Chaudhuri, Theoretical Soft Matter Group, University of Dueseldorf, Germany, *Inhomogeneous Shear Flow of Soft Jammed Materials*, 18.01.2012
- Basudev Lahiri, Center for Nanoscale Science and Technology, National Institute of Standards and Technology (NIST) Gaithersburg MD, USA, *Bio-sensing using split ring resonators*, 24.01.12
- A. S Majumdar, Professor – Astrophysics and Cosmology, SNBNCBS, *The Accelerating Universe: Challenges in Theory and Observations*, 03.02.12
- S. Dutta Gupta, Professor - School of Physics, University of Hyderabad, *Critical coupling to anti-lasers*, 24.02.2012
- Manish K. Niranjana, Department of Physics, IIT Hyderabad, *Novel Interface Magnetolectric Effects in Oxide Heterostructures: Design and predictions from first-principles*, 05.03.2012



- Sourish Basu, SRON Netherlands-Institute of Space Research, *Estimating the sources and sinks of CO2: How can Earth -monitoring satellites help?*, 06.03.2012
- R. Srikanth, PPISR, Bangalore, *The Born Rule, frequency operator and the infinite limit*, 15.03.12
- P.K. Mukhopadhyay, Head - Condensed Matter Physics and Material Sciences, SNBNCBS, Kolkata, *Discovery of a New Opto-Magnetic Mechanical Effect in a Ferro Magnetic Shape Memory Alloy*, 27.03.2012

### Bose Fest 2012

Bose Fest 2012 showcased the spirit of creativity and science through a 3-day long festival held within the Centre's premises from January 30 to February 1, 2012.

- Inaugurated by Prof. A.K Raychaudhuri, Director at the Silver Jubilee Hall
- Special welcome session dedicated to talks delivered by new faculty members
- 57 talks and 50 posters were placed across six sessions
- External judges chaired and judged the oral and poster presentations
- Tagore's *Chitrangada* and *Ghare-Baire* was staged by in-house members
- An evening was devoted to classical ragas as a tribute to Prof. S. N. Bose and his deeply felt passion for Indian classical music. The legendary sarod maestro Pandit Buddhadev Dasgupta and the young exponent of Tagore Classical music Shri Sounak Chattopadhyay was invited to perform at the Centre
- Family dinner was hosted at the SNBNCBS lawn
- "PHOTO FEST", the first ever photography exhibition at BOSE FEST. More than 55 collages which had more than 100 prints from students, faculty, and staff from the Centre were exhibited at the SNBNCBS lawn
- The curtains fell with the Prize distribution ceremony for the best oral & poster presentations

### Visitor, Associates and Student's Programme (VASP)

#### Distinguished Lecture Series

David Cox, Professor, Advanced Technology Institute, Faculty of Engineering and Physical Sciences, University of Surrey UK, *Focussed Ion Beam, Nanofabrication and Nanomanipulation*, 06.02.12 – 09.02.12

#### Associates & Short Term Visitors

- Goutam Mukherjee, Reader in Physics, Bidhan Chandra College, Asansol, West Bengal visited Professor S.S. Manna, 13.10.11- 01.11.11
- Pradip Mukherjee, Reader, Department of Physics, Presidency University, Kolkata visited Professor Rabin Banerjee & Dr. Biswajit Chakrabarty, 21.10.11- 04.11.11
- Nilotpal Ghosh, Assistant Professor (Senior), Vellore Institute of Technology, Tamilnadu visited Professor A. K. Raychaudhuri, 19.12.11-29.12.11
- Indranil Chattopadhyay, Aryabhata Research Institute for Observational Sciences, Nainital visited Professor Sandip K Chakrabarti, 13. 02.12 - 24.02.12
- Kuldeep Kumar, Assistant Professor, Department of Physics, Punjab University, Chandigarh visited Professor Rabin Banerjee, 11.12.11- 06.01.12
- Raju Roychowdhury, Post Doctoral Research Associate, Center for Quantum Spacetime, Sogang University, Seoul, South Korea visited Professor Rabin Banerjee, 02.12.11- 01.02.12
- Sunandan Gangopadhyay, Lecturer, West Bengal State University, Barasat – visited Professor Rabin Banerjee, 04.07.11 -15.07.11

### Conference, Workshop & Extension Programme (CWEP)

- *Workshop on the Role of Small Telescopes in Modern Astronomy Research*  
Convenor: Soumen Mandal, Department of Astrophysics and Cosmology, 07.11.11- 08.11.11
- *Summer School 2011*  
Convenor: Saikat Ghosh, Department of Condensed Matter Physics and Material Sciences, 23.06.11-24.06.11
- *Advanced School on High Resolution X-Ray Techniques, Atomic Force Microscopy and their Applications*  
Convenor - Barnali Ghosh Saha, Department of Condensed Matter Physics and Material Sciences, 14.12.11 – 15.12.11
- *Conference on Advanced and Functional Materials*  
Convenors - P.K. Mukhopadhyay, Department of Condensed Matter Physics and Material Sciences & S. Banerjee, SINP, 01.03.12 - 02.03.12

- *International Conference on Statistical Physics and Nonlinear Dynamics*

Convenors - Partha Guha, Department of Theoretical Sciences & Priya Mahadevan, Department of Condensed Matter Physics and Material Sciences, 12.03.12 - 16.03.12

### Advanced Post-Doctoral Manpower Programme (APMP)

#### Post Doctoral Research Associates

- Madhuparna Karmakar, Department of Theoretical Sciences, Mentor: Dr. Partha Guha, 01.11.2011
- Ramkrishna Das, Department of Astrophysics and Cosmology, Mentor: Dr. Soumen Mandal, 04.11.2011
- Sharvari Nadkarni Ghosh, Department of Theoretical Sciences, Mentor: Dr. Jayanta Kr. Bhattacharjee, 01.02.2012
- Rabindranath Gayen, Department of Condensed Matter Physics and Material Sciences, Mentor: Dr. Anjan Barman, 09.03.2012



**Debashree Bhattacharyya**  
Co-ordinator, EVLP



# S. N. Bose Silver Jubilee Lecture



# Theoretical Physics Seminar Circuit

## WORKSHOPS FUNDED

### Topical Research School (TRS)

C K Majumdar Memorial Summer Workshop 2011 – June 6 - 15, 2011; Jointly organized by Indian Association of Physics Teachers (RC 15) and S N Bose National Centre for Basic Sciences; Venue: SNBNCBS; Fund supported: 1.0 L

### Advance Research Workshop (ARW)

- Scientific meeting entitled “International Conference on Laser, Material Science & Communication” – December 7 - 9, 2011; Organized by Burdwan University, Physics Department; Venue: Bardhaman; Fund supported: 2.0 L
- Scientific meeting entitled “2nd International Symposium on Complex Dynamical Systems & Applications, Presidency University” - January 9 -11, 2012; Organized by Presidency University, Physics Department; Venue: University Campus, Kolkata; Fund supported: 2.0 L
- Scientific meeting entitled “Structure and Dynamics of Trapped Quantum Gases” - February 2 -4, 2012; Organized by Punjab University, Physics Department; Venue: Chandigarh; Fund supported: 2.0 L
- National Workshop on “Physics of Quantum and Nano Systems” - March 27 - 29, 2012; Organized by Vidyasagar University, Physics Department; Venue: Jhargram, Midnapore; Fund supported: 2.0 L

## VISITS AND SEMINARS

- Professor Subhasish Dutta Gupta, School of Physics, University of Hyderabad, June 23 – 26, 2011; Seminar title: *Goos-Hanschen Effect*.
- Dr. Navin Chandra, Assistant Professor, Vinoba Bhave University, Hazaribag, Jharkhand, November

1 - 3, 2011; Seminar title: *Electrostatics and Salt-Effects of Protein-Nucleic Acid Interaction*.

- Professor Mukunda P Das, Department of Theoretical Physics, Australian National University, Canberra, December 5 - 12, 2011; Seminar title: *Superconductivity: Centenary Year of its Discovery*.
- Professor N. D. Hari Dass, Chennai Mathematical Institute, December 12 -18 and December 22 – 24, 2011; Seminar title: *The OPERA Experiment and Superluminal Neutrinos*.
- Dr. Mousumi Upadhyay Kahaly, Postdoctoral Researcher, Physical Sciences and Engineering Division, King Abdullah University of Science and Technology (KAUST), December 23- 24, 2011; Seminar title: *Carbon Nanotubes with special type of stable defect line: Truly 1D transport*.
- Professor Fernando Vega Redondo, European University Institute, Florence, Italy, January 11- 13, 2012; Seminar title: *Social networks and the process of globalization*.
- Professor Andres F. Reyes Lega, Profesor Asociado Departamento de Fisica Universidad de los Andes Carrera, Bogota, Colombia, January 25 – 31, 2012; Seminar title: *Noncommutative Geometry-inspired approach to topological issues in quantum mechanics*.
- Professor Masud Chaichian, Helsinki University, Finland, January 27 to February 3, 2012; Seminar title: *CPT and Lorentz invariance, their relation and violation*.
- Dr. Anca Tureanu, Helsinki University, Finland, January 27 to February 3, 2012; Seminar title: *Noncommutative Quantum Field Theory, Symmetry and Dynamics*.
- Dr. Rajesh Gopal, Post Doctoral Fellow, Indian Institute of Astrophysics, Bangalore, February 14 - 18, 2012; Seminar title: *Magnetic fields in cosmology: Origin and effects*.



**Sugata Mukherjee**

Convener, Theoretical Physics Seminar Circuit

# Registrar



*Ranjan Chaudhury*

## **REPORT ON ADMINISTRATIVE MATTERS**

The administrative and technical staff members of the Centre have very professionally and sincerely carried out their duties for making the various activities of the Centre during 2011-2012 successful. Staff comprising of strength of approximately 22 in permanent, 13 in temporary and 51 in contractual category as on 31<sup>st</sup> March 2012, 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, security, EPABX, transport, cafeteria, electrical maintenance, AC maintenance, etc. has been made possible due to the professional services provided by the various services contract agencies working closely with the administrative departments of the Centre. The Centre has tried to enhance the capabilities of its administrative employees by encouraging them to attend various training programmes and workshops all through the year. The Centre for the first time organised an in-house Training Programme for Administrative Staff members jointly with IISWBM on "Behavioural Skill". The training programme was highly successful and certificates of participation were handed over to 48 number of participants. The Centre has maintained a close communication with the Department of Science and Technology by replying to their various enquiries and

answering Parliamentary Questions. The Hindi Cell of the Centre has been functioning effectively from April 2008 and substantial work has been undertaken regarding implementation of the Official Language. No cases related to vigilance and Complaints Committee has been reported during the period of 2011-2012. The Centre has also adhered to the norms of the Right to Information Act and so far has received five cases under the said Act in the last financial year all of which has been successfully disposed off.

## **WELFARE MEASURES AND LANGUAGE POLICY**

### **Official Language Policy**

The Centre paid emphasis on implementation of the Official Language in the year 2011-12. According to Rajbhasha Act, reply to Hindi letters was given in Hindi only. All the Official Registers, Forms, Visiting Cards and Letter heads are in bilingual format. Advertisements, tender notices, office orders and notices are circulated in Hindi also. Many of the internal noting and signing in the Attendance Register (on the first of every month) is done in Hindi. The Centre is a member of Calcutta Town Official Language Implementation Committee (CALTOLIC). The Centre has a Hindi Implementation Committee which meets regularly under the Chairmanship of Director. Almost 100% of the administrative staff now possess working knowledge of Hindi and have been

successfully trained/undergoing training in the 'Praveen' and 'Pragya' courses of the Department of Official Language, Government of India.

The newsletter of the Centre, published quarterly, contains at least one article in Hindi. 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.

### **Welfare Measure**

The Centre has its Contributory Medical Scheme (CMS) under which bills for both outdoor and indoor facilities are reimbursed for the staff and their dependents and students as per CGHS rates. The Centre has its own medical unit for catering to its staff members. Three doctors of different discipline viz. Allopathic, Homeopath and Ayurvedic are available for regular consultation in the medical unit

and provide free consultation. Facilities like oxygen, wheel chair, stretcher, rest bed are readily available. The Centre also has tie ups with some of the renowned hospitals in Kolkata who provide cash less indoor hospitalisation facility under CGHS Scheme to the employees and its family.

The Centre has a Crèche by the name of 'Kishlay' for the children of staff and students of the Centre.

The Centre has a modern Guest House comprising of 39 rooms and a fully AC Dining Hall and Kitchen with modern facilities, an ATM and Seminar room.

I would like to express my sincere thanks to the three Deputy Registrars of Administration, Finance and Accounts and Academic sections and to all administrative and academic staff members for their kind cooperation and help for smooth running of the Centre. I am also thankful to the Director for his valuable guidance and advice.



**Ranjan Chaudhury**  
Acting Registrar





# Committees

## GOVERNING BODY

**Dr. T. Ramasami** *Chairman*

Secretary, Department of Science & Technology  
Government of India, New Delhi

**Prof. G. K. Mehta** *Member*

Dist. Hon. Prof. IIT Kanpur & Hon. Eminent Scientist  
Inter University Accelerator Centre, New Delhi

**Prof. T. V. Ramakrishnan** *Member*

DAE Homi Bhabha Professor  
Banaras Hindu University, Varanasi

**Prof. Mustansir Barma** *Member*

Director, Tata Institute of Fundamental Research  
Mumbai

**Ms Anuradha Mitra** *Member*

Joint Secretary & Financial Adviser  
Department of Science & Technology, New Delhi

**Prof. Arup Kumar Raychaudhuri** *Member*

Director, S. N. Bose National Centre for Basic Sciences  
Kolkata

**Shri Samar Ghosh**, IAS *Member*

Chief Secretary, Government of West Bengal  
Kolkata

**Prof. Sibaji Raha** *Permanent Invitee*

Director, Bose Institute, Kolkata

**Prof. Kankan Bhattacharya** *Permanent Invitee*

Director, Indian Association for the Cultivation of  
Science, Kolkata

**Dr. Ranjan Chaudhury** *Non-Member Secretary*

Acting Registrar, S. N. Bose National Centre for Basic  
Sciences, Kolkata

## FINANCE COMMITTEE

**Prof. Arup Kumar Raychaudhuri** *Chairman*

Director, S. N. Bose National Centre for Basic Sciences  
Kolkata

**Prof. Sibaji Raha** *Member*

Director, Bose Institute, Kolkata

**Dr. Praveen Chaddah** *Member*

Director, UGC-DAE Consortium for Scientific Research  
Indore

**Ms Anuradha Mitra** *Member*

Joint Secretary & Financial Adviser  
Department of Science & Technology, New Delhi

**Dr. Ranjan Chaudhury** *Member Secretary*

Acting Registrar, S. N. Bose National Centre for Basic  
Sciences, Kolkata

## ACADEMIC AND RESEARCH PROGRAMME ADVISORY COMMITTEE

**Prof. V. S. Ramamurthy** *Chairman*

NIAS, Bangalore

**Prof. Dipankar Das Sarma** *Member*

IISc, Bangalore

**Prof. Naresh Kumar Dadhich** *Member*

IUCAA, Pune

**Prof. Deepak Dhar** *Member*

TIFR, Mumbai

**Prof. Siddhartha Roy** *Member*

IICB, Kolkata

**Prof. Arup Kumar Raychaudhuri** *Member*

Director, S. N. Bose National Centre  
for Basic Sciences, Kolkata

**Prof. Sandip Kumar Chakrabarti** *Member*

Dean (Academic Programme)  
S. N. Bose National Centre for Basic Sciences  
Kolkata

## BUILDING COMMITTEE

**Prof. Arup Kumar Raychaudhuri** *Chairman*  
Director, S. N. Bose National Centre for Basic Sciences

**Dr. Ranjan Chaudhury** *Member-Secretary*  
Acting Registrar, S. N. Bose National Centre for Basic Sciences

**Mr. Asim Sinha** *Member*  
Chief Engineer (Retired) Electrical, CPWD

**Prof. Sibabrata Halder** *Member*  
Head, Department of Architecture  
Bengal Engineering and Science University, Sibpur

**Shri Ranadhir Dey** *Member*  
Outstanding Scientist, VECC

**Mr. Jnanda Ranjan Bhattacharya** *Special Invitee*  
Superintending Engineer  
S. N. Bose National Centre for Basic Sciences

**Mr. Apurba Kanti Sarkar** *Special Invitee*  
Deputy Registrar (Finance)  
S. N. Bose National Centre for Basic Sciences

## CONSULTATIVE ADVISORY COMMITTEE

**Prof. Arup Kumar Raychaudhuri** *Chairman*  
Director, S. N. Bose National Centre for Basic Sciences

**Prof. Jayanta Kumar Bhattacharjee** *Member*  
Dean (Faculty), S. N. Bose National Centre for Basic Sciences

**Prof. Sandip Kumar Chakrabarti** *Member*  
Dean (Academic Programme) &  
Head, Department of Astrophysics and Cosmology  
S. N. Bose National Centre for Basic Sciences

**Prof. Rabin Banerjee** *Member*  
Head, Department of Theoretical Sciences  
S. N. Bose National Centre for Basic Sciences

**Dr. Gautam Gangopadhyay** *Member*  
Head, Department of Chemical, Biological and  
Macromolecular Sciences  
S. N. Bose National Centre for Basic Sciences

**Dr. Pratip Kumar Mukhopadhyay** *Member*  
Head, Department of Condensed Matter Physics and  
Material Sciences  
S. N. Bose National Centre for Basic Sciences

**Dr. Ranjan Chaudhury** *Member*  
Acting Registrar, S. N. Bose National Centre for Basic  
Sciences

**Mr. Apurba Kanti Sarkar** *Member*  
Deputy Registrar (Finance)  
S. N. Bose National Centre for Basic Sciences

**Ms. Shohini Majumder** *Member*  
Deputy Registrar (Administration)  
S. N. Bose National Centre for Basic Sciences

**Mr. Sunish Kumar Deb** *Member - Secretary*  
Deputy Registrar (Academic)  
S. N. Bose National Centre for Basic Sciences

## OFFICIAL LANGUAGE IMPLEMENTATION COMMITTEE

**Prof. Arup Kumar Raychaudhuri** *Chairman*  
Director

**Dr. Ranjan Chaudhury** *Member*  
Acting Registrar

**Dr. Manu Mathur** *Member*  
Associate Professor

**Mr. Apurba Kanti Sarkar** *Member*  
Deputy Registrar (Finance)

**Ms. Shohini Majumder** *Member*  
Deputy Registrar (Administration)

**Dr. Chhayabrita Biswas** *Member*  
Bose Fellow

**Mr. Sirsendu Ghosh** *Member*  
In-charge, Hindi Cell

**Mr. Santosh Kumar Singh** *Member*  
AR (Purchase)

**Ms. Sushmita Dasgupta** *Member*  
Part-time Hindi Officer





# *People at the Centre*



# Academic Members



## FACULTY MEMBERS

1	Arup Kumar Raychaudhuri	Senior Professor, CMPMS & Director
2	Amitabha Lahiri	Professor, TS & Associate Dean (IPhd Prog.)
3	Anita Mehta	Professor, TS
4	Anjan Barman	Associate Professor, CMPMS
5	Archan S. Majumdar	Professor, A&C
6	Biswajit Chakraborty	Associate Professor, TS & Associate Dean (Phd Prog.)
7	Debashis Gangopadhyay	Associate Professor, A&C
8	Goutam Gangopadhyay	Associate Professor & HOD, CBMS
9	J. K. Bhattacharjee	Distinguished Professor, TS
10	Jaydeb Chakrabarti	Associate Professor, CBMS
11	Kalyan Mandal	Professor, CMPMS
12	Manik Pradhan	Assistant Professor, CBMS
13	Manu Mathur	Professor, TS
14	M. Sanjay Kumar	Associate Professor, TS
15	Partha Guha	Associate Professor, TS
16	Pratip Kr. Mukhopadhyay	Associate Professor & HOD, CMPMS
17	Priya Mahadevan	Associate Professor, CMPMS
18	Prosenjit Singha Deo	Professor, CBMS
19	Punyabrata Pradhan	Assistant Professor, TS
20	Rabin Banerjee	Senior Professor & HOD, TS & Dean (Faculty)
21	Rajib Kumar Mitra	Assistant Professor, CBMS
22	Ranjan Chaudhury	Associate Professor, CMPMS
23	Ranjit Biswas	Associate Professor, CBMS
24	Saikat Ghosh	Assistant Professor, CMPMS
25	Sakuntala Chatterjee	Assistant Professor, TS
26	Samir K. Pal	Associate Professor, CBMS
27	Samir K Paul	Associate Professor, TS & Coordinator (Admission & Project Research)
28	Sandip K. Chakrabarti	Senior Professor & HOD, A&C and Dean (AP)
29	Soumen Mondal	Assistant Professor, A&C
30	Subhrangshu Sekhar Manna	Senior Professor & HOD, TS
31	Sugata Mukherjee	Associate Professor, CMPMS
32	Tanusri Saha Dasgupta	Professor, CMPMS

### EMERITUS PROFESSOR

1	Abhijit Mookerjee	CMPMS
2	S. K. Sharma	TS

### SENIOR VISITING SCIENTIST

1	A. K. Mallik	TS
2	B. B. Bhattacharya	TS

### RESEARCH SCIENTIST

1	Barnali Ghosh	CMPMS
2	Mahua Ghosh	CBMS

### BOSE FELLOW

1	Chhayabrita Biswas	CMPMS
2	Kinsuk Acharyya	A & C

### SCIENTIST-D

1	Kaustuv Das	CMPMS
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### SCIENTIST-C

1	Sudeshna Samanta	CMPMS
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### VISITING FACULTY FELLOW

1	Madhuri Mandal	CMPMS
2	Saswati Barman	CMPMS

### VISITING READER

1	Mithun Kumar Mitra	CBMS
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### VISITING RESEARCHER

1	Mukul Kabir	CMPMS
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### SABBATICAL VISITOR

1	Tapas Kumar Das	TS
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### POST DOCTORAL RESEARCH ASSOCIATE

1	B. Rajini Kanth	CMPMS
2	Priya Rajdev	CMPMS
3	Sanjay Gupta	CBMS
4	Bipul Rakshit	CMPMS
5	Tae Hun Lee	TS
6	Siddhartha Sinha	A&C
7	Jaita Banerjee	CMPMS
8	Prasad Basu	TS
9	Soumendu Datta	CMPMS
10	Gobinda Gopal Khan	CMPMS
11	Madhuparna Karmakar	TS
12	Jayee Bhattacharya	CMPMS
13	Ponraj Sabareesan	CMPMS
14	Sharvari Nadkarni Ghosh	TS
15	Gaurang Yashwant Mahajan	TS
16	Feroz Ahmad Mir	CMPMS
17	Ganapati Natarajan	CMPMS
18	Arya Paul	CMPMS
19	Ramkrishna Das	A&C
20	Rabindranath Gayen	CMPMS
21	Subhra Sen Gupta	CMPMS
22	Pinaki Laha	CMPMS



# Administrative And Technical Staff Members

1	Ranjan Chaudhury	Acting Registrar
2	Apurba Kanti Sarkar	Deputy Registrar(Finance)
3	Shohini Majumder	Deputy Registrar(Administration)
4	Sunish Kumar Deb	Deputy Registrar (Academic)
5	Avijit Ganguly	Campus Engineer cum Estate Officer
6	Saumen Adhikari	Librarian cum Information Officer
7	Sukanta Mukherjee	Assistant Registrar (Projects)
8	Santosh Kumar Singh	Assistant Registrar (Purchase)
9	Sirsendu Ghosh	Programme Coordinating Officer
10	Tapan Kumar Sen	Senior Programme Assistant
11	Jaydeep Kar	Programme Assistant
12	Prosenjit Talukdar	Programme Assistant
13	Shiba Prasad Nayak	Pump Operator
14	Bijoy Kumar Pramanik	Junior Assistant (Guest House)
15	Aditya Pal Choudhury	Project Assistant
16	Bhupati Naskar	Library Stack Assistant
17	Arun Kumar Bhattacharya	Library Stack Attendant
18	Sushanta Kumar Biswas	Driver
19	Pradip Kumar Bose	Tradesman 'A'
20	Partha Chakraborty	Attendant
21	Partha Mitra	Attendant
22	Ratan Acharya	Attendant
23	Swapan Ghosh	Attendant

**Rabin Banerjee**  
**Saumen Adhikari**

**Vigilance Officer**  
**Public Information Officer**

## PERSONNEL WITH TEMPORARY STATUS

1	Biman Roy	Attendant (Administration)
2	Dulal Chatterjee	Attendant (Maintenance)
3	Somnath Roy	Attendant (Accounts)
4	Sudhanshu Chakraborty	Attendant (Technical Cell)
5	Sukamal Das	Attendant (Central Registry)
6	Hiralal Das	Cleaner
7	Kartick Das	Cleaner
8	Motilal Das	Cleaner
9	Prakash Das	Cleaner
10	Ramchandra Das	Cleaner
11	Biswanath Das	Gardener
12	Nimai Naskar	Gardener
13	Rabi Orai	Gardener

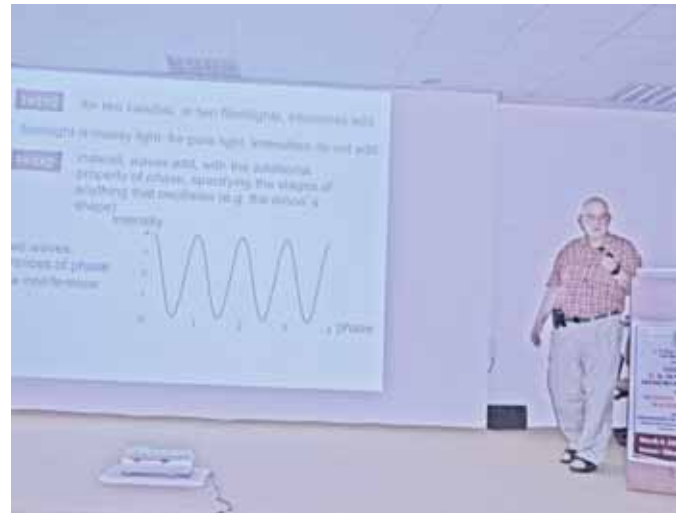
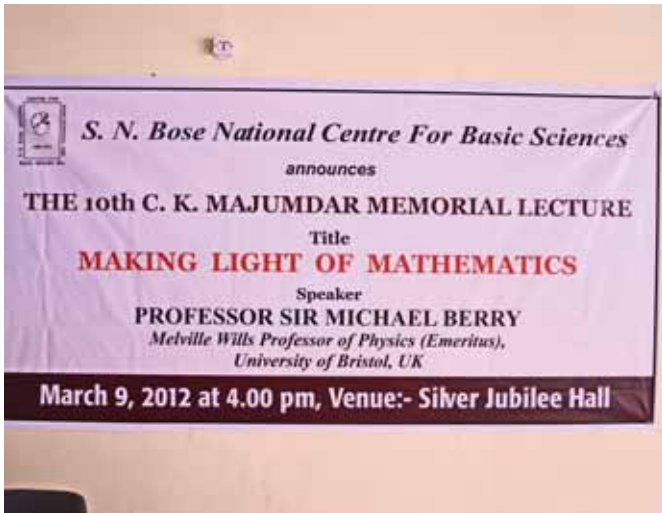
## PERSONNEL ON CONTRACTUAL APPOINTMENT

1	Sukumar Sarkar	Consultant (Administration)
2	Jnanada Ranjan Bhattacharya	Superintending Engineer
3	Dr. Swapan Kumar Bhattacharyya	Authorized Medical Officer
4	Dr. Trideb Kumar Sarkar	Doctor of Homeopathy
5	Dr. Gopal Chandra Sengupta	Doctor of Ayurvedic
6	Sougata Bhattacharyya	Facilitation Officer
7	Sushmita Dasgupta	Hindi Officer (Part-time)
8	Achyut Saha	PS to Director
9	Mahua Mitra	Executive Assistant (Admin.)
10	Sanjay Sarkar	Senior Computer Engineer
11	Sudeep Narayan Banerjee	Senior Computer Engineer
12	Abhijit Roy	Junior Computer Engineer
13	Banajyotsna Chattopadhyay	Junior Computer Engineer
14	Gurudas Ghosh	Technical Assistant (Library)
15	Amit Roy	Technical Assistant (Library)
16	Ananya Sarkar	Technical Assistant (Library)
17	Dipankar Roy	Technical Assistant
18	Indrajit Chatterjee	Technical Assistant
19	Piyali Bose	Technical Assistant
20	Shakti Nath Das	Technical Assistant
21	Surajit Mukherjee	Technical Assistant
22	Urmi Chakraborty	Technical Assistant
23	Ganesh Gupta	Jr. Engg (Electrical)
24	Supriyo Ganguly	Jr. Engg (Electrical)
25	Falguni Dutta	Jr. Engg (Civil)
26	Laxmi Sanpui	Jr. Engg (Civil)
27	Abu Torab Bin Aman	Office Assistant
28	Ayan Paul	Office Assistant
29	Swarup Dutta	Office Assistant
30	Indrani Laha	Office Assistant
31	Mitali Nanyasi (Bose)	Office Assistant
32	Subhodeep Mukherjee	Office Assistant
33	Sutapa Basu	Office Assistant
34	Suwendu Datta	Office Assistant
35	Dipanjan Dey	Office Assistant
36	Ritomoy Bhattacharya	Office Assistant
37	Chandrakana Chatterjee	Office Assistant
38	Tamosa Chary	Office Assistant
39	Moumita Bhattacharya	Office Assistant
40	Lina Mukherjee	Junior Office Assistant
41	Debashish Mitra	Telephone Operator
42	Siddhartha Chatterjee	Telephone Operator
43	Jinia Deb	Telephone Operator
44	Abhijit Mishra	Mechanic
45	Amit Kumar Ghosh	Mechanic
46	Harishikesh Nandi	Glass Blower (Part-time)
47	Gobinda Das	Driver
48	Arvind Paswan	Driver
49	Suranjan Deb	Telephone Technician
50	Kalyani Ghosh	Caretaker (Creche)





# 10th C K Majumdar Memorial Lecture



# The 22nd S. N. Bose Memorial Lecture



# Bose Fest



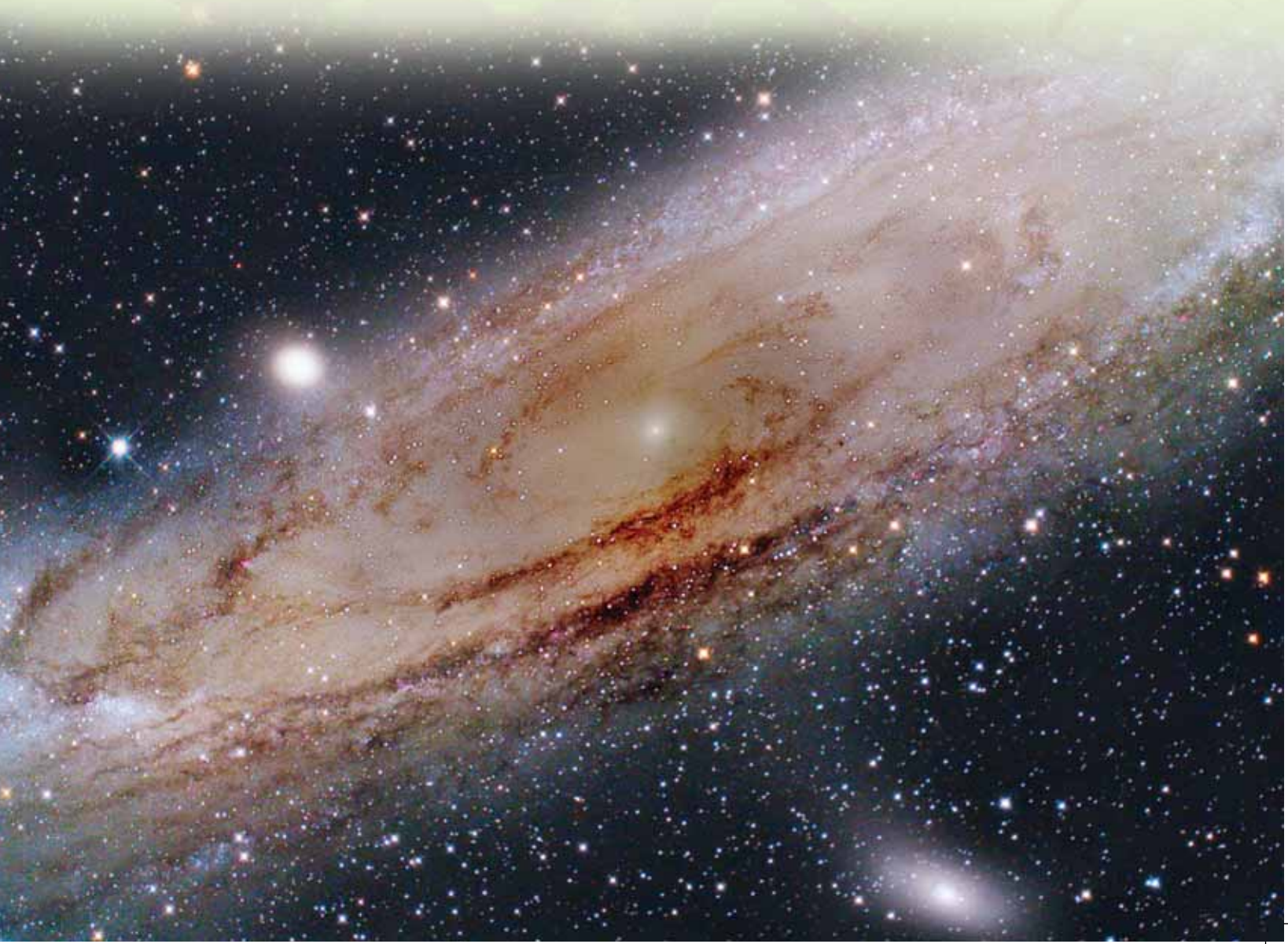
# The Photo Fest



The Photo fest, the very first photo exhibition in S. N. Bose Centre was jointly organized by the Bosonic Students' Society for Academics and Recreation (BOSSAR) and S. N. Bose Centre during the Bose Fest 2012. The contributions came from all ends, including the students, administrative staff and faculty members. The best photographs were chosen based on the viewer and judges votes. The photograph by Dr. Chhayabrita Biswas took over the lead, while that of Tamal Basak won in the Editor's pick category. The applause from every corner, with inspiration from the Director and the Bose Fest Convenor, Dr. Saikat Ghosh, lead the Photo Fest committee to prepare a Photo archive (Presently placed at the SNB Library), including its digital version. The carnival ended with a new promise to arrange such exhibition again.



*Department of*  
**Astrophysics & Cosmology**





Department of

# Astrophysics & Cosmology

**E**xtraordinary progress has been made in the activities of the Department in the academic year 2011-2012. Dr. Soumen Mondal and Dr. Ramkrishna Das joined the group as a faculty and as a Post-Doctoral fellow respectively. Both of them being optical/infra-red astronomers, the group is now ready to launch an optical astronomy programme. They will especially focus to search for extra-solar planets using transit method, photometric variability in star-forming regions and star-clusters, late M-giants and Mira variables, atmosphere of brown dwarfs, small solar system objects and optical/Near-IR Astronomical instrumentation. Preparations are being made to install a meter class telescope in the area. The department has three faculty members, one Bose Fellow, two post-doctoral fellows and twenty two PhD scholars. One faculty member Dr. Debashis Gangopadhyay resigned from the Centre.

In the field of astrochemistry and astrobiology, significant progresses in both the theoretical and the experimental fronts have been made. Formation of simple and complex molecules have been studied on grain surfaces using both the physisorption and chemisorption. Effects of grain size was also taken into account. A laboratory is being built to simulate chemical reactions which take place in the interstellar medium and the star forming region. These works are done by Dr. K. Acharyya.

In black hole astrophysics, the effects of cooling and viscosity on the accretion disk structure around a black hole are studied using coupled numerical simulation code and Monte Carlo code. The ionospheric perturbations due to solar flares and eclipse are modeled. Significant results have been obtained in computation of the reaction rates important for producing pre-biotic molecules in interstellar space. Balloon borne studies in X-rays/gamma-rays at an altitude of 40km have been made in collaboration with the Indian Centre for Space Physics. These works are done by Prof. S. K. Chakrabarti.

In Cosmology, the effects of the event horizon on cosmological back reactions are explored. In the problem of teleportation, the existence of hermitian witness operator has been demonstrated. A scheme has been formulated to test the non-locality of single photon states. These works are done by Prof. A. S. Majumdar.

Nineteen papers have been published in refereed journals in this year. One conference on the "Role of Small Telescopes in Modern Astronomy" and a discussion meeting on "Quantum Mechanics" were organized by the members of the department. One DST sponsored project by Prof. Majumdar, one ISRO/RESPOND sponsored project of Prof. Chakrabarti, one DST sponsored Fast Track Young Scientist scheme sponsored project of Dr. K. Acharyya are running at the Centre. Faculties and The Bose fellow participated in teaching several courses.

An edited volume on "75 Years of Quantum Entanglement: foundations and information theoretic applications" has been published by AIP which is co-authored by Prof. Majumdar.

## DEPARTMENTAL STATISTICS

Total number of faculties	3
Bose Fellow	1
Post-Doctoral Research Fellow	2
Ph. D. Students	22
Publications in journals only	20
Talks delivered by faculties/ post docs and students	23
External Projects	3



**Sandip Kumar Chakrabarti**

Head, Department of Astrophysics and Cosmology

- **Cosmology**: Back-reaction due to inhomogeneities and dark energy of the universe
- **Quantum information science**: Entanglement witness operator for quantum teleportation; Leggett model of crypto-nonlocality; fine-grained quantum uncertainty principle

Archan Subhra Majumdar  
Professor



We explore the effects of the event horizon on cosmological backreaction due to inhomogeneities in the universe. Beginning from the onset of the present accelerating era, we show that backreaction in presence of the event horizon causes acceleration to slow down in the subsequent evolution. Transition to another decelerating era could ensue eventually at a future epoch, ensuring avoidance of a big rip. We study the evolution of a non-Gaussian wave packet in the gravitational field and show the violation of the weak equivalence principle in quantum mechanics.

We demonstrate the existence of hermitian witness operators required for distinguishing states useful for performing quantum teleportation. We present an example of such a witness operator illustrating it for different classes of states, and show that its determination for an unknown state requires a much

lesser number of measurements compared to state tomography. We study quantum teleportation with the resource of non-orthogonal qubit states, presenting a comparison of the loss of teleportation fidelity with that of noisy channels.

We formulate a scheme for testing nonlocality of single photon states by using the set-up of spatially separated cavities. We remove the restriction on geometrical constraints for demonstrating the violation of Leggett-type nonlocal realist inequalities, enabling a clearer demonstration of quantum mechanical violation of such inequalities. We extend the fine-grained uncertainty principle to the case of tripartite systems. We show that a particular form of a local realist inequality is able to discriminate between classical physics, quantum physics and super-quantum correlations using the fine-grained uncertainty relation.

### PUBLICATIONS IN JOURNALS

1. N. Bose and A. S. Majumdar, *Future deceleration due to effect of event horizon on cosmic backreaction*, Mon. Not. R. Astron. Soc. Letters, 2011, **418**, L45
2. A. Rai, D. Home and A. S. Majumdar, *Leggett type nonlocal realist inequalities without any constraints on the geometrical alignment of measurement settings*, Phys. Rev. A, 2011, **84**, 052115
3. N. Ganguly, S. Adhikari, A. S. Majumdar, J. Chatterjee, *Entanglement witness operator for quantum teleportation*, Phys. Rev. Lett., 2011, **107**, 270501
4. T. Pramanik, S. Adhikari, A. S. Majumdar, D. Home, *Testing nonlocality of single photons in cavities*, Phys. Lett. A, 2012, **376**, 344
5. T. Pramanik and A. S. Majumdar, *Fine-grained uncertainty relation and nonlocality of tripartite*

*systems*, Phys. Rev. A, 2012, **85**, 024103

6. S. Adhikari, A. S. Majumdar, D. Home, A. K. Pan, P. Joshi, *Quantum teleportation using non-orthogonal entangled channels*, Phys. Scr., 2012, **85**, 045001
7. P. Chowdhury, D. Home, A. S. Majumdar, S. V. Mousavi, M. R. Mozaffari, S. Sinha, *Strong quantum violation of the gravitational weak equivalence principle by a non-Gaussian wave packet*, Class. Quant. Grav., 2012, **29**, 025010

### OTHER PUBLICATIONS

1. S. Adhikari, A. S. Majumdar, D. Home, A. K. Pan, *Swapping path-spin intraparticle entanglement onto spin-spin interparticle entanglement involving amplitude damping channel*, in proceedings of 75 Years of Quantum Entanglement: foundations and information theoretic applications, eds. D. Home, G. Kar, A. S. Majumdar, (AIP, Melville, New York, 2011), p 108





- P. Saha, A. S. Majumdar, N. Nayak, *Atomic entanglement mediated by various non-classical cavity fields*, in proceedings of 75 Years of Quantum Entanglement: foundations and information theoretic applications, eds. D. Home, G. Kar, A. S. Majumdar, (AIP, Melville, New York, 2011), p 183

### BOOK PUBLISHED

D. Home, G. Kar, A. S. Majumdar, *75 Years of Quantum Entanglement: foundations and information theoretic applications*, AIP Publications, Melville, New York, 2011

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Centre: Nilok Bose, Tanumoy Pramanik, Priyanka Chowdhury, Pratik Tarafdar, Sanjay Routh; Project: Ashutosh Rai, Subhadipa Das, Siladitya Mal; External: Nirman Ganguly, Sovik Roy; **Project Students:** Siddharth Das (Foundations of quantum mechanics and quantum information theory)

### POST DOCTORAL RESEARCHER

Siddhartha Sinha

### STUDENTS' PUBLICATIONS

M. Banik, Md. R. Gazi, Subhadipa Das, Ashutosh Rai, S. Kunkri, *Optimal free will on one side in reproducing the singlet correlation*, J. Phys. A: Math. Theor., 2012, **45**, 205301

### LECTURES DELIVERED

- Future deceleration due to effect of event horizon on backreaction from inhomogeneities*, COSMO-11, Porto, Portugal, August, 2011
- Quantum entanglement and dark energy of the universe*, 11<sup>th</sup> Asian Quantum information Science conference mini-workshop, KIAS, Seoul, Korea, August, 2011
- Quantum information processing*, National Seminar on Future challenges in Quantum Optics, Lady Brabourne College, Kolkata, September, 2011
- Entanglement witnesses*, International School and

Conference on Quantum Information, IOP Bhubaneswar, December, 2011

- Emergence of the classical world: some quantum mechanical interpretations*, 7<sup>th</sup> Nalanda Dialog, Nava Nalanda Mahavihara, Nalanda, January, 2012
- The accelerating universe: challenges in theory and observations*, SNBNCBS, Kolkata, February, 2012
- Quantum information science*, National Seminar on quantum information theory and computer science, JCC College, Kolkata, February, 2012
- Witness for quantum teleportation*, International workshop on quantum information, HRI Allahabad, February, 2012
- Dark energy from various approaches*, Advances in Astroparticle Physics and Cosmology, Darjeeling, March, 2012
- The accelerating universe*, Relativity and Cosmology Research Centre, Jadavpur University, Kolkata, March, 2012

### COURSES TAUGHT

- PHY303, Nuclear and Particle Physics, Fall (jointly with Prof. A. Sinha)
- PHY 506, Quantum Physics
- PHY 509, Relativity & Cosmology

### PARTICIPATION IN COMMITTEES

Internal: Library Committee, member; Conference, Workshop & Extension Program of EVLP, convener

### SPONSORED PROJECTS

Fundamental aspects of quantum theory and quantum information: a multidisciplinary approach (DST)

### MEETINGS ORGANIZED

Discussion meeting on quantum mechanics, March 7-9, 2012, SNBNCBS, Kolkata

- Formation of molecular hydrogen using Continuous Time Random Walk Monte Carlo method to explain its presence in the diffuse cloud and studied the effect of size distribution on the molecular hydrogen formation efficiency.
- Worked to build a Laboratory for studying Astrobiology and Astrochemistry related problem.



Kinsuk Acharyya  
Bose Fellow

Molecular hydrogen is the most abundant molecule in space. We worked to explore relatively unexplored aspect of the H<sub>2</sub> formation process, i.e., how does the presence of different sized grains with different temperature effects, H<sub>2</sub> formation efficiency? Recent studies established two facts: (i), H<sub>2</sub> formation efficiency is highly temperature sensitive and (ii) efficiency of H<sub>2</sub> formation is dependent on grain size, although not as profusely as its dependence on temperature but efficiency for bigger grains is higher than the smaller grains. We found, when only

physisorption sites are considered, smaller grains contributes very little to the overall H<sub>2</sub> formation due to greater temperature fluctuations. H<sub>2</sub> formation efficiency on silicate grains is very low due lower binding energy of hydrogen. Whereas, formation efficiency on carbonaceous grains relatively larger due to higher binding energy. In presence of both chemisorption and physisorption sites on the grains, H<sub>2</sub> formation efficiency is proportional to relative number density of the grains.

### SUPERVISION OF STUDENTS

**Ph.D. Student:** Wasim Iqbal; **Project Student:** Moumita Adhikari (M. Sc. Project)

### LECTURES DELIVERED

1. *How Molecules form in the Star Forming Regions*, European Space Agency, Madrid, Spain, May, 2011
2. *How Complex Molecules are Formed in the Dense Interstellar Medium*, Leiden Observatory, Netherlands, June, 2011
3. Seminar Lecture *How Molecules form in the Star Forming Regions?*, IIA, Bengaluru, July 11, 2011
4. *Interstellar Dusts and their Laboratory Analog*, in IDMC 2011 held at IUCAA, Pune, November 22 – 25, 2011

### ACADEMIC VISITS

1. Visited European Space Agency (ESAC), Madrid, May 23 - 29, 2011
2. Visited Leiden Observatory, June 04 - 11, 2011
3. IAU Symposium 280: Astrochemistry - Molecular Universe, Toledo, Spain, May 30 - June 03, 2011

### COURSES TAUGHT

1. 501, Research Methodology
2. PHY402, Seminar Course, Semester IV

### PARTICIPATION IN COMMITTEES

Internal: Newsletter Committee, Technical Cell

### SPONSORED PROJECTS

The Study of Photo-desorption and Photo-ionization of Complex Molecules in Star Forming Regions, DST project



Sandip Kumar Chakrabarti  
Senior Professor, Dean  
(Academic Program) and Head  
of the Department, Astrophysics  
and Cosmology

Black hole accretion disk - ionospheric perturbations - pre-biotic molecules

Effects of cooling and viscosity on the accretion disk structure around a black hole are studied using coupled numerical simulation code and Monte Carlo code. The ionospheric perturbations due to solar flares and eclipse are modeled. Significant results have been obtained in computation of the reaction rates important for producing pre-biotic molecules in interstellar space.

- i) Compton scattering of the low energy photons of the accretion disks by the hot electrons located at the base of the cosmic jets reduces the temperature of the base. As a result, the outflow rate is greatly reduced. We claim that in soft spectral states such jets should not form.
- ii) Viscosity transports angular momentum and allows matter to fall into the black hole. However, when viscosity decreases as one move away from the equatorial plane, the Keplerian disk is formed at the equatorial plane and is surrounded by low angular momentum, sub-Keplerian, matter. Thus, a centrifugal pressure supported boundary layer,

or CENBOL is produced. This is shown by actual numerical simulations.

- iii) Very low frequency (VLF) signal amplitude depends on the propagation path geometry and the reflection coefficient of the lower surface of the ionosphere. We show that deviation of VLF signal amplitude during a solar eclipse could be positive or negative depending on the location of the receiver.
- iv) We carry out a quantum chemical calculation coupled to hydro-chemical simulation to obtain spectral signatures of the precursors of the amino acids in the interstellar medium (ISM) in gas and ice phases. The influence of ice on vibrational frequencies of different pre-biotic molecules was obtained using Polarizable Continuum Model (PCM). Time dependent density functional theory (TDDFT) is used to study electronic absorption spectrum of these molecules. We find that around a dense cloud, 30% of the interstellar grain mantle could be occupied by the Methanol.

### PUBLICATIONS IN JOURNALS

1. K. Giri and Sandip K. Chakrabarti, *Hydrodynamic simulations of viscous accretion flows around black holes*, MNRAS, 2012, **421**, 666
2. S. Ray, S. K. Chakrabarti, S. Mondal, S. Sasmal, *Ionospheric anomaly due to seismic activities-III: Correlation between night time VLF amplitude fluctuations and effective magnitudes of earthquakes in Indian sub-continent*, Nat. Hazards and Earth Syst. Science, 2011, **11**, 2699
3. A. R. Rao et al., *Onboard performance of the RT-2 detectors*, Solar System Research, 2011, **45**, 123
4. P. S. Pal, S. K. Chakrabarti, A. Nandi, *Evidence of variation of the accretion flow geometry in GRS 1915+105 from IXAE and RXTE data*, IJMPD, 2011, **20**, 2281
5. S. Ray, S. K. Chakrabarti, S. Sasmal, *Precursory Effects in the night time VLF signal Amplitude for the 18th Jan. 2011 Pakistan Earthquake*, Ind. J. Physics, 2012, **86**, 85
6. I. Chattopadhyay and S. K. Chakrabarti, *Effects of the composition on transonic properties of accretion flows around black holes*, IJMPD, 2011, **20**, 1597
7. H. Ghosh, S. K. Garain, Kinsuk Giri, Sandip K. Chakrabarti, *Effect of Compton Cooling on the Hydrodynamic and the Spectral Properties of a Two Component Accretion Flow around a Black Hole*, MNRAS, 2011, **416**, 959
8. S. K. Chakrabarti, *Fundamental Concepts in Transonic Flow Paradigm of Black Hole Astrophysics*, IJMPD, 2012, **20**, 1723
9. A. Das, Sandip K. Chakrabarti, *Composition and*

evolution of Interstellar Grain mantle under the effects of Photodissociation, MNRAS, 2011, **418**, 545

10. C. B. Singh and S. K. Chakrabarti, *Model dependence of outflow rates from an accretion disk in presence of a dissipative standing shock*, IJMPD, 2011, **20**, 2507

### OTHER PUBLICATIONS

1. H. Ghosh, S. K. Garain, K. Giri and S. K. Chakrabarti, Sandip K., *Monte-Carlo Simulations of Comptonization Process in a Two Component Accretion Flow around a Black Hole in Presence of an Outflow*, Proc. XII Marcel Grossman Conference, 2012, p. 985 (World Scientific Publishers Co.)
2. P. S. Pal, S. K. Chakrabarti, A. Nandi, *Sequencing the Variability Classes of GRS 1915+105*, Proc. XII Marcel Grossman Conference, 2012, p. 969 (World Scientific Publishers Co.)
3. S. K. Chakrabarti, D. Bhowmick, R. Sarkar, S. Mondal, A. Sen, *High energy Astrophysics using Rubber Balloons*, Proc. 20<sup>th</sup> European Space Agency Symposium, 2011, p. 581 (ESA)
4. S. Pal, T. Basak, and S. K. Chakrabarti, *Advances in Geosciences, Solar Terrestrial (ST)*, Edited by Marc Duldig. Singapore: World Scientific, 2011, **27**, p.1
5. L. Majumdar, A. Das, S. K. Chakrabarti and S. Chakrabarti, *Chemical Evolution around star forming region: A time dependent study*, Proc. IAU Symposium, 2011, **280**, p. 400
6. A. Das and S. K. Chakrabarti, *Composition of the grain mantle: A Monte Carlo Study*, Proc. IAU Symposium, 2011, **280**, p. 399
7. R. Ruffini, L. Izzo, A. V. Penacchioni, C. L. Bianco, L. Caito, S. K. Chakrabarti, A. Nandi, *GRB 090618: a possible case of multiple GRB?*, Proceedings of the 25th Texas Symposium on Relativistic Astrophysics. Frank M. Rieger (Chair), Christopher van Eldik and Werner Hofmann (Eds.), p. 101

### BOOK PUBLISHED

Sandip Chakrabarti, Sudipta Sasmal and Suman Ray, *Short term Earthquake Prediction Using VLF Observations*, IN "The Frontiers of Earthquake Prediction Studies" Editor: Masashi Hayakawa (NSS publishers), 2012, p. 678

### SUPERVISION OF STUDENTS

**Ph.D. Students:** H. Ghosh (submitted thesis on *Monte Carlo Simulations of the Advective Inflow and Outflow around a Black Hole*); C. B. Singh (submitted thesis on *Analytical Studies of Origin of Outflows from Accretion disks around Black Holes*); S. Garain, K. Giri, V. Nwankwo, S. Pal. T. Basak, S. Sasmal, P. S. Pal, L. Majumdar, S. Mondal; **Project Students:** Summer Student: Bhupendra Mishra (IIT / Guwahati)

### LECTURES DELIVERED

1. Two lectures on *Astrophysical flows around black holes* at Erasmus Mundus Joint Doctorate Programme, University of Nice, May, 2011
2. *High Energy Astrophysics with weather balloons* at the 20th ESA conference on "Balloons and Rockets" in Heyres, France, May, 2011
3. *Perturbation of the GW signals from a binary system in presence of an accretion flow* at the Lijiang conference on Gravitation wave Astronomy, August, 2011
4. *Earthquakes and VLF signal anomalies* at the URSI conference in Istanbul, August, 2011
5. *Excitements in Astrophysics* at the National Council of Science Museums, September, 2011
6. Invited talks on *Accretion Processes around Black Holes and Physics of Jets and Chemical Evolution of the Universe and the Origin of Life* at the "International Conference on Astrophysics and Cosmology", Kathmandu, March, 2012

### ACADEMIC VISITS

Visited University of Nice as an Adjunct Faculty of the International Relativistic Astrophysics PhD (IRAP-PhD) programme, May, 2011

### COURSES TAUGHT

Research Methodology (Part) - First Semester, PhD programme

### PARTICIPATION IN COMMITTEES

- a. External: International Advisory committee: International Conference on Astrophysics and Cosmology, Kathmandu; International Coordination committee Member: 13th Marcel Grossman meeting on General Relativity and Gravitation, Stockholm; In Charge, Academic



Affairs and General Secretary of the Governing Body of Indian Centre for Space Physics; Editorial Board member: Indian Journal of Physics; Bulletin of Astronomical Society of India

- b. Internal: Head of the Dept. (Astrophysics and Cosmology); Academic and Research Advisory Committee (ARPAC); Departmental Research Committee (DRC); Consultative Advisory Committee (CAC); Students' Curriculum and Research Evaluation Committee (SCREC); Library and several other committees

#### **AWARDS / RECOGNITIONS**

Recipient of "Mitra Mandir" Eminent Personalities of India medalion (2012)

#### **MEETINGS ORGANIZED**

Chairman of "Role of Small Telescopes in Modern Astronomy", conference held at SNBNCBS, November 7-8, 2011

- Extra-solar planets
- Small solar system objects
- Brown dwarfs in star-forming regions
- High Angular resolution astronomy on M-Giants and Mira variables
- Astronomical Instrumentation



Soumen Mondal  
Assistant Professor

Our major research interest is in observational Astronomy, and I am working on few research problems that include detection of Extra-solar planets using transit search, photometric variability in star-forming regions and star-cluster, late M-giants and Mira variables, atmosphere of brown dwarfs, small solar system objects and optical/Near-IR Astronomical instrumentation.

At the Centre, recently we have initiated to establish the Astronomical observing facility and install small-class telescope for detection of Extra-solar planets using transit search from wide-angle sky survey. Transit happens when a planet obscures the star-light during its passage in-front of planet-hosting

star, and it is detected by the small but measurable drop in brightness produced as the planet crosses periodically in front the stellar disk. Scientific outcome of such program is not only limited to new discoveries of planets, but also we can estimate the fundamental parameters of the planets (e.g., mass, density, temperature etc.) and these will help us better understanding of the formation, structure and evolution of planets.

We are also studying photometric variability of pre-main sequence stars, brown dwarfs and short-period variable stars in star-forming regions and general fields.

### PUBLICATIONS IN JOURNALS

1. Y. C. Joshi, S. Joshi, B. Kumar, Soumen Mondal, L. A. Balona, *Photometric study and detection of variable stars in the open clusters - I. NGC 6866*, Monthly Notices of the Royal Astronomical Society, 2012, **419**, pp. 2379-2390
2. Sneha Lata, A. K. Pandey, G. Maheswar, Soumen Mondal, B. Kumar, *Photometric search for variable stars in the young open cluster Berkeley 59*, Monthly Notices of the Royal Astronomical Society, 2011, **418**, pp. 1346-1355

### SUPERVISION OF STUDENTS

**Project Students:** Somnath Mukhopadhyay (Post B.Sc. - 2nd Sem), Sanjana Banerjee (Summer project - M.Sc (Physics) -2nd Year, CU)

### POST DOCTORAL RESEARCHER

Ramkrishna Das

### LECTURES DELIVERED

1. Delivered talk on *Photometric variability studies on stellar sources* at a workshop on Role of small

telescopes in modern Astronomy Research held at S N Bose National Centre for Basic Sciences during November 7-8, 2011

2. Delivered invited talk on *The TAOS Project: Small Kuiper Belt Objects and Evolution of the Outer Solar System* at Bose Fest 2012 held at S N Bose National Centre for Basic Sciences during January 30 - February 01, 2012
3. Delivered invited talk *The TAOS Project: Small Kuiper Belt Objects and Evolution of the Outer Solar System* at 12th Planex workshop on Exploration of Asteroids and Comets at Physical Research Laboratory, Mt. Abu during January 2-6, 2012

### PARTICIPATION IN COMMITTEES

Internal: Member in Students' Curriculum & Research Evaluation Committee (SCREC)

### MEETINGS ORGANIZED

Organized and convener of a workshop "Role of small telescopes in modern Astronomy Research" during November 7-8, 2011 at S N Bose National Centre for Basic Sciences



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*Department of*  
**Chemical, Biological &  
Macro-Molecular Sciences**







Department of

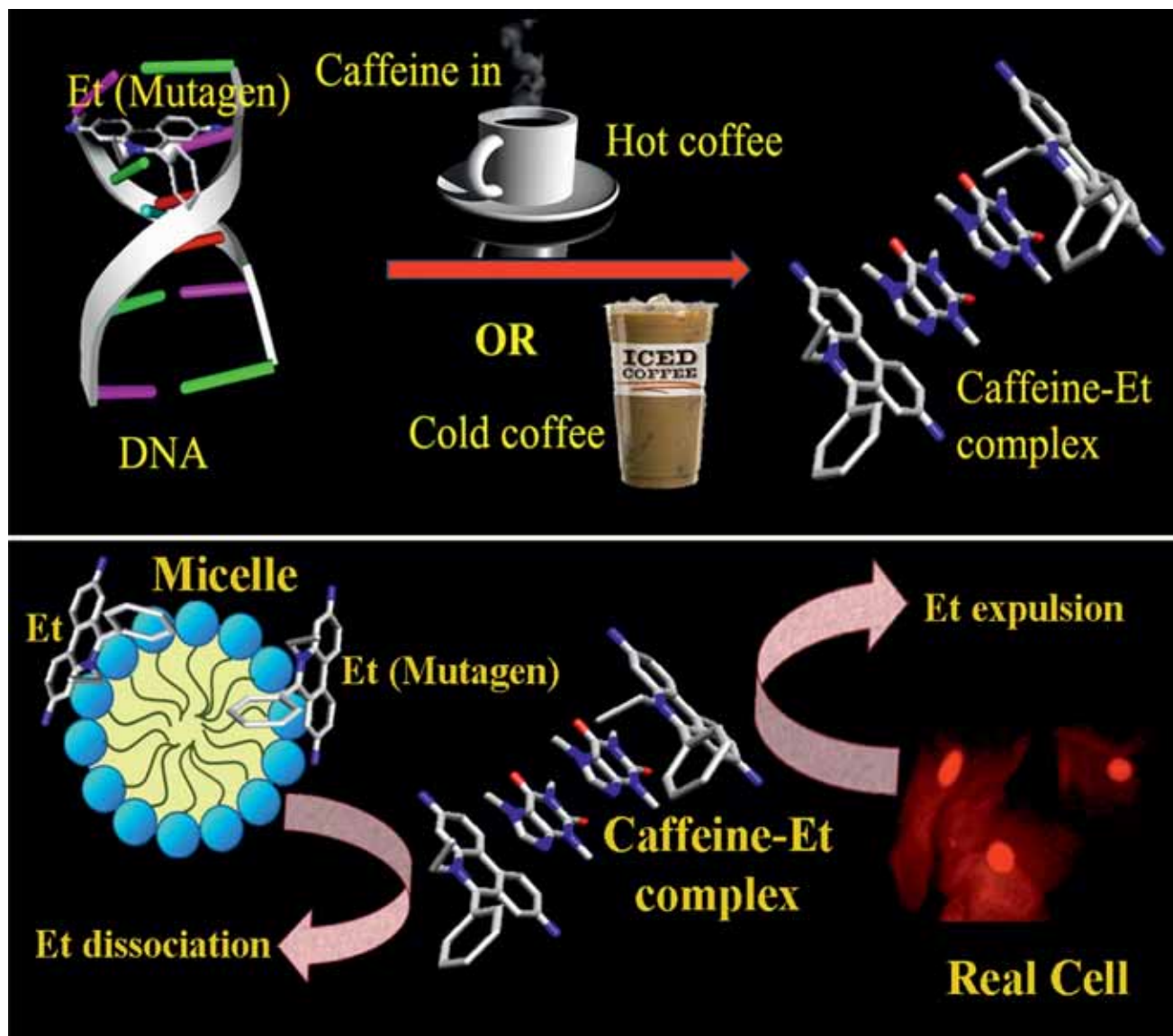
## Chemical, Biological & Macro-Molecular Sciences

**T**he department has multidisciplinary research activities. The activities are broadly described as follows:

The research activities of Dr. S K Pal are in the field of Experimental biophysics, Microemulsion and Biomimetic systems, Bio-nano Interface, Biomedical/environmental Instrumentation. In one of their recent works, for example, they reported a novel mechanism for ZnO nanoparticle (NP)-sensitized Bilirubin (BR) (a pathological marker of jaundice) degradation via defect-mediated nonradiative energy transfer pathway. Again among different sizes and shapes, ZnO particles with diameter of 5 nm having very high concentration of defect states are found to be the most effective catalyst, which particularly follows a pseudo first-order kinetics validating the Langmuir-Hinshelwood model of surface catalysis. The nontoxic wide band gap ZnO NPs essentially transmit defect-mediated visible optical radiation, which is not supposed to interfere with the conventional phototherapy process. The recyclable ZnO nanocatalysts which essentially invites an added advantage in potential therapeutic applications and/or in a flow-device is also of their present interest among many other relevant works.

Recent works from Dr. R. Biswas's group includes Ionic Liquids, Supercooled Molten Mixtures, Multi-component Solvent Mixtures, Complex Sugars, Time-resolved Fluorescence Experiments, Theoretical and Computer Simulation, Approach to understand simple chemical events (for example, cis-trans isomerization and particle diffusion) in Condensed Phases. More specifically they are on fluorescence spectroscopic investigation of Stokes' shift dynamics and rotational relaxation of a dipolar solute probe in molten mixtures of acetamide ( $\text{CH}_3\text{CONH}_2$ ) with sodium and potassium thiocyanates (Na/KSCN) at various temperatures and mixture compositions. Recently, Dr. Biswas and coworkers have been able to offer molecular level explanation for the experimentally observed biphasic Stokes' shift dynamics in polar ionic liquids and stretched exponential dynamics in non-dipolar ionic liquids. Their theory also substantiated the relation between dielectric response of these new class of liquids and Stokes' shift dynamics in them.

Dr. R. K. Mitra works on Time resolved fluorescence spectroscopy, high frequency (THz) spectroscopy, general physical chemistry, biomolecules (proteins, nucleic acids, enzymes etc.), bio-mimicking systems (micelles, reverse micelles, lamellae, vesicles etc.). He has shown that the absorption spectrum of a molecular magnet V15 (a polyoxovanadate) encapsulated in a protein HSA (human serum albumin), shows huge overlap with the emission spectrum of the tryptophan moiety of the protein which can offer donor-acceptor distance measurement through FRET. The activation energy of solvolysis of benzoyl chloride in AOT reverse micelle (RM) has been found to be a function of both the energy associated with the transition of bound to free water and the energy associated with the diffusion of free water to the reaction site. Addition of polyethylene glycol to an enzyme retards its efficiency and osmometric,



densimetric, time-resolved fluorescence spectroscopy reveals the dehydration of the salvation shell of the enzyme to be responsible for the effect. Spectroscopic studies reveal that both the morphology and the interlayer separation in nanoconfining macromolecular systems (like RM, lamellae etc.) play equally important roles in determining the dynamics of water relaxation.

Dr. M. Pradhan's emphasis is to work on Cavity Ring-Down Spectroscopy, Exhaled Breath Analysis, High-Resolution Mid-Infrared Quantum Cascade Laser Spectroscopy, Biomedical Optics and Instrumentation and Trace Chemical Sensing and Isotope Ratio Measurements in the Atmosphere.

Dr. J. Chakrabarti has shown that the effective colloidal interactions can be tuned changing the solvophobic interaction with the solvent particles. The effective interaction has been calculated via grand canonical monte-carlo simulations and estimated via the density functional theory. Both show that the effective interaction changes from attractive to repulsive one as the solvophobic interaction parameter decreases. This finding has tremendous implication in tuning the phase behaviour of colloids in a solvent.

Dr. P. Singha Deo had shown that evanescent modes play an important role in electron-wave experiments. They have looked at semiclassical formulas like Friedel sum rule and Wigner delay time at the Fano resonances.



They have shown that their results are valid for any potential that has mirror symmetry in the propagating direction and the magnetic response of quantum rings.

Dr. G. Gangopadhyay and coworkers have theoretically studied exact solutions of some quantum systems. For atom-field interaction, they gave Bloch space structure, the qutrit wave function and atom-field entanglement in three-level systems. They have also studied electronic nuclear entanglement in a conjugated polymer aggregate with a conical intersection. In a different context they have provided stochastic approaches to interfacial enzyme catalysis.

Dr. M. Ghosh's research interests involve understanding of the macromolecular basis in biological system driven by the quest of unraveling their structure, measuring their thermodynamic stability. They are interested in structure-function correlation of these complex systems.

Dr. M. Mitra is interested in the effect of charges on polymer equilibrium properties, theory of transitions in polyelectrolyte gels and brushes, kinetics of polyelectrolytes near the critical point, formation kinetics and static properties of ring polymers and phase transitions in 2D ring polymer systems.

Departmental Statistics: Faculty members: 9 (including a Visiting Reader); Number of PhD students: 33; Number of PDFs : 0; Total number of publications: 35; Total number of Projects: 3

#### DEPARTMENTAL STATISTICS

Total number of faculties	9
Post-Doctoral Research Fellow	0
Ph. D. Students	33
Publications in journals only	31
Talks delivered by faculties/ post docs and students	24
External Projects	3



**Gautam Gangopadhyay**

Head, Department of Chemical, Biological and  
Macromolecular Sciences

- Radiation matter interaction
- Molecular Physics and spectroscopy
- Complex dynamics in Chemistry and Biology

Gautam Gangopadhyay  
Associate Professor



We have worked on some exact solutions of quantum systems. For atom-field interaction, we gave Bloch space structure, the qutrit wave function and atom-field entanglement in three-level systems. In some other context of system heat-bath interaction, we have given a solution of the problem on Decoherence without dissipation due to fermionic bath. We have also studied electronic nuclear entanglement in a conjugated polymer aggregate with a conical intersection. We have provided a stochastic approach to describe interfacial enzyme catalysis.

In the spirit of Gillespie's stochastic approach we

have formulated a theory to explore the advancement of the interfacial enzyme kinetics at the single enzyme level which is ultimately utilized to obtain the ensemble average macroscopic feature, lag-burst kinetics. We have provided a theory of the transition from the lag phase to the burst phase kinetics by considering the gradual development of electrostatic interaction among the positively charged enzyme and negatively charged product molecules deposited on the phospholipid surface. Different diffusion time scales of the enzyme over the fluid and product regions are responsible for the memory among the successive turnover events in the lag phase unlike the burst phase.

#### PUBLICATIONS IN JOURNALS

1. S. Sen, M. R. Nath, T. K. Dey and G. Gangopadhyay, *Bloch space structure, the qutrit wave function and atom-field entanglement in three-level systems*, *Annals of Physics*, 2012, **327**, 224
2. B. Das and G. Gangopadhyay, *Stochastic theory of interfacial enzyme kinetics: A kinetic Monte Carlo study*, *Chem. Phys.*, 2012, **393**, 58
3. K. Banerjee and G. Gangopadhyay, *Electronic nuclear entanglement in a conjugated polymer aggregate with a conical intersection: spectral signatures*, *J. Phys. B*, 2012, **45**, 045102

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Kinshuk Banerjee(SRF), Biswajit Das(SRF), Anirban Karmakar(JRF)

#### LECTURES DELIVERED

*Diffusive motion in Physics, Chemistry and Biology*, in Phys. Dept., Silchar G. C. College, Silchar, February, 2012

#### PARTICIPATION IN COMMITTEES

Internal: CAC, SCRE, SAC, Library, EVLP (VASP, APMP) Committees





Jaydeb Chakrabarti  
Associate Professor

Statistical Mechanical description of static and dynamic phenomena in complex and soft condensed matter systems, including those of biological interests

We develop a framework for a molecular level understanding of the celebrated Stokes-Einstein-Debye (SED) formula. In particular, we explore reasons behind the surprising success of the SED model in describing dipolar solute rotation in complex polar media. Relative importance of solvent viscosity and solute-solvent dipolar interaction is quantified via a self-consistent treatment for the total friction on a rotating solute where the hydrodynamic contribution is modified by the friction arising from the longer ranged solute-solvent dipolar interaction. This approach satisfactorily describes the experimental rotation times measured using a dipolar solute, coumarin 153 (C153), in protic and aprotic polar liquids.

Many prokaryotic transcription factors home in on a

single or small number of target sites in the presence of huge number of non-specific sites. The non-specific genomic DNA is a competitor for binding to the specific sites, but is also used for target location to enhance the kinetics of search. However, the effect of sites that are similar in sequence to the specific sites and having an intermediate affinity between the non-specific and specific sites has not been fully explored. A model is also considered to study the kinetic effects of such sites, which show very significant kinetic effects as well due to binding at quasi-specific sites. In contrast to the  $\lambda$ -repressor, E.coli genome has orders of magnitude lower quasi-specific sites for GalR, thus causing little competition for the specific site; it also leads to a smooth genomic energy landscape making diffusion along DNA unhindered.

#### PUBLICATIONS IN JOURNALS

1. A. Das, R. Biswas and J. Chakrabarti, *Solute rotation in polar liquids: Microscopic basis for the SED model*, J. Chem. Phys., 2012, **136**, 014505
2. J. Chakrabarti, Navin Chandra, Paromita Raha, and Siddhartha Roy, *High-Affinity Quasi-Specific Sites in the Genome: How the DNA-Binding Proteins Cope with Them*, Biophysical Journal, 2011: 10.1016/j.bpj.2011.07.04

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Amit Das, Arup Bhowmik and Samapan Sikdar; **Project Student:** Suman Dutta (Summer 20011, 3rd and 4th semester)

#### LECTURES DELIVERED

1. *Conformational Contribution to thermodynamics*, ICSPND, SNBNCBS, March, 2012
2. *High Affinity Quasi-specific Sites in the Genome: How the DNA binding proteins cope with them*, Gordon research Conference, Galveston, TX, January, 2012

3. *Thermodynamics of protein-DNA binding: a microscopic view of the conformational landscape*, Current Trends in Condensed Matter, IISER-K, October, 2011
4. *Solute rotation in a polar liquid*, University of Dusseldorf, Germany, July, 2011
5. *Hydrophobic versus electrostatic interaction: stable macromolecular clusters*, IMSc, Chennai, May, 2011
6. *Solute rotation in a polar liquid*, JNCASR, Bangalore, May, 2011

#### ACADEMIC VISITS

Collaborative research with Prof. Harmut Lowen, University of Dusseldorf, Germany, June-July, 2011

#### COURSES TAUGHT

CB 533 Liquids Autumn 2011

#### PARTICIPATION IN COMMITTEES

Internal: Newsletter

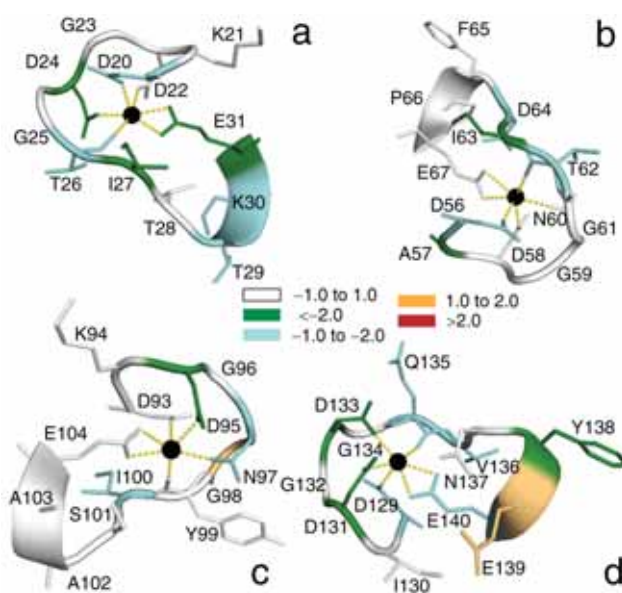
Understanding of the macromolecular basis in biological system driven by the quest of unraveling their structure & measuring their thermodynamic stability.

Mahua Ghosh  
Research Scientist



The  $\text{Ca}^{2+}$  bound Calmodulin (CaM) plays the role of primary mediator for target protein activities in response to changes in intracellular calcium levels. In order to provide a microscopic picture of  $\text{Ca}^{2+}$  binding to CaM we study the equilibrium and dynamic fluctuations of dihedral angles in CaM. We show that the uncorrelated equilibrium fluctuations reveal the thermodynamics of conformational changes. Our results on conformational free energy

and entropy correlate well with the elements of local structure, compositions of the loops and locations of the acidic residues. We compare our findings to different experimental studies on CaM. Substantial changes in the correlation of dynamic fluctuations are observed between residues of adjacent loops which are known to participate in cooperative binding of  $\text{Ca}^{2+}$  to CaM.



The side chains of the four EF-loops of CaM in holo form: (a) loop I, (b) loop II, (c) loop III and (d) loop IV. The colours indicate the respective conformational free energy changes (in  $\text{kJ mol}^{-1}$ ) of the residues.  $\text{Ca}^{2+}$  ions are shown by black spheres with the coordinations with loop-residues marked by yellow dots.

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Paramita Saha, Siddhi Chaudhuri;  
**Project Student:** Dhani Ram Mahato: M.Sc Project Student, BIT Mesra

## LECTURES DELIVERED

1. *Application of Physics in Biomacromolecular studies*, CKM Memorial Summer Workshop in Physics, SNBNCBS, June, 2011
2. *Thermodynamics of protein-DNA binding: a*

*microscopic view of the conformational landscape*, Gordon research Conference, Galveston, TX, January, 2012

## COURSES TAUGHT

CB 540: Study of Bio-macromolecules Autumn, 2011

## SPONSORED PROJECTS

DST fast-track project on "Structural and Functional Characterization of small Heat Shock Proteins from *Bradyrhizobium japonicum*"





Manik Pradhan  
Assistant Professor

- Cavity Ring-Down Spectroscopy
- Exhaled Breath Analysis
- High-Resolution Mid-Infrared Quantum Cascade Laser Spectroscopy
- Biomedical Optics and Instrumentation
- Trace Chemical Sensing and Isotope Ratio Measurements in the Atmosphere

We have explored a theoretical understanding of the sensitivity limit of a high-finesse optical cavity based technique such as cavity ring-down spectroscopy (CRDS) working in the near-IR spectral region. The limiting sensitivity of the ring-down cavity has been demonstrated by means of shot-noise limit (SNL) conditions. We have identified the existence of two different limiting conditions of a ring-down cavity. One is the detector noise limit (DNL) condition when it was considered that the noise level is constant during the entire ring-down decay of the light inside

the cavity. Another is the SNL condition, when it was considered that the noise at any point in the decay depends on the amplitude of the decay trace at that point. The theoretical values of the minimum detectable absorption coefficient and the noise-equivalent absorption (NEA) coefficient for the ring-down cavity operating at near-IR region are given by  $\alpha_{\min} = 1.90 \times 10^{-9} \text{ cm}^{-1}$  and  $\text{NEA} = 6.6 \times 10^{-10} \text{ cm}^{-1} \text{ Hz}^{-1/2}$ , respectively. The values are 10,000 times far better than for conventional multi-pass arrangements.

#### COURSES TAUGHT

PHY-291, Basic Laboratory II, 2nd Semester (Spring), 2012

#### PARTICIPATION IN COMMITTEES

- External:** Technical Committee for procuring Laser Isotope Analyzer, Indian Institute of Tropical Meteorology (IITM), Pune
- Internal:** Various Thesis and Interview Committees

#### AWARDS / RECOGNITIONS

"Rapid Grant for Young Investigators (RGYI)", 2011-12, Department of Biotechnology (DBT)

#### SPONSORED PROJECTS

Cavity Ring-Down Spectroscopy for Real-Time Breath Analysis: a Next-Generation Diagnostics in Modern Medicine, DBT

#### MEETINGS ORGANIZED

International Conference on Statistical Physics and Nonlinear Dynamics, March 12-16, 2012, Organizing Committee Member

- The effect of charges on polymer equilibrium properties
- Theory of transitions in polyelectrolyte gels and brushes
- Kinetics of polyelectrolytes near the critical point
- Formation kinetics and static properties of ring polymers
- Phase transitions in 2D ring polymer systems



Mithun Kumar Mitra  
Visiting Assistant Professor

We have developed a variational theory of polyelectrolyte gels in the presence of salt where the effective charge of the polymer is allowed to self-regularize. For charged gels in a salt-free solution we have characterized the collapsed to expanded state transition as a function of the crosslink density which is qualitatively shown to be different from the behavior of neutral gels. For charged gels in a monovalent salt solution, our theory reproduces all relevant experimental observations. For charged gels in a divalent salt solution, we predict a re-entrant transition due to overcharging of the polymer backbone leading to effective charge reversal. This phenomenon has not been observed in the experiments till date and is expected to occur with higher salt concentrations, or equivalently,

lower temperatures than have been studied so far.

For pressurized self-avoiding two-dimensional rings, we have studied the collapsed to inflated transition using both simulations and scaling analysis. Contrary to predictions of earlier studies, we find that in the case of self-avoiding rings, there exists a phase transition at non-zero values of the pressure. This critical pressure is found to scale with the system size analogous to the case of a self-intersecting ring. The phase transition separates a weakly inflated phase, in which the polymer ring is unfaceted, from a strongly inflated phase, in which the ring is faceted in the form of an N-gon. This transition can be either first or second order, depending on the interactions among the constituent monomers of the polymer ring.

### PUBLICATIONS IN JOURNALS

Mithun K. Mitra, Gautam I. Menon, R. Rajesh, *Thermodynamic behavior of two-dimensional vesicles revisited*, European Physical Journal E, 2012, **35**, 30

### OTHER PUBLICATIONS

Mithun K. Mitra, M. Muthukumar, *Theory of volume transitions in polyelectrolyte gels*, MRS Proceedings, 2012, 1418, mrsf11-1418-II07-02

### LECTURES DELIVERED

1. *Volume Transitions in Charged polymer systems*, Institute of Mathematical Sciences, Chennai, February, 2012
2. *Charged polymers: Gels and Brushes*, Indian Institute of Science Education and Research, Mohali, March, 2012

3. *Modified coarsening kinetics in the presence of free energy barrier*, International Conference on Statistical Physics and Nonlinear Dynamics, SNBNCBS, Kolkata, March, 2012
4. *Charged Polymers: Gels and Brushes*, Indian Institute of Technology, Bombay, April, 2012

### ACADEMIC VISITS

Collaborative Research, Institute of Mathematical Sciences, Chennai, February, 2012

### AWARDS / RECOGNITIONS

Awarded Senior Fellowship at Institute for Advanced Studies, Durham University, UK under the European Union Marie Curie COFUND Scheme, 2013







Prosenjit Singha Deo  
Professor

- Mesoscopic physics
- Quantum transport
- Density of states in open quantum systems

In one of our works we start from microscopic approach to many body physics and show the analytical steps and approximations required to arrive at the concept of quantum capacitance. In our other

work we address the following problem. When an STM tip is brought close to a nano sized sample then it can deliver or draw a current and how to determine this current using Landauer-Buttiker formalism.

#### PUBLICATIONS IN JOURNALS

1. S. Mukherjee, M. Manninen and P. Singha Deo, *Quantum capacitance: a microscopic derivation*, Physica E, 2011, **44**, p. 62
2. U. Satpathy and P. Singha Deo, *Injectance and a paradox*, IJMPB, 2012, **26**, p.1250028

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Sreemoyee Mukherjee, Urbashi Satpathi, Sumit Ghosh

#### LECTURES DELIVERED

*Injectance and a paradox*, Talk given at National University of Singapore on January 25, 2012, Host – Prof. R. Parwani

#### PARTICIPATION IN COMMITTEES

Internal: Member of EVLP committee

Time resolved fluorescence spectroscopy, high frequency (THz) spectroscopy, general physical chemistry, biomolecules (proteins, nucleic acids, enzymes etc.), biomimicking systems (micelles, reverse micelles, lamellae, vesicles etc.).

Rajib Kumar Mitra  
Assistant Professor



- 1) A combined THz/time resolved fluorescence study coupled with far and near-UV CD spectroscopy indicates that the hydration dynamics of a protein changed considerably for the native to extended transition (reversible process), whereas it does not follow any trend for the unfolded state (irreversible process). A considerable modification of the hydration structure in response of the structural modification of the protein is established.
- 2) Enzymatic activity of  $\alpha$ -chymotrypsin decreases with the addition of an osmotic/crowding agent, PEG 400. The entrance path for the substrate is stabilized (decrease in  $K_M$ ) whereas the exit channel is destabilized (decrease in  $k_{cat}$ ) with increasing osmotic stress (OS) as a result of the loss of critical water residues from the hydration shell of the enzyme.
- 3) Time-resolved fluorescence spectroscopic study reveals that the dynamics of water relaxation in a

water-cellulose mixture undergoes a characteristic transition beyond 20% cellulose concentration, wherein a microscopic phase transition between isotropic to cholesteric phase sets in, with a clear transition between 'bound' and 'bulk' states of water.

- 4) FIR- and MIR-FTIR studies of water-Dioxane mixtures reveal that hetero-molecular (water-Dx) hydrogen bond dominates in the water diluted region in the mixtures, and with progressive addition of water, bulk-like intermolecular three dimensional hydrogen bonded water network dynamics evolves beyond  $X_w=0.1$ . A fit of a double Debye relaxation model to the results of THz-TD spectra revealed the lack of cooperative water network dynamics at low water concentrations with a rapid onset of collective network motions beyond  $X_w>0.1$ .

## PUBLICATIONS IN JOURNALS

1. P. K. Verma, S. Rakshit, R. K. Mitra and S. K. Pal, *Role of hydration on the functionality of a proteolytic enzyme -chymotrypsin under crowded environment*, *Biochimie*, 2011, **93**, 1424 -1433
2. R. Saha, P. K. Verma, R. K. Mitra and S. K. Pal, *Structural and dynamical characterization of unilamellar AOT vesicles in aqueous solutions and their efficacy as potential drug delivery vehicle*, *Colloids and Surfaces B: Biointerfaces*, 2011, **88**, 345-353
3. T. Q. Luong, P. K. Verma, R. K. Mitra and M. Havenith, *Do Hydration Dynamics Follow the Structural Perturbation during Thermal Denaturation of a Protein: A Terahertz Absorption Study*, *Biophysical Journal*, 2011, **101**, 925-933 (Cover Article)
4. T. Q. Luong, P. K. Verma, R. K. Mitra and M. Havenith, *Onset of Hydrogen Bonded Collective Network of Water in 1,4-Dioxane*, *J. Phys. Chem. A* 2011, **115**, 14462–14469
5. S. Banerjee, D. Bhowmik, P. K. Verma, R. K. Mitra, A. Siddhanto, G. Basu and S. K. Pal, *Ultrafast Spectroscopic Study on Caffeine Mediated Dissociation of Mutagenic Ethidium from Synthetic DNA and Various Cell Nuclei*, *J. Phys. Chem. B*, 2011, **115**, 14776–14783
6. A. Patra, P. K. Verma and R. K. Mitra, *Slow Relaxation Dynamics of Water in Hydroxypropyl Cellulose-*



*Water Mixture Traces Its Phase Transition Pathway: A Spectroscopic Investigation*, J. Phys. Chem. B, 2012, **116**, 1508-1516

#### **SUPERVISION OF STUDENTS**

**Ph.D. Students:** Animesh Patra, Arindam Das, Debanjan Polley

#### **LECTURES DELIVERED**

*THz Domain: A New Spectroscopic Window for Soft*

*Materials*, XV National Conference on Surfactants, Emulsions and Biocolloids, University of Tripura, December 27 – 29, 2011

#### **COURSES TAUGHT**

PHY 391, Laboratory course, 3rd Semester, PBIR

#### **PARTICIPATION IN COMMITTEES**

Internal: Library Committee

Ionic Liquids, Supercooled Molten Mixtures, Multi-component Solvent Mixtures, Complex Sugars; Time-resolved Fluorescence Experiments, Theoretical and Computer Simulation Studies. Integrated Approach to Understand Simple Chemical Events (for example, cis-trans isomerization and particle diffusion) in Condensed Phases

Ranjit Biswas  
Associate Professor



1. Developed First Molecular Theory for Dynamic Solvent Response in Ionic Liquids of Different Types
2. Showed a Fundamental Difference in Solute-Solvent Coupling between Solute Solvation in Ionic Liquids and that in Supercooled Molten Mixtures
3. Demonstrated that the Above Difference Arises from a Strong Dynamical Heterogeneity in Supercooled Molten Mixtures at Higher Temperatures
4. Entropy Plays a Role in Water-Assisted Agglomeration of Alcohols at Small Concentration

#### PUBLICATIONS IN JOURNALS

1. Tuhin Pradhan, Harun Al Rasid Gazi, Biswajit Guchhait and Ranjit Biswas, *Excited State Intramolecular Charge Transfer Reaction in Non-aqueous Reverse Micelles: Effects of Solvent Confinement and Electrolyte Concentration*, Journal of Chemical Sciences, 2012, **124**, 355-373
2. Amit Das, Ranjit Biswas and J. Chakrabarti, *Solute Rotation in Polar Liquids: Microscopic Basis for the SED Model*, Journal of Chemical Physics, 2012, **136**, 014505 (01) – (08)
3. Tamisra Pal and Ranjit Biswas, *Heterogeneity and viscosity decoupling in (Acetamide + Electrolyte) Molten Mixtures: A Model Simulation Study*, Chemical Physics Letters, 2011, **517**, 180-185
4. Snehasis Daschakraborty and Ranjit Biswas, *Stokes' Shift Dynamics in Alkylimidazolium Aluminate Ionic Liquids: Domination of Solute-IL Dipole-Dipole Interaction*, Chemical Physics Letters, 2011, **510**, 202-206
5. Namrata Sarma, Jayanta M. Borah, Sekh Mahiuddin, Harun Al Rasid Gazi, Biswajit Guchhait and Ranjit Biswas, *Influence of Chain Length of Alcohols on Stokes' Shift Dynamics in Catanionic Vesicles*, Journal of Physical Chemistry B, 2011, **115**, 9040-9049
6. Snehasis Daschakraborty and Ranjit Biswas, *Stokes' Shift Dynamics in (Ionic Liquid + Polar Solvent) Binary Mixtures: Composition Dependence*, Journal of Physical Chemistry B, 2011, **115**, 4011- 4024
7. Harun Al Rasid Gazi and Ranjit Biswas, *Heterogeneity in Binary Mixtures of (Water + Tertiary Butanol): Temperature Dependence Across Mixture Composition*, Journal of Physical Chemistry A, 2011, **115**, 2447-2455
8. Harun Al Rasid Gazi and Ranjit Biswas, *Excited State Charge Transfer Reaction in (Mixed Solvent + Electrolyte) Systems: Role of Reactant-Solvent and Reactant-Ion Interactions*, Journal of Chemical Sciences, 2011, **123**, 265 – 277

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Biswajit Guchhait, Snehasis Daschakraborty, Tamisra Pal, Anuradha Das, Sandipa Indra, Suman De, and Kallol Mukherji;  
**Project Student:** Krishna Kumari Swain

#### LECTURES DELIVERED

1. Invited talk in the international conference on "Dynamics of Ionic liquids" at the Chiba University, Japan, on March 03, 2012 entitled, *Relaxation Dynamics of Ionic Liquids: An All-Atom Simulation Study*
2. Invited talk at the Kobe University, Japan on *Medium Decoupling of Dynamics at Temperatures ~100 K Above Glass-transition Temperature: A Case study with (Acetamide + Lithium Bromid/Nitrate) Melts* on February 29, 2012
3. Invited Talk at the Osaka University, Japan on *Origin of Ultrafast Solvation Response in Room Temperature Ionic Liquids* on February 28, 2012



4. Invited Talk at the Institute of Molecular Science (IMS), Japan on *Dynamics in Room Temperature Ionic Liquids: Theory and Simulations* on February 27, 2012
5. Invited Poster presentation at the international conference on "Statistical Mechanics of Liquids: From Water to Biomolecules" at the IMS, Japan during February 11 - 13, 2012 entitled, *Confined Water Dynamics as Probed by a Captive Solute: A Combined Experimental and All-Atom Simulation Study*
6. Invited talk in the international conference on "Chemistry and Complexity" held at the IACS, Kolkata during December 06 -08, 2011 entitled, *On the origing of ultrafast solvation in ionic liquids*
7. Invited Talk on *Heterogeneity and Decoupling in (Amide + Electrolyte) Molten Mixtures: A Combined Fluorescence and Simulation Study* in the International symposium held in IIT-Kharagpur to celebrate its Diamond Jubilee during October 20-23, 2011
8. Invited "International Year of Chemistry" Talk entitled *Fluorescence Dynamics in Supercooled Molten Mixture*, IISER-Pune, April 15, 2011
9. Invited Talk entitled *Stokes' Shift Dynamics in Pure Ionic Liquid and (Ionic Liquid + Polar Solvent) Binary Mixtures: Molecular Mechanisms for the Observed Bimodal Dynamics*, BARC, Mumbai, April 13, 2011
10. Invited Talk entitled *Heterogeneity in Solution Structure: Impact on Simple Chemical Events*, IISER-Kolkata, April 06, 2011

#### COURSES TAUGHT

CB 524 Physical Chemistry: Theory and Experiments; August-December, 2011

#### PARTICIPATION IN COMMITTEES

Internal: SCOLP (Convener)

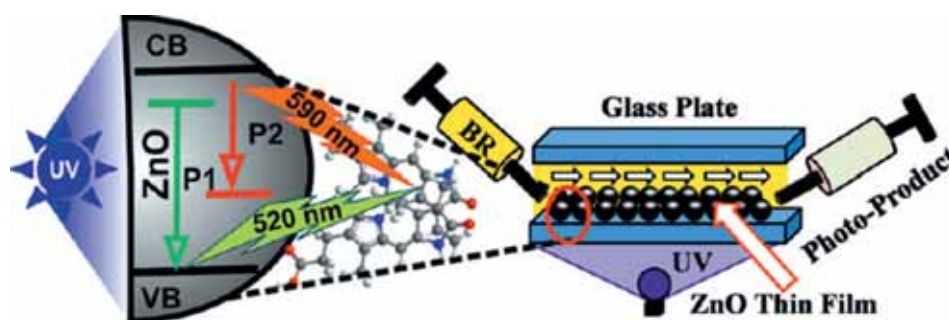
#### SPONSORED PROJECTS

1. "Investigation of Molecular Mechanism For Solute Dynamics in Aqueous Micellar Solutions Containing Ionic Liquid" (Co-PI, CSIR-Funded Simulation Project)
2. "Computational Materials Science - Thematic Unit" (Co-PI, DST-Funded Simulation Project)



In one of our recent works (J. Phys. Chem. C 2012, 116, 9608-9615) we report a novel mechanism for ZnO nanoparticle (NP)-sensitized Bilirubin (BR) (a pathological marker of jaundice) degradation via defect-mediated nonradiative energy transfer pathway. Among different sizes and shapes, ZnO particles with diameter of 5 nm having very high concentration of defect states are found to be the most effective catalyst, which particularly follows a

pseudofirst-order kinetics validating the Langmuir-Hinshelwood model of surface catalysis. The nontoxic wide band gap ZnO NPs essentially transmit defect-mediated visible optical radiation, which is not supposed to interfere with the conventional phototherapy process. Therefore, the recyclable ZnO nanocatalysts essentially invite an added advantage in potential therapeutic applications and/or in a flow-device that has been explored in the present study.



## PUBLICATIONS IN JOURNALS

1. T. Udayabhaskararao, Y. Sun, N. Goswami, S. K. Pal, K. Balasubramanian and T. Pradeep, *Ag<sub>7</sub>Au<sub>6</sub>: A 13 atom alloy quantum cluster*, *Angew. Chem. Int. Ed.*, 2012, **51**, 2155
2. T. Mondol, S. Batabyal and S. K. Pal, *Interaction of an Anti-tuberculosis Drug with Nano-sized Cationic Micelle: Förster Resonance Energy Transfer (FRET) from Dansyl to Rifampicin in the Microenvironment*, *Photochem. Photobiol.*, 2012, **88**, 328
3. S. Banerjee, P. K. Verma, R. K. Mitra, G. Basu and S. K. Pal, *Probing the interior of Self-assembled Caffeine Dimer at various Temperatures*, *J. Fluorescence*, 2012, **22**, 753
4. T. Mondol, S. Batabyal, A. Mazumder, S. Roy, and S. K. Pal, *Recognition of Different DNA Sequences by a DNA-binding Protein Alters Protein Dynamics Differentially*, *FEBS Lett.*, 2012, **586**, 258 (Cover Article)
5. S. Rakhshit, N. Goswami and S. K. Pal, *Slow solvent relaxation dynamics of nanometer sized reverse micellar systems through Tryptophan metabolite, Kynurenine*, *Photochem. Photobiol.*, 2012, **88**, 38
6. S. Singh, B. Saha, S. S. Sinha and S. K. Pal, *Construction of a Low Cost Laser-based Multiplexed Spectrometer: A Potential Probe for Environmental Pollution Monitoring*, *Int. J. Env. Waste Management*, 2012, **9**, 388
7. N. Goswami, A. Giri, M. S. Bootharaju, P. L. Xavier, T. Pradeep and S. K. Pal, *Copper Quantum Clusters in Protein Matrix: Potential Sensor of Pb<sup>2+</sup> ion*, *Anal. Chem.*, 2011, **83**, 9676
8. S. Banerjee, D. Bhowmik, P. K. Verma, R. K. Mitra, A. Siddhanto, G. Basu and S. K. Pal, *Ultrafast*

*Spectroscopic Study on Caffeine Mediated Dissociation of Mutagenic Ethidium from Synthetic DNA and Various Cell Nuclei*, J. Phys. Chem. B, 2011, **115**, 14776

9. T. Bora, H. H. Kyaw, S. Sarkar, S. K. Pal and J. Dutta, *Highly efficient ZnO/Au Schottky barrier dye sensitized solar cell: Role of gold nanoparticles on the charge transfer process*, Beilstein Journal of Nanotechnology, 2011, **2**, 681
10. N. Goswami, R. Saha, S. K. Pal, *Protein-assisted Synthesis Route of Metal Nanoparticles: Exploration of Key Chemistry of the Biomolecule*, J. Nanoparticle Res., 2011, **13**, 5485
11. R. Saha, P. K. Verma, R. K. Mitra and S. K. Pal, *Structural and Dynamical Characterization of Unilamellar AOT Vesicles in aqueous solutions and their efficacy as potential drug delivery vehicle*, Colloids and Surfaces B, 2011, **88**, 345
12. P. K. Verma, S. Rakshit, R. K. Mitra and S. K. Pal, *Role of hydration on the functionality of a proteolytic enzyme alpha-chymotrypsin under crowded environment*, Biochimie, 2011, **93**, 1424
13. S. Sarkar, A. Makhal, T. Bora, S. Baruah, J. Dutta, and S. K. Pal, *Photoselective Excited State Dynamics in ZnO-Au Nanocomposites and their Implications in Photocatalysis and Dye-Sensitized Solar Cells*, Physical Chemistry Chemical Physics, 2011, **13**, 12488

#### **SUPERVISION OF STUDENTS**

Ph.D. Students: Pramod K. Verma, Abhinandan Makhal, Nirmal Goswami, Surajit Rakhshit, Subrata Batabyal, Soma Banerjee, Anupam Giri, Soumik Sarkar, Ranajay Saha, Tanumoy Mondal; Project Students: Lakhmipriya Dutta

#### **LECTURES DELIVERED**

Keynote Speaker: The Fifth Saudi Science Conference, Umm Al Qura University, Saudi Arabia, held on April 16-18, 2012

#### **ACADEMIC VISITS**

1. Visiting Faculty, Noyes Laboratory of Chemical Physics, California Institute of Technology, Pasadena, California, USA
2. Institute Speaker: Asian Institute of Technology, Bangkok, Thailand

#### **COURSES TAUGHT**

1. Fundamental of Biophysics
2. Instrumental methods of analysis

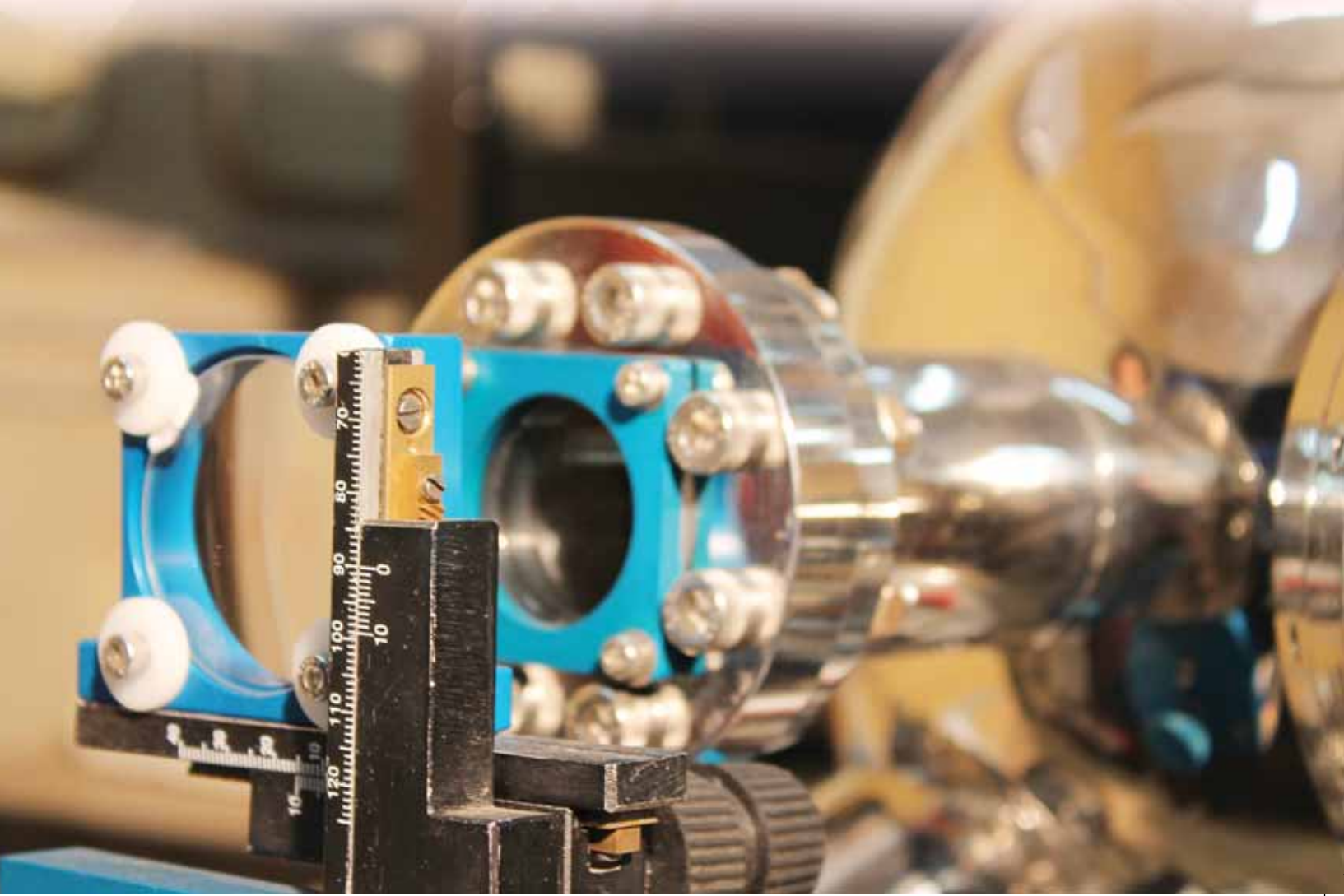
#### **PARTICIPATION IN COMMITTEES**

Internal: Chairman: Pest Control Committee

#### **PATENTS AWARDED/ APPLIED**

1. Sodium Bis(2-Ethylexyl) Sulfosuccinate (AOT) based Drug Delivery System. Indian Pat. Appl. (2011), 963/KOL/2011 dated 20th July 2011
2. Method and system of Enhanced degradation of Bilirubin Involving Zinc Oxide (ZnO) Nanoparticle. Indian Pat. Appl. (2011), 964/KOL/2011 dated 20th July 2011
3. Mouthwash/Oral care Formulation Involving Non-invasive Anti-mutagenic agent. Indian Pat. Appl. (2011), 969/KOL/2011 dated 22th July 2011
4. Tartrate Functionalized LSMO Nanoparticles, its manner of manufacture and Biomedical probe. Indian Pat. Appl. (2011), 979/KOL/2011 dated 25th July 2011
5. Waster blood based solar cell for low cost renewable energy Indian Pat. Appl. (2011), 980/KOL/2011 dated 25th July 2011

*Department of*  
**Condensed Matter Physics  
and Material Sciences**







*Department of*

# *Condensed Matter Physics and Material Sciences*

**T**he name of the department changed from the “Department of Material Sciences” to the present one, viz. the “Department of Condensed Matter Physics and Material Sciences” through the order of the registrar on 16/9/2011, after a general consensus among the faculty members about it. Faculties in this large department worked vigorously on various aspects of condensed matter physics, as well as took part in teaching courses, in the centre and out of it. There was large number of students in the department, including short-term students coming from other parts of India. In addition, there were a handful of postdoctoral research associates and research scientists too. These are all reflected in the following numbers (data only for the year concerned)

Type	Number
Total number of faculties	14
Number of publications in peer reviewed journals	59
Number of poster and other publications	23
Chapters of books written	2
Lectures delivered in conferences (including invited and oral)	88
Academic visits to India and abroad, during this time	16
Number of courses taught, internally (IPhD and PMSc) and externally (including at overseas)	14
Number of externally sponsored projects	32 (out of 41 in the whole centre)
Number of Ph.D. Students	57
Number of Project Students	19 (including IPhD summer students, external summer students)
Number of post doctoral researchers	15
Number of meetings organized	10
Awards / recognitions	2

In terms of individual efforts, while the details are given by each faculty member in their respective pages, the following is only a gist of major accomplishments, arranged in alphabetical order of names.

Prof. Abhijit Mookerjee and his group carried theoretical studies on the work they had started on the electronic, vibrational and magnetic properties of different materials. They also worked on disordered superconductors. They then started the work on excited state density functional theory with the Harbola-Sahni approach.

Dr. Anjan Barman and his group worked on ultralow time scale magnetization dynamics to study broadband ferromagnetic resonance in magnonic crystals etc. They also did theoretical modelling in micromagnetic simulations using finite difference and finite element methods to study the thermal conductivity in multilayers and alloy systems.

Prof. Arup K. Raychaudhuri's group focused on nanomaterials. They are specialists in nanofabrication and nanolithography, opto-electronic and transport properties of single nanowires of metals and semiconductors. In addition, they also looked at the Physics of correlated oxides.

Dr. Barnali Ghosh (Saha) worked on neutron diffraction study under high pressure in complex oxides of bulk and nanocrystals, and on multifunctional perovskite oxide systems.

Dr. Chhayabrita Biswas and her group worked on various Heusler alloys, like Ni-Mn-Z (Sn, In), Ni-Mn-Sn and Co-doped Ni-Mn-In Heusler alloys, from both theoretical view points and experimental aspects.

Prof. Kalyan Mandal and his group worked on many magnetic materials, including magnetic nanostructures like magnetite ( $\text{Fe}_3\text{O}_4$ ) nano-hollow spheres and their size dependent properties, defect originated magnetism in doped ZnO nanowires, multiferroic nanotubes and magnetocaloric effect.

Dr. Madhuri Mandal worked on nano materials with a hope to find suitable material for hyperthermia, drug release, biosensor, pollution control etc.

Dr. Pratip Kr. Mukhopadhyay's group concerned themselves with magnetic alloys, like disordered and ferromagnetic shape memory alloys. They made various such alloys and made different measurements with them, and found some unexplained and interesting behaviour. Some theoretical studies were also done to explain the data.

Dr. Priya Mahadevan with her group worked on many theoretical problems, including stability of binary oxides and contrasted the behaviour between  $\text{K}_2\text{O}_x$  and  $\text{H}_2\text{O}_x$ , graphene-like analogues among binary oxides and semiconductors; and defect-induced magnetism in ZnO in the realm of dilute magnetic semiconductors.

Dr. Ranjan Chaudhury and his group worked on theoretical analysis of inelastic neutron scattering in layered quantum ferromagnets, superconducting pairing in the occurrence of Kohn anomaly in elemental superconductor and superconducting pairing in low-dimensional systems.

Dr. Saikat Ghosh worked in general research area of experimental quantum optics and high precision spectroscopy. He was busy in setting up an imaging system (confocal microscope) to image and study optical properties of single nano-particles and molecules.

Dr. Saswati Barman worked with various simulation problems, including among others static and dynamic properties of nanomagnets, dynamics of antidote and permalloy lattices.

Dr. Sugata Mukherjee looked at problems on electronic structures of nanostructured Materials, and two dimensional structured carbon and boron nitrides.

Professor Tanusri Saha-Dasgupta and her group worked on various theoretical problems of electronic band structure and its various effects, like effect of size reduction in half-doped manganites, structures of bilayer



and trilayer nickelates, organic-inorganic hybrid framework compounds, low-dimensional quantum spin systems and carbon materials, olivines etc.

Finally, a discovery of a new light induced micromechanical actuation in a series of smart materials was announced in this year. It was a joint effort between a team from this department and another from the Department of Physics, National University of Singapore, Singapore. A colloquium was given in the centre, and an invited lecture was given at IIT/Madras, in the annual conference of Magnetic Society of India. A press brief was telecasted in DD Bangla and in the national news from Delhi.

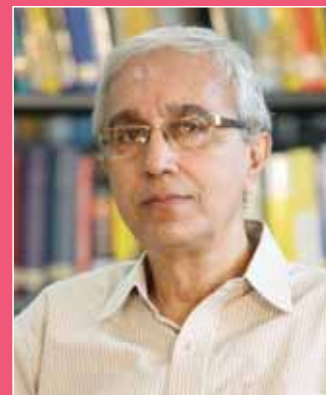


**Pratip Kumar Mukhopadhyay**

Head, Department of Condensed Matter Physics  
and Material Sciences

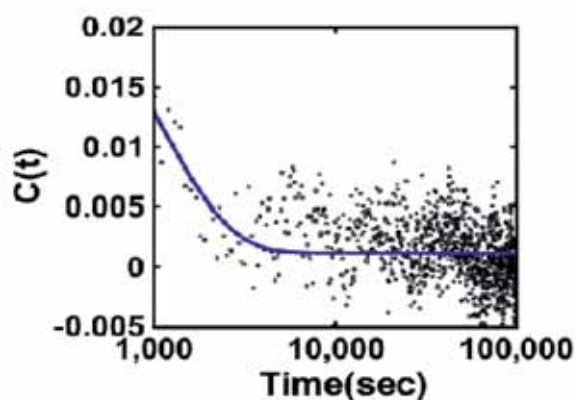
Electronic, vibrational and magnetic properties of disordered solids. Excited state density functional theory with the Harbola-Sahni approach

Abhijit Mookerjee  
Emeritus Professor



We developed techniques to study magnetization decay dynamics with inputs coming from first principles calculations. We can now directly compare with experimental data. We did this with the experimental results of Prof. A.K. Majumdar. This comparison allowed us not only the authentication of our theory but also lead to the understanding of abnormally slow decay in spin-glasses.

The effect of disorder on a negative-U Hubbard model was quite promising.



### PUBLICATIONS IN JOURNALS

1. Aftab Alam, Rajiv K. Chouhan, and Abhijit Mookerjee, *Thermal conductivity and diffusion-mediated localization in  $Fe_{1-x}Cr_x$  alloys from first principles*, Phys Rev, 2011, **B84**, 224309
2. Shreemoyee Ganguly, Indra Dasgupta, Abhijit Mookerjee, *Superconductivity in multi-band disordered systems : a vector recursion approach*, Phys Rev, 2011, **B84**, 174508
3. Prashant Singh, Moshior Rahman, Abhijit Mookerjee, *Magnetic transitions in  $Ni_{1-x}Mo_x$  and  $Ni_{1-x}W_x$  disordered alloys*, J Magn Magn Mat, 2011, **323**, 2478

### SUPERVISION OF STUDENTS

Ph.D. Students: Those that completed their PhDs: Moshior Rahman, Santosh Roy, Shreemoyee Ganguly, Mitali Banerjee, Rudra Banerjee; Still doing

their PhD: Prashant Singh, Ambika Prasad Jena, Rajiv Chouhan, Gopi C Kaphle, Tanmoy Ghosh (with P.K. Mukhopadhyay); Project Students: Pankaj Kumar

### COURSES TAUGHT

1. Advanced Statistical Mechanics at WBSU 4th Sem
2. Condensed Matter Physics at WBSU 3rd Sem
3. Adv Condensed Matter Physics at Lady Brabourne College 4th Sem

### PARTICIPATION IN COMMITTEES

External: VC's nominee in Selection Committee of Faculty at Presidency University; Member, Academic Committee, WBSU; Chairman,, Executive Committee, Kendriya Vidyalaya II, Salt Lake

### SPONSORED PROJECTS

NET-56 Project of the TWAS, Trieste jointly with Tribhuvan University, Nepal





Anjan Barman  
Associate Professor

Femto and picosecond magnetization dynamics, broadband ferromagnetic resonance, magnonic crystals, nanomagnetism, magnetic vortex dynamics, magnetic multilayers and exchange spring systems, micromagnetic simulations using finite difference and finite element methods, thermal conductivity in multilayers and alloy systems

We have demonstrated an all-optical excitation and detection of collective magnetization dynamics in arrays of coupled  $\text{Ni}_{80}\text{Fe}_{20}$  (permalloy) nanoelements with varying areal density and determined three different collective regimes in these arrays. At very high areal density, a uniform collective mode is observed. At intermediate areal densities, three nonuniform collective modes appear and at very low areal density, we observe noncollective dynamics. We have further used this technique to detect the ultrafast magnetization dynamics of arrays of 50nm permalloy dots down to the single nanodot regime for the first time. The single nanodot reveals one dominant resonant mode (edge mode) with slightly higher damping than that of the unpatterned thin film. With the increase in the areal density both the frequency and damping increases significantly due to the increase in the interdot magnetostatic

interactions and a mode splitting and jump in apparent damping are observed. We have also observed a configurational anisotropy in the precession frequency due to the symmetry of the magnetostatic stray field within the array.

We have fabricated and measured optically induced ultrafast precessional dynamics in Co antidot lattices with antidot diameter of 100nm and with varying lattice constants between 200nm and 500nm. We have observed tunable bandgaps and appearance of new bands with decrease in lattice constant. Analysis of mode profiles show various localized and extended modes.

We have developed of a new method for the numerical calculations of spin wave dispersions in magnetic nanostructures. The method is validated in various nanomagnetic systems and 1-D and 2-D magnonic crystals.

### PUBLICATIONS IN JOURNALS

1. D. Kumar, O. Dimitriyev, P. Sabareesan and A. Barman, *Numerical calculation of the spin wave dispersions in magnetic nanostructures*, J. Phys. D: Appl. Phys., 2012, **45**, 015001
2. S. Barman, A. Ganguly and A. Barman, *Phonon heat conduction in  $\text{Al}_x\text{Ga}_{1-x}\text{N}$ : a theoretical study*, Europhys. Lett., 2012, **97**, 36011
3. S. Pal, B. Rana, S. Saha, R. Mandal, O. Hellwig, J. Romero-Vivas, S. Mamica, J. W. Klos, M. Mruczkiewicz, M. Krawczyk, and A. Barman, *Time-resolved measurements of spin-wave spectra in CoO capped  $\{\text{Co}(t)/\text{Pt}(7\text{\AA})\}_n$  multilayers*, J. Appl. Phys., 2012, **111**, 07C507
4. B. Rana, D. Kumar, S. Barman, S. Pal, R. Mandal, Y. Fukuma, Y. Otani, S. Sugimoto and A. Barman, *Anisotropy in collective precessional dynamics in arrays of  $\text{Ni}_{80}\text{Fe}_{20}$  elements*, J. Appl. Phys., 2012, **111**, 07D503
5. A. K. Ghosh, H. Kevin, B. Chatterjee, G. D. Dwivedi, A. Barman, H.D. Yang, and S. Chatterjee, *Effect of Sr-doping on multiferroic properties of  $\text{Bi}_{0.8}\text{La}_{0.2}\text{Fe}_{0.9}\text{Mn}_{0.1}\text{O}_3$* , Solid State Commun., 2012, **152**, 557
6. B. Rana, D. Kumar, S. Barman, S. Pal, Y. Fukuma, Y. Otani and A. Barman, *Detection of picosecond magnetization dynamics of 50 nm magnetic dots down to the single dot regime*, ACS Nano, 2011, **5**, 9559
7. B. Rana, S. Pal, S. Barman, Y. Fukuma, Y. Otani and A. Barman, *All-optical excitation and detection of picosecond dynamics of ordered arrays of nanomagnets with varying areal density*, Applied Physics Express, 2011, **4**, 113003

8. B. Rana, A. Ganguly and A. Barman, *Magnetic shape anisotropy in chemically synthesized chains of nickel nanoparticles*, IEEE Trans. Magn., 2011, **47**, 2859
9. S. K. Mandal, A. R. Mandal, A. Barman and U. K. Gautam, *Visible photoluminescence from PbS nanorods: Effect of silver doping*, J. Nanosci. Nanotechnol., 2011, **11**, 10234
10. S. Pal, S. Saha, D. Polley and A. Barman, *Magnetization reversal dynamics in Co Nanowires with competing magnetic anisotropies*, Solid State Commun., 2011, **151**, 1994
5. Javid Ahmad Banday, Feroz Ahmad Mir, Saleem Farooq, Mushtaq Ahmad Qurishi, Surinder Koul, Tej Kishen Razdan, *Structural, Thermal and Optical Studies of Oxypeucedanin Hydrate Monoacetate Micro-Crystals from Prangos pabularia*, American Journal of Analytical Chemistry, 2012, **3**, 204

#### LECTURES DELIVERED

1. A. Barman, *Laser induced ultrafast spin dynamics in magnetic multilayers and nanomagnets arrays*, FNSCMPLA 2012, University of Burdwan, March 6-7, 2012
2. A. Barman, *Ultrafast magnetization dynamics in two-dimensional arrays of magnetic nanostructures*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
3. S. Pal, S. Barman, O. Hellwig, D. Polley and A. Barman, *Influence of exchange spring behaviour on the spin wave dynamics of the FePt/FeNi bilayers with varying FeNi thickness*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
4. R. Mandal, S. Saha, D. Kumar, S. Barman, S. Pal, K. Das, A. K. Raychaudhuri, Y. Fukuma, Y. Otani and A. Barman, *Tunable high frequency magnonic spectra in two dimensional in two dimensional arrays of nanoscale magnetic antidotes*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
5. S. Saha, R. Mandal, S. Barman, D. Kumar, B. Rana, Y. Fukuma, S. Sugimoto, Y. Otani, and A. Barman, *Spin wave dynamics in 2D artificial nanomagnetic lattices: the effect of lattice symmetry*, Advanced and Functional Materials, SNBNCBS, Kolkata, Mar 1-2, 2012
6. B. K. Mahato, B. Rana, R. Mandal, D. Kumar, S. Sugimoto, Y. Fukuma, Y. Otani, and A. Barman, *Normal modes of magnetization dynamic of square array of cross shaped magnetic dots*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
7. A. Ganguly, A. Barman and S. Barman, *Micromagnetic Simulations of Domain Wall Dynamics in Ferromagnetic Nanostripe*, Advanced

#### BOOK PUBLISHED

S. Pal, B. Rana, O. Hellwig, T. Thomson and A. Barman, *Correlation between perpendicular magnetic anisotropy and Gilbert damping in [Co/Pd]<sub>8</sub> multilayers with variable Co layer thickness*, Nanomaterials and their Applications, pp. 206, Allied Publishers Pvt. Ltd., 2011

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Bivas Rana, Semanti Pal, Dheeraj Kumar, Bipul Kumar Mahato, Sushmita Saha, Ruma Mandal, Arnab Ganguly, Debanjan Polle; **Project Students:** Arnab Ganguly, Debanjan Polle, Rajesh Dutta (IIT Madras)

#### POST DOCTORAL RESEARCHERS

Sabareesan Ponraj, Feroz Ahmed Mir, Pinaki Laha, Rabindranath Gayen

#### STUDENTS' PUBLICATIONS

1. P. Sabareesan and M. Daniel, *Magnetization reversal in nanopillar devices*, Phys. Scr., 2011, **84**, 035706
2. Feroz A. Mir, M. Ikram and Ravi Kumar, *Impact of substrate on some physical properties of PrFe<sub>0.5</sub>Ni<sub>0.5</sub>O<sub>3</sub> thin films*, Solid State Sciences, 2011, **13**, 1994
3. Feroz A. Mir, M. Ikram and Ravi Kumar, *Doping effects arising from Ni for Fe in PrFeO<sub>3</sub> ceramic thin films*, Philosophical Magazine, 2011, **92**, 1058
4. Javid A. Banday, F. A. Mir, Saleem Farooq, Mushtaq A. Qurishi, Surrinder Koul and T. K. Razdan, *Salicylic acid and Methyl gallate from the roots of Conyza canedensis*, International Journal of Chemical and Analytical Science, 2012, **3**, 1305



- and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
8. B. Rana, D. Kumar, S. Barman, S. Pal, R. Mandal, S. Sugimoto, Y. Fukuma, Y. Otani, and A. Barman, *Ultrafast Spin Dynamics in 2-D Nanoscale Magnonic Crystals: Anisotropy in Collective Modes*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
  9. D. Polley, S. Pal, O. Hellwig, R. K. Mitra and A. Barman, *Terahertz emission from [Co/Pd]<sub>8</sub> multilayers associated with laser induced ultrafast demagnetization*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
  10. Dheeraj Kumar, J. W. Klos, J. Romero-Vivas, M. Krawczyk and A. Barman, *The Effect of Edge Pinning on the Spectrum of Spin Waves in Magnonic Antidot Waveguides*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 1-2, 2012
  11. A. Barman, *All-optical excitation and detection of spin dynamics in 1-D and 2-D magnonic crystals*, India Singapore Joint Physics Symposium, IIT Delhi, February 20-22, 2012
  12. S. Barman, A. Ganguly and A. Barman, *Micromagnetic simulation of current induced oscillatory motion of vortex domain walls in notched ferromagnetic nanostripes*, ICONSAT, Hyderabad, January 20-23, 2012
  13. S. Pal, B. Rana, S. Saha, R. Mandal, O. Hellwig, T. Thomson, J. Romero-Vivas, S. Mamica, J. W. Klos, M. Mruczkiewicz, M. Krawczyk and A. Barman, *Time-resolved magnetization dynamics in magnetic multilayers with high perpendicular magnetic anisotropy*, ICONSAT, Hyderabad, January 20-23, 2012
  14. B. Rana, D. Kumar, S. Barman, S. Pal, R. Mandal, S. Sugimoto, Y. Fukuma, Y. Otani, and A. Barman, *Ultrafast magnetization dynamics in 2-D nanoscale magnonic crystals: anisotropy in collective modes*, ICONSAT, Hyderabad, January 20-23, 2012
  15. B. Rana, D. Kumar, S. Barman, S. Pal, R. Mandal, Y. Fukuma, Y. Otani, S. Sugimoto and A. Barman, *Anisotropy in collective precessional dynamics in arrays of Ni<sub>80</sub>Fe<sub>20</sub> nanoelements*, 56th MMM Conference, Scottsdale, Arizona, October 30 – November 03, 2011
  16. S. Pal, B. Rana, S. Saha, R. Mandal, O. Hellwig, J. Romero-Vivas, S. Mamica, J. W. Klos, M. Mruczkiewicz, M. Krawczyk, and A. Barman, *Time-resolved measurement of spin wave spectra in [Co(t)/Pt(7Å)]<sub>n</sub> multilayers*, 56th MMM Conference, Scottsdale, Arizona, October 30 – November 03, 2011
  17. A. Barman, *All-optical excitation and detection of spin waves in magnetic nanostructures*, C. K. Majumdar Memorial Workshop on Condensed Matter Physics, IACS, Kolkata, November 11, 2011
  18. A. Barman, *All-optical and spin torque induced dynamics in 1-D and 2-D magnonic crystals*, Magnetic Phase Transitions and Transformations, Kolkata, August 5-9, 2011
  19. B. Rana, S. Pal, Y. Fukuma, Y. Otani and A. Barman, *Transition from a collective to non-collective precessional dynamics in nanomagnet arrays with varying areal density*, IEEE International Magnetism Conference, Taipei, Taiwan, April 25-29, 2011
  20. S. Pal, B. Rana, O. Hellwig, T. Thomson and A. Barman, *Correlation between perpendicular magnetic anisotropy and Gilbert damping in [Co/Pd]<sub>8</sub> multilayers*, IEEE International Magnetism Conference, Taipei, Taiwan, April 25-29, 2011
  21. D. Kumar, A. Barman, M. Dvornik, O. Dmytriiev, V. V. Kruglyak, G. Venkat, A. Prabhakar, M. Krawczyk, M. Mruczkiewicz, M. Franchin, and H. Fangohr, *Proposal of a standard micromagnetic problem: calculation of spin wave dispersion in a nanoscale magnonic waveguide*, IEEE International Magnetism Conference, Taipei, Taiwan, April 25-29, 2011
  22. D. Kumar, O. Dymitriiev and A. Barman, *Numerical calculation of the dispersion of magnon waves in different kinds of magnonic crystals*, IEEE International Magnetism Conference, Taipei, Taiwan, April 25-29, 2011
  23. S. Pal, S. Saha, D. Polle and A. Barman, *Competing magnetic anisotropies in Co nanowires arrays*, IEEE International Magnetism Conference, Taipei, Taiwan, April 25-29, 2011
  24. B. Rana, A. Ganguly and A. Barman, *Magnetic*

*shape anisotropy in chemically synthesized Ni nanochains*, IEEE International Magnetics Conference, Taipei, Taiwan, April 25-29, 2011

#### ACADEMIC VISITS

1. UKIERI-DST collaborative research project, University of Exeter, Exeter, UK, September 2011
2. India-EU collaborative research project, University of Southampton, Southampton, UK, September, 2011

#### COURSES TAUGHT

1. PHY416: Optical Physics
2. PHY410: Advanced Techniques in Experimental Physics
3. PHY191: Basic Laboratory – I
4. PHY391: Basic Laboratory – II

#### PARTICIPATION IN COMMITTEES

- a. External: Co-ordinator of India-EU project DYNAMAG
- b. Internal: In-charge of Technical Cell; Member of works committee; Member of various purchase committees

#### SPONSORED PROJECTS

1. Spin-wave and domain wall dynamics in vertical magnetic nanowires, Funding agency: UKIERI-DST

2. Quasistatic and Ultrafast Magnetization Dynamics in Nanomagnet Arrays, Funding agency: Nano Mission, DST
3. Advanced computational studies of dynamic phenomena in magnetic nano-materials, Funding agency: DST- European Commission (FP7)
4. Magnonic Crystals: New paradigm towards microwave communications, Funding agency: DST-JST
5. Development of GHz frequency filters and attenuators using nanoscale magnonic crystals, Funding Agency: Department of Information Technology
6. Thematic Unit of Excellence on Nanodevice Technology, Funding Agency: Nano Mission, DST
7. Unit on Nanoscience, Funding Agency: Nano Mission, DST

#### MEETINGS ORGANIZED

1. Co-organized International Conference on Functional Oxide and New Carbon Materials at the SNBNCBS, 2012
2. Co-organized Conference on Advanced and Functional Materials at the SNBNCBS, 2012
3. Organized JST-DST workshop on Spin Physics at the SNBNCBS during December 7-8, 2011







Arup Kumar Raychaudhuri  
Director and Senior Professor

- Nanomaterials, Nanofabrication and Nanolithography, Opto-electronic and Transport properties of single nanowires of metals and semiconductors, Physics of correlated oxides, Some of the specific problems investigated: Finite size effects in metal nanotubes, spin polarized transport in nanomaterials in Coulomb blockade regime, Gate control of visible emission in ZnO nanostructured films, nanopatterning and FIB based nanofabrication
- Key words: Nanomaterials, Nanolithography, Correlated electron systems

Reversible control of the photoluminescence in the visible range with intensity modulation of 100% occurring, has been achieved by application of low bias to a device consisting of nanostructured ZnO film sandwiched between indium tin oxide electrode and a solid polymer electrolyte. A model has been proposed for the observed effect that is based on defect states of ZnO and the band bending at the ZnO-electrolyte interface that can be changed by the applied bias.

Magnetotransport properties of nanocrystals of functional magnetic oxides (with size down to 15 nm) have been done down to 0.3K and magnetic in fields up to 14 T. The observed phenomena have been analyzed using the concept of spin-polarized tunnelling in the presence of Coulomb blockade. The data were used to estimate the tunneling distances

and the inverse decay length of the tunnelling wave function and the height of the tunnelling barrier. The magneto-transport data were used to find the magnetic field dependences of the tunnelling parameters. The data taken over a large magnetic field range allowed us to separate out the different contributions to the inter-grain transport in the nanocrystalline system.

Non-Gaussian 1/f noise has been used to investigate the charge fluctuations in a correlated glassy phase of the polaronic carriers in the ferromagnetic insulating state (FMI) of a hole doped manganite single crystal. A sharp freeze-out of the noise magnitude with temperature on cooling as the system is cooled below a certain temperature where the freezing temperature shows a kinetic character.

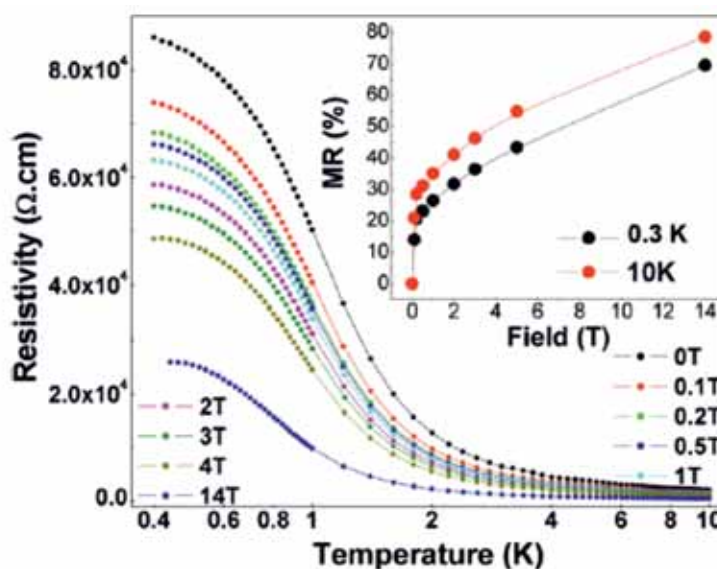


Fig.:1 Resistivity vs temperature plots for  $\text{La}_{0.67}\text{Ca}_{0.33}\text{MnO}_3$  nanocrystals ( $d \sim 15\text{nm}$ ) at low temperatures 0.3K to 10K in magnetic fields upto 14T showing spin polarized transport under Coulomb blockade

## PUBLICATIONS IN JOURNALS

1. M. Ghosh and A. K. Raychaudhuri, *Electric field induced reversible control of visible photoluminescence from ZnO nanoparticles*, Applied Physics Letters, 2011, **98**, 153109
2. Barnali Ghosh, K. Das and A. K. Raychaudhuri, *Voltage bias induced modification of the transport property of all oxide  $Pr_{0.5}Ca_{0.5}MnO_3/SrTi_{0.95}Nb_{0.05}O_3$  junctions*, Journal of Applied Physics, 2011, **109**, 083934
3. S. Batabyal, A. Makhal, K. Das, A. K. Raychaudhuri, S. K. Pal, *Ultrafast dynamics of excitons in semiconductor quantum dots on a plasmonically active nano-structured silver film*, Nanotechnology, 2011, **22**, 195704
4. J. P. Naik, P. D. Prewett, K. Das, A. K. Raychaudhuri, *Instabilities in Focused Ion Beam-Patterned Au Nanowires*, Microelectronic Engineering, 2011, **88**, 2840
5. S. Das, K. Das, R. K. Singha, S. Manna, A. Dhar, S. K. Ray and A. K. Raychaudhuri, *Improved infra-red photoluminescence characteristics from circularly ordered self-assembled Ge islands*, Nanoscale Research Letters, 2011, **6**, 416
6. Manotosh Chakravorty, Kaustuv Das, A. K. Raychaudhuri, J. P. Naik and P. D. Prewett, *Temperature dependent resistivity of platinum-carbon composite nanowires grown by focused ion beam on  $SiO_2/Si$  substrate*, Microelectronic Engineering, 2011, **88**, 3360
7. S. Chandra, A. I. Figueroa, B. Ghosh, A. K. Raychaudhuri, M. H. Phan, P. Mukherjee, H. Srikanth, *Fabrication and magnetic response probed by RF transverse susceptibility in  $La_{0.67}Ca_{0.33}MnO_3$  nanowires*, Physica B, 2012, **407**, 175
8. Sudeshna Samanta, A. K. Raychaudhuri, Ya. M. Mukhovsky, *Non-Gaussian resistance noise in the ferromagnetic insulating state of a hole-doped manganite*, Physical Review B, 2012, **85**, 045127
9. K. Das, S. Das, R. K. Singha, S. K. Ray, A. K. Raychaudhuri, *Preferential ordering of self-assembled Ge islands on focused ion-beam patterned  $Si(100)$* , J Nanopart Res., 2012, **14**, 725
10. Tapati Sarkar, M. Venkata Kamalakar, A. K. Raychaudhuri, *Electrical transport properties of nanostructured ferromagnetic perovskite oxides*

*$La_{0.67}Ca_{0.33}MnO_3$  and  $La_{0.5}Sr_{0.5}CoO_3$  at low temperatures ( $5 K > T > 0.3 K$ ) and high magnetic field*, New Journal of Physics, 2012, **14**, 033026

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Rajesh Neogy, Shanewz Mandal, Manotosh Chakravorty, Rajib Nath, Rabeya Basori, Putul Malla Chowdhury, Sabyasachi Ghosh, Rishi Ghimire; **Project Student:** Nirel Desai

## POST DOCTORAL RESEARCHERS

Kaustuv Das, Sudeshna Smanata

## STUDENTS' PUBLICATIONS

Rajesh Kumar Neogy and Rajib Nath, *Synthesis of Micron Sized Gold Network Structure by Assembling Individual Gold Nanoparticles by Laser Assisted PEGylation Method*, Micro and Nanosystems, 2011, **3**, 319

## LECTURES DELIVERED

1. *Metals, Insulators and Oxides*, Bose Colloquium, S. N. Bose National Centre for Basic Sciences, September 16, 2011
2. *Resistive switching in nanoscale oxides and charge transfer complex*, CTCM, IISER, Kolkata, October 7-9, 2011
3. *Combining top-down and bottom-up fabrications: Experiments on single nanowires and nanotubes*, Invited talk, "Chemistry & Physics of Advanced Materials", Vedic Village, Kolkata, October 28-30, 2011
4. *Growth, characterization and Electrical measurements on single nanowires and devices*, Invited talk "International Symposium on Analytical Science and Technology", Daejeon, Korea, November 15-17, 2011
5. *Combining top-down and bottom-up fabrications: Experiments on single nanowires and nanotubes*, Invited Talk "International Conference on Theoretical and Applied Physics", Department of Physics & Meteorology, IIT Kharagpur, December 1-2, 2011
6. *Ferromagnetic insulating state of manganite: Is it an electron glass?*, ICTS Condensed Matter Physics Program (ICMP 2011), Bangalore, December 19-22, 2011
7. *Combining top-down and bottom-up fabrications: Experiments on single nanowires and nanotubes*,

Invited Talk "ICONSAT 2012", Hyderabad, January 20-23, 2012

8. *Joy of Small things*, Invited Colloquium, MSU, Baroda, February, 2012
9. *Joy of Small things and challenges ahead*, Programme for 29th OPS Convention and National Seminar on Nano Science and Nano Technology, Odisha Physical Society, Bhubaneswar, February 11, 2012
10. *The never ending surprises of perovskite oxides*, Key note address, AMST 2012, Gurajat University, Ahmedabad, February 3-4, 2012
11. *Structure and magnetism in Complex oxides: Neutron scattering as a probe*, Discussion meeting on Neutron scattering, BARC, Mumbai, March 12-13, 2012

#### ACADEMIC VISITS

1. For Scientific Collaborative Work with Professor D.E. Logan and Participation in the Inaugural Oxford – India Celebration, Oxford University, UK, June 15-24, 2011
2. To work on the collaborative project (UKIERI) with Prof. P.D. Prewett, Birmingham, UK, August 18-26, 2011

#### PARTICIPATION IN COMMITTEES

- a. External: Member, Science and Engineering Research Council, Department of Science and Technology; Member, Nanosciennce Advisory Group of Nanomission; Member Board of Governors, IIT/Kanpur; Member Council, Bose Institute, Kolkata; Visitors nominee in Selection Committee for Faculty at IIT/ Guwahati, IIT/Kharagpur; Chairman, Project Advisory Group for projects in Department of Information Technology
- b. Internal: Member, Governing Body; Chairman-Finance Committee, Building Committee, Consultative Advisory Committee, Medical Committee, Selections and Assessment committees for Faculties

#### AWARDS / RECOGNITIONS

6th National Research Award for Nanoscience and Technology-Nanomission

#### SPONSORED PROJECTS

1. J.C. Bose Fellowship, Prof. A.K. Raychaudhuri, DST, SR/S2/JCB-17/2006
2. Centre for Nano Technology, Prof. A.K. Raychaudhuri, DST, SR/S5/NM-31/2005
3. Development of cryostats and electronic measurement units for physical properties measurements using a zero-loss dewar, Prof. A.K. Raychaudhuri, DST, IR/S2/PU-03/2006
4. Utilization of Synchrotron Radiation Sources and Neutron Sources abroad, Prof. A.K. Raychaudhuri, DST, SR/S9/Z-18/2007
5. Design and Fabrication of Nanomachined Thermal Sensors using FIB (DST – UKIERI), Prof. A.K. Raychaudhuri, DST, DST/UKIERI/SA/P-29/09
6. Neutron diffraction studies of collapse of charge ordering in narrow band half-doped manganite  $Y_{0.5}Ca_{0.5}MnO_3$  nanoparticles, A.K. Raychaudhuri, UGC DAE CSR, CSR/AO/MUM/CRS-M-154
7. EICOON – Euro Indo forum for nano materials research coordination & cooperation of researchers in sustainable energy technologies, Prof. A.K. Raychaudhuri, Dr. Sugata Mukherjee, University of Twente
8. Unit on Nanoscience at SNBNCBS, Kolkata (UNANST – II), Prof. A.K. Raychaudhuri, DST, SR/NM/NS-53/2010
9. Investigation of strain-dependent magnetization dynamics and electronic transport in magnetic oxides for spintronics and signal processing applications, Prof. A.K. Raychaudhuri, DST-DAAD (Indo-German), INT/FRG/DAAD/P-210/2011, dated 9-7-2011
10. Electroresistance in single crystals and thin films of mixed valence manganites, Prof. A.K. Raychaudhuri, DST, (DST-RFBR)(RUSP-1183)INT/RFBR/P-110
11. Thematic Unit for Excellence on Nanodevice Technology, Prof. A.K. Raychaudhuri / Dr. Anjan Barman (Coordinator), DST, SR/NM/NS-09/2011
12. UKIERI/AKR/11-12/70 – "Nano Breath App, Prof. A.K. Raychaudhuri, IND/CONT/E/11-12/086

- Neutron diffraction study under High pressure in complex oxides of bulk and nanocrystals.
- Fabrication of resistive switching devices of multifunctional perovskite oxide systems and transport measurement
- Electron Energy loss spectroscopy study in multifunctional oxide nanowires and nanocrystals.

Barnali Ghosh (Saha)  
Research Scientist (Scientist-D)



## Destabilization of ground state of low doped manganites under hydrostatic pressure:

**A Neutron Diffraction study up to 10GPa:** Our motivation was to see whether, whether the ground state of the low doped manganite can be destabilized by external hydrostatic pressure. We had observed the metallization of FMI state of low doped manganite system under hydrostatic pressure and high magnetic field. The metallic phase so created under pressure has no appreciable magnetoresistance (MR); though the ferromagnetic metallic (FMM) phase of optimally doped sample shows CMR. The Neutron diffraction measurement done under high hydrostatic pressure up to 10GPa shows that the pressure leads to a change in the crystal structure and most importantly collapse of the magnetic moment to a low value that leads to absence of any MR under pressure induced metallization. Hence the ground state of low doped manganite system can be destabilized by applying hydrostatic pressure; investigated both by transport and Neutron Diffraction study.

### Work done other than research activities:

As a Reserach Scientist of Technical cell I have to be actively involved in the instrumental facility management and equipment installation which looks after the overall running of the major instrumental facilities at our centre. As a Research Scientist in Technical Cell; I am directly and actively involved in

maintenance of equipments; purchase and installation of new instruments under Technical cell. I am also involved in the appointment and Job allotment of Technical staffs.

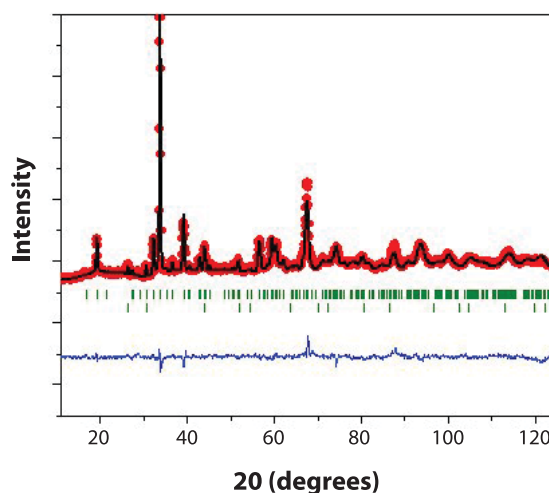


Fig : Neutron diffraction data under hydrostatic pressure (10GPa) in low doped manganite

### Working as an Active Member of Technical cell:

Technical cell looks after the over all running of the major instrumental facilities at our centre. As a Research Scientist under Technical Cell; I am directly and actively involved in maintenance of equipments; purchase and installation of new instruments under Technical cell. I am also involved in the appointment and Job allotment of Technical staffs.

## PUBLICATIONS IN JOURNALS

1. Barnali Ghosh, K. Das, and A. K. Raychaudhuri, *Voltage bias induced modification of the transport property of all oxide  $Pr_{0.5}Ca_{0.5}MnO_3/SrTi_{0.95}Nb_{0.05}O_3$  junctions*, J. Appl Phys., 2011, **109**, 083934
2. S. Chandra, A. I. Figueroa, Barnali Ghosh, A. K. Raychaudhuri, M. H. Phan P. Mukherjee, H. Srikanth, *Fabrication and magnetic response probed by RF*

*transverse susceptibility in  $La_{0.67}Ca_{0.33}MnO_3$  nanowires*, Physica B, 2012, **407**, 175–178

### POST DOCTORAL RESEARCHER

Nilotpal Ghosh under EVLP

### LECTURES DELIVERED

International Conference on Nano Science and Technology (ICONSAT-2012) Hyderabad, India during January 20-23, 2012

### ACADEMIC VISITS

1. Collaborative Research Schemes (CRS) using facility under Solid state physics division, National Facility for Neutron Beam Research (NFNBR), BARC & UGC-DAE consortium for scientific research, Mumbai Centre, India, June, 2011
2. National Science & Technology University for Steel (MISiS) Moscow, Russia during October, 2011 under DST-RFBR Programme.

### COURSES TAUGHT

PHY 391

### PARTICIPATION IN COMMITTEES

- a. External: Member of Editorial Board/Referee:

Referee of journals: i) Journal of Material Science and Engineering B, ii) Journal of Applied Physics, iii) Solid State Communications

- b. Internal: Technical cell, Various purchase committees, Clean room committee

### SPONSORED PROJECTS

DST sponsored Project under Women Scientist Scheme: (SR/WOS-A/PS-15/2008)

### MEETINGS ORGANIZED

Advanced School on High Resolution X-Ray Techniques, Atomic Force Microscopy and their Applications, December 14-15, 2011

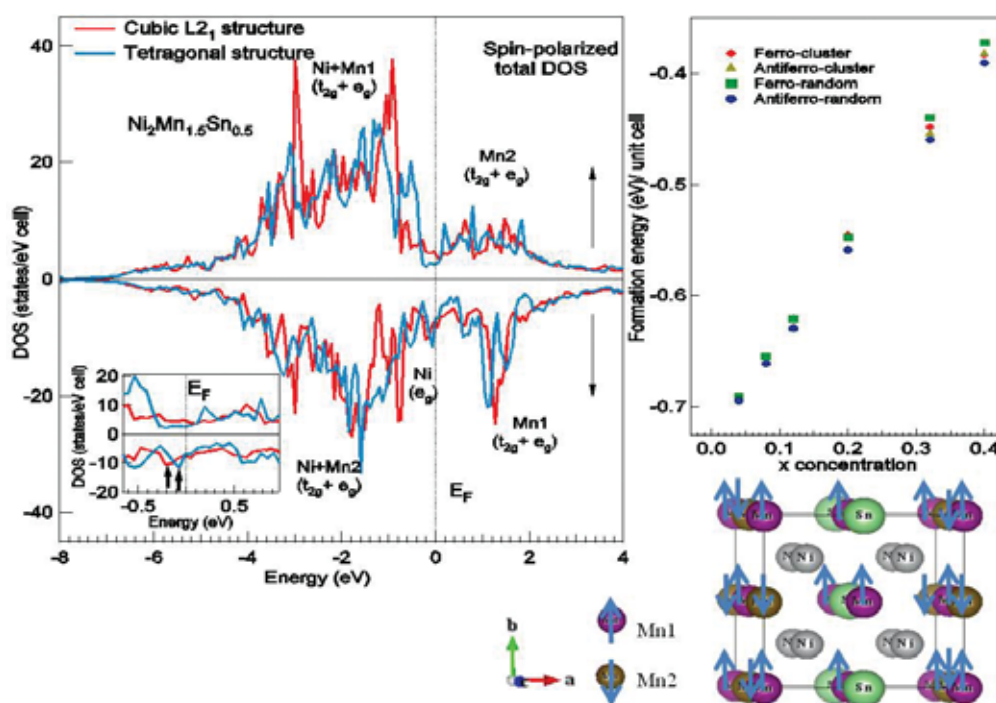
- Electronic structure investigation (Theoretical) of Ni-Mn-Sn Heusler alloys with martensitic phase transition
- Temperature and magnetic field dependent structural transformation of Ni-Mn-Z (Sn, In) Heusler alloys
- Transport, magneto-transport and magnetic properties of Co-doped Ni-Mn-In Heusler alloys

Chhayabrita Biswas  
Bose Fellow



The  $\text{Ni}_2\text{Mn}_{1+x}\text{Sn}_{1-x}$  is doped with Mn at the Sn site. The theoretical calculations show that the Mn prefers to randomly occupy the Sn site rather than clustering. The original Mn (Mn1) has long range ferromagnetic ordering while the substituted Mn (Mn2) has antiferromagnetic ordering with Mn1. Due to antiferromagnetic exchange interaction the average total magnetic moment of the system decreases with increasing Mn2 concentration. The stoichiometric  $\text{Ni}_2\text{MnSn}$  has no structural transition. The structural transition is observed from  $x=0.3$  Mn substitution. The Mn1 minority spin states and Mn2 majority spin states are unoccupied. Ni  $e_g$  state of minority DOS shifts towards the  $E_F$  upon structural transition due to hybridization of Ni-Mn2 3d states. The temperature dependent structural transition show that the  $L2_1$  structure of  $\text{Ni}_2\text{Mn}_{1.4}\text{Sn}_{0.6}$  is transformed to Orthorhombic structure at 10K

temperature. The orthorhombic structure is basically 4O modulated with a mixture of 14M modulated phase also. The martensitic transition temperature range has mixed phase of Austenite and martensite. The temperature dependent neutron diffraction of Ni-Mn-In alloys show that the martensitic transition to low symmetry structure do not occur with the application of magnetic field. The austenitic phase is arrested and martensitic transition does not occur. The Co is doped at the Ni site to form a quaternary Heusler alloy that show martensitic transition. The transition temperature is around room temperature. The magnetic measurements show that ferromagnetic and anti-ferromagnetic state co-exists during the martensitic transition. The reverse phase transition occurs with the application of magnetic field.



## PUBLICATIONS IN JOURNALS

Sandeep Singh and C. Biswas, *Magnetoresistance origin in martensitic and austenitic phase of  $Ni_2Mn_{1+x}Sn_{1-x}$* , Appl. Phys. Letts. 2011, **98**, 212101

## OTHER PUBLICATIONS

1. Aniruddha Biswas, Vasudeva Siruguri, Chhayabrita Biswas and Madangopal Krishnan, *Structural Analysis of Ni-Mn-Sn Ferromagnetic Shape Memory Alloy*, International Conference on shape memory and Superelastic Technologies, HongKong, China, November 7 – 9, 2011
2. Sandeep Singh, Soumyadipta Pal, C. Biswas, Ganesh Adhikary, P. Mahadevan and K. Maiti, *Electronic structure of disordered  $Ni_2Mn_{1.4}Sn_{0.6}$* , International Conference on Ferromagnetic Shape Memory Alloys (ICFSMA-2011), Dresden, Germany, July 18 – 22, 2011
3. Soumyadipta Pal, Priya Mahadevan and C. Biswas, *Effect of Mn doping in  $Ni_2Mn_{1+x}Sn_{1-x}$  alloys: ab-initio approach*, National Symposium on "Advances in Materials Science and Technology (AMST-2012)", Gujarat University, February 3 – 4, 2012
4. Sandeep Singh, Ganesh Adhikary, D. Biswas, Kalobaran Maiti and C. Biswas, *Electronic structure modification of  $Ni_2Mn_{1.4}Sn_{0.6}$  upon martensitic phase transition*, AIP Conf. Proc, 2011, 1349, 849

5. Sandeep Singh and C. Biswas, *Disorder induced resistivity changes in  $Ni_2Mn_{1+x}Sn_{1-x}$* , AIP Conf. Proc, 2011, 1349, 1005

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Sandeep Singh, Soumyadipta Pal

## LECTURES DELIVERED

1. Invited: *Co nanodots on Au(887): modified superperiodic potential*, National Workshop on Physics of Quantum Nano Systems, Vidyasagar University, West Bengal, India, March, 2012
2. Invited: *Electronic properties of  $Ni_2Mn_{1+x}Sn_{1-x}$  disordered Heusler alloys*, National School cum Workshop on Magnetic Phase Transitions and Transformations, Kolkata, India, August, 2011
3. *Electronic structure of disordered  $Ni_2Mn_{1.4}Sn_{0.6}$* , International Conference on Ferromagnetic Shape Memory Alloys (ICFSMA-2011), Dresden, Germany, July, 2011

## PARTICIPATION IN COMMITTEES

**Internal:** Technical cell, Newsletter, Rajbhasha, Student Advisory Committee

## SPONSORED PROJECTS

DST-KEK project, Indian Beamline, "The crystal Structure determination across martensitic transition in Ni-Mn-Sn based Heusler alloys", Photon Factory, Japan, October, 2011

- Magnetic nanostructures
- Defect originated magnetism
- Multiferroic materials
- Magnetocaloric effect

Kalyan Mandal  
Professor



**M**agnetite ( $\text{Fe}_3\text{O}_4$ ) nano-hollow spheres were synthesized in one step template free solvothermal method and their size dependent magnetic and electrical properties were investigated in details. Size of the hollow spheres was varied from 100 nm to 725 nm by changing the concentration of capping agent (PVP). The domain structure of these spheres changed from pseudo single domain (PSD) to multi domain (MD) state with the increase in sphere size from 100 nm to 725 nm as evident from Day plots.

Cation vacancy-induced  $d^0$  room temperature ferromagnetism was observed in nonmagnetic potassium doped ZnO nanowires (NWs) synthesized within the pores of the AAO template. Remarkable enhancement in the ferromagnetic signature and photoluminescence characteristics was found in the K-doped ZnO NWs with respect to the pristine ZnO NWs through defect-engineering. The presence of

large amount of zinc vacancies in the NWs have been confirmed by photoluminescence measurements. It is found that the incorporation of K-related defects in ZnO NWs promotes the formation of zinc vacancies by reducing the formation energy of the zinc vacancy and hence stabilizes the hole-mediated ferromagnetism. This study demonstrates that the ferromagnetism can be tuned by controlling the cation vacancy defects by making control over the dopant percentage in the host.

Arrays of single phase perovskite-type polycrystalline pure, Pr and Cr doped and Pr-Cr co-doped  $\text{BiFeO}_3$  (BFO) nanotubes (NTs) (~50 nm wall thickness) have been synthesized using simple wet chemical liquid phase deposition template assisted technique. Spontaneous enhancement in the ferroelectricity, magnetoelectricity and ferromagnetic ordering are evidenced in the Pr and Cr co-doped BFO NTs.

### PUBLICATIONS IN JOURNALS

1. D. Sarkar, K. Mandal and M. Mandal, *Synthesis of chainlike  $\alpha\text{-Fe}_2\text{O}_3$  nanoparticles in DNA template and their characterization*, *Nanoscience and Nanotechnology Letters*, 2011, **3**, 170 – 174
2. D. Sarkar, M. Mandal, R. Das, and K. Mandal, *Fabrication of biologically functionalized, electrically conducting, and aligned magnetic nanoparticles*, *IEEE Transaction on Magnetism*, 2011, **47**, 3163 – 3166
3. S. Chakraborty, K. Mandal, D. Sarkar, V. J. Cremaschi, J. M. Silveyra, *Dynamic coercivity of Mo-doped FINEMETs*, *Physica B*, 2011, **406**, 1915 – 1918
4. S. Ghosh, G. G. Khan, B. Das and K. Mandal, *Vacancy-induced intrinsic  $d^0$  ferromagnetism and photoluminescence in potassium doped ZnO nanowires*, *Journal of Applied Physics*, 2011, **109**, 123927
5. R. Das and K. Mandal, *Effect of barium substitution on ferroelectric and magnetic properties of bismuth ferrite*, *IEEE Transaction on Magnetism*, 2011, **47**, 4054 - 4057
6. S. Ghosh, M. Mandal and K. Mandal, *Effects of Fe doping and Fe-N-codoping on magnetic properties of  $\text{SnO}_2$  prepared by chemical co-precipitation*, *Journal of Magnetism and Magnetic Materials*, 2011, **323**, 1083-1087

### OTHER PUBLICATIONS

1. D. Sarkar, M. Mandal and K. Mandal, *Fabrication and Characterization of DNA templated Electrically Conducting Chainlike Magnetic Nanoparticles*, *Proceedings of International Conference on Materials for Advanced Technologies (ICMAT 2011)*, at Singapore
2. D. Sarkar, M. Mandal and K. Mandal, *Magnetite*





*Hollow Spheres*, Proceedings of International Conference on Nanomaterials and Nanotechnology (ICNANO 2011), Delhi, India

3. S. Ghosh, G. G. Khan and K. Mandal, *Vacancy-induced  $d^0$  Ferromagnetism in Non-magnetic Potassium Substituted ZnO Nanowires*, Proceedings of International Conference on Materials for Advanced Technologies (ICMAT 2011), at Singapore
4. A. K. Singh, G. G. Khan, B. Das, K. Mandal, *Structural and magnetic characterization of permalloy nanostructure using self developed AAO templates*, Proceedings of International Conference on Nanomaterials and Nanotechnology (ICNANO-2011), Delhi, India
5. R. Das and K. Mandal, *Effect of Ba substitution on ferroelectric and magnetic properties of  $\text{BiFeO}_3$* , Proceedings of INTERMAG 2011, 2011, Taipei, Taiwan
6. R. Das and K. Mandal, *Influence of Barium Doping on Magnetic and Ferroelectric Properties in Bismuth Ferrite Thin Films*, Proceedings of International Conference on Materials for Advanced Technologies (ICMAT 2011), at Singapore
7. R. Das, G. G. Khan and K. Mandal, *Multiferroic properties in Pr and Cr co-doped  $\text{BiFeO}_3$  nanotubes fabricated by template assisted route*, Proceedings of International Conference on Nano Science and Technology 2012, Hyderabad, India
2. A lecture series (4 lectures) on, *Magnetic nanomaterials* in AICTE sponsored two-weeks staff development programme on Recent advances in mechanics and their application in nano engineering and technology (invited) organised by the Department of Mechanical Engineering, North-Eastern Regional Institute of Science and Technology, on August 08 – 09, 2011
3. *Finite size effect on magnetic nanomaterials* in UGC sponsored state level seminar on Nanoscience and Nanotechnology: Present and future at Kandi Raj College, Kandi, Murshidabad on January 12, 2012
4. *Models of hysteresis in magnetic materials* (invited), in National school cum workshop on, Magnetic phase transition and transformations, at Jadavpur University, Kolkata, on August 06, 2011
5. *Magnetic nanomaterials*, in C. K. Majumdar Memorial Summer Workshop in Physics 2011, at S. N. Bose National Centre for Basic Sciences, Salt Lake, Kolkata, on June 13, 2011
6. *Finite size effect on magnetic properties*, in Programme for summer project students, at SNBNCBS, on June 14, 2011
7. *Synthesis and study of ferrite nanoparticles*, in National Workshop on Physics of Quantum and Nano-Systems (invited) organised by Vidyasagar University at Jhargram (Midnapore), on March 27, 2012
8. *Preparation and study of magnetic nanowires*, in 35<sup>th</sup> meeting of basic science committee of BRNS, at Bhabha Atomic Research Centre, Mumbai, on August 25, 2011

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Bipul Das (submitted thesis in October, 2011), Arka Chaudhury, Shyamsundar Ghosh, Debashis Sarkar, Rajasree Das, Ashutosh Singh;  
**Project Students:** Ashutosh Kumar Singh ("Template assisted synthesis of 1D magnetic nickel nanostructures", A Post B.Sc. Project)

### POST DOCTORAL RESEARCHERS

Gobinda Gopal Khan, Madhuri Mandal

### LECTURES DELIVERED

1. *Nanostructured iron oxides: Their properties with finite size effect*, in National seminar on recent trends on novel materials (invited) organised by Vidyasagar University at Midnapore, on November 29, 2011

### ACADEMIC VISITS

1. Magnetic flux leakage laboratory, Bhabha Atomic Research Centre, Mumbai, August 24-25, 2011
2. Research and Development Division, Indian Oil Corporation, Faridabad, Delhi, on August 12, 2011

### COURSES TAUGHT

1. PHY 291, Basic Laboratory-II, second semester, 2011 and 2012
2. PHY 391, Methods of experimental physics, third semester, 2011
3. PHY 410, Advanced techniques in experimental physics, fourth semester, 2012

4. PHY 413, Magnetism and superconductivity, fourth semester, 2011

#### **PARTICIPATION IN COMMITTEES**

- a. External:** Council Member, Indian Physical Society; Member, Faculty selection Committee, NIT, Rourkela;
- b. Internal:** Visitors, Associates and Students Programme; Students' Curriculum and Research Evaluation Committee; Transport committee; Various interview and Ph.D. committees

#### **AWARD / RECOGNITION**

Humboldt fellowship for a renewed research stay in Germany.

#### **SPONSORED PROJECTS**

1. "Preparation and study of magnetic nanowires", funded by Board of Research in Nuclear Sciences, India
2. "Preparation and study of nanostructured dilute magnetic semiconductors" funded by Council of Scientific and Industrial Research, India

3. "Development of multiferroic materials with improved magnetoelectric properties"- funded by SNBNCBS, India
4. "Study of magnetocaloric effect", funded by DRDO, India

#### **MEETINGS ORGANIZED**

1. "C. K. Majumdar Memorial Summer Workshop in Physics 2011", June 06 – 15, 2011, at S. N. Bose National Centre for Basic Sciences, Salt Lake, Kolkata
2. UGC sponsored state level seminar on "Nanoscience and Nanotechnology: Present and future", January 12-13, 2012, at Kandi Raj College, Kandi, Murshidabad
3. One day national seminar on, "Physics education and basic research", July 15, 2011, at Saha Institute of Nuclear Physics, Salt Lake, Kolkata
4. National school cum workshop on, "Magnetic phase transition and transformations", August 03-09, 2011, at Jadavpur University, Kolkata





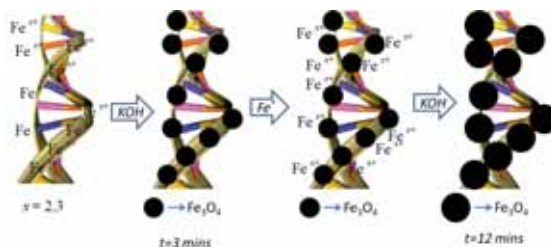
Madhuri Mandal  
Visiting Faculty Fellow

Synthesis and characterization of nanoparticles for Hyperthermia, drug release, biosensor, pollution control etc.  $\text{Fe}_3\text{O}_4$ , gold coated iron, co-ferrite etc nanoparticles have been synthesized and studied. These studies show some promising results which give an indication of applicability of these materials in the field of Hyperthermia, pollution control etc.

We have studied static and dynamic magnetic properties of free and DNA attached magnetite particles of variable sizes. Chainlike formation of the nanoparticles is obtained using DNA as template material. Particle size is varied from 7 nm to 17 nm simply by varying the duration of addition of co-precipitating agent. FTIR study confirms the bonding between metal ions and the phosphate backbone of DNA chain.

Effect of surface anisotropy on the magnetic properties of the nanoparticles can be clearly observed from all the AC and DC magnetic

measurements data. DC magnetic measurements reveal the decrease in anisotropy energy with increasing particle diameter. Bonding between metal cations and oxygen anions of the DNA chain affect the anisotropy energy; thus plays an important role in changing the magnetic properties. Both static and dynamic magnetic characterization supports the noninteracting, single domain, superparamagnetic nature of the smaller magnetite particles. Such type of biologically functionalized magnetic nanoparticles will be useful for hyperthermia treatment, bio-organ imaging etc.



### PUBLICATIONS IN JOURNALS

1. Madhuri Mandal, Debasish Sarkar and Ayan Bandyopadhyay, *Self-assembly of  $\text{Fe}_3\text{O}_4$  nanoparticles in chainlike Array on DNA template, their characterization and cancer cell identification*, Journal of International Academy of Physical Sciences, 2011, **15**, pp.503-506
2. Debasish Sarkar, Madhuri Mandal, Rajashree Das, Kalyan Mandal, *Fabrication of biologically functionalized electrically conducting and aligned magnetic nanoparticles*, IEEE Transactions on magnetics, 2011, **47**, 10, pp. 3163-3166
3. D. Sarkar, M. Mandal, *Static and dynamic Magnetic characterization of DNA Templated chain like Magnetite nanoparticles*. J. Phys. Chem. C, 2012, **116**, pp. 3227-3234

### OTHER PUBLICATIONS

1. Madhuri Mandal, Bipul Das, Debasish Sarkar, Kalyan Mandal, *Synthesis of tri-functional  $\text{Ni}_{\text{core}}\text{-Au}_{\text{shell}}$  nano-chain by DNA*, CMDAYS-2011, 2011

2. Madhuri Mandal, *DNA Templated Nano-Chain of  $\text{Fe}_{\text{core}}\text{-Au}_{\text{shell}}$  and a Preliminary Study for Cancer Cell Labeling and Treatment*, West Bengal Science and Technology Congress, 1-2 March, 2012

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Debasish Sarkar; **Project Students:** Shreyasi Ghatak (Summer Project)

### LECTURES DELIVERED

Invited talk, Madhuri Mandal, *Possible application of nanoparticles in Biology*, Nanoscience and Nanotechnology: Present and Future, Kandi Raj College, 12-13 January, 2012

### PARTICIPATION IN COMMITTEES

- a. **External:** Magnetic Society of India
- b. **Internal:** Technical Committee

### SPONSORED PROJECTS

Synthesis of DNA and Micelles Templated Magnetic Nanoparticles and their Necessary Surface Functionalization for Bio – Medical Applications, Funded by DST (SERC Fast Track)

The focus area of our work is on ferromagnetic shape memory alloys. We made various such alloys and made different measurements with them. We did theoretical and experimental studies on different magnetic alloys. We also worked on polymer composites and magneto-rheological fluids of such alloys. Additionally we worked on oxide thin films.

Pratip Kumar Mukhopadhyay  
Associate Professor and HOD

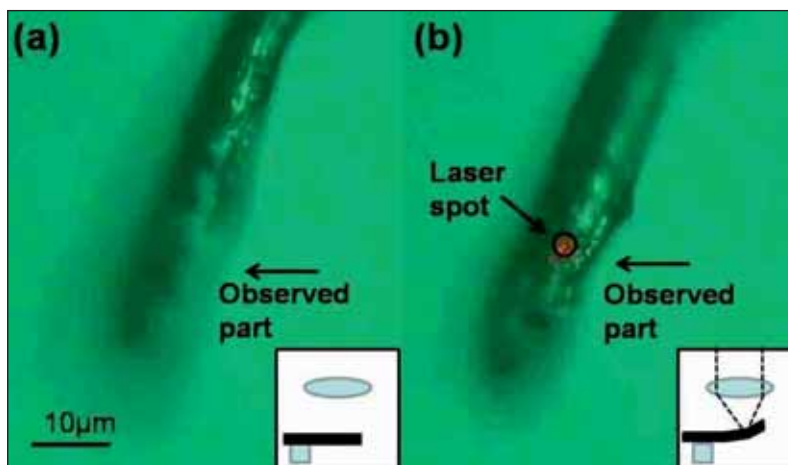


**W**e worked on various aspects of ferromagnetic shape memory alloys, especially the magneto-strain, optical polarization effects, novel magnetic field induced effect etc.

We also worked on theoretical formalism to analyze our data on dynamic elastic property measurements on a typical such alloy.

We **discovered** a novel photo-induced mechanical actuation in a particular series of these alloys. This is the first time an inanimate object was found to react and move to incident light, like 'touch-me-not' plant. A lot of experiments was done to understand the behavior, but no plausible explanation was found.

Therefore, more experiments are planned, in an effort to understand the behavior, and if possible, to harness this for practical use; robotics and remote controlled action are such target areas. In addition, in the institute colloquium, given to announce this discovery, physicists – especially cardiologists came to listen, to see if this can be used by the medical community. Preliminary discussions with them are under way. In a national conference of Magnetic Society of India, held in IIT/Madras, the discovery talk was also given on invitation. The following picture shows the first photograph of this photo-induced actuation.



The dynamic effects should be best seen in the video files in the following website:  
[http://bose.res.in/~pkm/FSMA\\_Light\\_Actuation](http://bose.res.in/~pkm/FSMA_Light_Actuation)

On polymeric composites, we tried to make soft smart materials. Similarly in case of MR fluids, we for the first time tried to explore the unique properties of these alloys.

In a series of quaternary alloys, we found a very interesting effect that is not yet found and understood. It is seen in magnetization only during heating up under high magnetic fields. This is under active investigation.

In case of binary magnetic alloys, we had a theoretical

group that is providing us with an electronic band structure calculations on some of the alloys that we are making in the lab. Measurements were done not only in our centre and in the neighboring institutes, some experiments were carried out in Japan too. The magnetic behavior is under consideration.

Finally, as an attempt to go for thin film batteries, our work on various layered oxide thin films were also carried out.



## PUBLICATIONS IN JOURNALS

1. Zhibin Hu, B. Rajini Kanth, Rajesh Tamang, Binni Varghese, Chorong-Haur Sow and P. K. Mukhopadhyay, *Visible microactuation of a ferromagnetic shape memory alloy by focused laser beam*, Smart Materials and Structures, 2012, **21**, 032003
2. K. Srinivasa Rao, B. Rajini Kanth, G. Srujana Devi and P. K. Mukhopadhyay, *Structural and optical properties of nanocrystalline WO<sub>3</sub> thin films*, Journal of Materials Science-Materials in Electronics, 2011, **22**, 1466-1472

## OTHER PUBLICATIONS

1. B. Rajini Kanth and P. K. Mukhopadhyay, A comparative study between bulk and thin films of boron doped NiMnGa Ferromagnetic Shape memory alloys, ICFSMA, Dresden, Germany, July 18-22, 2011
2. P. K. Mukhopadhyay, Madhuparna Karmakar, B. Rajini Kanth and S. N. Kaul, Experimental and theoretical investigations into the twinning energy of an FSMA system, American Physical Society, APS March Meeting 2011, March 21-25, 2011

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Sandeep Agarwal, Tanmoy Ghosh, Md. Injamamul Arief, Sudipta Bera (since resigned), Nandan Das(since resigned), Arun Lakshmanan (project trainee); **Project Students:** M.Tech: Jitesh Sharma; Summer students: Gopal Mapdar, Rishi Maity, Sougata Mallick, Suman Karmakar

## POST DOCTORAL RESEARCHERS

B. Rajinikanth (since resigned), Madhuparna Karmakar (since resigned)

## LECTURES DELIVERED

1. *Materially Smart– Smart Materials, Summer Project students*, SNBNCBS, June 15, 2011
2. *Investigations of the twinning energy of an FSMA system by experimental and theoretical techniques*, Invited Talk, Osaka University, ICMM 2011, September 07, 2011
3. *Measurement of Magnetisation, Experimental sensitivity and possible sources of errors in the measurement*, MPTT, Invited talk, August 03-09, 2011
4. *The fascinating world of Ferromagnetic Shape Memory Alloys*, Advanced and Functional Materials, SNBNCBS, March 01-02, 2012
5. *Discovery of a new opto-magnetic-mechanical effect in a Ferro Magnetic Shape Memory Alloy*, Invited talk, MagMA 2012, IIT/Madras, March 13, 2012

6. *Discovery of a new opto-magnetic-mechanical effect in a Ferro Magnetic Shape Memory Alloy*, Institute colloquium, March 27, 2012
7. *Introduction to the fascinating world of Ferro Magnetic Shape Memory Alloys, a series of smart materials*, Invited talk, Department of Physics, Manipur University, March 29, 2012

## ACADEMIC VISITS

Invited under Global Centre for Excellence in Material Design, Osaka University, to visit Prof. Kakeshita's lab, from January 19 – February 18, 2012

## COURSES TAUGHT

1. Phy 191, Basic Laboratory 1, SNBNCBS (Fall 2011)
2. Phy 501, Error Analysis, SNBNCBS (Fall 2011)
3. Advanced courses in Osaka University, Japan (February 2012)
  - a. Amorphous Solids (Glass)
  - b. Low temperature techniques
  - c. Spin Glass – Experiments and theory

## PARTICIPATION IN COMMITTEES

- a. External:** Member of International Advisory Board, CIMTEC 2012, Tuscany, Italy; International Scientific Committee member – ICFSMA 2011, Dresden, Germany; Member, governing body, Magnetic Society of India
- b. Internal:** Convenor, Project Cell; Incharge, Mechanical Workshop; Convenor, Technical Committee; Convenor, liquid helium plant committee; Convenor and chairman, NPEP, EVLP; Member of various thesis committees, purchase committees, SCRE committee, CAC, Library committee, AC and BoS for CU-IPh.D. course etc.

## AWARDS / RECOGNITIONS

1. Ph.D. examiner for a student in NIT, Rourkella
2. Referee for various journals, national and international
3. Referee for Young Physicist Colloquium, August 2011, IPS
4. Project reviewer for DST

## MEETINGS ORGANIZED

1. Convenor of Conference on Advanced and Functional Materials at the SNBNCBS, March, 2012
2. Member of Organizing Committee, National school cum workshop on, "Magnetic phase transition and transformations", August 03-09, 2011, at Jadavpur University, Kolkata

Stability of binary oxides; Graphene-like analogues among binary oxides; Defect-induced magnetism in ZnO

Priya Mahadevan  
Associate Professor



One has studied that the valency associated with oxygen is -2, while that with K is expected to be +1. This makes one expect that the most stable oxide would be  $K_2O$  and even if other oxides existed, they would be less stable. In a recent work (PRB 84, 035116 (2011)), we have shown that  $K_2O_2$  turns out to be the most stable oxide and the reasons for this are discussed. In contrast we also examine the case of  $H_2O$  and  $H_2O_2$  and show why water is more stable. Graphene-like analogues among binary oxides and semiconductors are of tremendous interest in recent times. A recent experimental work synthesised a bulk metastable phase of ZnO which was analogous to graphene. Examining the stability of this within first-

principle electronic structure calculations (PRL 107, 085508 (2011)), one found unstable phonons suggesting that the structure was unstable. This was traced to the incorrect nature of bonding that arises from the wrong location of Zn d states. Correcting for this, we were able to obtain stable phonons.

The area of defect-induced magnetism has been of tremendous interest in recent times, concomitant with the interest in dilute magnetic semiconductors. In a recent work we have considered the example of the oxide semiconductor ZnO and examined various defects to set up a set of basic rules to determine which defects could induce a local moment formation.

#### PUBLICATIONS IN JOURNALS

1. K. Nandy, Priya Mahadevan and D. D. Sarma,  *$K_2O_2$ : The most stable oxide of K*, Phys. Rev. B., 2011, **84**, 035116
2. B. Rakshit and Priya Mahadevan, *Stability of the bulk phase of layered ZnO*, Phys. Rev. Lett., 2011, **107**, 085508

#### BOOK PUBLISHED

Kapil Gupta and Priya Mahadevan, Strain induced ferromagnetic state in an otherwise nonmagnetic oxide, in *Simulation and Characterization of the Advanced Materials* (Research Signpost), ed Sudhir Kumar, 2011

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Ashis Kumar Nandy, Abhinav Kumar, Hirak Chandra, Kapil Gupta, Saikat Debnath, Ruma Das, Basudeb Mandal, Shishir Kumar Pandey (on project); **Project Students:** Gurjeet Singh (IT-BHU), Debsankar Banerjee (IITM)

#### POST DOCTORAL RESEARCHER

Bipul Rakshit

#### LECTURES DELIVERED

1. *Magnetism where you least expect it*, IISER Trivandrum, Trivandrum, March, 2012
2. *Stability of the Bulk phase of layered ZnO*, Two Day Conference on Advanced and Functional Materials, SNBNCBS, Kolkata, March, 2012
3. *Mechanism for the high Neel temperature in  $SrTcO_3$* , Discussion meeting on Spintronics, Coorg, February, 2012
4. *The unusual physics and chemistry of alkali metal oxides*, IISER Mohali, Mohali, February, 2012
5. *Models for structure and magnetism*, CSTEP, Bangalore, January, 2012
6. *Stability of the Bulk phase of layered ZnO*, International Conference on Physics of Novel and Emerging Materials, IACS, Kolkata, November, 2011
7. *Stability of the Bulk phase of layered ZnO*, Seventh JNC Conference on the Chemistry of Materials, Kochi, October, 2011
8. *Electron-doped  $CrO_2$ : An unusual example of a charge-ordered ferromagnet*, TIFR, Mumbai, May, 2011



### ACADEMIC VISITS

Indo-EU project, University of Vienna, Vienna, April, 2011

### COURSES TAUGHT

Condensed Matter Physics, August – December, 2011

### PARTICIPATION IN COMMITTEES

**External:** Council member, MRSI; Executive council member, MRSI, Kolkata; **Internal:** Various thesis committees, committees as in-charge of computer centre

### SPONSORED PROJECTS

1. DST-Nanomission project on Electronic and Structural properties of semiconductors at the nanoscale
2. Indo-EU project on Advanced Theories of Transition Metal Oxides (ATHENA)
3. Indo-Taiwan project on Advanced Functional Oxides

### MEETINGS ORGANIZED

International Conference on Statistical Physics and Nonlinear Dynamics, March 12-16, SNBNCBS, Kolkata

- Analysis of inelastic neutron scattering results from layered quantum ferromagnets in terms of spin dynamics induced by topological excitations has been carried out in collaboration with Dr. S.K. Paul and Shubhojit Sarkar (our Ph.D. Student at SNBS)
- The significance of superconducting pairing in the occurrence of Kohn anomaly in elemental superconductor has been explored in collaboration with Professor M.P. Das (ANU, Canberra)
- Superconducting pairing in low-dimensional systems has been investigated with explicit effects of lattice incorporated in the theoretical formalism and applied to organic superconductors in collaboration with Soumi Roychowdhury (my Ph.D. Student at SNBS)
- The behaviour of the spin stiffness constant and the charge stiffness constant for a doped quantum antiferromagnet on low dimensional lattices was theoretically studied in collaboration with Ms. Nimisha Kashyap (M.Sc. Summer student from NIT, Rourkela)

Ranjan Chaudhury  
Associate Professor



The occurrences of central peak in  $S(q,\omega)$  in the constant- $q$  scan for the spin  $\frac{1}{2}$  layered ferromagnet  $K_2CuF_4$  have been critically analysed with the help of semi-classical-like treatment involving vortex-antivortex configuration dynamics. The detailed investigation establishes convincingly that the full quantum treatment corresponding to Kosterlitz-Thouless scenario is extremely important for correct understanding of the spin dynamics of such system.

The phenomena of Kohn singularity and Kohn anomaly in a BCS superconductor have been theoretically investigated and defined. The calculational results have been applied to the elemental conventional superconductors Pb and Nb and they support the experimental claim of occurrence of Kohn anomaly. Moreover, the influence of the nature of superconducting pairing on this phenomenon has also been probed.

Cooper's one pair problem has been revisited in the case of quasi-one dimensional organic superconductors like  $(TMTSF)_2X$  type of salts. Invoking a pairing mechanism of electronic type, mediated by charge transfer exciton. The calculational results from the theoretical treatments and the experimental observations agree quite well for various material parameters including superconducting transition temperature, electronic density of states at the Fermi energy etc.

The spin stiffness constant and the charge stiffness constant for strongly correlated t-J model were calculated for low dimensional lattices in the high doping regime. It is found that in 1d although both of the above quantities decrease with increase in doping concentration, the hopping induced responses in both spin and charge sectors exhibit rapid decay and a cross over with non-analytic behaviour at some critical doping concentration, in contrast to the exchange related part.

## OTHER PUBLICATIONS

1. Ranjan Chaudhury and M.P. Das, *Kohn Anomaly Energy in Conventional Superconductors Equals Twice the Energy of the Superconducting Gap: How and Why?*, Proceedings of the 33<sup>rd</sup> International Workshop on Condensed Matter Theories, Quito, Ecuador, 2011, **25**, 296
2. R. Chaudhury, F. Demmel and T. Chatterji, *Dynamical Response of Single Bi-layer Spin Model: A Theoretical Analysis*, Cond-mat. Arxiv: 1104.4197v1, 2011
3. S. Sarkar, S. K. Paul and R. Chaudhury, *Theoretical analysis of neutron scattering results for quasi-two-dimensional ferromagnets*, Cond - mat. Arxiv:1203.3069, 2012

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Soumi Roychowdhury, Shubhojit Sarkar; **Project Students:** Nimisha Kashyap (NIT, Rourkela) for summer project for M.Sc. During May-July, 2011 at SNBNCBS, entitled "Analysis of the Behaviour of Spin Stiffness and Charge Stiffness for the Doped Quantum Antiferromagnet on Low Dimensional Lattice"

## LECTURES DELIVERED

Presented a paper entitled *Spin dynamics of quantum spin models in layered systems – signature of Kosterlitz-Thouless scenario?* at the conference ULT 2011 held in Daejeon, South Korea during August 19-22, 2011



### **COURSES TAUGHT**

1. PHY 413; "Magnetism & Superconductivity"; 4<sup>th</sup> (2 batches)
2. PHY 601; "Advanced Condensed Matter Physics: Magnetism & Superconductivity"; 2<sup>nd</sup> (2 batches)

### **PARTICIPATION IN COMMITTEES**

**Internal:** Officiating as Acting Registrar of SNBNCBS since 04.08.2011; Programme

Coordinator of EVLP till 31.07.2011; Chairman of Housing Allotment Committee till 31.08.2011; Convener of Admission Committee; Chairman of Security Monitoring Committee till 31.08.2011; Member of Medical Committee; Chairman of Provident Fund Trustee Board; Member of a Committee to renovate the Bose Archive; Member of a Committee to formulate rules for Students' Programme

Saikat Ghosh  
Assistant Professor



**M**y general research area is experimental quantum optics and high precision spectroscopy. Currently I am working on setting up an imaging system (confocal microscope) to image and study optical properties of single nano-particles

and molecules. In particular, the experiment is geared towards excitation of such nano-particles with quantum states of light, a field that is still at its infancy with lot of promise for new physics and applications in using quantum information effectively.

### SUPERVISION OF STUDENTS

**Project Students:** Post B.Sc. student Tejas Rathod: Summer, 2011; Semester I, 2011 and Semester II, 2012 (Topic: Experimental study of trapping particles and studying thermodynamics of small systems)

### LECTURES DELIVERED

1. *Towards strong coupling of quantum emitters inside optical fibers and cavities*, Invited Talk, ICAPP2011 (1st International Conference on Advanced Photonic Polymers), Yokohama, Japan, December, 2011
2. *Cavity QED: A new regime of atom-photon interactions*, Department Colloquia, IIT, Kanpur, November, 2011
3. *Cavity QED*, HCU-TIFR Discussion Meeting on Modern Optics Hyderabad, August, 2011
4. *Possibilities of Cavity QED with Plasmons*, Presented at the Panel Discussion, Office of Scientific Advisors to the Government of India,

National Physical Laboratory, New Delhi, July, 2011

5. *Strong coupling to Quantum Emitters-I, II*, TPSC seminar series, Hyderabad Central University, Hyderabad, April, 2011

### ACADEMIC VISITS

1. Prof. Dan Ralph, Cornell University, August-September, 2011
2. Prof. Konzo Hakuta, The University of Electro-Communications, Chofu, Tokyo, Japan, December, 2011

### COURSES TAUGHT

PHY 191 Electronics 1st Semester, Post B.Sc

### PARTICIPATION IN COMMITTEES

**Internal:** TPSC

### MEETINGS ORGANIZED

Trends in Optics, June 23 - 24, 2011, LH3, SNBNCBS





Saswati Barman  
Visiting Faculty Fellow

- Static and Dynamic properties of nanomagnets: Micromagnetic Simulation of dynamics of exchange spring magnets, dynamics of Co antidot lattices, dynamics of permalloy dot arrays, domain wall dynamics in permalloy nanowires
- Monte Carlo Simulation: Dipolar and exchange energy effects in magnetic thin films and magnetic multilayers
- Phonon heat conduction in  $\text{Al}_x\text{Ga}_{1-x}\text{N}$

Theoretical investigation of the lattice thermal conductivity of films of GaN and  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  have been performed by using both Debye's and Callaway's model. We find that in films of GaN, phonon impurity scattering plays a significant role in controlling thermal conductivity not only around the thermal conductivity peak region but over a very large range of temperature, even beyond the Debye temperature. Large contribution of alloy mass disorder and point impurity scattering is the primary reason for the increase in thermal conductivity of  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  alloy film beyond room temperature. Above room temperature, Metal Oxide Chemical Vapor Deposition (MOCVD) films have lower thermal conductivity compared to Hydride Vapor Phase Epitaxy (HVPE) films due to the presence of larger amount of defects

in MOCVD films as compared to HVPE films. Variation of thermal resistivity of  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  with  $x$  in  $\text{Al}_x\text{Ga}_{1-x}\text{N}$  shows a peak at  $x=0.7$  due to the highest contribution of mass disorder.

The static magnetic configuration of the domain wall in a Permalloy nanostripe is either a vortex domain wall or transverse domain wall or a combination of both depending upon the aspect ratio of the nanostripe. We find that for nanostripes of dimension  $2000 \times 200 \times 20 \text{ nm}^3$ , vortex domain wall forms and the spin transfer torque induced displacement of the center of the vortex domain wall shows an oscillatory motion under the application of a DC pulsed current with the adiabatic spin torque. The frequency of oscillation increases with the introduction of nonadiabatic spin momentum transfer torque.

### PUBLICATIONS IN JOURNALS

1. S. Barman, A. Ganguly, and A. Barman, *Phonon heat conduction in  $\text{Al}_x\text{Ga}_{1-x}\text{N}$ : a theoretical study*, Europhys. Lett., 2012, **97**, 36011
2. B. Rana, D. Kumar, S. Barman, S. Pal, R. Mandal, Y. Fukuma, Y. Otani, S. Sugimoto and A. Barman, *Anisotropy in collective precessional dynamics in arrays of  $\text{Ni}_{80}\text{Fe}_{20}$  elements*, J. Appl. Phys., 2012, **111**, 07D503
3. B. Rana, D. Kumar, S. Barman, S. Pal, Y. Fukuma, Y. Otani and A. Barman, *Detection of picosecond magnetization dynamics of 50 nm magnetic dots down to the single dot regime*, ACS Nano, 2011, **5**, 9559
4. B. Rana, S. Pal, S. Barman, Y. Fukuma, Y. Otani and A. Barman, *All-optical excitation and detection of picosecond dynamics of ordered arrays of nanomagnets with varying areal density*, Applied Physics Express, 2011, **4**, 113003
5. S. Barman, *Effect of isotopic purity on thermal conductivity of BN: A theoretical study*, Europhys. Lett., 2011, **96**, 16004

### SUPERVISION OF STUDENTS

**Project Student:** Arnab Ganguly

### LECTURES DELIVERED

1. *Anisotropy in collective precessional dynamics in arrays of  $\text{Ni}_{80}\text{Fe}_{20}$  nanoelements*, B. Rana, 56th MMM Conference, Scottsdale, Arizona, October 30 – 3 November 03, 2011
2. *Influence of exchange spring behaviour on the spin wave dynamics of the FePt/FeNi bilayers with varying FeNi thickness*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 01 – 02, 2012
3. *Tunable high frequency magnonic spectra in two dimensional arrays of nanoscale magnetic antidotes*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 01 – 02, 2012

4. *Spin wave dynamics in 2D artificial nanomagnetic lattices: the effect of lattice symmetry*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 01 – 02, 2012
5. *Micromagnetic Simulations of Domain Wall Dynamics in Ferromagnetic Nanostripe*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 01 – 02, 2012
6. *Ultrafast Spin Dynamics in 2-D Nanoscale Magnonic Crystals: Anisotropy in Collective Modes*, Advanced and Functional Materials, SNBNCBS, Kolkata, March 01 – 02, 2012
7. *Micromagnetic simulation of current induced oscillatory motion of vortex domain walls in notched ferromagnetic nanostripes*, ICONSAT, Hyderabad, January 20 - 23, 2012
8. *Ultrafast magnetization dynamics in 2-D nanoscale magnonic crystals: anisotropy in collective modes*, ICONSAT, Hyderabad, January 20 - 23, 2012

#### ACADEMIC VISITS

24 months review meeting of India-EU collaborative project, "Computational Studies of Dynamic Phenomena in Magnetic Nano-Materials", September 2011, Southampton, UK

#### COURSES TAUGHT

PHY 204, Computational methods in physics II, Spring Semester (January – May 2012)

#### AWARDS/RECOGNITIONS

DST WOS-A

#### SPONSORED PROJECTS

1. Advanced Computational Studies of Magnonic Crystals, Principal Investigator, PI, DST WOS-A Scheme
2. Computational Studies of Dynamic Phenomena in Magnetic Nano-Materials, Co-PI, India-EU collaborative project in Computational Materials Science, 2009-2012





Sugata Mukherjee  
Associate Professor

- Electronic structure of Nanostructured Materials
- Computational Condensed Matter Physics
- Calculation of electronic properties of two dimensional nanomaterials of Carbon and Boron Nitride

First principles electronic structure calculations based on Density Functional Theory were continued incorporating the generalized gradient Approximation (GGA) and also van der Waals (vdW) interactions to examine ground state properties of Graphene and Boron Nitride nanomaterials. It was found that inclusion of vdW interaction is important for accurate determination of their electronic structure. The formation energy of BN domains in graphene was calculated for small 2x2 supercells and

it was found that hexagonal CBN can be stably formed for a wide range of concentrations of BN domains. It is planned to extend these calculations to large supercells to study the effect of mixing or segregation of larger BN domains in graphene. The band structure of multilayers of graphene and h-BN was also investigated with varying BN concentration and it was obtained that such multilayers exhibit semiconducting properties with varying band gap.

#### PUBLICATIONS IN JOURNALS

T. P. Kaloni and S. Mukherjee, *Comparative study of Electronic properties of Graphite and hexagonal Boron Nitride (h-BN) using Pseudopotential plane wave method*, Modern Physics Letters B, 2011, **25**, 1855

#### OTHER PUBLICATIONS

1. S. Mukherjee, *Electronic structure and properties of carbon and boron nitride based nanomaterials*, in Proc of EICOON Workshop and Summer School, VTT Research Centre, Espoo, 2011, p 51
2. S. Mukherjee, *Electronic properties of graphene doped by boron and nitrogen*, in Proc Int Conference on Materials for Advanced Technology (ICMAT-2011), Singapore, E 3-4, 24, 2011
3. S. Mukherjee, *First-principles study of electronic structure of 2d carbon and boron-nitride nanomaterials*, in Proc 58th American Vacuum Soc Meeting, Nashville, 2011, p 174
4. S. Mukherjee and T. P. Kaloni, *Electronic properties of graphene doped by boron and nitrogen*, in Proc ISCAN-2011, Richmond, M-8, 2011

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Sandeep Chakraborty (until Sept 2011); **Project Students:** Sandeep Chakraborty (summer project, 2011, GGA and vdW based DFT calculations on Graphite and h-BN)

#### LECTURES DELIVERED

1. First-principles study of electronic structure of 2d carbon and boron-nitride nanomaterials, Colloquium talk given at Aalto University, Espoo (Finland), June, 2011
2. Electronic structure and properties of carbon and boron nitride based nanomaterials, Invited talk given at EICOON Workshop and Summer School, VTT Research Centre, Espoo (Finland), June 13-17, 2011
3. Electronic properties of graphene doped by boron and nitrogen, presented at Int Conference on Materials for Advanced Technologies, Singapore, June 26 – July 01, 2011
4. First-principles study of electronic structure of 2d carbon and boron-nitride nanomaterials, presented at 58<sup>th</sup> American vacuum Society Meeting, Nashville (USA), October 30 – November 04, 2011
5. Electronic properties of graphene doped by boron and nitrogen, presented at Int Symposium on Clusters and Nanomaterials (ISCAN-2011), Richmond (USA), November 7-10, 2011
6. First-principles calculations of electronic properties of carbon and boron nitride based nanomaterials, Invited talk in Symposium on Clusters and Cluster-assembled Nanomaterials, HRI Allahabad, November 28 – December 01, 2011

### ACADEMIC VISITS

Visited Centre of excellence of Computational Materials Science at Aalto University, Espoo (Finland) in June 2011 at their invitation

### PARTICIPATION IN COMMITTEES

**a. External:** External examiner of M.Tech in Materials Science at BESU, Sibpur, May, 2011

**b. Internal:** TPSC Convener; Served in various committees, both statutory and other, as Acting Registrar until 2.8.2011; Served in various evaluation committees

### SPONSORED PROJECTS

EU-India Project on Nanomaterials Research for Sustainable Energy (Co-PI), University of Twente





Tanusri Saha-Dasgupta  
Professor

- Effect of size reduction on charge and orbital ordering in half-doped manganite
- Electronic and magnetic structure of bilayer and trilayer nickelates
- Electronic structure and magnetic properties of organic-inorganic hybrid framework compounds
- Low-dimensional quantum spin systems
- Low dimensional carbon materials
- Visualizing frozen point defect tracks in Fe-containing olivines

Motivated by recent experimental results, we studied the effect of size reduction on half-doped manganite,  $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$ , using the combination of density-functional theory (DFT) and dynamical mean-field theory (DMFT). We found that upon size reduction the charge-ordered antiferromagnetic phase, observed in bulk, is destabilized, giving rise to the stability of a ferromagnetic metallic state. Our theoretical results, carried out on a defect-free nanocluster in isolation,

established the structural changes that follow upon size reduction to be responsible for this. Our study further pointed out the effect of size reduction to be distinctively different from application of hydrostatic pressure. Interestingly, our DFT+DMFT study additionally reports the correlation-driven stability of the charge-orbitally ordered state in bulk  $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$ , even in the absence of long-range magnetic order.

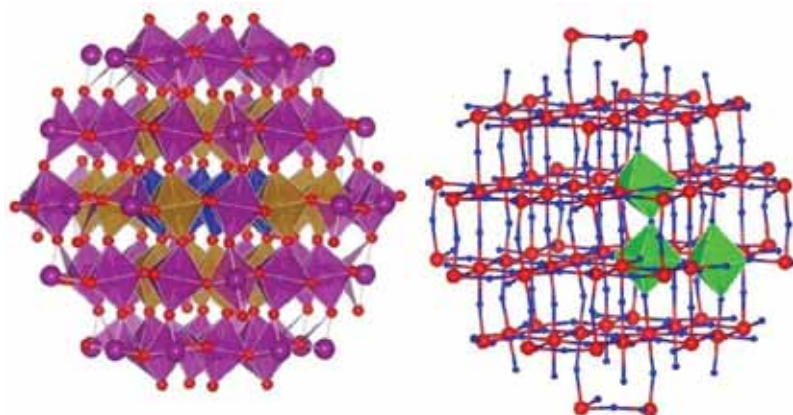


Fig1: Left: Constructed nanocluster of  $\text{La}_{0.5}\text{Ca}_{0.5}\text{MnO}_3$ . In magenta, brown, and blue, we show the  $\text{MnO}_6$  octahedra belonging to the outer most surface layer, next to the surface, and the core region. Right: The structural unit, highlighted in green, chosen out of nanocluster, used for building up of model for DMFT calculation. The big and small spheres in the unshaded region represent Mn and O atoms, respectively.

### PUBLICATIONS IN JOURNALS

1. Santu Baidya and T. Saha-Dasgupta, *Electronic structure and phonons in  $\text{La}_2\text{CoMnO}_6$ : A ferromagnetic insulator driven by Coulomb-assisted spin-orbit coupling*, Phys. Rev. B, 2011, **84**, 035131
2. Harald Jeschke, Ingo Opahle, Hem Kandpal, Roser Valentí, Hena Das, Tanusri Saha-Dasgupta, Oleg Janson, Helge Rosner, Andreas Brühl, Bernd Wolf, Michael Lang, Johannes Richter, Shijie Hu, Xiaoqun Wang, Robert Peters, Thomas Pruschke, and Andreas Honecker, *Multistep Approach to Microscopic Models for Frustrated Quantum Magnets: The Case of the Natural Mineral Azurite*, Phys. Rev. Lett., 2011, **106**, 217201
3. Soumendu Datta, Mukul Kabir, and Tanusri Saha-Dasgupta, *Ab initio study of structural stability of small 3d late transition metal clusters: Interplay of magnetization and hybridization*, Phys. Rev. B, 2011, **84**, 075429
4. Santu Baidya, Prabuddha Sanyal, Hena Das, Bertrand Roessli, Tapan Chatterji, and T. Saha-Dasgupta, *Understanding neutron scattering data in  $\text{YMn}_2\text{O}_5$ : An effective spin Hamiltonian*, Phys. Rev. B, 2011, **84**, 054444
5. S. Chatterjee and T. Saha-Dasgupta, *Electronic and magnetic structure of the mixed-valence cobaltite  $\text{CaBaCo}_4\text{O}_7$* , Phys. Rev. B, 2011, **84**, 085116
6. Paolo Barone, Sudipta Kanungo, Silvia Picozzi, and Tanusri Saha-Dasgupta, *Mechanism of ferroelectricity in d3 perovskites: A model study*, Phys. Rev. B, 2011, **84**, 134101

7. Sudipta Kanungo and T. Saha-Dasgupta, *First-principles study of organic-inorganic hybrid framework compound Mn(C<sub>4</sub>H<sub>4</sub>O<sub>4</sub>)*, Phys. Rev. B, 2011, **84**, 134415
8. Hena Das, G. Sangiovanni, A. Valli, K. Held, and T. Saha-Dasgupta, *Size Control of Charge-Orbital Order in Half-Doped Manganite La<sub>0.5</sub>Ca<sub>0.5</sub>MnO<sub>3</sub>*, Phys. Rev. Lett., 2011, **107**, 197202
9. Mukul Kabir, Swarnakamal Mukherjee, and Tanusri Saha-Dasgupta, *Substantial reduction of Stone-Wales activation barrier in fullerene*, Phys. Rev. B, 2011, **84**, 205404
10. Soumyajit Sarkar, I. Dasgupta, Martha Greenblatt, and T. Saha-Dasgupta, *Orbital ordering in FeV<sub>2</sub>O<sub>4</sub>: Spinel with two orbitally active sites*, Phys. Rev. B Rapid Commun., 2011, **84**, 180411
11. Soumyajit Sarkar and T. Saha-Dasgupta, *Orbital ordering in FeV<sub>2</sub>O<sub>4</sub>: Spinel with two orbitally active sites*, Phys. Rev. B, 2011, **84**, 235112
12. Soumyajit Sarkar, Kartick Tarafder, Peter M Oppeneer, Tanusri Saha-Dasgupta, *Spin-crossover in cyanide-based bimetallic coordination polymers—insight from first-principles calculations*, J. Mater. Chem., 2011, **21**, 13832
13. Jaita Paul, Swarnakamal Mukherjee, Tanusri Saha-Dasgupta, *A first principles density functional investigation of ligand-protected eight atom gold nanoclusters*, AIP Advances, 2011, **1**, 032150
14. M. Reehuis, T. Saha-Dasgupta, D. Orosel, J. Nuss, B. Rahaman, B. Keimer, O. K. Andersen, and M. Jansen, *Magnetic properties of PdAs<sub>2</sub>O<sub>6</sub>: A dilute spin system with an unusually high Néel temperature*, Phys. Rev. B, 2012, **85**, 115118
15. Hena Das, G. Sangiovanni, A. Valli, K. Held, and T. Saha-Dasgupta, *Das et al. Reply*, Phys. Rev. Lett., 2012, **108**, 129702
3. *Calculation of Tc trend in High Tc cuprates ?*, TUE Vienna, November, 2011
4. *Interplay of spin, charge and orbital in spinels*, Rutgers University, December, 2011
5. *Size control of properties in half-doped manganites*, MONAMI meeting, Bangalore, January, 2012
6. *Correlation in oxides: Total energy conference*, Barcelona, January, 2012
7. *Electronic structure of metalorganic compounds*, University of Gottingen, January, 2012
8. *Metalorganics*, Spintronics Meeting, Coorg, February, 2012
9. *Size control of properties in half-doped manganites*, APS March meeting, Boston, March, 2012
10. *Materials to Models*, DST Inspire Program at KIIT University, Bhubaneswar, March, 2012

#### ACADEMIC VISITS

1. Visit to Uppsala University under Indo-Swedish research project, November, 2011
2. Visit to TU, Vienna under Indo-EU research project, November, 2011

#### PARTICIPATION IN COMMITTEES

- a. **External:** Member of the committee for IUSSTF-APS Professorships and Student Visitations between India and USA; Member of organizing committee for the research workshop to be held in IIP, Natal, Brazil, December, 2012; Member of organizing committee for Indo-Swedish conference to be held in Kolkata, February, 2013
- b. **Internal:** Convener, APMP

#### AWARDS / RECOGNITIONS

Selected as organizer and sorting committee member of the focused session on Complex Oxides at APS March meeting, Boston, 2012

#### SPONSORED PROJECTS

1. Swarnajayanti Fellowship, funded by DST, 1/2/2006-SF
2. Understanding Physics and Chemistry of novel material using NMTO Wannier Functions, funded by Indo-German, FP/2004(40)
3. Advanced Materials Research Unit (AMRU), funded by DST, IR/S2/PU-09/2006
4. DST/TSD/09-10/37 - MONAMI – Modeling of NANO – Scaled Advanced Materials Intelligently, funded by DST (Int Div), INT/EC/MONAMI (25/233513)/2008 (i)
5. SRC/TSD/09-10/38 - Magnetism in organic materials, funded by Swedish Research Council (SRC)

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Hena Das (PhD received in December, 2011), Soumyajit Sarkar (PhD to be submitted in July, 2012), Swastika Chatterjee (PhD to be submitted in August, 2012), Sudipta Kanungo, Santu Baidya, Swarnakamal Mukherjee

#### POST DOCTORAL RESEARCHERS

Soumendu Datta, Satyaki Kar, Rina Dutta (external)

#### LECTURES DELIVERED

1. *Lecture course in correlation effects and LMTO basis set*, Louisiana State University, July, 2011
2. *Double perovskites*, Indo-Israeli conference, Cochin, October, 2011





Null Curves  
Hypersurfaces  
Semi-Riemannian  
Manifolds

*Department of*  
**Theoretical Sciences**

NPS



Partia  
Solitary



*Department of*

# *Theoretical Sciences*

**T**he members of the Department of Theoretical Sciences (DTS) were actively engaged in research in various fields. Several students of this department continued to publish of their own. Majority of the faculty members took part in the teaching activities, offered general as well as special courses, supervised project students. DTS's weekly journal club talk series has been revived from middle of February on the initiative of Sharvari Nadkarni Ghosh, Sakuntala Chatterjee and Punyabrata Pradhan which has created much interest among the students and faculty.

Following is the summary of the research activities under different subject headings:

## **QUANTUM FIELD THEORY**

A partition function is constructed in 2+1 quantum gravity with a positive cosmological constant, which is convergent to one loop level. A semi-classical like theoretical analysis for evaluating dynamical structure function corresponding to topological excitations in quasi-two dimensional spin-1/2 Heisenberg ferromagnet  $K_2CuF_4$  has been done.

$SU(N)$  Schwinger bosons are exploited to construct and analyze the coupled irreducible representations of  $SU(N) \hat{\wedge} SU(N)$  in terms of the invariant group. The corresponding projection operators are explicitly constructed in terms of the invariant group generators.

The similarities and dissimilarities between two most canonical i.e. Moyal and Voros star products used in Noncommutative geometry, were studied both from mathematical and physical perspectives in 2+1 dimension. This was then generalised to 3+1 dimension and aspects of Noetherian symmetry in Noncommutative Quantum Mechanics were studied, in an abstract setting, to show that  $SO(3)$  symmetry does not survive at the level of the action, in presence of interaction, even if the  $SO(3)$  automorphism symmetry is restored by Drinfel'd twist.

## **QUANTUM OPTICS AND QUANTUM INFORMATIONS**

A class of optical beams has been proposed and investigated that have the structure of the polar eigenfunctions of the anisotropic commensurate two-dimensional oscillator.

## **GRAVITY AND BLACK HOLES**

A non-perturbative proof of the no hair theorems corresponding to scalar and Proca fields for stationary axisymmetric de Sitter black hole space times has been possible. The method developed for this proof also applies to asymptotically flat and under a reasonable assumption, to asymptotically anti-de Sitter space times.

A method has been developed to calculate the critical exponents for phase transition in AdS black holes. Revealed the importance of trivial symmetries in Poincare gauge theories. Canonical formulation of higher derivative theories was analyzed.

## MATHEMATICAL PHYSICS

The scattering phase functions of light scattered by a biomedical tissue has been studied from the point of view of characterizing the tissue. Analytic formulas for absorption and scattering of light from polycyclic aromatic hydrocarbon component of the interstellar dust have also been obtained.

## STATISTICAL PHYSICS

Spatiotemporal heterogeneities in granular media, surface dynamics in driven systems, synaptic metaplasticity and memory, unusual properties of zero-temperature dynamics in constrained spin models, agent-based models of competitive learning, game-theoretic models of synaptic plasticity, the statistical analysis of saccades and fixations and the encoding-aided optimization of NP hard problems have been studied.

In the context of 'Explosive Percolation' it has been shown that the exponent which characterizes the growth of the largest component at the percolation threshold may be used to determine if the transition is continuous or discontinuous. The percolation threshold is measured by the average value of percolation probability where the Order Parameter makes its maximal jump and this definition has been turned out to be quite useful.

The question whether it is possible to define an intensive thermodynamic variable which would equalize for two nonequilibrium steady-state systems kept in contact has been explored. In terms of this intensive variable, one could characterize a nonequilibrium system and understand fluctuations in terms of a nonequilibrium free energy function, analogous to the description in equilibrium.

Chemotaxis motion of E.coli bacteria has been studied using numerical simulation and analytical calculation. It has been found that in the long time limit, the chemotaxis motion can be described as a competition between drift and diffusion. Through this study, it has been possible to provide a new description for E.coli chemotaxis that is significantly different from the existing models.

## NONLINEAR PHYSICS

The sound attenuation near the critical demixing point in certain binary liquids seems to have a strange behavior in addition to the critical anomaly. We found that these binary mixtures exhibit micelle formation and curiously enough the attenuation associated with the micelle formation can have a persistent high frequency contribution. On a different note, we looked at the well known centre focus problem from a renormalization group standpoint, used a toy model to arrive at certain features of rotating turbulence and extended the Lindstedt Poincare technique to study oscillations in molecular potentials where the time period diverges at a finite energy.

Hamiltonization of planar nonautonomous and nonplanar autonomous systems has been studied. Given a planar nonautonomous system it has been found that for transforming this system into a Hamiltonian system, it suffices to determine certain two auxiliary functions. This construction was illustrated through examples.

## DEPARTMENTAL STATISTICS

Faculty members	15
Post-Doctoral Research Fellows	5
Ph. D. Students	25
Publications in journals	37
Talks delivered by faculty/PDRF, Ph.D. and students	34
External Projects	5



**Subhrangshu Sekhar Manna**  
Head, Department of Theoretical Sciences





Amitabha Lahiri  
Professor

- Mathematical physics, Application of category theory in physics
- Differential geometry, Principal fiber bundles and connections on path spaces
- Uniqueness properties of black hole solutions
- No-hair theorems for black holes
- Electroweak scattering processes without a Higgs boson

A non-perturbative proof of the no hair theorems was found corresponding to scalar and Proca fields for stationary axisymmetric de Sitter black hole spacetimes. The method developed for this proof also applies to asymptotically flat and under a reasonable assumption, to asymptotically anti-de Sitter spacetimes.

A category that arises in the context of parallel transport over spaces of paths was studied within a purely category-theoretic setting. Drawing motivation from the geometric background, it was shown how

a monoidal category gives rise to a 'fattened' version with a certain product operation.

The amplitude for elastic scattering of longitudinally polarized massive W bosons diverges at tree level, thus violating unitarity, in the absence of any additional particle. This is considered one of the strongest arguments for the existence of the Higgs particle. It was shown that a triplet of antisymmetric tensor bosons interacting with the gauge bosons via a B $\wedge$ F coupling can also cancel the divergence. No Higgs-like excitation is needed.

#### PUBLICATIONS IN JOURNALS

Sourav Bhattacharya and Amitabha Lahiri, *No hair theorems for stationary axisymmetric black holes*, Phys. Rev. D, 2011, **83**, 124017

#### OTHER PUBLICATIONS

1. Sourav Bhattacharya and Amitabha Lahiri, *Cosmic strings with positive  $\dot{E}$* , Proceedings of the 12<sup>th</sup> Marcel Grossmann meeting, July 12-18, 2009, Paris, 2012, 1877
2. Amitabha Lahiri, Review of *A proposal for covariant renormalizable field theory of gravity* by Shin'ichi Nojiri and Sergei D. Odintsov, Mathematical Reviews, MR2659293, 2011

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Submitted: Sourav Bhattacharya, Black holes and the cosmological constant, Jadavpur University; Working: Debmalya Mukhopadhyay, Subhasish Chakrabarty, Ishita Datta Choudhury and Nandini Midya

#### POST DOCTORAL RESEARCHER

Tae-Hun Lee

#### LECTURES DELIVERED

1. *Proving no hair theorems for black holes with a positive cosmological constant* at the Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune, July, 2011
2. *Unitarity in  $W_L^+W_L^-$  scattering without a Higgs particle* at Field Theory: Recent Trends and Applications, IISER-Kolkata, August, 2011
3. *Massive Vector Bosons* at Benaras Hindu University, February, 2012
4. *Unitarity in  $W_L^+W_L^-$  scattering without a Higgs particle* at Benaras Hindu University, February, 2012

#### SPONSORED PROJECTS

Symmetries of non-Abelian two-form gauge theories by Department of Science & Technology, India (No. SR/S2/HEP-0006/2008)

Synaptic metaplasticity and memory: agent-based models of competitive learning: game-theoretic approaches to neuroscience: dynamics of surfaces in driven systems: statistical analysis of real cognitive processes: optimization of NP-hard problems: zero-temperature dynamics and its mathematical formulations

Anita Mehta  
Professor



In a paper with D P Shinde (SNB) and R K Mishra (CBCS), visual movements of sample populations subjected to visual and aural input were tracked in a taskless paradigm. The probability distributions of saccades and fixations were obtained and analyzed. Scale-invariance was observed in the saccadic distributions, while the fixation distributions revealed the presence of a characteristic (attentional) time scale for literate subjects.

In a paper with JM Luck (CEA Saclay), two models of a metaplastic synapse were devised and analysed to investigate the comparative storage of long-term memory. While the transient behaviour of the models is different, their asymptotic behaviour is robustly characterised by power-law forgetting, consistent with experimental results.

In two papers with Gaurang Mahajan (SNB), a game-theoretic model of synaptic interactions was presented, whose dynamics was driven by

competition between synapses in their weak and strong states. Learning and forgetting under various protocols was examined, and good agreement found with experiment.

The effect of memory and different updating paradigms in a game-theoretic model of competitive learning was investigated with A A Bhat (SNB). One of the most interesting results is that a long memory of earlier outcomes can occasionally compensate for the choice of a globally inferior strategy.

The zero-temperature dynamics of the compacting of a column of grains with long range directed interactions was studied, such that grain orientations were constrained to minimise void space (with J M Luck (CEA Saclay) and L S Schulman (Clarkson)). The presence of Jordan forms in the spectral properties was interpreted in terms of the constraints imposed on a grain by its neighbours in the neighbourhood of jamming.

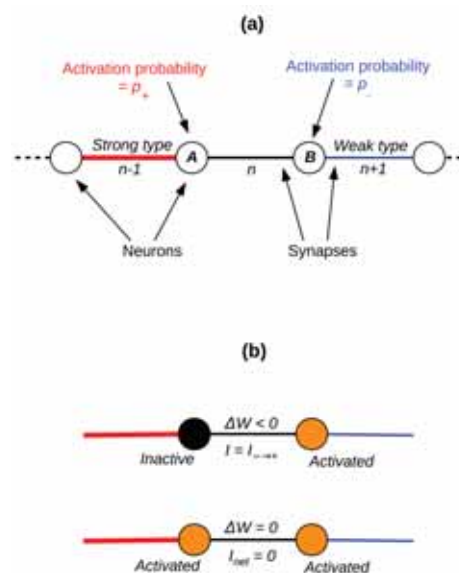


Fig. 1: (Color online) (a) A1-D lattice of neural units connected by undirected binary synapses. (b) Two possible "outcomes" when a synapse has a "strong" type and a "weak" type neighbor (as in (a) above). The middle synapse is under consideration (for being updated) in this case.



## PUBLICATIONS IN JOURNALS

1. D. P. Shinde, Anita Mehta and R. K. Mishra, *Searching and fixating: scale-invariance vs. characteristic timescales in attentional processes*, Europhysics Letters, 2011, **94**, 68001
2. Gaurang Mahajan and Anita Mehta, *Competing synapses with two timescales -- a basis for learning and forgetting*, Europhysics Letters, 2011, **95**, 48008
3. Ajaz Ahmad Bhat, Gaurang Mahajan and Anita Mehta, *Learning with a network of competing synapses*, PLoS ONE, 2011, **6(9)**: e25048 doi:10.1371/journal.pone.0025048
4. Anita Mehta and J. M. Luck, *Power-law forgetting in synapses with metaplasticity*, J. Stat. Mech., 2011, P09025
5. Ajaz Ahmed Bhat and Anita Mehta, *The dynamics of competitive learning: the role of updates and memory*, Phys. Rev. E, 2012, **85**, 011134
6. L. S. Schulman, J. M. Luck and Anita Mehta, *Spectral properties of zero temperature dynamics in a model of a compacting granular column*, Journal of Statistical Physics, 2012, **146**, 924–954, DOI 10.1007/s10955-012-0429-6

## SUPERVISION OF STUDENTS

**Ph.D. Students:** Ajaz Ahmed Bhat, Bandan Chakraborty, D. P. Shinde

## POST DOCTORAL RESEARCHER

Gaurang Mahajan

## LECTURES DELIVERED

1. Seminar at the Physics Department, University of Naples, Naples, Italy, June, 2011.
2. Seminar at Calcutta University, Calcutta, August, 2011.
3. Invited speaker at "Econophysics of Systemic Risk and Network Dynamics", Centre for Applied Mathematics and Computational Science, Calcutta, October, 2011.

## ACADEMIC VISITS

Senior Visiting Scientist at the Institut de Physique Theorique, Saclay, France, May-June, 2011

## AWARDS / RECOGNITIONS

1. Appointed Science Ambassador, Indo-US Science and Technology Forum, November, 2011
2. Appointed Member of Working Group for Women in Physics, Asia-Pacific Physics Conferences, 2010-
3. Appointed Expert Reviewer at European Research Council Executive Agency, 2010-2013
4. Appointed Member, Board of Graduate Studies, Indus International University, Himachal Pradesh, 2011 -
5. On Editorial Board of Granular Matter and CHAOS
6. Member of Scientific Committee of 'Association pour l'Etude de la Micromécanique des Milieux Granulaires' since its inception

## SPONSORED PROJECTS

1. Code-switching in normative multilingualism, DST
2. Generativity in cognitive networks, DST

Quantum Field theory, Noncommutative Quantum Mechanics and Field Theory. Aspects of symmetries in Noncommutative theories. Connes spectral triplets in Noncommutative spaces and physical implications

Biswajit Chakraborty  
Associate Professor



I continued working on the aspects of symmetries of Noncommutative quantum systems. Initially, the formalism of Hilbert-Schmidt operators was extended to the nontrivial 3D Moyal space to construct the quantum Hilbert space of a quantum mechanical system and the issue of Noetherian symmetry at the level of the Schroedinger action was investigated. Although, the automorphism symmetry under rotation is restored through the deformed

coproduct, we showed that this still does not ensure the Noetherian symmetry at the level of action. We demonstrated the explicit non-invariance of the action by considering a rotationally invariant harmonic oscillator potential. This issue was not investigated properly in the literature earlier, where only infinitesimal rotations were considered and that too the rotational parameters were taken to satisfy non-trivial commutation relations.

#### PUBLICATIONS IN JOURNALS

1. Prasad Basu, Biswajit Chakraborty, Frederik G. Scholtz, *A unifying perspective on the Moyal and Voros products and their physical meanings*, J. Phys. A, 2011, **A44**, 285204
2. Debabrata Sinha, Biswajit Chakraborty, Frederik G. Scholtz, *Noncommutative Quantum Mechanics in three dimension and rotational symmetry*, J. Phys. A, 2012, **A45**, 105308

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Yendremban Chaoba Devi and Jang Bahadur Ghosh; **Project Students:** Arpan K. Mitra (a Post-B.Sc student (SNBNCBS) carried out his summer 2011 and 3rd semester project under my supervision), Soumya Kanti Bose ((SNBNCBS) carried out his summer as well as 3rd and 4th semester project under my supervision); Ritam Sinha (St.Xavier's College, Kolkata), Arvind Kumar (Punjab Technical University) and Gopal Hazra (IIT, Kharagpur), who were selected by the three Academy of Sciences, carried out their summer project under my supervision.

#### LECTURES DELIVERED

Gave a talk on *Symmetries in Noncommutative Quantum systems* at the International workshop on "Field Theory: Recent trends and Applications" held at the Indian Institute of Science Education & Research, Kolkata, during August, 2011

#### ACADEMIC VISITS

I visited National Institute for Theoretical Physics, Stellenbosch, South Africa during February-March 2012 for collaborative research programme under the Indo-South Africa Project entitled "Astrophysical and Cosmological implications of Noncommutative spacetime" funded by DST, Govt. of India and South African National Research Foundation.

#### COURSES TAUGHT

Taught "Classical Dynamics" (PHY 101) to the first semester batch of Post B.Sc. during August-December, 2011

#### PARTICIPATION IN COMMITTEES

- a. External:** Was in the committee of external examiners for the M.Sc. thesis of Mr.Hendrikus Wilhelm Groenewald, entitled "A Noncommutative Walecka model: An effective theory for interacting nucleons of finite size", submitted in 2011 in the Physics Department, Faculty of Science, Stellenbosch University, South Africa.
- b. Internal:** Member of CWEP of EVLP

#### SPONSORED PROJECTS

Indo-South Africa Project entitled "Astrophysical and Cosmological implications of Noncommutative spacetime" funded by DST, Govt. of India and South African National Research Foundation.







Jayanta Kumar Bhattacharjee  
Distinguished Professor

- Statistical Physics: Equilibrium and Non-equilibrium
- Critical Phenomena
- Turbulence
- Nonlinear Dynamics

We have looked at problems in nonlinear dynamical systems where renormalization group can be effectively used. Also certain issues in rotating turbulence have been addressed. Further the question of critical sound attenuation has been examined for micellar solutions.

### PUBLICATIONS IN JOURNALS

1. A. Basu and J. K. Bhattacharjee, *Fluctuating hydrodynamics and turbulence in a rotating fluid: Universal Properties*, Phys. Rev. E, 2012, **85**, 023611
2. J. K. Bhattacharjee, U. Kaatze and S. Z. Mirzaev, *Does the viscosity exponent derive from ultrasonic attenuation spectra?*, Int. J. Thermophys., 2012, **33**, 469
3. T. Roy, S. Ghosh and J. K. Bhattacharjee, *Perturbation theory for Maxwell's equations with a time-dependent current source*, EPJ Plus, 2011, **126**, 119
4. H. K. Pharasi, R. Kannan, K. Kumar and J. K. Bhattacharjee, *Turbulence in rotating Rayleigh Benard convection in low Prandtl number fluids*, Phys. Rev. E, 2011, **84**, 047301
5. J. K. Bhattacharjee and U. Kaatze, *Anomalous*

*dynamics of non-ionic micelles in water*, J. Phys. Chem. B, 2011, 115, 6069

6. A. Sarkar, S. Chakraborty, D. Banerjee and J. K. Bhattacharjee, *Centre or limit cycle: Renormalization group as a probe*, Europhys J D, 2011, **64**, 479

### OTHER PUBLICATIONS

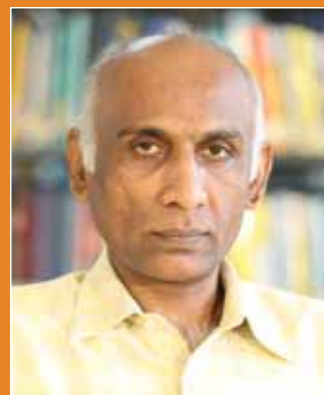
J. K. Bhattacharjee and Arnab K. Ray, *Hydraulic Jump*, J. Phys.: Conf. Ser., 2011, **319**, 012003

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Raka Dasgupta, Amartya Sarkar, Arghya Dutta, Sukla Pal, Arghya Das

### COURSES TAUGHT

1. PHY103 Quantum Mechanics I, 1<sup>st</sup> Semester
2. PHY202 Quantum Mechanics II, 2<sup>nd</sup> Semester



This work is centred around the analogy between the paraxial wave equation in classical optics and the Schrodinger equation. We had earlier constructed the coherent states for the commensurate anisotropic two-dimensional oscillator and studied their classical limit. Following this line, we have recently proposed a class of optical beams that have the structure of the eigensolutions of the commensurate anisotropic two-dimensional oscillator. Some work on the study

of the various properties of such beams has been undertaken. Further work is under way.

An important relation between the polar and cartesian eigenfunctions of the isotropic two-dimensional oscillator has been has existed in the literature for a decade. Our work hinges on generalizing this relation to the case of the commensurate anisotropic two-dimensional oscillator.

#### **PUBLICATIONS IN JOURNALS**

J. Solomon Ivan, M. Sanjay Kumar, R. Simon, *A measure of non-Gaussianity for quantum states*, Quantum Information Processing, 2011, **11**, 853

#### **COURSES TAUGHT**

1. PHY301 Quantum Mechanics III Semester III

2. PHY203 Electromagnetic Theory Semester II
3. PHY416 Optical Physics Semester IV

#### **PARTICIPATION IN COMMITTEES**

**Internal:** Admissions Committee, EVLP (VASP) Committee





Manu Mathur  
Professor

- Invariants, Projection Operators &  $SU(N) \times SU(N)$  Irreducible Schwinger Bosons
- Line Discontinuities, Local action with both the fields & its dual, and spin from no spin in two dimensional scalar theory

In the first work mentioned above, we exploit  $SU(N)$  Schwinger bosons to construct and analyze the coupled irreducible representations of  $SU(N) \times SU(N)$  in terms of the invariant group. The corresponding projection operators are constructed in terms of the invariant group generators. We also construct  $SU(N) \times SU(N)$  irreducible Schwinger bosons which directly create these coupled irreducible states. The  $SU(N)$  Clebsch-Gordan coefficients are computed as the

matrix elements of the projection operators.

In the second work a local action with both the real scalar field and its dual is presented in two Euclidean dimensions. The role of singular line discontinuities is emphasized. Exotic properties of the field with its dual, the generation of spin from scalar fields, and quantization of dual charges are pointed out. Wick's theorem and rotation properties of fermions are recovered for half-integer quantization.

#### PUBLICATIONS IN JOURNALS

Manu Mathur, Indrakshi Raychowdhury and T. P. Sreeraj, *Invariants, projection operators and  $SU(N) \times SU(N)$  irreducible Schwinger bosons*, Journal Of Mathematical Physics, 2011, **52**, 113505

#### OTHER PUBLICATIONS

Chandrasekhar Chatterjee, E. Harikumar, Manu Mathur, Indrajit Mitra, H. S. Sharatchandra, *Line discontinuities, local action with both the field and its dual, and spin from no spin in two-dimensional scalar theory*, 2011, arXiv:1111.5218

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Indrakshi Raychowdhury, T. P. Sreeraj

#### LECTURES DELIVERED

*SU(N) Irreducible Schwinger Bosons*, University of Hyderabad, April, 2011

#### ACADEMIC VISITS

TPSC, University of Hyderabad, Hyderabad, April, 2011

#### COURSES TAUGHT

PHY102, MATHEMATICAL METHODS, First Semester

#### PARTICIPATION IN COMMITTEES

**Internal:** Hostel Committee, Hindi Committee, Canteen Committee.

Nonlinear dynamics, Hamiltonization and first integrals for nonlinear ordinary differential equations (ODEs), geometric mechanics

Partha Guha  
Associate Professor



1. We studied Hamiltonization of planar nonautonomous and nonplanar autonomous systems. Given a planar nonautonomous system we find that for transforming this system into a Hamiltonian system, it suffices to determine certain two auxiliary functions. We illustrated our construction through examples.
2. The problem of finding a Lagrangian for a given ODE is generally known in classical mechanics as the inverse variational problem. We have derived

the Lagrangians of fourth and sixth order ODEs using Jacobi's last multiplier. We also derived the Hamiltonians of these equations using the Jacobi-Ostrogradski formalism.

3. We have studied Jacobi's last multiplier (JLM) to construct the Hamiltonians of certain well known first-order systems of equations arising in biology. We also used JLM to probe isochronicity properties of planar ODEs.

#### PUBLICATIONS IN JOURNALS

1. Partha Guha, Anindya Ghose Choudhury, A. S. Fokas, *Hamiltonians and conjugate Hamiltonians of some fourth-order nonlinear ODEs*, *Nonlinear Anal.* 2012, **75**, 2126–2138
2. A. Ghose Choudhury, Partha Guha, Nikolay A. Kudryashov, *A Lagrangian description of the higher-order Painlevé equations*, *Appl. Math. Comput.*, 2012, **218**, 6612–6619
3. Partha Guha, A. Ghose Choudhury, *Hamiltonization of higher-order nonlinear ordinary differential equations and the Jacobi last multiplier*, *Acta Appl. Math.*, 2011, **116**, 179–197
4. Partha Guha, A. Ghose Choudhury, *The role of the Jacobi last multiplier and isochronous systems*, *Pramana*, 2011, **77**, 917-927

#### OTHER PUBLICATIONS

Partha Guha, *Area-Preserving 2D Flows, Hydrodynamical Systems and Metriplectic Dynamics*, page 96-106, Proceedings of the National Seminar on Mathematical Modelling of National Phenomena, ISNA, 2011

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Barun Khanra (external)

#### LECTURES DELIVERED

1. Three lectures on *KAM theory* at IIT Madras, February 2012
2. Title: *Darboux integrability for 3D dynamical systems and Nambu metriplectic problem*, Talk given at Physics Seminar, IIT Madras, February 02, 2012
3. Title: *Nonlocal transformations and Isochronicity Condition of the Lienard Equation*, Invited speaker Complex Dynamical Systems and Applications-CDSA2012, Presidency University, Kolkata- January 09-11, 2012
4. Title: *Euler-Poincaré flows on the space of tensor densities*, Talk given at Theoretical Physics division, University of Zaragoza, December 1, 2011
5. Title: *Hamiltonian formulation of generalized peakon type systems*, Talk given at Nonlinear Mathematics Seminar, Department of Mathematics, University of Surrey, November 25, 2011
6. Title: *Group and Hamiltonian description of integrable systems*, Talk given at Mathematics Seminar, University of Kent, UK, June 24, 2011
7. Title: *Area-Preserving 2D Hydrodynamical Flows and Metriplectic Dynamics*, Invited speaker Hamiltonization of ODEs and dissipative dynamical systems at Kent on June 27 – 29, 2011



### ACADEMIC VISITS

1. Visited department of mathematics, University of Kent under Indo-UK project, June 23-30, 2011.
2. Visited Theoretical Physics division, Technical University of Clausthal, November 10-24, 2011; Department of Mathematics, City University London, November 24-26, 2011; Theoretical Physics division, University of Zaragoza, November 26 - December 06 2011.

### MEETINGS ORGANIZED

1. Convenor of an international meeting on *Statistical mechanics and nonlinear dynamics* March 12- 16, 2012, SNBNCBS, Kolkata.
2. Co-Convenor of a meeting 'Hamiltonization of ODEs and dissipative dynamical systems' at Kent on June 27-29, 2011 (jointly with Prof. Andy Hone).

- Nonequilibrium thermodynamics
- Fluctuation relations in driven systems
- Driven lattice gases, zero range processes

Punyabrata Pradhan  
Assistant Professor



Among the vast set of non-equilibrium systems, an important subset is that having a non-equilibrium stationary state. Unlike in equilibrium, a system in a non-equilibrium stationary state has a nonzero steady current and, in general, cannot be described by the Boltzmann distribution. Even for this simplest class of driven systems with a stationary state, there is no well-founded thermodynamic theory. We enquire whether a driven many-particle system can be characterized by an intensive thermodynamic variable which equalizes upon contact. We have

addressed this question by studying "equilibration" in a class of simple stochastic model-systems (e.g., various mass-transport models and driven lattice gases) when two systems are kept in contact and allowed to exchange a conserved quantity. Interestingly, for a few classes of driven systems, we found that there can be a remarkably simple thermodynamic structure where the zeroth law of thermodynamics and fluctuation-response relation are satisfied quite well in a wide range of parameter values.

#### PUBLICATIONS IN JOURNALS

1. P. Pradhan, R. Ramsperger, and U. Seifert, *Approximate thermodynamic structure for driven lattice gases in contact*, Physical Review E, 2011, **84**, 041104
2. P. Pradhan and U. Seifert, *Thermodynamic theory of phase transitions in driven lattice gases*, Physical Review E, 2011, **84**, 051130

#### SUPERVISION OF STUDENTS

**Ph.D. Student:** Sayani Chatterjee; **Project Student:** Debolina Basu (Post B. Sc.)

#### LECTURES DELIVERED

1. *Thermodynamic theory of driven lattice gases in contact*, S. N. Bose National Centre for Basic Sciences, Kolkata, March, 2012
2. *Thermodynamic theory of non-equilibrium steady-state systems in contact*, University of Calcutta, Kolkata, February, 2012
3. *Thermodynamic structure for non-equilibrium steady-state systems in contact*, Tata Institute of

Fundamental Research, Mumbai, November, 2011

#### ACADEMIC VISITS

Visit for collaborative research, Tata Institute of Fundamental Research, Mumbai, November, 2011

#### COURSES TAUGHT

1. PHY 201, Statistical Mechanics, Spring - 2012
2. PHY 603, Statistical Physics, Spring - 2012

#### PARTICIPATION IN COMMITTEES

**Internal:** Internal Member for the Thesis Committee (for Ajaz Ahmed Bhat, transfer to the Centre's JRF); Internal Member for the Thesis Committee (for D. P. Shinde, transition to SRF); Internal Member for the Thesis Committee (for Anuradha Das, transition to SRF)

#### MEETINGS ORGANIZED

International Conference on Statistical Physics and Nonlinear Dynamics, CSPND2012, March 12 - 16, 2012, S. N. Bose National Centre for Basic Sciences, Kolkata





Rabin Banerjee  
Senior Professor

- Phase transitions and critical phenomena in black holes
- Dual composition of odd-dimensional models
- Poincare gauge transformations and their relation with trivial gauge symmetries
- Topologically massive gravity
- Properties of higher derivative systems
- Black hole thermodynamics in noncommutative space

A detailed investigation of phase transitions in various black holes was done using a variant of the Ehrenfest scheme. We also developed a novel approach to calculate the (static) critical exponents. Results were consistent with mean field theory calculations. Thermodynamics of black holes in a noncommutative space was also discussed. Using equations of motion we were able to reveal a doublet structure in a (new) three dimensional model of massive gravity.

Poincare gauge theories were studied in details. Their Hamiltonian formulation was elaborated. The (missing) connection between Poincare gauge transformations and Hamiltonian gauge transformations was revealed through the use of trivial gauge symmetries.

A new approach to analyse constrained systems with higher derivatives was formulated. Gauge symmetry and W-symmetry were discussed from a unified viewpoint in a specific (higher derivative) model.

#### PUBLICATIONS IN JOURNALS

1. Rabin Banerjee, Dibakar Roychowdhury, *Critical phenomena in Born-Infeld AdS black holes*, Phys. Rev. D, 2012, **85**, 044040
2. Rabin Banerjee, Debraj Roy, *Poincaré gauge symmetries, hamiltonian symmetries and trivial gauge transformations*, Phys.Rev.D, 2011, **84**, 124034
3. Rabin Banerjee, Dibakar Roychowdhury, *Thermodynamics of phase transition in higher dimensional AdS black holes*, JHEP, 2011, **11**, 004
4. Rabin Banerjee, Sunandan Gangopadhyay, Debraj Roy, *Hamiltonian analysis of symmetries in a massive theory of gravity*, JHEP, 2011, **1110**, 121
5. Rabin Banerjee, Pradip Mukherjee, Biswajit Paul, *Gauge symmetry and W-algebra in higher derivative systems*, JHEP, 2011, **08**, 085
6. Rabin Banerjee, Sunandan Gangopadhyay, *Komar energy and Smarr formula for noncommutative Schwarzschild black hole*, Gen. Rel. Grav., 2011, **43**, 3201

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Bibhas Majhi (degree awarded), Sujoy Modak (Thesis submitted), Debraj Roy, Dibakar Roychowdhury, Arindam Lala, Biswajit Paul, Sarmistha Kumar (external student)

#### STUDENTS' PUBLICATIONS

1. Sunandan Gangopadhyay, Dibakar Roychowdhury, *Analytic study of Gauss-Bonnet holographic superconductors in Born-Infeld electrodynamics*, JHEP, 2012, **05**, 156
2. Sunandan Gangopadhyay, Dibakar Roychowdhury, *Analytic study of properties of holographic superconductors in Born-Infeld electrodynamics*, JHEP, 2012, **05**, 002
3. Pradip Mukherjee, Biswajit Paul, *Gauge invariances of higher derivative Maxwell-Chern-Simons field theory -- a new Hamiltonian approach*, PRD, 2012, **85**, 045028
4. Sujoy Kumar Modak, Saurav Samanta, *Effective Values of Komar Conserved Quantities and Their Applications*, Int.J.Theor.Phys, 2012, **51**, 1416

#### LECTURES DELIVERED

1. *Hawking effect from anomalies and tunneling*, Frontiers Of Research In Physics, Karimganj College, Karimganj, December, 2011
2. *Conic sections in physics*, UGC sponsored Frontiers In Theoretical Physics, Narsingha Dutta College, Howrah, December, 2011
3. *Conic sections in nature*, IAPT Annual Meeting, SNBNCBS, June, 2011

4. *Conic sections in nature*, IIT Patna, March, 2012
5. *From conic sections to black holes*, Inter University Accelerator Centre, Delhi, February, 2012

#### **COURSES TAUGHT**

QFT 1, Introduction to quantum field theory (special paper for MSc. West Bengal State University, Barasat), Fall Semester

#### **PARTICIPATION IN COMMITTEES**

**a. External:** Member, Board of UG studies, Presidency University

**b. Internal:** Chairman, Library committee







Sakuntala Chatterjee  
Assistant Professor

- Non-equilibrium Statistical Physics: Driven Diffusive Systems, Phase Ordering, Passive Scalar Advection, Work Fluctuation Theorem
- Biological Physics: Chemotaxis of E.coli bacteria
- Reaction and Diffusion in Microporous Solids: Molecular Traffic Control inside Zeolites

Chemotaxis motion of a single E.coli bacterium was studied in one dimension. Using numerical simulations and analytical techniques we have developed a coarse-grained model which differs from existing coarse-grained description of E.coli movement. We also discuss the origin of the discrepancy.

A reaction diffusion model was used to study

isomerization reaction inside TNU-9 zeolite, which plays the role of a catalyst. Our extensive numerical simulation shows that molecular traffic control (MTC), i.e. channeling reactant and product molecules along different pathways can greatly enhance the efficiency of the catalytic grain. This is the first ever study of MTC inside a realistic zeolite channel topology.

#### PUBLICATIONS IN JOURNALS

1. Sakuntala Chatterjee, Rava A da Silveira and Yariv Kafri, *Chemotaxis when bacteria remember: drift vs diffusion*, PloS Computational Biology, 2011, **7**, e1002283
2. Sakuntala Chatterjee, R. Harish, Gunter M Schuetz, *Strong molecular traffic control effect in TNU-9 zeolite channel topology*, Journal of Physical Chemistry B, 2011, **115**, 15289

#### SUPERVISION OF STUDENTS

**Ph.D. Student:** Sukla Pal (Jointly with J K

Bhattacharjee); **Project Student:** Shauri Chakrabarti

#### LECTURES DELIVERED

*Work Fluctuation in Driven Dissipative Systems*, SNBNCBS, International Conference on Statistical Physics and Nonlinear Dynamics, Kolkata, March, 2012

#### MEETINGS ORGANIZED

International Conference on Statistical Physics and Nonlinear Dynamics, March 12-16, 2012, SNBNCBS, Kolkata

- 2+1 Quantum Gravity
- Topological Excitations in Quantum Spin Systems in Low Dimensions

Samir Kumar Paul  
Associate Professor



a) There has been a definite trace of AdS/CFT correspondence in 2+1 dimensional gravity corresponding to the negative cosmological sector. Also the famous BTZ black hole solution is well known in this sector. In contrast to this not so much is known in the positive cosmological constant sector. We have studied nonperturbative quantization of the first order formulation of 2+1 gravity with positive cosmological constant and showed that the partition function is finite at one loop level. The action we consider is similar to the theories we presented before, except that the new parameter we introduced in the theory corresponds to a positive cosmological constant. Our result is significant in showing that the partition function can be tamed to be convergent in contrast to the earlier results of divergent ones by others. The work is done in collaboration with Rudranil Basu at Bose Centre (Rudranil Basu and

Samir K. Paul, *Consistent 3D Quantum Gravity on Lens Spaces*, Phys. Rev.D, 2012, **85**, 023520).

b) We have performed a semi-classical like theoretical analysis (based on available literature) for evaluating dynamical structure function corresponding to topological excitations in quasi-two dimensional spin-1/2 Heisenberg ferromagnet  $\{K_2\}Cu\{F_4\}$ . Comparing with the results of neutron scattering experiments on the above material we observed occurrence of negative values of the dynamical structure function within the experimental resolution width. This strongly suggests the necessity of developing a full quantum formalism to calculate dynamical spin-spin correlation for a spin-1/2 ferromagnet. The work is done in collaboration with Subhajit Sarkar and Ranjan Chaudhury at Bose Centre (arXiv : cond-mat : 1203.3069 ).

### PUBLICATIONS IN JOURNALS

Rudranil Basu and Samir K. Paul, *Consistent 3D Quantum Gravity on Lens Spaces*, Phys. Rev.D, 2012, **85**, 023520

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Rudranil Basu (Joint Supervisor: Parthasarathi Majumdar, SINP Kolkata), Subhajit Sarkar (Joint Supervisor: Ranjan Chaudhury, Bose Centre, Kolkata); **Project Student:** Post B.Sc. PBIR-Ph: Ankita Chakraborty (Project Topic: Identification of two dimensional Ising model at its critical point, with Conformal Field Theory)

### LECTURES DELIVERED

Invited talk given on *Some aspects of Chern-Simons Quantization*, Workshop on Field Theory: Recent

trends and applications, August 22 – 25, 2011, IISER, Kolkata, Mohunpur Campus

### COURSES TAUGHT

1. PHY 404, Advanced Mathematical Methods, 4<sup>th</sup> semester PBIR-Ph, 2011- 2012
2. PHY 405, Advanced Quantum Field Theory, 4<sup>th</sup> semester PBIR-Ph, 2011- 2012

### PARTICIPATION IN COMMITTEES

- a. External:** Moderation Board for 2<sup>nd</sup> and 3<sup>rd</sup> semester exams of M.Sc. Physics Programme by Bose Institute and St. Xaviers College
- b. Internal:** Security Monitoring Committee, PF Trustee Board, Admission Committee, SCRE committee, SCOLP





Subhrangshu Sekhar Manna  
Senior Professor

- Explosive Percolation
- Space Filling Percolation

**Nature of Transition in Explosive Percolation**  
The growth of the average size  $\langle s_{\max} \rangle$  of the largest component at the percolation threshold  $P_c(N)$  on a graph of size  $N$  has been defined as  $\langle s_{\max}(P_c(N), N) \rangle \sim N^\chi$ . Here we argue that the precise value of the growth exponent  $\chi$  indicates the nature of percolation transition;  $\chi < 1$  or  $\chi = 1$  determines if the transition is continuous or discontinuous. We show that a related exponent  $\eta = 1 - \chi$  which describes how the average maximal jump sizes in the Order Parameter decays on increasing the system size, is

the single exponent that describes the finite-size scaling of a number of distributions related to the fastest growth of the Order Parameter in these problems. Excellent quality scaling analysis are presented for the two single peak distributions corresponding to the Order Parameters at the two ends of the maximal jump, the bimodal distribution constructed by the weighted average of these distributions and for the distribution of the maximal jump in the Order Parameter.

#### SUPERVISION OF STUDENTS

**Ph.D. Students:** Abhijit Chakraborty, Biplab Bhattacharya; **Project Student:** Sukanya Bhattacharya

#### LECTURES DELIVERED

1. *A conservative self-organized extremal model for wealth distribution*, ECONOPHYSICS – KOLKATA VI: Econophysics of Systemic Risk and Network Dynamics at Saha Institute of Nuclear Physics, October 21-25, 2011
2. *A conservative self-organized extremal model for wealth distribution*, Workshop on Networks: Structure and Function, IISc Bangalore, November 04-05, 2011
3. *Nature of Transition in Explosive Percolation*, Fracture & Flow in Porous Media, Institute of Mathematical Sciences, Chennai, January 11-14, 2012

4. *International Trade Networks*, in Workshop on Social Networks, Institute of Mathematical Sciences, Chennai, February 20-24, 2011
5. *Nature of Transition in Explosive Percolation*, International Conference on Statistical Physics and Nonlinear Dynamics, SNBNCBS, March 12-16, 2012

#### COURSES TAUGHT

PH104, Computational Methods, 1<sup>st</sup> Semester

#### SPONSORED PROJECTS

Fracture & flow in porous media: Application in geothermal installation, hydrocarbon production & CO<sub>2</sub> storage – an India and Norway joint collaboration project

#### MEETINGS ORGANIZED

Fracture & Flow in Porous Media, Institute of Mathematical Sciences, Chennai, January 11-14, 2012

- Biomedical tissue characterization using light scattering technique
- Development of analytic formulas for extinction contributions of major dust components of interstellar dust



Subodh Kumar Sharma  
Emeritus Professor

1. In simulations of light propagation in soft biomedical tissues, the tissue is often modeled as a turbid medium. One such model assumes scatterers to be spherical with a fractal size distribution. It was demonstrated some time back that a soft tissue can be characterized from its near forward scattering phase function completely within the framework of this model. As a continuation, we examined the accuracy of the anomalous diffraction approximation. It was shown that tissue scattering coefficient can be expressed in a closed analytic form in this approximation. The experimentally observed wavelength dependence of scattering coefficient easily follows from this analytic form. This approximation is found to yield good results for the phase function and the asymmetry parameter

as well. The results are also important from the point of view of constructing more realistic models with nonspherical scatterers.

2. The frequency and size distribution dependence of extinction spectra for astronomical silicate and graphite grains was analyzed by us in the context of MRN type interstellar dust models in a series of two papers earlier. The grains in the MRN model are taken to be homogeneous spheres with a power law size distribution. In a continuation of this work, we obtained analytic formulas for the scattering and absorption spectrum of the third and the last major constituent of the dust model, namely, the polycyclic aromatic hydrocarbons (PAHs). Relative contribution of the PAHs vis a vis graphite grains was examined. Results will be published soon.

### PUBLICATIONS IN JOURNALS

S. K. Sharma and S. Banerjee, *On the validity of anomalous diffraction approximation in light-scattering studies of soft biomedical tissue*, J. Mod. Opt., 2012, **59**, 701

### SUPERVISION OF STUDENTS

**Ph.D. Students:** Pritesh Randive (IUCAA)

### LECTURES DELIVERED

1. *Elastic light scattering for particle characterization*, L N Mittal Institute of Information Technology, Jaipur, April, 2011
2. *Analytic formulas for frequency and size distribution dependence of absorption and scattering efficiencies of PAHs*, IUCAA Pune, November, 2011
3. *Characterization of soft biomedical tissues by elastic light scattering*, SINP, December, 2011

4. *Analytic formulas for the absorption and extinction spectrum of astronomical PAHs*, Silchar, February, 2012

### ACADEMIC VISITS

Visiting Professor, Assam University, Silchar, January – February, 2012

### PARTICIPATION IN COMMITTEES

**External:** Member, Board of Studies, Department of Applied Optics and Photonics, Calcutta University

### SPONSORED PROJECTS

ISRO-RESPOND Project: Developing analytic formulas for extinction spectra of major interstellar dust components





# Facilities



# Library



## About Library

S N Bose Library is a specialized library in the field of Basic sciences. Since its inception in the year 1986, the library has been playing an important role in the development of learning and research activities. Apart from the Centre's faculty and student members, the library provides information support to numerous professionals working on basic sciences throughout the country.

## Collection

The Library has a collection of more than 12470 books and more than 8000 bound volume journals. The Library subscribes 151 important journals published by reputed publishers mostly in electronic version. In addition, being a member of National Knowledge Resource Consortium, 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, Indiatat etc. Library has a Fiction Section with a good collection of books on Hindi and Bengali literature i.e. novels, short stories, biographies, dramas, general knowledge, environmental sciences and many more for all type of readers. Library possesses a good collection of audio-visual materials. The Library has separate magazine and newspaper

reading section. 25 popular magazines and 13 daily newspapers in different languages are subscribed regularly. The library is enriched with a valuable archive of S N Bose. This archive includes some rare books of his personal collection.

## Library Hours

The Library is open from Morning 8.00 A.M. to Night 12.00 A.M. except Sundays and national holidays. However circulation counter is open from 9:00 AM to 5:30 PM.

## Library Users

Being a research library, its majority of resources are online journals and databases which are accessible within the campus LAN. On an average, 48 users visit the library per day.

## Services

- Reading Facility: Library provides reading facility to its members as well as outside visitors. All the books including reference collections are classified and is open-accessed.
- Document Lending service: Each member is entitled to issue 6 books and 2 bound volumes of journals at a time.

- Reference Service: Reference service is given via e-mail, telephone or personally with the help of different reference tools like encyclopedias, directories, dictionaries, atlases, yearbooks etc.
- OPAC : Library offers Online Public Access Catalogue (OPAC) which allows user to browse library collection through web (Web OPAC).
- E-resources and Internet Facility: Library is well equipped with a good number of computers with internet connection through cable LAN and wireless networking facility for laptop users. Library is having access to plenty of electronic journals, databases, archives and consortiums. User is having full access to the e-resources.
- Reprographic Services: Library has one printer cum copier, one colour printer, a photocopy machine and few laser printers.
- Audio-visual Room: Library has a separate Audio-Visual Room for showing multimedia presentation, video lectures, documentaries etc. The room is also equipped with projector, screen, white board and sitting arrangements. The room is also used as a discussion room for teachers and students.
- Bibliometric Services: Library helps to prepare various bibliometric reports specially usage statistics, citation analysis, h-index, Impact factor of Journals etc.
- 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 other libraries under DST and CSIR. SNB library has institutional membership of Saha Institute of Nuclear Physics (SINP) and British Council Library (BCL), Kolkata.
- Book Exhibition: Library conducts Book Exhibitions within the Centre's campus for selection of useful books for the library. Book suppliers attend the

exhibition with their variety of publications. Book exhibitions are usually taken place twice in a year.

- Library is for leisure: Library has a separate section for Bengali, Hindi, and English literature, fiction, classic literature, novel etc.
- Digital Repository: Library has digital archives of "S.N. Bose Archive and Digital Multimedia", Ph.D. Thesis, "Multimedia collection of different seminar and cultural program", E-books etc.

### Resources and Services Added in the F.Y. 2011-12

- Library premises have been covered by Close Circuit Camera Surveillance System for greater security. Continuous video clips are recorded in hard disk drive through DVR system.
- Library organized book exhibitions within the Centre's campus for wider selection of books by all faculty, staff and student members.
- A special Fiction Section has been made in the Library for books on classic literature, novel, short story, biography and books of general interests. Reading arrangement is also created to the adjacent place.
- An audio-visual room has been made in the library with sitting arrangement of 20 persons. The room is equipped with projector, screen and white board.
- Library has been compiling the Annual Report, Annual Research Profile, Diary, and Calendar of the Centre and coordinated the process of printing.
- For beautification of library, some flower vases with colourful flowers are placed at different locations of library.
- To enrich the library, 1020 new books have been procured, 21 new journals and databases including full electronic archive of the 'Nature' and 'Science' have been added to library collections.



**Saumen Adhikari**  
Librarian - cum - Information Officer





# Engineering Section



The Engineering Section of SNBNCBS was ever focused for development or creation of various facilities for the Centre. Simultaneously, it emphasized on proper upkeep of the campus as advised by the authority. The Engineering Section actively participated in organizing various programmes of the Centre. The major activities of the Engineering Section during the FY: 2011-12 are as follows.

## Infrastructure Development

- Accommodating students was a major concern for the Centre. This year, construction of six storied *Krishnachura Hostel Building* (G+5, 122 bed) have been completed. With all amenities like under ground water reservoir with Pump house, Fire Pump, Stand by Fire pump, Jockey Pump are installed in the basement of Pump House adjacent to under ground reservoir. A 6" diameter M.S. Black Steel pipe laid all round the building with nos. Of fire hydrants installed in vulnerable points to meet any eventuality at the outbreak of fire.

The wide link path made of coloured paver block surrounding the Hostel and 4 m. Post of ornamental lantern which adds aesthetic view together with 0.60 m. Height Bolard garden lamp on the peripheral of landscape which graces the Hostel beautifully.

- Creation of infrastructure / facilities was closely associated with upcoming scientific programmes and academic growth. Creation of two air-conditioned Lecture Halls equipped with modern systems, four laboratories, a new Students' Bay

(Study Zone) are significant addition.

- In the Clean Room Building, apart from installation of different scientific instrument, a utility area equipped with modern gadgets has been provided. This Clean Room Building is one of the unique facilities in Eastern India.
- A new 8 passenger lift has been installed in Main Building (Part-B) replacing the old one which was creating frequent trouble.
- A deep Tube well was bored and installation of submersible pump motor set was completed in view of ensuring sufficient water supply to *Krishnachura Hostel Building*.

## Maintenance & Housekeeping

- Maintenance of buildings, roads, sanitary, plumbing & electrical installations.
- Horticulture and beautification of the campus.
- Housekeeping of Main Building and Hostels at CB-38 & GD-76.
- Organizing Intensive plantation programme at the Campus.
- Managing asset movement, office & residential space allotment.

## Support Services

Engineering Section has provided necessary support services for all Seminars and Annual Programmes organized at the Centre e.g. various memorial lectures, workshops, schools, Bose Fest-2012.

**Jnanada Ranjan Bhattacharya**  
Superintending Engineer

# Computer Centre



The Computer Centre on the third floor serves the computational needs of the S. N. Bose National Centre. At the end of the academic year 2011-2012, there were about 500 users with accounts in the central file server (NFS), including all faculty, academic staff and students. These accounts were distributed according to departmental affiliations among four SuperMicro servers, each with a 2.2GHz AMD processor and 300 GB hard disk, one for each department and these have been augmented.

The email accounts are held in a mail server of the same specifications as above, which also hosts the web pages. The Centre has a 100Mbps internal network with an 8Mbps external (internet) link. Since last year we have also become a part of the National Knowledge network which will give us access to a 100 Mbps leased line. In addition wireless facilities are available at several locations. Several laser printers are available for meeting the printing needs of the Centre.

Computational facilities include a parallel computing cluster built by SuperMicro was installed, containing 40 nodes (320 processors). Each node has two quad-core processors, 16GB RAM and 500 GB hard disk. In addition the cluster has a 2 Terabyte Network Access Storage device. In addition we have two small clusters

consisting of 96 processors each for serial users. Three smaller clusters and another similar cluster, bought under individual research projects funded by the DST, are also installed in the Computer Centre. The computational facilities of the AMRU project, including a parallel computing cluster, are maintained separately, and are networked with the Computer Centre.

Since last year an intranet server was set up to fulfill internal requirements of official notification etc. The server runs a web-based general notice board, where the Centre's general, official, academic, seminar related, placement related or lost & found related notices are posted. The server also hosts web pages for on line booking of lecture halls and guest house internally. In addition the design and maintenance of various conference web-pages, on line admissions as well as the online registration for new students are handled by the Computer Centre.

A senior computer engineer, Mr. Sudeep Narayan Banerjee, and two junior computer engineers, Mr. Avijit Roy and Ms. Banajyothsna Chattopadhyay, as well as a technical assistant Mr. Bijoy Pramanik, help in the maintenance of the computers and networking as well as the online activities of the Centre.

*Priya Mahadevan*

**Priya Mahadevan**  
In-charge, Computer Centre

# Project Cell



The project cell is used as a source for keeping tab on the cornucopia of projects that are running in the Centre. This includes some internally funded and mainly externally funded projects, from India and abroad. The project cell has a website <http://www.bose.res.in/~prjcell>, from where the relevant forms can be downloaded.

The following table summarizes the details of the externally funded projects in the Centre, for the last five years: The following external projects were running during 2011-2012:

Year	No. of Projects	Amount Received ( ₹ )
2007-2008	25	6,07,13,160=00
2008-2009	27	1,15,61,417=00
2009-2010	39	5,51,44,887=00
2010-2011	40	4,83,19,968=00
2011-2012	41	7,13,74,645=00

1. Swarnajayanti Fellowship, by Dr. T. Saha Dasgupta, funded by DST, 1/2/2006-SF
2. Understanding Physics and Chemistry of novel material using NMTO Wannier Functions, by Dr. T. Saha Dasgupta, funded by Indo-German, FP/2004(40)
3. Advanced Materials Research Unit (AMRU), by Dr. T. Saha Dasgupta, funded by DST, IR/S2/PU-09/2006
4. J.C. Bose Fellowship, by Prof. A. K. Raychaudhuri, funded by DST, SR/S2/JCB-17/2006
5. Centre for Nano Technology, by Prof. A. K. Raychaudhuri, funded by DST, SR/S5/NM-31/2005
6. Development of cryostats and electronic measurement units for physical properties measurements using a zero-loss dewar, by Prof. A. K. Raychaudhuri, funded by DST, IR/S2/PU-03/2006
7. Utilization of Synchrotron Radiation Sources and Neutron Sources abroad, by Prof. A. K. Raychaudhuri, funded by DST, SR/S9/Z-18/2007
8. INAE (Emeritus Scheme), by Prof. B. B. Bhattacharya, funded by INAE, INAE/405/NS
9. Study of Biomolecular recognition with Time-resolved Optical Spectroscopy, by Dr. Samir K. Pal, funded by DST, SR/SO/BB-15/2007
10. DST/BGS/08-09/03 -Growth, characterization and study of resistive switching in multifunctional perovskite oxide systems, by Dr. Barnali Ghosh Saha, funded by DST (WOS-A), SR/WOS-A/PS-15/2008
11. DST/PSD/08-09/04 - Electronic states and transport in mesoscopic systems, by Dr. Prosenjit Singha Deo, funded by DST, SR/S2/CMP-40/2007
12. DST/BC/08-09/10 -Astrophysical and cosmological implication of noncumulative space time, by Dr. Biswajit Chakraborty, funded by DST (Indo SA Jt. Proj), INT/SAFR/P3(11)/2009
13. DST/AL/08-09/12 - Symmetries of non-abelian two-form gauge theories, by Dr. Amitabha Lahiri, funded by DST, SR/S2/HEP-0006/2008

14. DST/AB/09-10/17 –Quasistatic and Ultrafast Magnetization Dynamics in Nanomagnet Arrays, by Dr. Anjan Barman, funded by DST, SR/NM/NS-09/2007
15. DST/AB/09-10/18 –DYNAMAG: Advanced Computational Studies of Dynamic Phenomena in Magnetic Nano-Materials, by Dr. Anjan Barman, funded by DST & European Commission, INT/EC/CMS(24/233552) /2008(i)
16. DST/ASM/09-10/19 - Fundamental Aspects of Quantum Theory and Quantum information: A Multidisciplinary Approach, by Dr. Archan S. Majumdar, funded by DST, IR/S2/PU-16/2007
17. DST/MM/09-10/21 –Synthesis of DNA and Micelles Templated Magnetic Nanoparticles and their Necessary Surface Functionalization for Bio –Medical Applications, by Dr. Madhuri Mandal, funded by DST (SERC Fast Track), SR/FT/CS-090/2009
18. DST/PM/09-10/22 – ATHENA – Advanced Theories for Functional Oxides: New Routes to Handle the Devices of the Future (India European Union Research Project), by Dr. Priya Mahadevan, funded by DST, INT/EC/ATHENA (3) / 233553/2008 (i)
19. DST/SB/09-10/23 – Investigation of Static and Dynamic Magnetic Properties of Nanomagnetic Systems, by Dr. Saswati Barman, funded by DST (Fast Track), SR/FTP/PS-71/2007
20. DRDO/KM/09-10/24 -Study of magneto caloric effect, by Dr. Kalyan Mandal, funded by DRDO, ERIPR/ER/0902182/M/01/1296
21. DST/AB/09-10/27 -Spin wave and domain wall dynamics in vertical magnetic nanowires (DST-UKIERI), by Dr. Anjan Barman, funded by DST, DST/UKIERI/SA/P-2 /2008
22. CSIR/KM/09-10/29 -Preparation and study of nanostructured dilute magnetic semiconductors, by Dr. Kalyan Mandal, funded by CSIR, 03(1178)/10/EMR-II
23. DST/AM/09-10/30 - Generativity in Cognitive Networks, by Prof. Anita Mehta (From SNBNCBS), funded by DST, SR/CSI/44/2008(11)
24. DST/AB/09-10/31 - Magnonic Crystals: New paradigm towards microwave communications, by Dr. Anjan Barman, funded by DST (DST-JST Prog), INT/JP/JST/P.23/2009
25. BRNS(DAE)/KM/09-10/36 - Preparation and study of magnetic nanowires, by Dr. Kalyan Mandal, funded by BRNS (DAE), 2009/37/16/BRNS
26. DST/TSD/09-10/37 - MONAMI – Modeling of NANO – Scaled Advanced Materials Intelligently, by Dr. Tanusri Saha Dasgupta, funded by DST (Int Div), INT/EC/MONAMI (25/233513)/2008 (i)
27. SRC/TSD/09-10/38 - Magnetism in organic materials, by Dr. Tanusri Saha Dasgupta, funded by Swedish Research Council (SRC)
28. Design and Fabrication of Nanomachined Thermal Sensors using FIB (DST – UKIERI), by Prof. A. K. Raychaudhuri, funded by DST, DST/UKIERI/SA/P-29/09
29. Contacting 3D electrodeposited nanowires: new opportunities for sprintonics technology (DST – UKIERI), by Dr. Kalyan Mandal, funded by DST, DST/UKIERI/SA/P-13/09
30. Neutron diffraction studies of collapse of charge ordering in narrow band half-doped manganite  $Y_{0.5}Ca_{0.5}MnO_3$  nanoparticles, by Prof. A. K. Raychaudhuri, funded by UGC DAE CSR, CSR/AO/MUM/CRS-M-154
31. EICOON – Euro Indo forum for nano materials research coordination & cooperation of researchers in sustainable energy technologies, by Prof. A. K. Raychaudhuri and Dr. Sugata Mukherjee, funded by University of Twente
32. DST/AKR/09-10/40 - Unit on Nanoscience at SNBNCBS, Kolkata (UNANST – II), by Prof. A. K. Raychaudhuri, funded by DST, SR/NM/NS-53/2010
33. DST/PM/10-11/41 – Electronic and structural properties of semiconductors at the nanoscale, by Dr. Priya Mahadevan, funded by DST (Nano Mission), SR/NM/NS-91/2010(G)
34. DST/KA/10-11/43 – The study of photo-desorption and photo-ionization of Complex Molecules in Star Forming Regions, by Dr. Kinsuk Acharyya, funded by DST (SERC Fast Track), SR/FTP/PS-075/2010(G)
35. DST/SB/10-11/50 – Advanced Computational Study of Magnonic crystals, by Dr. Saswati Barman, funded by DST (Women Scientist Scheme – A), SR/WOS-A/PS-27/2010(G)



36. DIT/AB/10-11/52 – Development of GHz Frequency Filters and Attenuators using Nanoscale Magnonic Crystals, by Dr. Anjan Barman, funded by DIT, 1(7)/2010/M&C
37. DST/AKR/10-11/53 – Investigation of strain-dependent magnetization dynamics and electronic transport in magnetic oxides for spintronics and signal processing applications, by Prof. A. K. Raychaudhuri, funded by DST-DAAD (Indo-German), INT/FRG/DAAD/P-210/2011 dated 9-7-2011
38. DST/AKR/10-11/55 – Electroresistance in single crystals and thin films of mixed valence manganites, by Prof. A. K. Raychaudhuri, funded by DST (DST-RFBR), (RUSP-1183) INT/RFBR/P-110
39. DST/BBB/11-12/61 – Geoelectrical Methods: Theory and Application, by Prof. Bimalendu B. Bhattacharya, funded by DST (SERB) HR/UR/09/2011 dated 13-2-2012
40. DST/AKR/11-12/63 – Thematic Unit for Excellence on Nanodevice Technology, by Prof. A. K. Raychaudhuri / Dr. Anjan Barman (Coordinator), funded by DST, SR/NM/NS-09/2011
41. UKIERI/AKR/11-12/70 – Nano Breath App, by Prof. A. K. Raychaudhuri, funded by IND/CONT/E/11-12/086
- No. of visits under exchange programme : 37**



**Pratip Kumar Mukhopadhyay**  
Convenor, Project Cell

# Technical Cell



The technical cell was formed on May, 2008. It looks after a number of high end and state of the art equipment, which 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

of the instruments are available in the website : [www.bose.res.in/~technicalcell](http://www.bose.res.in/~technicalcell)

At present the major equipment facilities falling under technical cell are as below:

## A) Major Facilities under Technical cell:

Equipments:	Number of internal users/year	Number of external users/year	No. of hours used/ year
<p>1) <b>X-ray Diffraction #1:</b>  <b>PANalytical X-PERT PRO</b>                      with solid state detector  <b>Installed: 2005</b>  <b>Different measurement modes:</b>                      i) Powder diffraction                      ii) Thin film reflectivity                      iii) High resolution rocking curve analysis                      iv) Stress/texture analysis                      v) Small angle x-ray scattering (SAXS)</p>	32	20	1500hrs
<p>2) <b>X-ray Diffraction #2:</b>  <b>Rigaku, model: MiniFLEX II</b>  <b>Installed: March, 2011</b>  <b>Measurement mode:</b> Powder diffraction</p>	15		400hrs
<p>3) <b>Environmental SEM (ESEM)</b> with W-filament and E-beam lithographic facility  <b>FEI QUANTA 200 ESEM</b>                      Resolution ~ 2.4nm under high vacuum and ~3.0nm under low vacuum</p>	30	22	1450hrs



Equipments:	Number of internal users/year	Number of external users/year	No. of hours used/ year
<p>4) <b>Vibrating Sample Magnetometer (VSM):</b>  <b>Lakeshore (Model no: 7407)</b>  <b>Installed: April, 2006</b>            Temperature range:77K -400K magnetic field range: ±1.6 Tesla;            sensitivity ~1.25 micro-emu</p>	34		2400hrs
<p>5) <b>Atomic Force Microscopy (AFM)</b> with lithography facility  <b>Model : Veeco CPII</b>  <b>Installed: 2005</b></p>	22		1200hrs
<p>6) <b>Pulsed Laser Deposition (PLD) Unit:</b>  <b>Model: Compex Pro 201 made by Coherent Inc.</b>  <b>Installed: Nov. 2008</b>  <b>Pulsed Excimer Laser:</b>            Wavelength: 248nm(KrF) &amp;193nm (ArF)            Max<sup>m</sup> power: 700mJ            Repetition rate:10Hz</p>	15		1600hrs
<p>7) <b>High Resolution Transmission Electron Microscope (HRTEM):</b> with 200KV EFG source  <b>Model: Technai G<sup>2</sup> S-Twin (FEI, Netherland)</b>  <b>Installed: April, 2011</b>            i) Resolution 0.2 nm            ii) High resolution HAADF STEM detector with magnification range 200 x to 1M x.</p>	14		900hrs

**B) Other facilities under Technical cell:**

1. Differential Scanning Calorimeter (DSC):	2.TG-DTA:	Dynamic Light Scattering (DLS):	Spectroscopic Ellipsometer:	Sputtering/ evaporation unit:	Liquid N2 plant
Model: DSC Q 2000 (TA Instruments) Installed: Jan 2011	Model: Perkin Elmer made system the Temperature range of 50°C to 1200°C.	Model: Zetasizer system resolution of < 1nm	Model: WVASE32 system (J. A. Woollam Co. Inc.)	Model: HINDHIVAC dc and rf magnetron sputtering system. With resistive evaporation attachment	Stirlab 200 (Stirling made production capacity of 1.7L/hour.

### C) Upgradation of major Facilities:

X-ray Diffraction #1: PANalytical X-PERT PRO	Atomic Force Microscopy (AFM)	Pulsed Laser Deposition (PLD) Unit	Vibrating Sample Magnetometer (VSM):	High Resolution Transmission Electron Microscope
<b>Upgraded in April 2009</b> i) high temperature (1600 °C) attachment ii) pixel detector.	<b>Upgraded in August 2011</b> Innova model of Bruker with added advantages of better precision in nanolithography and nanomanipulation	<b>Upgraded in March 2012</b> i) High pressure RHEED system (RHV-KSA) from STAIB Instruments, Germany for in situ analysis of the deposited film by laser ablation. The electron source energy ~ 35 KeV	<b>Upgraded in August 2009</b> High temperature attachment: ~1273K	<b>Upgraded in August 2011</b> i) Electron Energy Loss Spectroscopy (EELS) attachment model: GIF Quantum 963 from Gatan, USA. energy resolution ~ 0.9 eV.

### D) List of Technical Cell members:

Dr. Anjan Barman	(In-charge)	
Dr. Barnali Ghosh (Saha)	(Scientist-D of Technical Cell)	
Ms. Shohini Majumder	Member	
Dr. Kaustuv Das	Member	
Dr. Kinshuk Acharyya	Member	
Dr. Chhayabrita Biswas	Member	
Dr. Rajib Kumar Mitra	Member	
Dr. Madhuri Mandal	Member	

The Technical Cell has following staffs, who perform the daily operation and maintenance of the equipments under the Technical Cell. Some of them are also responsible for the Teaching Laboratory (C. K. M Laboratory).

**Secretary:** Mr. Shudhanshu Chakraborty

**Technical Assistants:** Mr. Shakti Nath Das, Ms. Piyali Bose, Mr. Surajit Mukherjee, Mr. Dipankar Roy, Mr. Indrajit Chatterjee, Ms. Urmi Chakrabarti.



**Anjan Barman**  
for Technical Cell





# Mechanical Workshop



In this year, the mechanical workshop and the glass blowing section worked all along to cater to the needs of various people from the Centre. Since the earlier workshop man resigned in the first quarter of the year, a fresh candidate was chosen after due interviews. He started from 1<sup>st</sup> September, 2011. He finished 60 major jobs in the remaining part of year. All the laboratories, technical cell and other departments of the Centre benefited through it.

The glass blower comes regularly on every Tuesday in the week, but comes on other days too, as per demand. He finished 57 jobs during this time span. A very important facility that is provided here is vacuum or argon gas filled ampouling from glass or quartz. This facility even attracted a user from outside, a faculty from Calcutta University used to send his students for some works. Outside works are chargeable.

*P. K. Deutthopadhyay*

**Pratip Kumar Mukhopadhyay**  
In-charge, Mechanical Workshop

# Guest House



## **BHAGIRATHI – GUEST HOUSE**

The Centre has its own modern guest house and cafeteria located within the premises. In the guest house there are five (5) fully air conditioned suites and three (3) transit rooms each having attached bath and kitchenette, four (4) double-bed and twenty seven (27) single bed air –conditioned fully furnished rooms. The second and the third floor of the guest house comprising forty four (44) single rooms and eight (8) double rooms are being presently used for accommodating students. During the period 2011-2012 occupancy in all the rooms of Bhagirathi was for about 4300 days and it accommodated around 830 guests. (Suites and transits are given on restricted occasion; at any given point of time 20-30% rooms i.e. 6-8 rooms are kept vacant for emergency usage.) A small seminar room with sitting capacity of thirty (30) people has been developed within the guest house premises for hosting seminars, conferences, meetings etc. The Bhagirathi - Guest House also provides 24 hours STD/ISD, Internet, Laundromat, ATM and car parking facilities. Bagirathi has a modern cafeteria and a kitchen which serves around ninety (90) persons. 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 hi-tea on special occasions viz. seminars,



conferences etc. of the Centre.

## **STUDENTS' HOSTEL**

The Centre provides residential accommodation to around one hundred and thirty (130) students currently enrolled in various programmes. The second and third floor of the Bhagirathi guest house comprising forty four (44) single rooms and eight (8) double rooms are used for accommodating students. The New Hostel Block – Radhachura provides accommodation for thirty (30) students and Essential Staff Quarters has accommodation for approximately twenty (20) students. The remaining students, approximately thirty four (34) in number are provided accommodation in rented apartments located within close proximity to the Centre. The Centre also provides accommodation to post doctoral fellows. A large hostel – Krishnachura with total strength of 122 rooms is nearing completion within the campus of the Centre to accommodate all the students.

## **ESSENTIAL STAFF QUARTER**

The Essential Staff Quarter building located within the Centre's premises currently houses several scientists/ post doctoral fellows and one permanent staff. Rest of the rooms provides accommodation to the students.

*Ranjan Chaudhury*

**Ranjan Chaudhury**  
Acting Registrar

# Crèche



**K**ishlay 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. Parents need to be assured that their children are being looked after in an environment, which is safe and provides a stimulus for intellectual as well as emotional growth leading to increased productivity at the workplace. At present, there are two children in 'Kishlay'.

**Shohini Majumder**  
Deputy Registrar, Administration

# Cultural Programmes



Throughout the year, the Centre organized a number of cultural events to ensure that there is healthy interaction between all the staff and students of the Centre.

On the occasion of 65<sup>th</sup> Independence Day on 15<sup>th</sup> August 2011, Prof. Jayanta Kumar Bhattacharjee, Distinguished Professor and Dean (Faculty) hoisted the National Flag. To celebrate the 63<sup>rd</sup> Republic Day on 26<sup>th</sup> January 2012, Prof. Arup Kumar Raychaudhuri, Director hoisted the National Flag. On both the occasions, National Anthem was sung by students and staff present and parade was performed by the Centre's security personnel. On this occasion small replicas of national flag were distributed amongst the members present in the gathering and tea and snacks were served in the canteen.

The Centre celebrated Satyendra Nath Bose's 118<sup>th</sup> birthday on 1<sup>st</sup> January 2012. The bust of Satyendra Nath Bose was garlanded by the Director and other senior faculties and sweets were distributed among the staff members on the occasion.

On the occasion of Bose Fest held during 29<sup>th</sup> January 2012 – 1<sup>st</sup> February 2012, Family Day was celebrated on the evenings of 30<sup>th</sup> and 31<sup>st</sup> January 2012. On 30<sup>th</sup> January 2012, the staff and students presented an in-house programme comprising of individual

performances of singing and recitation and featuring dance drama 'Chitrangada'. On 31<sup>st</sup> January 2012, sarod recital by eminent instrumentalist Pandit Buddhadeb Dasgupta was complemented by Shounak Chattopadhyay who gave an engrossing demonstration on the role of Indian classical music on Tagore's songs. The functions were followed by grand dinner on both the days. The programmes were attended by friends and family members of staff and students and was a huge success. On 1<sup>st</sup> February 2012, Tagore's 'Ghare Baire' (Home and the Outer World) was presented by the staff and students of the Centre in the form of a sruti natak.

Like in previous years, the Centre also organised number of programmes in September to celebrate the Hindi Mahina. As a part of the programme, the following programme was undertaken:

- Signing of Attendance Register in Hindi
- Every day one new Hindi word with its English meaning displayed in the Reception area

The official inauguration of the Hindi Diwas was made by the Dean (Faculty) on 14<sup>th</sup> September, 2011. The occasion was graced by Dr. Prem Shankar Tripathi, Head, Department of Hindi, Surendranath College (Evening).

*Shohini Majumder*

**Shohini Majumder**  
Deputy Registrar, Administration



# *Publications*



# List of Publications

## ASTROPHYSICS AND COSMOLOGY

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2. A. Rai, D. Home and **A. S. Majumdar**, *Leggett type nonlocal realist inequalities without any constraints on the geometrical alignment of measurement settings*, Phys. Rev. A, 2011, **84**, 052115.
3. N. Ganguly, S. Adhikari, **A. S. Majumdar**, J. Chatterjee, *Entanglement witness operator for quantum teleportation*, Phys. Rev. Lett., 2011, **107**, 270501
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5. T. Pramanik and **A. S. Majumdar**, *Fine-grained uncertainty relation and nonlocality of tripartite systems*, Phys. Rev. A, 2012, **85**, 024103
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7. P. Chowdhury, D. Home, **A. S. Majumdar**, S. V. Mousavi, M. R. Mozaffari, S. Sinha, *Strong quantum violation of the gravitational weak equivalence principle by a non-Gaussian wave packet*, Class. Quant. Grav., 2012, **29**, 025010
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9. **K. Giri** and **Sandip K. Chakrabarti**, *Hydrodynamic simulations of viscous accretion flows around black holes*, MNRAS, 2012, **421**, 666
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12. **P. S. Pal, S. K. Chakrabarti**, A. Nandi, *Evidence of variation of the accretion flow geometry in GRS 1915+105 from IXAE and RXTE data*, IJMPD, 2011, **20**, 2281
13. S. Ray, **S. K. Chakrabarti, S. Sasmal**, *Precursory Effects in the night time VLF signal Amplitude for the 18th Jan. 2011 Pakistan Earthquake*, Ind. J. Physics, 2012, **86**, 85
14. I. Chattopadhyay and **S. K. Chakrabarti**, *Effects of the composition on transonic properties of accretion flows around black holes*, IJMPD, 2011, **20**, 1597
15. **H. Ghosh, S. K. Garain, Kinsuk Giri, Sandip K. Chakrabarti**, *Effect of Compton Cooling on the Hydrodynamic and the Spectral Properties of a Two Component Accretion Flow around a Black Hole*, MNRAS, 2011, **416**, 959
16. **S. K. Chakrabarti**, *Fundamental Concepts in Transonic Flow Paradigm of Black Hole Astrophysics*, IJMPD, 2012, **20**, 1723
17. A. Das, **Sandip K. Chakrabarti**, *Composition and evolution of Interstellar Grain mantle under the effects of Photodissociation*, MNRAS, 2011, **418**, 545
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19. Y. C. Joshi, S. Joshi, B. Kumar, **Soumen Mondal**, L. A. Balona, *Photometric study and detection of variable stars in the open clusters - I. NGC 6866*, Monthly Notices of the Royal Astronomical Society, 2012, **419**, pp. 2379-2390

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22. **B. Das** and **G. Gangopadhyay**, *Stochastic theory of interfacial enzyme kinetics: A kinetic Monte Carlo study*, Chem. Phys., 2012, **393**, 58
23. **K. Banerjee** and **G. Gangopadhyay**, *Electronic nuclear entanglement in a conjugated polymer aggregate with a conical intersection: spectral signatures*, J. Phys. B, 2012, **45**, 045102
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31. T. Q. Luong, **P. K. Verma**, **R. K. Mitra** and M. Havenith, *Do Hydration Dynamics Follow the Structural Perturbation during Thermal Denaturation of a Protein: A Terahertz Absorption Study*, Biophysical Journal, 2011, **101**, 925-933 (Cover Article)
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36. **Tamisra Pal** and **Ranjit Biswas**, *Heterogeneity and viscosity decoupling in (Acetamide +Electrolyte) Molten Mixtures: A Model Simulation Study*, Chemical Physics Letters, 2011, **517**, 180-185
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- Solvent) Binary Mixtures: Composition Dependence, Journal of Physical Chemistry B, 2011, **115**, 4011-4024
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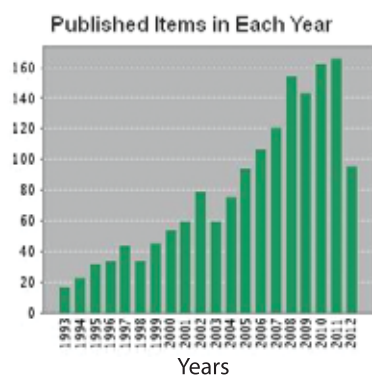
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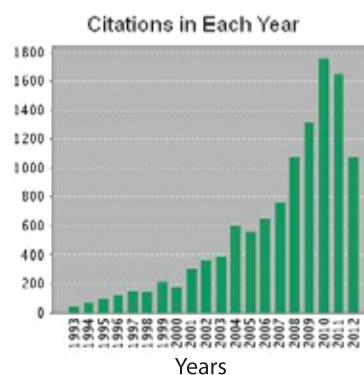
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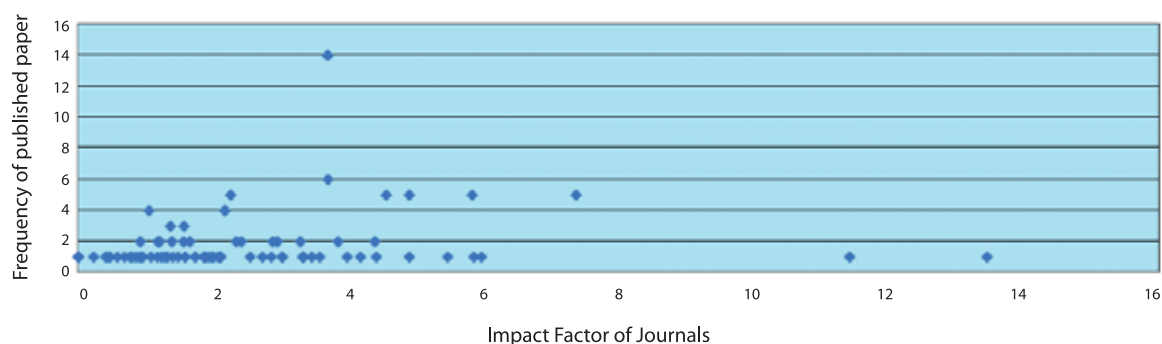


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1	ACS Nano	11.421	1	11.421
2	Acta Applicandae Mathematicae	0.899	1	0.899
3	AIP Advances	New Journal	1	0
4	American Journal of Analytical Chemistry	0.765	1	0.765
5	Analytical Chemistry	5.856	1	5.856
6	Angewandte Chemie International Edition	13.455	1	13.455
7	Annals of Physics	2.857	1	2.857
8	Applied Mathematics and Computation	1.317	1	1.317
9	Applied Physics Express	3.013	1	3.013
10	Applied Physics Letters	3.844	2	7.688
11	Beilstein Journal of Nanotechnology	0.789	1	0.789
12	Biochimie	3.022	1	3.022
13	Biophysical Journal	4.39	2	8.78
14	Chemical Physics	1.896	1	1.896
15	Chemical Physics Letters	2.337	2	4.674
16	Classical and Quantum Gravity	3.32	1	3.32
17	Colloids and Surfaces B	3.456	1	3.456
18	European Physical Journal D	1.476	1	1.476
19	European Physical Journal E	1.944	1	1.944
20	European Physical Journal Plus	New Journal	1	0
21	Europhysics Letters	2.171	4	8.684
22	FEBS Letters	3.33	1	3.33
23	General Relativity and Gravitation	2.069	1	2.069
24	IEEE Transaction on Magnetics	1.363	3	4.089
25	Indian Journal of Physics	0.226	1	0.226
26	International Journal of Chemical and Analytical Science	0.47	1	0.47
27	International Journal of Environment and Waste Management	1.581	1	1.581
28	International Journal of Modern Physics B	0.402	1	0.402
29	International Journal of Modern Physics D	1.046	4	4.184
30	International Journal of Theoretical Physics	0.845	1	0.845
31	International Journal of Thermophysics	0.953	1	0.953
32	Journal of Applied Physics	2.168	4	8.672
33	Journal of Chemical Physics	3.333	1	3.333
34	Journal of Chemical Sciences	1.177	2	2.354
35	Journal of Fluorescence	2.107	1	2.107
36	Journal of High Energy Physics	5.831	5	29.155
37	Journal of International Academy of Physical Sciences	Open Journal	1	0
38	Journal of Magnetism and Magnetic Materials	1.384	2	2.768
39	Journal of Materials Chemistry	5.968	1	5.968
40	Journal of Materials Science-Materials in Electronics	1.076	1	1.076
41	Journal Of Mathematical Physics	1.291	1	1.291
42	Journal of Modern Optics	1.17	1	1.17
43	Journal of Nanoparticle Research	3.287	2	6.574
44	Journal of Nanoscience and Nanotechnology	2.107	1	2.107
45	Journal of Physical Chemistry A	2.946	2	5.892
46	Journal of Physical Chemistry B	3.696	6	22.176
47	Journal of Physics A	1.564	3	4.692

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48	Journal of Physics B: Atomic, Molecular and Optical Physics	1.875	1	1.875
49	Journal of Physics D	2.544	1	2.544
50	Journal of Statistical Mechanics	1.727	1	1.727
51	Journal of Statistical Physics	1.397	1	1.397
52	Micro and Nanosystems	0.931	1	0.931
53	Microelectronic Engineering	1.557	2	3.114
54	Modern Physics Letters B	0.438	1	0.438
55	Monthly Notices of the Royal Astronomical Society	4.9	5	24.5
56	Monthly Notices of the Royal Astronomical Society: Letters	4.9	1	4.9
57	Nanoscale Research Letters	2.726	1	2.726
58	Nanoscience and Nanotechnology Letters	New Journal	1	0
59	Nanotechnology	3.979	1	3.979
60	Natural Hazards and Earth System Sciences	1.983	1	1.983
61	New Journal of Physics	4.177	1	4.177
62	Nonlinear Analysis	1.579	1	1.579
63	Philosophical Magazine	1.241	1	1.241
64	Photochemistry and Photobiology	2.413	2	4.826
65	Physica B	0.916	2	1.832
66	Physica E	1.234	1	1.234
67	Physica Scripta	1.204	2	2.408
68	Physical Chemistry Chemical Physics	3.573	1	3.573
69	Physical Review A	2.878	2	5.756
70	Physical Review B	3.691	14	51.674
71	Physical Review D	4.558	5	22.79
72	Physical Review E	2.255	5	11.275
73	Physical Review Letters	7.37	5	36.85
74	Physics Letters A	1.731	1	1.731
75	PloS Computational Biology	5.468	1	5.468
76	PLoS ONE	4.411	1	4.411
77	Pramana	0.575	1	0.575
78	Quantum Information Processing	2	1	2
79	Smart Materials and Structures	2.089	1	2.089
80	Solar System Research	0.682	1	0.682
81	Solid State Communications	1.649	2	3.298
82	Solid State Sciences	1.856	1	1.856
<b>Total</b>			<b>147</b>	<b>424.235</b>

A Comparative Study between the Impact Factor of journals and the number of papers published in those journals







# *Accounts*



# SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098

## BUDGET SUMMARY 2011-2012

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2011-2012.

			Figure in Lakhs (Rs.)
	<b>Actuals 2010-2011</b>	<b>Budget Estimate 2011-2012</b>	<b>Revised Estimate 2011-2012</b>
Non-Plan	29.13	28.59	* 30.14
Plan	2983.71	3397.43	* 3477.56
<b>TOTAL</b>	<b>3012.84</b>	<b>3426.02</b>	<b>3507.70</b>

\* Sanctioned by DST Plan Rs. 2988 lakhs, Non-Plan Rs. 22 lakhs and released as under :

### Non-Plan

- |  |                 |
|--|-----------------|
| 1. Sanction Letter No. AI/SNB/003/2011/NP dated 19.12.11 | Rs. 22.00 lakhs |
|  | Rs. 22.00 lakhs |

<b>Plan</b>	
1. Sanction Letter No. AI/SNB/003/2011/1 dated 26.04.11	Rs. 435.00 lakhs
2. Sanction Letter No. AI/SNB/003/2011/2 dated 22.06.11	Rs. 401.00 lakhs
3. Sanction Letter No. AI/SNB/003/2011/3 dated 26.06.11	Rs. 759.00 lakhs
4. Sanction Letter No. AI/SNB/003/2011/4 dated 05.09.11	Rs. 580.00 lakhs
5. Sanction Letter No. AI/SNB/003/2011/5 dated 19.12.11	Rs. 413.00 lakhs
6. Sanction Letter No. AI/SNB/003/2011/6 dated 22.02.12	Rs. 400.00 lakhs
	Rs. 2988.00 lakhs
<b>TOTAL</b>	<b>Rs. 3010.00 lakhs</b>

## AUDITORS' REPORT TO THE GOVERNING BODY OF **SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**

1. We have audited the attached **BALANCE SHEET** of **Satyendra Nath Bose National Centre for Basic Sciences**, as at 31<sup>st</sup> March, 2012, the **INCOME AND EXPENDITURE ACCOUNT** and the **RECEIPTS AND PAYMENTS ACCOUNTS** for the year ended on that date annexed thereto. These financial statements are the responsibility of the Centre's management. Our responsibility is to express an opinion on these financial statements based on our audit.
2. We conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.
3.
  - (i) We have obtained all the information and explanations, which to the best of our knowledge and belief were necessary for the purpose of our audit.
  - (ii) 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.
  - (iii) The Balance Sheet, the Income and Expenditure Account and the Receipts and Payments Accounts dealt with by this report are in agreement with the books of account.
  - (iv) In our opinion, the Balance Sheet and the Income and Expenditure Account dealt with by this report comply with the applicable accounting standards.
4. In our opinion and to the best of our information and according to the explanations given to us, the said accounts give a true and fair view in conformity with the accounting principles generally accepted in India
  - (i) in the case of the Balance Sheet, of the state of affairs of the Centre as at 31<sup>st</sup> March 2012;  
and
  - (ii) in the case of the Income and Expenditure Account, of the surplus for the year ended on that date.

Kolkata  
Dated : 27-07-2012

For Mookherjee Biswas & Pathak  
Chartered Accountants  
FRN : 301138E

**S P Mukherjee**  
Partner

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

<b>BALANCE SHEET AS AT 31ST MARCH 2012</b>			
	<b>Schedule</b>	<b>Current Year</b>	<b>Previous Year</b>
<b>FUNDS AND LIABILITIES</b>		<b>Rs.</b>	<b>Rs.</b>
CAPITAL FUND	<b>1</b>	860435783.63	738682068.05
RESERVES AND SURPLUS	<b>2</b>	-	
EARMARKED/ENDOWMENT FUNDS	<b>3</b>	155596109.13	105517835.13
SECURED LOANS AND BORROWINGS	<b>4</b>		
UNSECURED LOANS AND BORROWINGS	<b>5</b>		
DEFERRED CREDIT LIABILITIES	<b>6</b>		
CURRENT LIABILITIES AND PROVISIONS	<b>7</b>	17838917.31	22065033.31
<b>TOTAL</b>		<b>1033870810.07</b>	<b>866264936.49</b>
<b>ASSETS</b>			
FIXED ASSETS	<b>8</b>	664462881.85	557412114.27
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	<b>9</b>	84653322.00	21586378.00
INVESTMENTS - OTHERS	<b>10</b>	181831289.00	161989592.00
CURRENT ASSETS, LOANS, ADVANCES ETC.	<b>11</b>	102923317.22	125276852.22
MISCELLANEOUS EXPENDITURE (to the extent not written off or adjusted)			
<b>TOTAL</b>		<b>1033870810.07</b>	<b>866264936.49</b>
SIGNIFICANT ACCOUNTING POLICIES	<b>24</b>		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	<b>25</b>		

Per our report of even date

Date : 27.07.2012  
 Place : Kolkata

For Mookherjee Biswas & Pathak  
 Chartered Accountants

S P Mukherjee  
 Partner

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

<b>INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2012</b>			
	<b>Schedule</b>	<b>Current Year</b>	<b>Previous Year</b>
<b>INCOME</b>		<b>Rs.</b>	<b>Rs.</b>
Income from Sales/Services	<b>12</b>	3892818.00	3081391.50
Grants/Subsidies	<b>13</b>	154845954.00	140060788.00
Fees/Subscriptions	<b>14</b>		
Income from Investments (Income on Investment from earmarked/endowment Funds transferred to Funds)	<b>15</b>		
Income from Royalty, Publication etc.	<b>16</b>		
Interest Earned	<b>17</b>	12678175.00	7240634.00
Other Income	<b>18</b>	410504.00	209616.00
Increase/(decrease) in stock of finished goods and works-in-progress	<b>19</b>		
<b>TOTAL (A)</b>		<b>171827451.00</b>	<b>150592429.50</b>
<b>EXPENDITURE</b>			
Establishment Expenses	<b>20</b>	69801131.00	59559351.00
Other Administrative Expenses etc.	<b>21</b>	88776039.00	78475566.83
Expenditure on Grants, Subsidies etc.	<b>22</b>		
Interest	<b>23</b>		
<b>TOTAL (B)</b>		<b>158577170.00</b>	<b>138034917.83</b>
<b>Balance being excess of Income over Expenditure (A-B)</b>		13250281.00	12557511.67
Prior period adjustments (Credit)		636294.00	332860.00
Transfer to/from Capital Fund			
<b>BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND</b>		<b>13886575.00</b>	<b>12890371.67</b>
SIGNIFICANT ACCOUNTING POLICIES	<b>24</b>		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	<b>25</b>		

Per our report of even date

Date : 27.07.2012  
 Place : Kolkata

For Mookherjee Biswas & Pathak  
 Chartered Accountants

S P Mukherjee  
 Partner

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

<b>RECEIPTS AND PAYMENTS ACCOUNTS</b>						
<b>For the year ended 31st March 2012</b>						
	<b>RECEIPTS</b>	<b>Current Year</b>	<b>Previous Year</b>	<b>PAYMENTS</b>	<b>Current Year</b>	<b>Previous Year</b>
<b>I. Opening Balances</b>				<b>I. Expenses :</b>		
a) Cash in hand		28797.00	12816.00	a) Establishment Expenses	84327142.00	69087344.00
b) Bank Balances :				b) Administrative Expenses	63356421.00	59145020.00
i. In current accounts (Schd 11A)		39835843.85	34845481.85	c) Maintenance	24086170.00	22689312.00
ii. In deposit accounts				<b>II. Payments made against funds for</b>		
Schedule - 10		161989592.00	96442875.00	<b>various Projects</b>		
Schedule - 11A		14524667.00	51523070.00			
iii. Savings accounts (Schd 11A)		37008247.02	24090014.02			
iv. Remittance-in-Transit		-	-			
<b>II. Grants Received</b>				<b>III. Investments and deposits made</b>		
a) From Government of India				a) Out of Earmarked/Endowment/ Own funds	79961107.00	78850495.00
- For the year		383835327.00	345197345.00	b) CPWD Deposit and NBCC Deposit	31182167.00	45841211.00
- For the previous year				c) Bank Guarantee & LC A/C	29102275.00	295880.00
b) From State Government						
c) From Other sources (details)						
(Grants for capital & revenue exp.						
To be shown separately)						
				<b>IV. Expenditure on Fixed Assets &amp;</b>		
				<b>Capital Work-in-Progress</b>		
				a) Purchase of Fixed Assets	103534344.00	103182395.50

Contd.

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES  
BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

RECEIPTS	Current Year	Previous Year	PAYMENTS	Current Year	Previous Year
<b>III. Income on Investments from</b>					
a) Earmarked/Endow Funds			b) Expenditure on Capital Work-in-Progress		
b) Own Funds (Oth. Investment)	7925770.00	6373921.00	<b>V. Refund of surplus money/Loans</b>		
<b>IV. Interest Received</b>			a) To the Government of India		
a) On Bank deposits	4842425.00	868941.00	b) To the State Government		
<b>V. Other Income</b>	3909117.00	4098275.50	c) To other providers of funds		
<b>VI. Amount Borrowed</b>			<b>VI. Finance Charges (Interest)</b>		
<b>VII. Any other receipts</b>	6913296.00	12961996.00	<b>VII. Other Payments</b>	22897417.00	23082306.00
<b>VIII. Amount transferred to Current /Savings Account from Deposit Account</b>	43862642.00	79146375.00	<b>VIII. Closing Balances</b>		
			a) Cash in hand	31443.00	28797.00
			b) Bank Balances :		
			i. In current accounts (Schd.11A)	20224290.85	39835843.85
			ii. In deposit accounts		
			Schedule - 10	181831289.00	161989592.00
			Schedule - 11A	39343983.00	14524667.00
			iii. Savings accounts(Schd.11A)	24797675.02	37008247.02
			iv. Remittance-in-Transit	-	-
	<b>704675723.87</b>	<b>655561110.37</b>		<b>704675723.87</b>	<b>655561110.37</b>

Per our report of even date

Date : 27.07.2012

Place : Kolkata

For MOOKHERJEE BISWAS & PATHAK

Chartered Accountants

S P Mukherjee

Partner



**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012				
	Current Year		Previous Year	
	₹	₹	₹	₹
<b>SCHEDULE 1 - CAPITAL FUND :</b>				
Balance as at the beginning of the year	738682068.05		595334394.38	
Add : Contributions towards Corpus/Capital Fund	146154046.00		149939212.00	
Less : Depreciation for the year	30932779.78		19481910.00	
Add : Surplus during the year	13886575.00		12890371.67	
Less : Adjustment for Depreciation (Last Year)	7354125.64			
Less : Adjustment for Last Year (Revenue Items)		860,435,783.63		738682068.05
<b>BALANCE AS AT THE YEAR - END</b>		<b>86043 5783.63</b>		<b>738682068.05</b>
<b>SCHEDULE 2 - RESERVES AND SURPLUS :</b>				
	Current Year		Previous Year	
	₹	₹	₹	₹
1. <u>Capital Reserve :</u>				
As per last Account				
Addition during the year				
Less : Deductions during the year				
2. <u>Revaluation Reserve :</u>				
As per last Account				
Addition during the year				
Less : Deductions during the year				
3. <u>Special Reserves :</u>				
As per last Account				
Addition during the year				
Less : Deductions during the year				
4. <u>General Reserve :</u>				
As per last Account		-		-
Add : Surplus during the year				
<b>TOTAL</b>		-		-

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012							Amount (Rs.)	
	FUND-WISE BREAK UP						TOTAL	
	Project Fund	Medical fund	Leave Salary	Gratuity Fund	Corpus Fund	Current Year	Prev. Year	
<b>SCHEDULE 3 - EARMARKED/ ENDOWMENT FUNDS</b>								
<b>a) Opening balance of the funds</b>	63475658.75	1580541.00	19751333.00	16932405.00	3777897.38	105517835.13	90910117.13	
<b>b) Additions to the Funds</b>								
i) Donations/grants/ Contributions	83835327.00	512916.00	-	-	765000.00	85113243.00	60835278.00	
ii) Income from investments made on account of funds	1985448.00	104446.00	1446665.00	1305351.00	246783.00	5088693.00	2436322.00	
iii) Other additions -Provision during the year	-	-	1625353.00	2899283.00	-	4524636.00	5411456.00	
<b>TOTAL (a + b)</b>	<b>149296433.75</b>	<b>2197903.00</b>	<b>22823351.00</b>	<b>21137039.00</b>	<b>4789680.38</b>	<b>200244407.13</b>	<b>159593173.13</b>	
<b>c) Utilisation/Expenditure towards objectives of funds</b>								
i) Capital Expenditure								
Fixed Assets	12872039.00	-	-	-	-	12872039.00	23452984.00	
Others								
Total								
ii) Revenue Expenditure								
Salaries, Wages and allowances etc.	20442498.00	-	-	-	-	20442498.00	16682282.00	
Rent								
Other Administrative expenses								
Other Payments	9721537.00	-	796160.00	816064.00	-	11333761.00	13940072.00	
iii) Adjustment (Interest)								
<b>TOTAL ( c )</b>	<b>43036074.00</b>	<b>-</b>	<b>796160.00</b>	<b>816064.00</b>	<b>-</b>	<b>44648298.00</b>	<b>54075338.00</b>	
<b>NET BALANCE AS AT THE YEAR-END (a+b-c)</b>	<b>106260359.75</b>	<b>2197903.00</b>	<b>22027191.00</b>	<b>20320975.00</b>	<b>4789680.38</b>	<b>155596109.13</b>	<b>105517835.13</b>	

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012		Amount (Rs.)		
	Current Year		Previous Year	
<b>SCHEDULE 4 - SECURED LOANS AND BORROWINGS:</b>				
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)				
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012				
(Amount - Rs.)				
	Current Year		Previous Year	
	<b>SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS</b>			
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)				
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>

SCHEDULE 6 - DEFERRED CREDIT LIABILITIES				
(Amount - Rs.)				
	Current Year		Previous Year	
	a) Acceptances secured by hypothecation of capital equipment and other assets			
b) Others				
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012				
(Amount - Rs.)				
SCHEDULE 7 - CURRENT LIABILITIES AND PROVISIONS	Current Year		Previous Year	
<b>A. CURRENT LIABILITIES</b>				
1. Acceptances				
2. Sundry Creditors:				
a) For Capital expenditure	2164102.00		9260733.00	
b) Others - Revenue expend.(including Project Rs.30000.00)	5979423.00		4534687.00	
3. Current Liabilities	2495665.00		2294188.00	
4. Deposit from Contractors	2357492.88		2492760.88	
5. Other Liabilities	234893.00		170228.00	
6. Deposit from Students	575500.00		476500.00	
7. Deposit from Contractual Employees	969549.00		772040.00	
8. Provident Fund Account (Payable)	275410.00		-	
9. Project Overhead Fund	2717410.43		1993240.43	
<b>TOTAL (A)</b>	<b>17769445.31</b>	<b>-</b>	<b>21994377.31</b>	
<b>B. PROVISIONS</b>				
1. For Taxation				
2. Gratuity				
3. Superannuation/Pension				
4. Accumulated Leave Encashment				
5. Trade Warranties/Claims				
6. Others - Adhoc Bonus	69472.00		70656.00	
<b>TOTAL (B)</b>	<b>69472.00</b>	<b>-</b>	<b>70656.00</b>	
<b>TOTAL (A + B)</b>	<b>17838917.31</b>	<b>-</b>	<b>22065033.31</b>	



# SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

## BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012

### SCHEDULE 8 - FIXED ASSETS

DESCRIPTION	GROSS BLOCK			Cost/valuation at the year-end
	Cost/valuation As at begin. of the year	Additions during the year	Adjustment during the year	
<b>A. FIXED ASSETS :</b>				
1. LAND :				
a) Freehold				
b) Leasehold	10950654.60			10950654.60
2. BUILDINGS :				
a) On Freehold Land				
b) On Leasehold Land	176698183.86	0.00		176698183.86
c) Ownership Flats/Premises				
d) Superstructures on Land not belonging to the entity				
3. PLANT MACHINERY & EQUIPMENT	212036843.22	72422141.00		284458984.22
4. VEHICLES	321013.00	-		321013.00
5. FURNITURE, FIXTURES	26396416.22	4688630.00		31085046.22
6. OFFICE EQUIPMENT	1965505.29	176980.00		2142485.29
7. COMPUTER/PERIPHERALS	45235997.44	5667513.00		50903510.44
8. ELECTRIC INSTALLATIONS	5379058.00	14,800.00		5393858.00
9. LIBRARY BOOKS	155575687.11	14509128.00		170084815.11
10. TUBEWELLS & W.SUPPLY		-		
11. OTHER FIXED ASSETS	84225.55	0.00		84225.55
<b>TOTAL OF CURRENT YEAR</b>	<b>634643584.29</b>	<b>97479192.00</b>	-	<b>732122776.29</b>
<b>PREVIOUS YEAR</b>	<b>541706361.79</b>	<b>92937222.50</b>	-	<b>634643584.29</b>
<b>B. CAPITAL WORK IN PROGRESS</b>	<b>48669459.00</b>	<b>47858481.00</b>	<b>0.00</b>	<b>96527940.00</b>
<b>TOTAL (A + B)</b>	<b>683313043.29</b>	<b>145337673.00</b>	<b>0.00</b>	<b>828650716.29</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

(Amount - Rs.)					
DEPRECIATION				NET BLOCK	
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
-			-	10950654.60	10950654.60
22985189.24	2880181.00	334,697.41	26200067.65	150498116.21	153712994.62
28515977.61	10955058.00	977,798.87	40448834.48	244010149.74	183520865.61
319784.19	228.81	-	320013.00	1000.00	1228.81
10490898.53	1748086.00	602,644.70	12841629.23	18243416.99	15905517.69
496700.93	94422.71	20,315.84	611439.48	1531045.81	1468804.36
27497634.96	7474679.31	4,047,052.05	39019366.32	11884144.12	17738362.48
1799597.20	199227.00	20,482.91	2019307.11	3374550.89	3579460.80
33765745.35	7576895.95	1,349,867.15	42692508.45	127392306.66	121809941.76
				-	
29401.01	4001.00	1,266.71	34668.72	49556.83	54824.54
<b>125900929.02</b>	<b>30932779.78</b>	<b>7,354,125.64</b>	<b>164187834.44</b>	<b>567934941.85</b>	508742655.27
<b>106419019.02</b>	<b>19481910.00</b>	-	<b>125900929.02</b>	<b>508742655.27</b>	435287342.77
				<b>96527940.00</b>	48669459.00
<b>125900929.02</b>	<b>30932779.78</b>	<b>7,354,125.64</b>	<b>164187834.44</b>	<b>664462881.85</b>	557412114.27



**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012

<b>SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS</b>		<b>(Amount Rs.)</b>	
	<b>Current Year</b>	<b>Previous Year</b>	
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	46586056.00	-	
Gratuity Fund Investment	15707283.00	9770433.00	
Leave Salary Fund Investment	16975507.00	11815945.00	
Staff Medical Fund Investment	1580541.00	-	
Corpus Fund Investment	3803935.00	-	
<b>TOTAL</b>	<b>84653322.00</b>	<b>21586378.00</b>	
<b>SCHEDULE 10 - INVESTMENTS - OTHERS</b>		<b>Current Year</b>	<b>Previous Year</b>
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	33936469.00	13566850.00	
Fixed Deposit with Union Bank Of India	147894820.00	143422742.00	
Fixed Deposit with Axis Bank	-	5000000.00	
<b>TOTAL</b>	<b>181831289.00</b>	<b>161989592.00</b>	

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012

<b>SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.</b>				
<b>A. CURRENT ASSETS :</b>	<b>Current Year</b>		<b>Previous Year</b>	
1. <u>Inventories :</u>				
a) Stores and Spares		121474.35		127984.35
2) <u>Cash balances in hand</u>		31443.00		28797.00
3) <u>Bank Balances :</u>				
a) <u>With Scheduled Banks :</u>				
<b>On Current Accountns :</b>				
Indian Overseas Bank (CA-089302000000220)	5705660.62		1965074.00	
Canara Bank (CA-2549201000044)	-		382495.62	
Indian Overseas Bank (CA-089302000000273)	5264923.73		21332181.73	
Union Bank of India (CA-460901010034252)	<u>9253706.50</u>	20224290.85	<u>16156092.50</u>	39835843.85
<b>On Deposit Accounts for LC &amp; BG :</b>				
Indian Overseas Bank (CA-089302000000220)	10753568.00		10760063.00	
Indian Overseas Bank (CA-089302000000273)	<u>28590415.00</u>	39343983.00	<u>3764604.00</u>	14524667.00
<b>On Savings Accounts :</b>				
Indian Overseas Bank (SB-089301000010662)	19701972.02		28460510.02	
Indian Overseas Bank (SB-089301000012029)	545912.00		163159.00	
Indian Overseas Bank (SB-089301000011479)	3189716.00		6095611.00	
Union Bank of India (SB-460901110050013)	524986.00		-	
Axis Bank (SB-775010100024408)	167606.00		2050368.00	
Axis Bank (SB-775010100017860)	<u>667483.00</u>	24797675.02	<u>238599.00</u>	37008247.02
5. Remittance - in - Transit				
6. <u>Post Office - Savings Accounts</u>				
<b>TOTAL (A)</b>		<b>84518866.22</b>		<b>91525539.22</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2012

(Amount Rs.)				
SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC (Contd.)				
	Current Year		Previous Year	
<b>B. LOANS, ADVANCES AND OTHER ASSETS</b>				
1. <u>Loans:</u>				
a) Staff including HBA, Vehicle & PC Advance (includes Project A/c Rs. 281803.00)		1950566.00		2259086.00
b) Other Entities engaged in activities/objectives similar to that of the Entity				
c) Other - Provident Fund Account (Receivable)		-		2720084.00
2. <u>Advances and other amounts recoverable in cash or in kind or for value to be received:</u>				
a) On Capital Account - NBCC & CPWD Deposit Account		5577526.00		21296671.00
b) Prepayments				
c) Others (Security Deposits)		548818.00		500104.00
d) Contractors & Suppliers		91941.00		159817.00
3. <u>Income Accrued:</u>				
a) On Investments from Earmarked/Endowment Funds (Including Project Rs. 326862.00)		7430017.00		5574055.00
b) On investments - Others		2805583.00		1241496.00
c) On Loans and Advances				
d) Others				
4. Claims Receivable - Grant-in-Aid Receivable		-		-
	<b>TOTAL (B)</b>	<b>18404451.00</b>		<b>33751313.00</b>
	<b>TOTAL (A + B)</b>	<b>102923317.22</b>		<b>125276852.22</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012 (Amount Rs.)		
SCHEDULE 12 - INCOME FROM SALES/SERVICES	Current Year	Previous Year
1) <u>Income from Sales</u>		
a) Sale of Finished Goods		
b) Sale of Raw Material		
c) Sale of Scraps		
2) <u>Income from Services</u>		
a) Guest House Rent	1226126.00	1017500.00
b) Hostel Charges ( Recovery of HRA)	1527923.00	1162679.00
c) Equipment Utilisation Fees	77500.00	83000.00
d) Hostel Maintenance Fees	759851.00	566723.00
e) Project Overhead	296000.00	239000.00
f) Others	5418.00	12489.50
<b>TOTAL</b>	<b>3892818.00</b>	<b>3081391.50</b>
SCHEDULE 13 - GRANTS/SUBSIDIES	Current Year	Previous Year
(Irrevocable Grants & Subsidies Received)		
1) Central Government	154845954.00	140060788.00
2) State Government(s)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organisations		
6) Others		
<b>TOTAL</b>	<b>154845954.00</b>	<b>140060788.00</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

**SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012**

(Amount Rs.)

<b>SCHEDULE 14 - FEES/SUBSCRIPTIONS</b>	<b>Current Year</b>	<b>Previous Year</b>
1) Entrance Fees		
2) Annual Fees/Subscriptions		
3) Seminar/Program Fees		
4) Consultancy Fees		
5) Others		
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>

Note: Accounting Policies towards each item are to be disclosed

(Amount Rs.)

<b>SCHEDULE 15 - INCOME FROM INVESTMENTS</b>	<b>Investment from Earmarked Fund</b>		<b>Investment - Others</b>	
	<b>Current Year</b>	<b>Previous Year</b>	<b>Current Year</b>	<b>Previous Year</b>
(Income on Invest. From Earmarked/Endowment Funds transferred to Funds)				
1) Interest				
a) On Govt. Securities				
b) Other Bonds/Debentures				
2) Dividends:				
a) On Shares				
b) On Mutual Fund Securities				
3) Rents				
4) Others				
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>
<b>TRANSFERRED TO EARMARKED/ ENDOWMENT FUNDS</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>	<b>Nil</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012		
(Amount - Rs.)		
SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATION ETC.	Current Year	Previous year
1. Income from Royalty		
2. Income from Publications		
3. Others		
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>
SCHEDULE 17 - INTEREST EARNED	Current Year	Previous year
1) On Term Deposits :		
a) With Scheduled Banks	12326626.00	7010841.00
b) With Institutions		
c) Others		
2) On Savings Accounts:		
a) With Scheduled Banks	229699.00	76,691.00
b) Post Office Savings Accounts		
c) Others		
3) On Loans:		
a) Employees/Staff	121850.00	153,102.00
b) Others		
4) Interest on Debtors and Other Receivables		
<b>TOTAL</b>	<b>12678175.00</b>	<b>7240634.00</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012		
(Amount - Rs.)		
SCHEDULE 18 - OTHER INCOME	Current Year	Previous Year
1) Profit on Sale/disposal of Assets:		
a) Owned assets		
b) Assets acquired out of grants, or received free of cost		
2) Export Incentives realized		
3) Fees for Miscellaneous Services		
4) Miscellaneous Income	410504.00	209616.00
<b>TOTAL</b>	<b>410504.00</b>	<b>209616.00</b>
SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS	Current Year	Previous Year
a) Closing stock		
Finished Goods		
Work-in-progress		
b) Less : Opening Stock		
Finished Goods		
Work-in-progress		
<b>NET INCREASE/(DECREASE) [a-b]</b>	<b>Nil</b>	<b>Nil</b>
SCHEDULE 20 - ESTABLISHMENT EXPENSES	Current Year	Previous Year
a) Salaries and Wages	60048491.00	49107323.00
b) Other Allowances and Bonus	69472.00	71625.00
c) Contribution to Provident Fund	2057104.00	2029073.00
d) Contribution to Other Fund - Gratuity Fund, Leave Salary Fund etc	4524636.00	5560614.00
e) Staff Welfare Expenses (Medical)	1108940.00	943936.00
f) Contribution to NPS	456212.00	254899.00
g) Others	1536276.00	1591881.00
<b>TOTAL</b>	<b>69801131.00</b>	<b>59559351.00</b>

**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012		
(Amount - Rs.)		
SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.	Current Year	Previous Year
a) Extended Visitors Programme.( Including Seminars & Workshops)	5890065.00	8676153.00
b) Meeting Expenses	554,318.00	961,693.00
c) Library General Expenses	35135.00	26883.00
d) Electricity and Power	15217554.00	13543185.00
e) Laboratory Expenses	7267036.00	3600703.00
f) Insurance	8313.00	8248.00
g) Repairs and Maintenance	27890297.00	26258474.83
h) TPSC	1,514,552.00	1,097,179.00
i) Student Hostel Rent	2,100,735.00	1,425,067.00
j) Vehicles Hire Charges	1000335.00	781063.00
k) Postage, Telephone and Communication Charges	2271992.00	2109553.00
l) Printing and Stationary	1208974.00	1115980.00
m) Travelling and Conveyance Expenses	2529268.00	1628804.00
n) Contingency/consumables to Faculty	68,697.00	166,211.00
o) Silver Jubilee Year	117,251.00	410,323.00
p) Auditors' Remuneration	32584.00	29781.00
q) Bank Charges	405,432.00	370,551.00
r) Professional Charges ( Legal Charges )	63034.00	206781.00
s) Staff Training	157,158.00	18,580.00
t) Patent & Trademark	111,059.00	8,824.00
u) Integrated Ph.D.	16683340.00	14273737.00
v) Import Clearing Expenses including Custom Duty	204415.00	143361.00
w) Hindi Programme	132,668.00	45,508.00
x) Advertisement and Publicity	1092876.00	1005959.00
y) Others	578820.00	562965.00
z) Municipal Tax	1640131.00	-
<b>TOTAL</b>	<b>88776039.00</b>	<b>78475566.83</b>



**SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**  
**BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2012		
(Amount - Rs.)		
SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.	Current Year	Previous Year
a) Grants given to Institutions/Organisations		
b) Subsidies given to Institutions/Organisations		
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>
SCHEDULE 23 - INTEREST	Current Year	Previous Year
a) On Fixed Loans		
b) On Other Loans (including Bank Charges)		
c) Others (specify)		
<b>TOTAL</b>	<b>Nil</b>	<b>Nil</b>

# **SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**

## **BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

### **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 the interest on Fixed Deposits kept as Lien against LC/BG issued by Bank and Guest House Rent are 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.

##### **5.1 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, 1956.

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.

5.5 Individual items costing Rs. 5000/- or less is not capitalized but charged in Accounts.

##### **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 CITY, KOLKATA 700 098**

- 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. 3119586.00 against 100% margin money by way of fixed deposit (Previous year Rs. 2736063.00).
  - Letters of Credit opened by Bank on behalf of the Centre and Project– Rs. 36224415.00 (Previous year Rs. 8024000.00) 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.0.51 Crores (Previous year Rs.0.02 Crores).
- 2.2.1 Physical verification of fixed assets was conducted by an external agency in the financial year 2008-09. Fixed assets register has not been updated for the financial years 2009-10, 2010-11 and 2011-12.
- 2.2.2 Rs. 38286905.42 (Rs. 30932779.78 for the year & Rs. 7354125.64 as adjustment for last year) being depreciation on Fixed Assets was not passed through Income & Expenditure Account and instead directly debited to Capital Fund in terms of accounting policy clause 5.4 of Schedule 24.
- 2.2.3 Capital work-in-progress as on 1<sup>st</sup> April, 2011 was Rs. 48669459.00, addition during the year is Rs. 47858481.00, totaling to Rs. 96527940.00, leaving balance of Rs. 96527940.00 which has been carried forward.

# **SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES**

## **BLOCK JD, SECTOR-III, SALT LAKE CITY, KOLKATA 700 098**

### **SCHEDULE 25**

#### 2.2.4 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.

#### 2.4 Taxation

In view of there being no taxable income under Income-tax Act 1961, no provision for Income tax has been considered necessary.

#### 2.5 Foreign Currency Transactions

##### i) Expenditure in foreign currency:

- a) Travel : Nil
- b) Remittances and Interest payment to Financial Institutions/Banks in Foreign Currency : Nil
- c) Other expenditure : Nil
  - Commission on Sales
  - Legal and Professional Expenses
  - Miscellaneous Expenses
  - Bank Charges

##### ii) Earnings :

Value of Exports on FOB basis : Nil

2.6 Transfer of Fixed Assets from project to general fund upon completion of project has not been done pending approval from DST, Govt. of India.

2.7 In absence of any specific directions from Appropriate Authority contributions to Medical Fund Rs. 2197903.00 (previous year Rs. 1580541.00) by the employees are appearing under Earmarked & Endowment Fund as on 31-03-2012.

2.8 An amount of Rs. 275410.00 is payable to P.F. Account appearing under Current Liabilities (previous year Rs. 2720084.00 was shown under Current Assets).

2.9 Corresponding figures for the previous year have been re-grouped/re-arranged, wherever necessary.

Kolkata

Dated : 27-07-2012



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