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SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES, ANNUAL REPORT 2009-2010

ANNUAL REPORT 2009 - 2010

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

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SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES

Annual Report 2009 – 2010
Satyendra Nath Bose National Centre for Basic Sciences
Kolkata

Annual Report Committee
Prof. Subhrangshu Sekhar Manna, Chairman
Dr. Rajib Kumar Mitra
Mr. Sougata Bhattacharya
Ms. Mahua Mitra
Ms. Indrani Laha

Publisher
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PREFACE

An Annual Report reflects the activities of an organization in a year. For a scientific research centre like ours it would naturally describe mainly the research activities. In the present report our academic members have described their research activities in detail, in terms of the front level research topics they are actively pursuing; brief descriptions of the problems, results and the publications that resulted from their research. Experimental researchers have described their works with schemes, plots and photographs of their experiments.

The next important activity is the teaching. To make the young students ready for commencing research work two different types of courses are being organized during last several years. Students who join the Centre after their bachelor degree enroll in the Post B. Sc. Integrated Ph. D. programme and carry out course work for two years where as those who come with M. Sc. degrees initiate research work after one year of course work, both courses being run by our own faculty.

Apart from these there are many other activities one needs to report for our Centre. For example, the administrative members organize cultural programmes on different occasions to make the academic campus more enjoyable. Every year we celebrate the Independence day and the Republic day, organize the Open House on the Science day for the general public, especially for the school children and also hold an autumn evening of cultural programme participated by all categories of members of our Centre.

The following pages of this report briefly describe all these activities. We are most grateful to the faculty, administrative members and students for extending all kinds of help whatever required, promptly and accurately. We thank M/S Cygnus Advertising (India) Pvt. Ltd. for the nice design and get up of this report.

Finally I would like to profusely thank my team members Mr. Sougata Bhattacharya, Ms. Indrani Laha, Ms. Mahua Mitra and Dr. Rajib Kumar Mitra for their very enthusiastic and continuous support throughout the preparation of this Annual Report.

Subhrangshu Sekhar Manna
Chairman, Annual Report Committee

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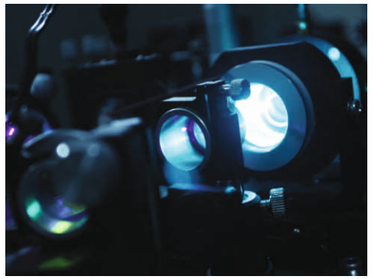


DEPARTMENT OF CHEMICAL, BIOLOGICAL AND MACRO MOLECULAR SCIENCES

DEPARTMENT OF MATERIAL SCIENCES

DEPARTMENT OF THEORETICAL SCIENCES

FACILITIES

PUBLICATIONS

ACCOUNTS

MESSAGE FROM THE DIRECTOR

It gives me great pleasure to present to you the annual report of our Centre for the year 2009-2010. The annual report for any scientific institution is an important document because it serves as a benchmark and helps to chronicle the progress. Being a publicly funded institution, it is also the document of our accountability.

The Centre expresses its gratitude to the Department of Science and Technology (DST) for generous enhancement in funding. The enhancement in funding has allowed us to make, for the first time, a planned input to develop our research infrastructure including our computational facilities. The building of the research infrastructure through procurement and installation of a number of essential equipments for common use are allowing us to do new experiments. The high performance cluster computing is allowing us to take up new challenges in computation which I believe will be an expanding activity of the Centre. This has facilitated the process to initiate new projects with internal funding and enabled us to obtain new sponsored projects. This is reflected in the project cell report. The culture of supporting research by obtaining projects through the process of peer review and competitive bidding enhances the quality of research and in our Centre this is appreciated.

I am deeply indebted to the members of our Governing Body, Academic and Research Programme Advisory Committee, Finance Committee and Building Committee for helping us to do better. Without sound advice, proactive policy and guidance from these various committees, it will be indeed difficult for us to perform. The Centre in due course also has strengthened its internal management and decision making process through the formation of the Consultative Advisory Committee (CAC), which is meeting once a month regularly for over last 40 months. I also would like to thank the 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.

The Centre in June 2010 will complete 24 years of its existence. Within few months starting late 2010 the Centre will celebrate its Silver Jubilee. For us, enhancing our performance and output, are important because it is our objective that when we celebrate the Silver Jubilee we can show a high level of research accomplishments. At this age of an institution it should be mature and professional institution with a focus on output and excellence. This is also a time when we stock check whether we have or in due course we can build niche areas and make impact. It is important that we matter to Science and the Nation.

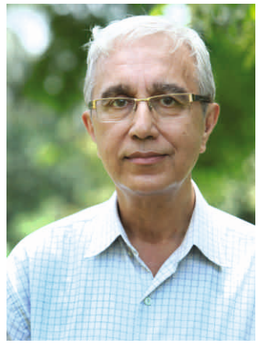
The Centre, as a part of its growth in research, has decided to increase its intake for Ph. D. students. I am happy to note that increasing number of our students with NET qualifications are joining the Centre. The Centre has initiated the construction of a new hostel complex. When completed in middle of 2011 we expect that the on campus student accommodation will be more than 150. As an impact this will enhance the Guest House accommodation as well as transit family accommodation significantly as a good part of these facilities is now used for housing students.

My sincere thanks and best wishes to the students and faculty colleagues (enabled by a facilitating administration) for putting us on a path of high rate of growth. We are looking forward to a rewarding year to come. I am indeed grateful to all our faculties, staff and students for a very fruitful year and for giving me enough reason to feel happy and proud.

For the first time the report submission by individual faculty/staff has been made on-line. Thanks to the annual report committee for making the report.

Arup Kumar Raychaudhuri
Director

DEAN, FACULTY



The continuing rise in the number of quality publications by our Faculty has saturated somewhat in the past year. This year saw 139 publications from our regular and visiting faculties, giving an average of 3.56 per person. There was some soul searching regarding this and about how to maintain the momentum in our continuing growth in research publications. Saturation is inevitable, unless there is continual infusion of new faculty, post-doctoral fellows and research students. The Centre has attempted all three to varying degrees of success.

Sponsored projects do reveal a lot about how our research is perceived by funding agencies and also our status within the research community. The past year saw as many as 39 individual projects sanctioned to our faculty, over and above the two large institutional projects (UNANST on nano-science and technology and AMRU on advanced materials research). This brought in as much as ₹ 5.5 crore to the Centre's coffers.

Strong collaborations continued between our faculty and scientists both from India and also from countries like Japan, Korea, South Africa, Brazil, Germany, Austria, USA, Sweden, UK, Poland, Italy, France, Australia, Nepal and Bangladesh.

With the Silver Jubilee coming up next year, it was decided to revamp our external visitor's programme by arranging exciting lectures by renowned scientists and organizing Workshops and Conferences on frontline topics.

Abhijit Mookerjee
Dean, Faculty

DEAN, ACADEMIC PROGRAMME

The centre witnessed a strong growth in the number of NET qualified entrants in the Ph. D. programme. Our Bose memorial lecture this year carried a different flavour. Professor Masashi Hayakawa who delivered the lecture has an electrical engineering background and is a proponent of a new technique for earthquake predictions using electromagnetic effects. The bi-monthly Bose Colloquium expanded its orbit by including noted economists like Abhirup Sarkar (I. S. I.) and Sugato Marjit (I. S. S.) in addition to the usual list of noted scientists like Mustansir Barma (T. I. F. R.) and Diptiman Sen (I. I. Sc.)

20TH S. N. BOSE MEMORIAL LECTURE

Is Prediction of Earthquake possible by means of Electromagnetic Effects? By Masashi Hayakawa, University of Electro-Communications, Chofu, Tokyo, Japan, 16th March 2010

SEMINARS HELD

1. *Optical properties of carbon nanohoops from first principles* by Dr. Joydeep Bhattacharjee, Molecular Foundry, Lawrence Berkeley National Lab, Berkeley, CA 94720, USA on 06.04.2009.
2. *Search for radio transients near our Galactic centre: Discovery of a new class of source* by Dr. Sabyasachi Pal, National Centre for Radio Astronomy (NCRA), Pune on 08.04.2009.
3. *Synthesis and application of metal nanoparticles* by Dr. Saikat Mandal, National Institute for Material Science (NIMS), Tsukuba, Japan on 09.04.2009.
4. *Fulbright Nehru Fellowships* by Dr. Diya Dutta, Deputy Director, United States India Educational Foundation on 05.05.2009.
5. *Quantum dots, rings and wires* by Dr. P. Singha Deo, Department of Chemical, Biological and Macro Molecular Sciences, SNBNCBS, Kolkata on 18.06.2009
6. *Magnetic Resonance Force Microscopy: a novel quantum probe* by Dr. S. Guchhait, University of Texas, Austin, USA on 07.07.2009.
7. *Condensation Dynamics* by Dr. Analabha Roy, University of Texas, Austria on 17.08.2009.
8. *Role of Coulomb Interactions in Manganities – the quantum Coulomb glass* by Dr. Tribikram Gupta, Matscience, Chennai on 18.08.2009.
9. *Multiscalling modeling of solids as a composite of quantum mechanical and classical domain* by Dr. Aditi Mallik, Motorola, USA on 08.12.2009.
10. *Universal d wave gap shape in the entire doping range of the cuprate High Temperature Superconductors* by Dr. Utpal Chatterjee, Materials Science Division, Argonne National Laboratory on 22.12.2009.
11. *Correlated electron dynamics: an introduction to the Local Moment Approach* by Dr. David Logan, Physical & Theoretical Chemistry Laboratory University of Oxford on 12.01.2010.
12. *Kondo physics in multilevel quantum dots* by Dr. David Logan, Physical and Theoretical Chemistry Laboratory University of Oxford on 14.01.2010.

13. *Tera(hertz)-Talk with Artificial and Real Atoms* by Dr. Pankaj K. Mandal, Rowland Institute at Harvard, Harvard University 100 Edwin H Land Blvd, Cambridge, MA 02142, USA on 21.01.2010.

14. *Laser-assisted Self-assembly of Thin Films to form Patterned Arrays of Nanowires and Nanoparticles: Some Applications in Nanomagnetism* by Dr. Anup K. Gangopadhyay, Dept. of Physics, Washington University, St. Louis, MO 63021, USA on 03.02.2010.

15. *Cosmic inflation meets particle physics* by Dr. Koushik Dutta, Max-Planck-Institut für Physik, Germany on 18.02.2010.

16. *Spinodal decomposition assisted crystallization in binary polymer mixtures* by Dr. Mithun Mitra, University of Massachussetts, Amherst, USA on 19.02.2010.

17. *Probing a Stochastic Gravitational Wave Background using a Network of Laser Interferometric Detectors* by Dr. Sanjit Mitra, Jet Propulsion Laboratory, California Institute of Technology on 19.02.2010.

18. *Competition between Ferrimagnetism and Magnetic Frustration in Zinc Substituted* $YBaFe_4O_7$ by Ms. Tapati Sarkar, Laboratoire CRISMAT, UMR 6508 CNRS ENSICAEN, 6 bd Maréchal Juin, 14050 CAEN, France on 11.03.2010.

19. *Torsional Electromechanics of Carbon and Inorganic Nanotubes* by Dr. K. S. Nagapriya Kavoori, Department of Materials and Interfaces Weizmann Institute of Science Rehovot, Israel on 16.03.2010.

MEETINGS ORGANIZED

1. *DYNAMAG, a DST-EU Funded Project –Internal Kick-off Meeting*, Convener: Dr. Anjan Barman, September 14, 2009.

2. *Applications of Dual Beam Scanning Electron Microscope and Environmental Scanning Electron Microscope,* Dr. Barnali Ghosh and Dr. Kaustuv Das, October 5-9, 2009.

3. *Magnetism, Superconductivity and Phase Transitions in Novel and Complex Materials (MSM09)*, Dr. Tanusri Saha Dasgupta and Dr. Chhayabrita Biswas, November 11-14, 2009.

4. *Physics of New Materials – The JNC Research Conference in collaboration with SNBNCBS,* Dr. Umesh Waghmare, JNC and Dr. Anjan Barman, January 16-18, 2010.

5. *Science with Very Low Frequency Radio Waves – Theory and Observations,* Professor Sandip Kumar Chakrabarti, 14-18 March 2010.

COURSES OFFERED

Post B. Sc. Integrated Ph. D. Programme

1st Semester: PHY101, *Classical Dynamics,* Binayak Dutta-Roy; PHY102, *Mathematical Methods I*, Rabin Banerjee; PHY103, *Quantum Mechanics I*, Amitabha Lahiri; PHY104, *Electromagnetic Theory I*, Jayanta Kumar Bhattacharjee and Arup Kumar Raychaudhuri; HUM/PHY105, *Computational Methods in Physics I*, Priya Mahadevan; PHY191, *Basic Laboratory I*, Pratip Kumar Mukhopadhyay, Jaya Basu, CU.

2nd Semester: PHY201, *Statistical Mechanics*, Jayanta Kumar Bhattacharjee; PHY202, *Mathematical Methods II*, Debashis Gangopadhyay; PHY203, *Quantum Mechanics II*, Amitabha Lahiri; PHY204, *Electromagnetic Theory II*, Makhtedar Sanjay Kumar; HUM/PHY205, *Computational Methods II*, Subhrangshu Sekhar Manna, Sanjay Gupta; PHY291, *Basic Laboratory II*, Kalyan Mandal.

3rd Semester: PHY301, *Quantum Mechanics III*, Makhtedar Sanjay Kumar; PHY302, *Condensed Matter Physics*, Alak Kumar Majumdar; PHY303, *Nuclear and Particle Physics*, Asim K Ray; PHY304, *Project Based Courses*, Faculty Supervisors as per choice of projects; PHY391, *Methods of Experimental Physics*, Faculty Supervisors in experimental research.

4th Semester: PHY401, *Project Based Course*, Faculty Supervisors to float projects; PHY402, *Seminar Course*, Asim Kumar Ray; PHY404, *Advanced Mathematical Methods*, Partha Guha; PHY405, *Advanced Quantum Field Theory*, Binayak Dutta Roy; PHY406, *Advanced Statistical Physics*, Jayanta Kumar Bhattacharjee; PHY410, *Advanced Techniques in Experimental Physics*, Students to choose Project Supervisors; PHY413, *Magnetism and Superconductivity*, Ranjan Chaudhury, Kalyan Mandal; PHY414, *Micro-electronics and VLSI Design*, Swapan Sen.

Post M. Sc. Ph. D. Programme

Department of Theoretical Sciences: TS501, *Quantum Mechanics III*, Makhtedar Sanjay Kumar; TS502, *Condensed Matter Physics*, Alak Kumar Majumdar; TS503, *Nuclear and Particle Physics*, Asim Kumar Ray; TS591, *Project/Research Methodology*, Faculty Supervisors.

Department of Material Sciences: MS511, *Computational Methods in Physics*, Priya Mahadevan; MS512, *Condensed Matter Physics*, Alak Kumar Majumdar; MS513, *Quantum Mechanics III (Audit)*, Makhtedar Sanjay Kumar; MS591, *Project/Research Methodology*, Faculty Supervisors; Post M. Sc. Course Work: *Advanced Condensed Matter Physics: Physics of Materials and Electronic Structure*: Sugata Mukherjee and Tanusri Saha Dasgupta.

Department of Astrophysics and Cosmology: AC531, *Computational Methods in Physics*, Priya Mahadevan; AC532, *Mathematical Methods I*, Rabin Banerjee; AC591, *Project/Research Methodology*, Faculty Supervisors.

Department of Chemical Biological and Macromolecular Sciences: CB521, *Numerical Methods*, Sanjay Gupta; CB522, *Condensed Matter*, Sanjay Gupta; CB523, *Advanced Equilibrium Statistical Mechanics*, Jaydeb Chakrabarti; CB524, *Physical Chemistry: Experiments and Theory*, Ranjit Biswas; CB525, *Instrumental Methods of Analysis*, Samir Kumar Pal; CB526, *Fundamentals of Biophysics*, Samir Kumar Pal / Rajib Mitra; CB591, *Project/Research Methodology*, Faculty Supervisors.

SUMMER PROJECTS

[1] Arnab Ghosal, Bhavsar Chandrasekhar Arun, Moumita Nandi, Nityananda Sharma, Papori Gogoi, Poulami Dutta, Progna Banerjee, R. Periyasamy, Venkat Rao, Swarnabha Sen [2] Chandrakantha Reddy, Geetha Palanisamy, Badari Narayana Rao, Pankaj Joshi [3] Musfira Jilani, Pratyush Raj, Jyotiranjan Beuria [4] Vishal Das, Souratosh Khan, Abhishek Mondol

[1] Supported by Satyendra Nath Bose National Centre for Basic Sciences.

[2] Supported by Indian Academy of Science.

[3] Supported by Jawaharlal Nehru Centre for Advanced Scientific Research.

[4] Self supported.

PH. D. AWARDED

1. *Theories on noncommutative spaces and deformed symmetries,* by Saurav Samanta, Supervisor: Rabin Banerjee, in Jadavpur University, submitted on 7.07.2008 and awarded on 08.04.2009.

2. *Electronic and magnetic properties of quantum spin systems*, by Badiur Rahaman, Supervisor: Tanusri Saha Dasgupta, in Jadavpur University, submitted on 07.03.2008 and awarded on 08.04.2009.

3. *Ultrafast spectroscopy and biocompatibility of nano-crystals*, by S. Shankara Narayanan, Supervisor: Samir Kumar Pal, in Jadavpur University, submitted on 18.08.2008 and awarded on 20.05.2009.

4. *Electronic structure and optical response in disordered alloys,* by Kartick Tarafdar, Supervisor: Abhijit Mookerjee, in Jadavpur University, submitted on 11.06.2008 and awarded on 17.06.2009.

5. *Turbulence in rotating fluids,* by Sagar Chakraborty, Supervisor: Jayanta Kumar Bhattacharjee and Partha Guha, in West Bengal University of Technology, submitted on 11.11.2008 and awarded on 14.12.2009.

6. *Photophysical studies of small lizards and their interactions with biological macromolicules*, by Debapriya Banerjee, Supervisor: Samir Kumar Pal, in Jadavpur University, submitted on 20.11.2008 and awarded on 26.08.2009.

7. *Medium effects on chemical reactions in electrolyte solutions, binary mixtures and confined environments: a spectroscopic study*, by Tuhin Pradhan, Supervisor: Dr. Jaydeb Chakrabarti and Dr. Ranjit Biswas, in Jadavpur University, submitted on 23.02.2009 and awarded on 22.09.2009.

PH. D. THESIS SUBMITTED

1. *Structural, electronic and magnetic properties of doped wide band gap semiconductors,* by Manoj Kumar Yadav, Supervisor: Abhijit Mookerjee, in Jadavpur University, submitted on 03.09.2009.

2. *Synthesis, characterization and investigation of electrical transport in metal nanowires and nanotubes,* by M. Venkata Kamalakar, Supervisor: Arup Kumar Raychaudhuri, in Jadavpur University, submitted on 04.06.2009.

3. *Tuning of ground state and phase transition in complex oxide nanomaterials,* by Tapati Sarkar, Supervisor: Arup Kumar Raychaudhuri, in Jadavpur University, submitted on 05.05.2009.

4. *Growth, structure and properties of ultra-thin metal-organic films*, by Mrinal Kanti Bera, Supervisor: M. K. Sanyal (SINP) and S. Dattagupta (IISERK), in West Bengal University of Technology, submitted on 07.09.2009.

5. *Study of low frequency conduction fluctuations in perovskite manganites,* by Sudeshna Samanta, Supervisor: Arup Kumar Raychaudhuri, in Jadavpur University, submitted on 31.07.2009.

6. *Structural and electronic properties of semi-conductors: bulk and nanoscale,* by Roby Cherian, Supervisor: Priya Mahadevan, in Jadavpur University, submitted on 08.09.2009.

7. *Magnetic, transport and electronic properties of inter-metallic perovskite compounds*, by Abhishek Pandey, Supervisor: R. Ranganathan (SINP) and S. Dattagupta (IISERK), in West Bengal University of Technology, submitted on 28.08.2009.

8. *Field theory aspects of cosmology and black holes,* by Shailesh Kulkarni, Supervisor: Rabin Banerjee, in Jadavpur University, submitted on 28.08.2009.

9. *Energy and electron transfer in complex molecular systems,* by Dipankar Rana, Supervisor: Gautam Gangopadhyay, in Jadavpur University, submitted on 16.10.2009.

10. *Theoretical and computer simulation studies of chemical events in solutions,* by Hemant Kumar Kashyap, Supervisor: Ranjit Biswas, in Jadavpur University, submitted on 27.10.2009.

11. *Equilibrium and dynamics of structural transitions,* by Jayee Bhattacharya, Supervisor: Surajit Sengupta, in Jadavpur University, submitted on 22.09.2009.
12. *Some aspects of magnetic properties of amorphous magnetic materials,* by Suman Sinha, Supervisor: Kalyan Mandal, in Jadavpur University, submitted on 03.02.2010.

PH. D. THESIS COLLOQUIA

1. *Magnetic, transport and electronic properties of inter-metallic perovskite compounds,* Abhishek Pandey, 07.08.2009.
2. *Theoretical and computer simulation studies of chemical events in solutions,* Hemant Kumar Kashyap, 20.07.2009.
3. *Synthesis, characterization and investigation of electrical transport in metal nanowires and nanotubes,* M. Venkat Kamalakar, 16.04.2009.
4. *Structural, electronics and magnetic properties of doped wide band gap semiconductors*, Manoj Kumar Yadav, 14.08.2009.
5. *Growth, morphology and structural properties of ultra-thin metal-organic films*, Mrinal Kanti Bera, 07.08.2009.
6. *Structural and electronic properties of semi-conductors: bulk and nanoscale,* Roby Cherian, 28.08.2009.
7. *Field theory aspects of cosmology and black holes,* Shailesh Kulkarni, 24.07.2009.
8. *Study of low frequency conduction fluctuations in perovskite manganites*, Sudeshna Samanta, 23.07.2009.
9. *Tuning of ground state and phase transition in complex oxide nanomaterials,* Tapati Sarkar, 16.04.2009.
10. *Some aspects of the magnetic properties of amorphous magnetic materials,* Suman Sinha, 16.11.2009.

Jayanta Kumar Bhattacharjee
Dean, Academic Programme

REGISTRAR

REPORT ON ADMINISTRATIVE MATTERS

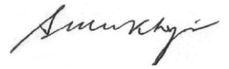
The administrative and technical staff members of the Centre have very professionally and sincerely carried out their duties for making their various activities of the Centre in 2009-2010 successful. Staff comprising of strength of approximately 20 in permanent, 13 in temporary and 46 in contractual category as on 31st March 2010, have functioned effectively under the able leadership of the Director and Registrar. The smooth running of day to day activities of the Centre including electrical maintenance, AC maintenance, guest house, security, EPABX, transport, cafeteria has been made possible due to the professional services provided by the various services contract agencies working closely with the various administrative departments of the Centre. The Centre has tried to enhance the capabilities of its administrative employees by encouraging them to attend various training programme and workshops. The Centre has maintained a close communication with the Department of Science and Technology by replying to their various enquiries and 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 2009-2010. The Centre has also adhered to the norms of the Right to Information Act and so far has received one case under the said Act.

WELFARE MEASURES AND LANGUAGE POLICY

The Centre paid emphasis on implementation of the Official Language in the year 2009-10. According to Rajbhasha Act, reply to Hindi letters was given in Hindi only. Most of the Registers and Forms are in bilingual format. Signing in the Attendance Register (on the first of every month) is done in Hindi. The Centre is adhering to the practice of initiating notes, notices, office orders, advertisements etc. in Hindi. The Centre has printed greeting cards and calendar for the year 2010 in Hindi. Centre's newsletter has also been printed in Hindi. The Centre became 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. Majority of the administrative staff now possess working knowledge of Hindi. The Centre has installed the new Hindi software titled 'Saransh' in all the computers in the administration. The Centre is also in the process of developing Centre's website in Hindi.

The year also saw Hindi Diwas being celebrated in great zeal, with the month of September being declared as Hindi month. Quiz, debates, screening of Hindi movie and a Hindi cultural function were organised as part of 'Hindi Pakhwara'.

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.



Sugata Mukherjee
Acting Registrar

COMMITTEES

GOVERNING BODY

Dr. T. Ramasami Secretary Department of Science & Technology Government of India, New Delhi	Chairman
Prof. G. K. Mehta DAE Senior Scientist Nuclear Science Centre, New Delhi	Member
Prof. T. V. Ramakrishnan DAE Homi Bhabha Professor Banaras Hindu University, Varanasi	Member
Prof. Mustansir Barma Director Tata Institute of Fundamental Research Mumbai	Member
Shri K. P. Pandian Joint Secretary & Financial Adviser Department of Science & Technology New Delhi	Member
Prof. Arup Kumar Raychaudhuri Director S. N. Bose National Centre for Basic Sciences Kolkata	Member
Shri Asok Mohan Chakraborty, IAS Chief Secretary Government of West Bengal, Kolkata	Member
Prof. Sibaji Raha Director, Bose Institute, Kolkata	Permanent Invitee
Prof. Kankan Bhattacharya Director, Indian Association for the Cultivation of Science Kolkata	Permanent Invitee
Dr. Sugata Mukherjee Acting Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Non-Member Secretary

FINANCE COMMITTEE

Prof. Arup Kumar Raychaudhuri Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Prof. Sibaji Raha Director Bose Institute Kolkata	Member
Dr. R. K. Choudhury Head, Nuclear Physics Division Bhabha Atomic Research Centre Mumbai	Member
Shri K. P. Pandian Joint Secretary & Financial Adviser Department of Science & Technology New Delhi	Member
Dr. Sugata Mukherjee Acting Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member Secretary

ACADEMIC AND RESEARCH PROGRAMME ADVISORY COMMITTEE

Prof. S. K. Joshi NPL, New Delhi	Chairman
Prof. D. D. Sarma IACS, Kolkata	Member
Prof. N. K. Dadhich IUCAA, Pune	Member
Prof. Deepak Dhar TIFR, Mumbai	Member
Prof. Siddhartha Roy Director, IICB, Kolkata	Member
Prof. Arup Kumar Raychaudhuri Director, SNBNCBS	Member
Prof. Jayanta Kumar Bhattacharjee Dean, Academic Programme SNBNCBS	Member

BUILDING COMMITTEE

Prof. Arup Kumar Raychaudhuri Director S. N. Bose National Centre for Basic Sciences Kolkata	Chairman
Dr. Sugata Mukherjee Acting Registrar S. N. Bose National Centre for Basic Sciences Kolkata	Member Secretary
Mr. C. S. Prasad Chief Engineer, CPWD Or his nominee/any retired Chief Engineer of CPWD	Member
Prof. Sibabrata Halder Head, Department of Architecture, Bengal Engineering and Science University Sibpur	Member
Mr. Ranadhir Dey Outstanding Scientist, VECC	Member
Mr. Jnanada Ranjan Bhattacharya Superintending Engineer S. N. Bose National Centre for Basic Sciences Kolkata	Special Invitee
Mr. Apurba Kanti Sarkar Deputy Registrar (Finance) S. N. Bose National Centre for Basic Sciences Kolkata	Special Invitee

OFFICIAL LANGUAGE IMPLEMENTATION COMMITTEE

Prof. Arup Kumar Raychaudhuri Director	Chairman
Dr. Sugata Mukherjee Acting Registrar	Member
Prof. S. K. Sharma Professor	Member
Dr. Manu Mathur Associate Professor	Member
Mr. Apurba Kanti Sarkar Deputy Registrar (Finance)	Member
Dr. Chhayabrita Biswas Bose Fellow	Member
Ms. Shohini Majumder Deputy Registrar (Administration)	Member
Mr. Sirsendu Ghosh In-charge, Hindi Cell	Member
Mr. S. K. Singh PCO (Purchase)	Member
Ms. Surasree Banerjee Dutta **Ms. Sushmita Dasgupta** Part-time Hindi Officer	Member

PEOPLE AT THE CENTRE

ACADEMIC MEMBERS

FACULTY MEMBERS

1.	Arup Kumar Raychaudhuri	Director
2.	Abhijit Mookerjee	Distinguished Professor
3.	Jayanta Kumar Bhattacharjee	Distinguished Professor
4.	Sandip Kumar Chakrabarti	Senior Professor
5.	Anita Mehta	Professor
6.	Rabin Banerjee	Professor
7.	Subhrangshu Sekhar Manna	Professor
8.	Surajit Sengupta	Professor
9.	Amitabha Lahiri	Associate Professor
10.	Anjan Barman	Associate Professor
11.	Archan Subhra Majumdar	Associate Professor
12.	Biswajit Chakraborty	Associate Professor
13.	Debashis Gangopadhyay	Associate Professor
14.	Gautam Gangopadhyay	Associate Professor
15.	Jaydeb Chakrabarti	Associate Professor
16.	Kalyan Mandal	Associate Professor
17.	Manu Mathur	Associate Professor
18.	Partha Guha	Associate Professor
19.	Prasenjit Singha Deo	Associate Professor
20.	Pratip Kumar Mukhopadhyay	Associate Professor
21.	Priya Mahadevan	Associate Professor
22.	Ranjit Biswas	Associate Professor
23.	Samir Kumar Pal	Associate Professor
24.	Tanusri Saha Dasgupta	Associate Professor
25.	Makhtedar Sanjay Kumar	Reader
26.	Ranjan Chaudhury	Reader
27.	Samir Kumar Paul	Reader
28.	Sugata Mukherjee	Reader

VISITING SCIENTISTS

1.	Bimalendu Bhusan Bhattacharya	INAE Distinguished Professor
2.	Nilkantha Nayak	Visiting Professor

EMERITUS SCIENTISTS

1.	Alak Kumar Majumdar	Emeritus Scientist
2.	Subodh Kumar Sharma	Emeritus Scientist

BOSE FELLOWS

1.	Chhayabrita Biswas	Material Sciences
2.	Kinsuk Acharyya	Astrophysics and Cosmology
3.	Rajib Kumar Mitra	CBMS

VISITING FACULTY FELLOWS

1.	Barnali Ghosh (Saha)	Material Sciences
2.	Kuntal Chakrabarti	Material Sciences
3.	Sarathi Kundu	Material Sciences
4.	Saswati Barman	Material Sciences
5.	Srikanta Sinha	Astrophysics and Cosmology
6.	Sumita Datta	CBMS

VISITING FACULTY

	Srilekha Banerjee	Theoretical Sciences

POST DOCTORAL FELLOWS

1.	Analabha Roy	Theoretical Sciences
2.	Anindya Das	Material Sciences
3.	Celine Gerard	Material Sciences
4.	Kaustuv Das	Material Sciences
5.	Madhuri Mandal	Material Sciences
6.	Prabuddha Sanyal	Material Sciences
7.	Priya Rajdev	Material Sciences
8.	Satyabrata Adhikari	Theoretical Sciences

RESEARCH ASSOCIATE

1.	Anupam Mukherjee	Material Sciences
2.	Bhogoju Rajini Kanth	Material Sciences
3.	Bipul Rakshit	Material Sciences
4.	Sanjay Gupta	CBMS
5.	Siddhartha Sinha	Astrophysics and Cosmology
6.	Tae-Hun Lee	Theoretical Sciences

RESEARCH SCHOLARS AT POST M. SC. PH. D. PROGRAMME

Extended Senior Research Fellow: Tuhin Pradhan, Hemant Kumar Kashyap.

Senior Research Fellow: Manoj Kuamr Yadav, Harun Al Rashid Gazi, Mitali Banerjee (UGC), Moshiur Rahaman (TWAS-Bose Fellow), Sourav Bhattacharya, Roby Cheriyan (CSIR), Bibhas Ranjan Majhi, Debabrata Pal, Hena Das, Rajesh Kumar Neogy, Raka Dasgupta, Himadri Ghosh, Pramod Kumar Verma (CSIR).

Junior Research Fellow: Ambika Prasad Jena (CSIR), Debraj Ray, Kinsuk Giri, Abhinandan Makhal (CSIR), Abhijit Chakraborty, Amit Das (CSIR), Arnab Sen, Debmalya Mukhopadhyay, Manotosh Chakravorty (CSIR), Sandeep Agarwal (CSIR), Sandip Singh, Shahnewaz Mondal (CSIR), Snehasis Das Chakraborty (CSIR), Sudipto Kanungo, Sujoy Pal, Tamal Basak, Tanumoy Pramanik (UGC), Shyamsundar Ghosh (CSIR), Anupam Giri (UGC), Ashutosh Kumar Yadav, Bivas Rana (UGC), Debashish Sarkar (CSIR), Deepak S. Jalla (CSIR), Madhumita Basu, Putul Malla Chowdhury (CSIR), Rabaya Basori, Ranajay Saha, Ruma Das (CSIR), Saikat Debnath (CSIR), Santu Baidya, Semanti Pal, Soma Banerjee (UGC), Soumik Sarkar (UGC), Sreemoyee Mukherjee, Subrata Batabyal (CSIR), Sumit Ghosh (CSIR), Surajit Rakshit (CSIR), Tamisra Pal, Tanumoy Mondal, Urbashi Satpathi, Debabrata Sinha (CSIR), Thaneshwor Prashad Kaloni, Sudipta Kumar Bera (CSIR), Soumi Roy Chowdhury, Sujit Sarkar (UGC), Biswajit Paul (CSIR).

RESEARCH SCHOLARS AT POST B. SC. INTEGRATED PH. D. PROGRAMME

Extended Senior Research Fellow: Sagar Chakraborty (CSIR).

Senior Research Fellow: Abhishek Pandey, Mrinal Kanti Bera (CSIR), Navin Chandra [External], Chandra S. Chatterjee, M Venkata Kamalakar, Saikat Chatterjee, Santosh Roy, Tapati Sarkar, Tamoghna Kanti Das, Arya Paul, Arnab Saha, Bipul Das. Shreemoyee Ganguly, Abhinav Kumar.

Junior Research Fellow: Amartya Sarkar, Indrakshi Roychowdhury, Nilok Bose, Oindrila Ganguly, Rajiv Kumar Chouhan, Rudranil Basu, Sudip Kumar Garain, Arghya Dutta (CSIR), Ansuman Dey.

M. Sc. Students: Arup Bhowmik, Atanu Nath, Debashis De Munshi, Sanjib Ghosh, Soumyadipta Pal, Sreemoy Chakraborty, Sukla Pal. Anand Kumar Gupta, Arghya Das, Arijit Chatterjee, Arnab Ganguly, Ashutosh Kumar Singh, Biplab Bhattacharjee, Debanjan Polley, Kumar Jang Bahadur Ghosh, Subhasis Chakraborty.

RESEARCH SCHOLARS IN PROJECTS

Extended Senior Research Fellow: Sudeshna Samanta – Project Nanotechnology, Jayee Bhattacharya – Project Monami.

Senior Research Fellow: Hirak Kumar Chandra [Indo-German Project], Ashutosh Rai [DST Project].

Junior Research Fellow: Prajna Mukherjee (AMRU), Sirshendu Bhattacharyya (AMRU), Arka Choudhury (DST Project), Dheeraj Kumar (DST Project), Jayasree Pan (DST Project), Kingshuk Bandopadhyay (DST Project), Milan Agarwal (DST Project), Rajasree Das (DST Project), Subhadipa Das (DST Project), T. Phanindra Sai (DST Project), Arun Lakshmanan (DST Project), Dattatraya P. Shinde (DST Project).

ADMINISTRATIVE AND TECHNICAL STAFF MEMBERS

1.	Sugata Mukherjee	Acting Registrar
2.	Manu Mathur	Acting Librarian
3.	Rabin Banerjee	Vigilance Officer
4.	Sirsendu Ghosh	Public Information Officer

OTHER MEMBERS

1.	Apurba Kanti Sarkar	Deputy Registrar(Finance)
2.	Shohini Majumder	Deputy Registrar(Administration)
3.	Sunish Kumar Deb	Deputy Registrar (Academic)
4.	Sukanta Mukherjee	Assistant Registrar (Projects)
5.	Santosh Kumar Singh	Programme Coordinating Officer
6.	Sirsendu Ghosh	Programme Coordinating Officer
7.	Tapan Kumar Sen	Upper Division Clerk
8.	Jaydeep Kar	Junior Assistant
9.	Prosenjit Talukdar	Junior Assistant
10.	Shiba Prasad Nayak	Pump Operator
11.	Bijoy Kumar Pramanik	Junior Assistant (Guest House)
12.	Bhupati Naskar	Library Stack Assistant
13.	Aditya Pal Choudhury	Project Assistant
14.	Arun Kumar Bhattacharya	Library Stack Attendant
15.	Sushanta Kumar Biswas	Driver
16.	Pradip Kumar Bose	Tradesman 'A'
17.	Partha Chakraborty	Attendant
18.	Partha Mitra	Attendant
19.	Ratan Acharya	Attendant
20.	Swapan Ghosh	Attendant

PERSONNEL WITH TEMPORARY STATUS

1.	Sudhanshu Chakraborty	Attendant (Technical Cell)
2.	Biman Roy	Attendant (Computer)
3.	Dulal Chatterjee	Attendant (Maintenance)
4.	Sukamal Das	Attendant (Central Registry)
5.	Somnath Roy	Attendant (Accounts)
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 Orao	Gardener

PERSONNEL ON CONTRACTUAL APPOINTMENT

1.	Sukumar Sarkar	Consultant (Administration)
2.	Jnanada Ranjan Bhattacharya	Superintending Engineer
3.	Asish Pal	Campus Engineer
4.	Dr. Swapan Kumar Bhattacharyya	Medical Officer
5.	Dr. Tridib Kumar Sarkar	Doctor of Homeopathy
6.	Sougata Bhattacharyya	Facilitation Officer
7.	Surasree Banerjee Dutta	Hindi Officer (Part-time)
8.	Sushmita Dasgupta	Hindi Officer (Part-time)
9.	Achyut Saha	PS to Director
10.	Mahua Mitra	Exec. Assistant (Admin.)
11.	Amitava Ghosh	Senior Computer Engineer
12.	Saswata Mukherjee	Senior Computer Engineer
13.	Anjan Mukherjee	Junior Computer Engineer
14.	Dipanwita Das	Junior Computer Engineer
15.	Sudeep Narayan Banerjee	Junior Computer Engineer
16.	Amit Roy	Technical Assistant (Library)
17.	Gurudas Ghosh	Technical Assistant (Library)
18.	Kumarjit Chowdhury	Technical Assistant
19.	Nasiruddin Mondal	Technical Assistant
20.	Pallab Chakraborty	Technical Assistant
21.	Piyali Bose	Technical Assistant
22.	Rajib Mandal	Technical Assistant
23.	Shakti Nath Das	Technical Assistant
24.	Surajit Mukherjee	Technical Assistant
25.	Ganesh Gupta	Junior Engg (Electrical)
26.	Supriyo Ganguly	Junior Engg (Electrical)
27.	Laxmi Sanpui	Junior Engg (Civil)
28.	Raju Roy	Junior Engg (Civil)
29.	Susanta Mitra	Junior Engg (Civil)
30.	Abu Torab Bin Aman	Office Assistant
31.	Ayan Paul	Office Assistant
32.	Indrani Laha	Office Assistant
33.	Mitali Nanyasi	Office Assistant
34.	Mitali Pal	Office Assistant
35.	Subhodeep Seal	Office Assistant
36.	Sutapa Basu	Office Assistant
37.	Suvodip Mukherjee	Office Assistant
38.	Swarup Dutta	Office Assistant
39.	Lina Mukherjee	Junior Office Assistant
40.	Debasish Mitra	Telephone Operator
41.	Moumita Bhattacharya	Telephone Operator
42.	Siddhartha Chatterje	Telephone Operator
43.	Abhijit Mishra	Mechanic
44.	Subrata Das	Mechanic
45.	Arvind Paswan	Driver
46.	Gobinda Das	Driver

DEPARTMENT OF ASTROPHYSICS AND COSMOLOGY

DAC

DEPARTMENT OF ASTROPHYSICS AND COSMOLOGY

The department has three Faculty members, one Bose Fellow, one visiting faculty, one Post-Doctoral fellow and eleven Ph. D. students.

K. Acharyya, while concentrating on building a future Astrobiology laboratory to mimic Interstellar space, was also engaged in theoretical work on the formation of grain-mantle in frigid condition. They find that when the number density of accreting O is less than 3 times that of CO, methanol is always over-produced. They also find that the grain growth increases the rate of depletion of gas phase species, which results in lower gas phase abundance and shorter depletion time scales.

S. K. Chakrabarti carried out research in several fields which include relativistic astrophysics around black holes, computation of the spectral properties of emitted radiations from the accretion disks, study of the QPOs in persistent and outbursts black hole candidates, effects of energetic phenomena on electron content and the reflection height of the ionosphere, formation of complex molecules in star forming regions. He also participated in instrumentations and data analysis related to the RT-2 payloads which were sent to a lower earth orbit using Russian Satellite CORONAS-PHOTON.

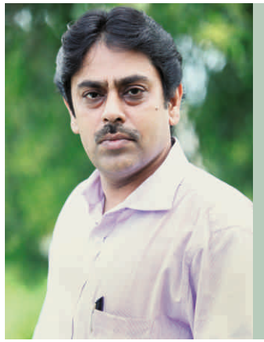
D. Gangopadhyay developed a formalism for estimating quantum fluctuations of the background temperature in the early universe using a Lagrangian for k-essence fields. Here, a single scalar field can account for the inflationary scenario as well as the dark matter and dark energy realms. He works on the global Lorentz invariance and quantum gravity. He has also developed quantum logic gates with q-deformed oscillators and constructed a decoherence model with them.

A. S. Majumdar is working both on basic problems in Cosmology as well as quantum information science. He constructed a unified model of inflation in the early universe and present era acceleration. He works on the constituents of the dark matter, emergence of the dark energy and primordial black holes. In the quantum information front, he works on the efficiency of quantum teleportation using mixed entangled channels. In particular, he shows that single particle path-spin entangled states could be used as quantum channels in protocols for teleportation.

S. Sinha (visiting faculty fellow) completed a work on the effect of non-alignment of a detector with the spin axis of a satellite on the measurements performed by the detectors.

All in all, the department published 17 research papers in refereed journal. One edited book was published by AIP, NY. An international conference on Very low Frequency Radio waves was organized where many international figures participated. Prof. Hayakawa of Tokyo University presented the second S. Chandrasekhar Lecture. The students interacted with scientists of France, Korea, Australia, Brazil, Germany and Japan.

Sandip Kumar Chakrabarti
Head, Department of Astrophysics and Cosmology



Archan Subhra Majumdar

Associate Professor

- Cosmology: Dark energy through various standard approaches, such as k-essence, and non-standard approaches, such as quantum decoherence; primordial black holes as dark matter.
- Quantum Information theory: entanglement and nonlocality of mixed states; protocols for information processing through single particle hybrid entangled states.

Cosmology: (i) We have constructed a unified model of inflation in the early universe and present era acceleration. Observational results have been used to put constraints on the model parameters. (ii) Applying a model for quantum decoherence to the constituents of dark matter in the universe, we have shown that the required magnitude and equation of state of dark energy emerges in the present era. (iii) We have shown that primordial black holes in Brans-Dicke gravitational theory could accrete radiation in the early universe, and thereby survive up to present eras and constitute a fraction of the dark matter in our universe.

Quantum Information science: (i) We have performed a comparative study of the efficiency of quantum teleportation using mixed entangled channels. (ii) We have shown that single particle path-spin entangled states could be used as quantum channels in protocols for teleportation and entanglement swapping. Our works demonstrate that such hybrid entanglement confined to the level of single particles could be used as resource for performing information transfer tasks.

PUBLICATIONS IN JOURNALS

1. A. S. Majumdar, D. Home and S. Sinha, *Dark energy from quantum wave function collapse of dark matter*, Phys. Lett. B, 2009, **679**, 167.
2. B. Nayak, L. P. Singh and A. S. Majumdar, *Effect of accretion on primordial black holes in Brans-Dicke theory,* Phys. Rev. D, 2009, **80**, 023529.
3. N. Bose and A. S. Majumdar, *Unified model of k-inflation, dark matter and dark energy*, Phys. Rev. D, 2009, **80**, 103508.
4. T. Pramanik, S. Adhikari, A. S. Majumdar, D. Home, A. K. Pan, *Information transfer using a single particle path-spin hybrid entangled state*, Phys. Lett. A, 2010, **374**, 1121.
5. S. Adhikari, A. S. Majumdar, D. Home, A. K. Pan, *Swapping path-spin intra-particle entanglement onto spin-spin inter-particle entanglement*, Europhys. Lett., 2010, **89**, 10005.
6. S. Adhikari, A. S. Majumdar, S. Roy, B. Ghosh, N. Nayak, *Teleportation via maximally and non-maximally entangled mixed states*, Quant. Inf. Comm., 2010, **10**, 0398.

OTHER PUBLICATIONS

1. A. S. Majumdar, *Cosmology with primordial black holes,* J. Phys. Conference Series, 2010, **222**, 012023.
2. A. S. Majumdar, *Probing dark matter in primordial black holes*, Recent Developments in Theoretical Physics, 2010, eds. S. Ghosh and G. Kar World Scientific, p53.

SUPERVISION OF STUDENTS

Ph. D. Students: Nilok Bose, Tanumoy Pramanik, Deepak Jalla, Ashutosh Rai, Subhadeepa Das; **External Students:** Sovik Roy, Nirman Ganguly.

POST DOCTORAL RESEARCHERS

Dr. Satyabrata Adhikari, Dr. Siddhartha Sinha

STUDENTS' PUBLICATIONS

1. N. Ganguly, S. Adhikari, *Witness for edge states and its characteristics*, Phys. Rev. A, 2009, **80**, 032331.
2. A. Ahanj, S. Kunkri, A. Rai, R. Rehman, P. Joag, *Bounds on Hardy's nonlocality from the principle of information causality*, Phys. Rev. A, 2010, **81**, 032103.

LECTURES DELIVERED

1. *k-essence models of unified inflation, dark matter and dark energy*, CERN, Geneva, September 2009.
2. *Cosmology with primordial black holes*, Academy of Athens, Greece, September 2009.
3. *Quantum information processing with single particle entangled states*, IOP, Bhubaneswar, January 2010.

COURSES TAUGHT

PHY292, Quantum Information theory, Fall semester.

PARTICIPATION IN COMMITTEES

Internal: Annual Report Committee 2008-2009 (Convener), Library Committee, SCRE Committee.

SPONSORED PROJECTS

Fundamental aspects of quantum theory and quantum information (DST).

Debashis Gangopadhyay

Associate Professor

- Application of standard quantum field theoretic techniques to understand the early universe, dark matter, dark energy and the evolution of the universe.
- Use k-essence scalar fields to study blackhole singularities.
- Continue developing an alternative formulation for quantum computation using q-deformed qubits.

A formalism for estimating quantum fluctuations of the background temperature in the early universe has been developed using a Lagrangian for k-essence fields. The formalism is valid in an epoch when the scale factor was very small compared to the present epoch but very large compared to the inflationary epoch. Expansion is naturally built into the theory with the existence of growing classical solutions of the scale factor. Moreover, a single scalar field can account for the inflationary scenario as well as the dark matter and dark energy realms.

In the context of emergent gravity, a new scaling relation has been set up and a Lagrangian obtained for the k-essence field which can account for the acceleration of the universe.

It has been shown in the context of quantum computation with q-deformed oscillators that a depolarising channel can be realised using q-deformed qubits.

It has been shown that quantum gravity induced violation of global Lorentz invariance is not always possible with explicitly Lorentz frame dependent dimension five operators as proposed by Myers and Pospelov. Special field configurations exist for the scalar case where Lorentz Invariance holds. Same is true also for the Myers-Pospelov electromagnetic Lagrangian.

PUBLICATIONS IN JOURNALS

Debashis Gangopadhyay, *Estimating Temperature Fluctuations in the Early Universe,* Gravitation and Cosmology, 2010, **16**, 231.

SUPERVISION OF STUDENTS

Ph. D. Student: Oindrila Ganguly.

COURSES TAUGHT

PHY202, Mathematical Methods, Fall semester

Kinsuk Acharyya
Bose Fellow

Research Area : Astrobiology and Astrochemistry, Problems worked on:

- Formation of water and methanol in star forming regions using continuous time random walk Monte Carlo method.
- Effect of growth and grain size distribution on the chemical evolution of dense cloud.
- Building a laboratory for studying Astrobiology related problems.

We investigated the formation of complex molecules during the chemical evolution of a cold dense interstellar cloud and studied the affect of grain size distribution and grain growth on the molecular abundances. We found that the grain growth increases the rate of depletion of gas phase species, which results lower gas phase abundance and shorter depletion time scale, where as grain species shows stronger non thermal desorption, which results a higher gas phase abundances of species like water, methanol, etc. The effect of size distributions are related to the effective surface area, in the absence of grain growth, depletion and non thermal desorption are directly proportional to initial effective surface area, but in the presence of grain growth it is not straight forward and changes species to species. In a separate work we studied evolution of grain mantle in various interstellar environments using continuous time random work Monte Carlo method to find out effects of initial conditions and densities on the composition of the grain mantle. We found that, when the number density of accreting O is less than 3 times that of CO, methanol is always over-produced. Using available reaction pathways it appears to be difficult to match the exact observed abundances of the grain mantle molecules. Only in a narrow region of parameter space major important molecules are produced with in the observed limit.

SUPERVISION OF STUDENTS

Ph. D. Students: Wasim Iqbal.

LECTURES DELIVERED

Effect of Grain sizes and Grain Growth on the chemical evolution of dense cloud at Nasa Astrobiology Institute workshop, Carnegie Institution, Washington, DC, March, 2010.

ACADEMIC VISITS

Ohio State University, 01 January to 31 March, 2010.

PARTICIPATION IN COMMITTEES

Internal: Newsletter Committee, Technical Cell member.

Sandip Kumar Chakrabarti
Senior Professor

- Relativistic Astrophysics around black holes - the steady and time dependent behavior of the hydrodynamics of flows and the spectral and the timing properties of the emitted radiations from the accretion disks and jets and outflows, X-ray imaging in space missions using Fresnel zone plates, interaction of high energy radiation with ionosphere and the disturbances caused in the lower ionosphere.

By conducting hydrodynamic simulations, we found that in a major region of the parameter space spanned by specific energy and angular momentum the shock around the black hole oscillates and the radiation from the flow produces features similar to that observed in black holes. We found that the frequency of the quasi-periodic oscillations (QPOs) from several black hole candidates increase monotonically with time after the outbursts and these can be explained by a propagatory oscillating shock which moves at a constant velocity. We also found that the hardness intensity diagram during an outburst can be reproduced by simply varying two accretion rates, namely, the Keplerian rate and the sub-Keplerian rate. We point out that the viscosity could be the cause of the variation of these rates.

We determined the resolution of hard X-ray imager made by a pair of Fresnel zone plates using a quasi-parallel X-ray beam and found that the theoretical resolution could be achieved only if the second zone plate is suitably modified to compensate for the divergence of the beam.

PUBLICATIONS IN JOURNALS

1. S. K. Chakrabarti, S. Palit, D. Debnath, A. Nandi, V. Yadav, R. Sarkar, *Fresnel Zone Plate Telescopes for X-ray Imaging I: Experiments with a quasi-parallel beam*, Exp. Astronomy, 2009, **24**, 109.
2. S. K. Chakrabarti, B.G. Dutta and P.S. Pal, *Accretion flow behaviour during the evolution of the Quasi Periodic Oscillation Frequency of XTE J1550-564 in 1998 outburst*, MNRAS, 2009, **394**, 1463.
3. S. Mondal, P. Basu and S. K. Chakrabarti, *Studies of accretion flows around rotating black holes - III. Shock oscillations and an estimation of the spin parameter from QPO frequencies*, MNRAS, 2009, **396**, 1038.
4. H. Ghosh, S. K. Chakrabarti and P. Laurent, *Monte-Carlo Simulations of Thermal Comptonization Process in a Two Component Accretion Flow Around a Black Hole*, IJMPD, 2009, **18**, 1693.
5. S. Sasmal and S. K. Chakrabarti, *Ionosperic Anomaly due to Seismic Activities -I: Calibration of the VLF signal of VTX 18.2KHz Station From Kolkata and Deviation During Seismic events*, Nat. Hazards Earth Syst. Sci., 2009, **9**, 1403.
6. K. Giri, S. K. Chakrabarti, M. M. Samanta, D. Ryu, *Hydrodynamic Simulations of Oscillating Shock Waves in a Sub-Keplerian Accretion Flow Around Black Holes*, MNRAS, 2009, **403**, 516.
7. S. Palit, S. K. Chakrabarti, D. Debnath, A. R. Rao, A. Nandi, Vipin K. Yadav, V. Girish, *Fresnel Zone Plate Telescopes for X-ray Imaging II: Numerical simulations with parallel and diverging beams*, Exp. Astronomy, 2009, **27**, 77.
8. S. Das, S. K. Chakrabarti and S. Mondal, *Studies of dissipative standing shock waves around black holes*, MNRAS, 2010, **401**, 2053.
9. H. Ghosh, S. Garain, S. K. Chakrabarti and P. Laurent, *Monte-Carlo Simulations in a Two component Flow in presence of Outflow*, IJMPD, 2010, **19**, 607.
10. S. Mandal and S. K. Chakrabarti, *On the Evolution of Accretion Rates in Compact Outburst Sources*, Astrophysical Journal Letters, 2010, **710**, 147.

OTHER PUBLICATIONS

1. S. K. Chakrabarti, 2009, *Generalized Accretion Flow Configuration: Rationale and Observational Evidences*, (Eds.) S. K. Chakrabarti, G. S. Bisnovatyi-Kogan and A.I. Zhuk, p. 244 (AIP:NY).
2. S. K. Chakrabarti, S. Palit, A. Nandi, V. K. Yadav, D. Debnath, 2009, *Fresnel Zone Plate Telescopes as high resolution imaging devices*, in Proceedings of International conference on Space Science and Technology, Thessaloniki, Greece, Eds. G. Lampropoulos and M. Petrou (ISBN-9-781901-725384).
3. V. K. Yadav, S. K. Chakrabarti, A. Nandi, S. Palit, 2009, *X-ray experiments for Space applications in intermediate energy range* in Proceedings of International conference on Space Science and Technology, Thessaloniki, Greece, Eds. G. Lampropoulos and M. Petrou (ISBN-9-781901-725384).
4. A. Nandi, A. R. Rao, S. K. Chakrabarti, J. P. Malkar, S. Sreekumar, D. Debnath, M. K. Hingar, T. Kotoch, Y. Kotov, A. Arkhangelskiy, 2009, *Indian Payloads (RT-2 Experiment) Onboard CORONAS-PHOTON Mission*, in Proceedings of International conference on Space Science and Technology, Thessaloniki, Greece, Eds. G. Lampropoulos and M. Petrou (ISBN-9-781901-725384).
5. S. K. Chakrabarti, 2010, *Black Hole Astrophysics in 'The Sun, Stars, the Universe and General Relativity'*, R. Ruffini and G. Vereschagin (Eds.) 41.
6. S. K. Chakrabarti and S. Chakrabarti, 2010, *Evolution of Pre-biotic molecules during star formation in 'The Sun, Stars, The Universe and General Relativity'*, R. Ruffini and G. Vereschagin (Eds.), 51.

BOOKS PUBLISHED

S. K. Chakrabarti, A. I. Zhuk and G. S. Bisnovatyi-Kogan (Editors): *Astrophysics and Cosmology after Gamow*, American Institute of Physics (New York).

SUPERVISION OF STUDENTS

Ph. D. Students: Himadri Ghosh, Sudip Garain, Kinsuk Giri, Arnab Sen, Tamal Basak, Sujay Pal, Dipak Debnath, Broja Gopal Dutta, Ritabrata Sarkar, Ankan Das.

LECTURES DELIVERED

1. *Seeing is believing - Do we see black holes?* 12th Marcel Grossman Conference held at UNESCO HQ July 12-18, 2009.
2. *Evolution of QPOs in Transient Black Holes,* 12th Marcel Grossman Conference held at UNESCO HQ July 12-18, 2009.
3. *Shock waves in Accretion flows into black holes*, 'Astronomy and beyond: Astrophysics, Cosmology, Radioastronomy, High Energy Physics and Astrobiology' conference in Odessa, Ukraine, 17-23rd Aug. 2009.
4. *Fresnel Zone Plate Telescopes as high resolution imaging devices*, *Indian Payloads (RT-2 Experiment) Onboard CORONAS-FOTON Mission* and *X-ray experiments for Space applications in intermediate energy range* at the International Conference on Space Technology, Thessaloniki, 24-26th August, 2009.
5. *X-Ray and Gamma-Ray Astronomy from the Moon*, International Conference on 'Low Cost Planetary Missions' at Goa, 31st Aug-4th September, 2009.
6. *Unification of Accretion and Outflows Around Black Holes*, 1st Galileo - Xu Guanqi meeting at Shanghai in October. 2009.
7. *Evolution of Telescope based Observations*, Commemorative 150th Birth Centenary of J.C. Bose and 400th year of Galileo's observation (IYA prog.), BESU, West Bengal, Nov. 2010.
8. *Importance of Galileo and Darwin today*, IYA programme (400yrs. of Galileo Telescope and 200 years of Darwin's birth), Baruipur and Dhonekhali.
9. *Chemical Evolution during Star formation and effects of X-rays and Gamma Rays*, I. I. T. Roorkee at the Conference on 'Origin of Life'.
10. *VLF Research at SNBNCBS and ICSP*, International Conference on 'Very Low Frequency Radio Waves: Theory and Observations' (VELFRATO-10).

ACADEMIC VISITS

Visited Nice Observatory and presented a series of five talks on *Accretion Process on to Black Holes* at the International Centre for Relativistic Astrophysics Ph. D. Programme.

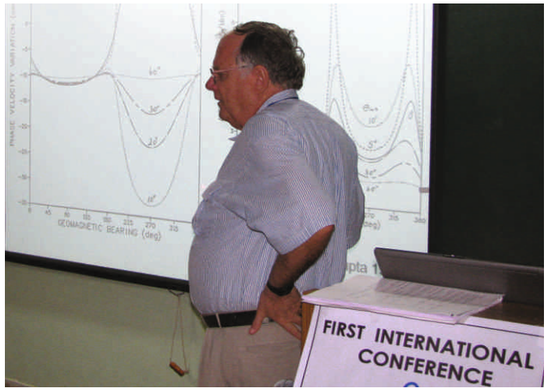
PARTICIPATION IN COMMITTEES

a. **External:** International Advisory Committee member of 1st Galileo-Xu Guanqi conference (Shanghai); George Gamow meeting (Odessa) and Origin of Life conference (Roorkee); Chaired APT4 session on `Astrophysical Black Holes: From Quasars to Nano-Quasars' of the 12th Marcel Grossman Conference (UNESCO-HQ, Paris, July 2009); Editorial board member of Indian Journal of Physics and Open Astronomy Journal (Bentham); In Charge, Academic Affairs of Indian Centre for Space Physics.

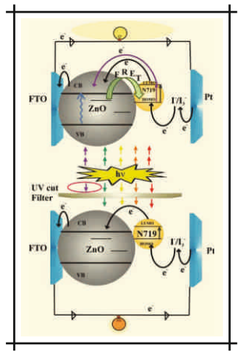
b. **Internal**: Head of the Department, Astrophysics and Cosmology; Convener, Very Low frequency Radio Waves: Theory and Observations (VELFRATO-10).

FIRST INTERNATIONAL CONFERENCE ON VERY LOW FREQUENCY RADIO WAVES: THEORY AND OBSERVATIONS (VELFRATO-10)

13 - 18 MARCH, 2010



DEPARTMENT OF CHEMICAL, BIOLOGICAL AND MACRO MOLECULAR SCIENCES



DCBMS

DEPARTMENT OF CHEMICAL, BIOLOGICAL AND MACRO MOLECULAR SCIENCES

The department has multidisciplinary research activities. They are broadly classified as follows.

SPECTROSCOPY AND SOLVATION DYNAMICS

The research activities of Dr. Samir Kumar Pal in the field of experimental Biophysics are interdisciplinary in nature that applies the theories and methods of physics. The studies include molecular recognition of small ligands / drugs by biological macromolecules to complicated protein-DNA, Protein-Protein complexation. Recent works from the group explores the fundamental role of solvent molecules (mostly water) in the close vicinity of the biological macromolecules in the molecular recognition and complexation processes. Femtosecond-microsecond resolved photoluminescence, FTIR, UV-VIS absorption/Emission, DLS, CD, TG-DTA, HRTEM, ESEM, XRD, Mass spectrometry are the tools of the experimental works. The interface between the biological sciences and nanoscience constitutes one of the most interesting and technologically promising frontiers in modern science. Research at this interface is yielding new ways to do biomedical and pharmaceutical separations, new high-tech approaches for delivery of drugs and other biomolecules to the human body, new ways to remediate environmental pollution, and new highly sensitive and selective biosensing devices. The group is involved in the synthesis of various bionanoconjugates. Selective attachment of inorganic semiconductor/metal quantum dots (QD) to various biological macromolecules is the key feature of the nanoconjugates.

Recent works from Dr. Ranjit Biswas's group includes fluorescence spectroscopic investigation of Stokes' shift dynamics (Fig. 1) and rotational relaxation of a dipolar solute probe in molten mixtures of acetamide (CH_3CONH_2) with sodium and potassium thiocyanates (Na / KSCN) at various temperatures and mixture compositions. Recently, 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 substantiates the relation between dielectric response of these new class of liquids and Stokes' shift dynamics in them. This theory also predicts increase in polarity parameter values with temperature, which is actually seen in experiments. Simulation study carried out in this group using model potential suggests dipole-dipole interaction may increase the medium viscosity considerably. In addition, simulation studies of asymmetric binary mixtures reveal complex composition and particle shape dependence of transport properties, and indicate limited validity of hydrodynamic relations for mass and angular diffusions in such mixtures.

Dr. Rajib Kumar Mitra 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 solvation 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.

LIQUID STATE THEORY

Dr. Jaydeb 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.

In a different context it is shown that the specific binding between DNA and a protein involves structural adjustments of both the DNA and protein where the x-ray data of a given DNA-protein complex, namely, TATA box-TBP complex is considered. Thus they show that the specificity of binding is sensitive to the base pairs. This result is important in designing stable complexes essential for many applications in drug designing.

MESOSCOPIC PHYSICS

Since 1998 till date a series of experiments show that phase of electron wavefunction can be measured just like the phase of classical waves. Dr. Prasenjit Singha Deo has shown that evanescent modes play an important role in these experiments. They have looked at semi classical formulas like Friedel sum rule and Wigner delay time at the Fano resonances. The exact density of states at the resonance and the exact life time of the resonances can be obtained from these semi classical formulas which are much simpler than their rigorous quantum mechanical versions. Hence this can be of great help to experimentalists as well as theoreticians. They have shown that their results are valid for any potential that has mirror symmetry in the propagating direction. Another series of experiments done since 1991 has to do with the magnetic response of quantum rings. Once again the evanescent modes arise because the rings have a finite thickness. This diamagnetic contribution ignored so far can naturally explain the experimental results provided they ensemble average to give a periodicity of half flux quantum.

CHEMICAL PHYSICS

Dr. Gautam Gangopadhyay and coworkers have theoretically studied the nature of symmetry of the interchain excitonic states for a network of conjugated polymer aggregate system consisting of N equivalent polymer chains. For equivalent tetramer aggregates with square planar (2D) and tetrahedral (3D) structures, permutation symmetry approach is an appropriate general recipe to classify the symmetry of the eigenstates of both the tetramer systems. Using the dimer model they have explained the basic features of Lamellar and herringbone aggregate spectra.

In a different context, motivated by the single molecule enzymatic experiments they have provided a master equation description of enzyme catalysis in a chemiostatic condition for an immobilized oligomeric molecule with many equivalent active sites. For the oligomeric enzyme, the net rate of the reaction in the nonequilibrium steady state is multiplied by the number of active sites which is further enhanced by more than two orders of magnitude with the application of external force of 10-100pN through the techniques of atomic force microscopy.

MACROMOLECULAR ASSEMBLY

Using a model solid, which exhibits both martensitic and ferritic microstructures, Prof. Surajit Sengupta showed that accommodation of interfacial mismatch occurs by the appearance of specific dynamical heterogeneities, defined as a cluster of moving or active particles. They describe the sharp transition in terms of thermodynamics of space-time trajectories of the 'faster' active particles moving in the potential energy topography set by the 'slower' inactive particles. A particularly popular preparation strategy for two-dimensional of colloid arrays is the evaporation of a solution containing latex particles on a hydrophilic substrate. Here they show that by careful substrate preparation, one can produce extremely large crystalline arrays of silica particles

controlling only the initial solvent density and drying time. In the context of non-local elasticity and non-affine displacements in elastic solids they studied the process for a simple triangular lattice of particles connected by harmonic springs in two-dimensions.

QUANTUM MONTE CARLO SIMULATION

Dr. Sumita Datta is working on the application of Quantum Monte Carlo techniques to atom, molecules and condensed matter Physics in the following contexts: lowest order relativistic correction for Helium, the lowest order Relativistic corrections for the Hydrogen Molecule, Sigma. Pi and Delta wave functions for the Hydrogen Molecule, the lowest order Relativistic corrections for several homonuclear diatomics, quantum simulation of Anderson localization of the cold atoms in 3d.

DEPARTMENTAL STATISTICS

Faculty strength: 8 (including a Visiting Faculty Fellow); **Number of Ph. D. Students:** 25**; Number of Post-doctoral Researchers:** 1

Total number of publications: 26

Total number of Projects: 5

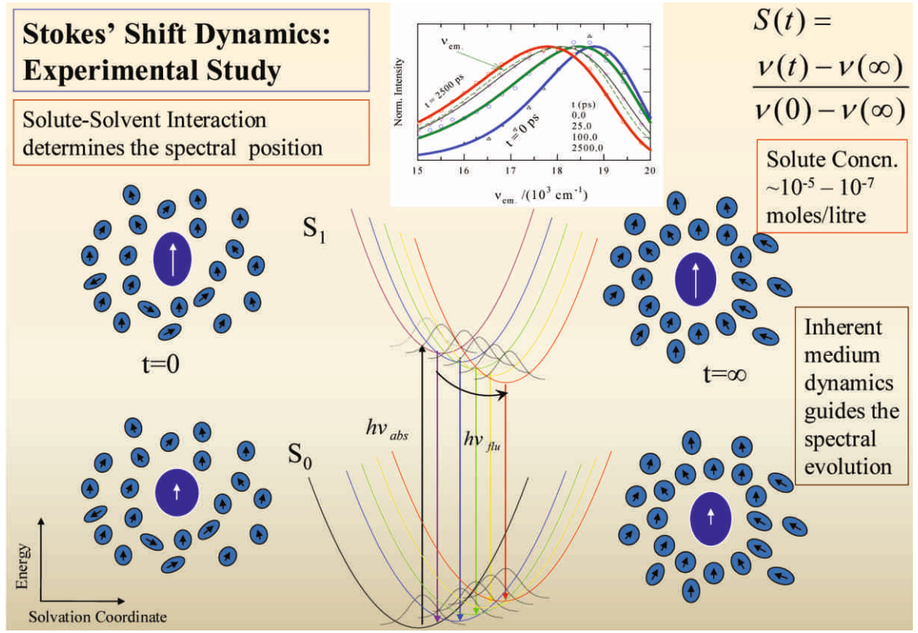


Fig. 1: Pictorial representation of dynamical solvent response to a laser-excited dipolar solute

Gautam Gangopadhyay
Head, Department of Chemical, Biological and Macro- Molecular Sciences

Gautam Gangopadhyay
Associate Professor

- Characterization of luminescence properties of aggregates of polymeric chains in terms of the nonadiabatic molecular processes. The key ingredient is the fact that the potential energy surfaces of different electronic states are not mutually independent and thus gives rise to strange excited state static and dynamic properties.
- Recently we have studied on the enzyme catalysis in various heterogeneous set up. In this context we have developed some analytical theories and tools for computer simulation of complex systems.

We have theoretically studied the nature of symmetry of the interchain excitonic states for a network of conjugated polymer aggregate system consisting of N equivalent polymer chains. For equivalent tetramer aggregates with square planar (2D) and tetrahedral (3D) structures, permutation symmetry approach is an appropriate general recipe to classify the symmetry of the eigenstates of both the tetramer systems. The absorption and emission spectra for different classes of aggregates, over a wide range of temperatures, are explained in terms of the symmetry properties of the coupled excitonic states. We have also studied the effect of geometry of dipolar orientations on the spectra of dimer and trimer chain aggregates in a different context. Using the dimer model we have explained the basic features of Lamellar and herringbone aggregate spectra. We have also explained the blue shift in absorption for the cyclic trimer compared to its linear counterpart for comparable interchain interactions for thiophene aggregates which was discussed earlier through Frenkel exciton theory with only electronic degrees of freedom.

Motivated by the single molecule enzymatic experiments we have provided a master equation description of enzyme catalysis in a chemiostatic condition for an immobilized oligomeric molecule with many equivalent active sites. For the oligomeric enzyme, the net rate of the reaction in the nonequilibrium steady state is multiplied by the number of active sites which is further enhanced by more than two orders of magnitude with the application of external force of 10-100pN through the techniques of atomic force microscopy.

PUBLICATIONS IN JOURNALS

1. Kinshuk Banerjee and Gautam Gangopadhyay, *Aggregation of a network of conjugated polymer chains : symmetry of the excitonic states and spectral features*, J. Phys. B, 2009, **42**, 165106.
2. Kinshuk Banerjee and Gautam Gangopadhyay, *Effect of geometry of dipolar orientations on the spectra of dimer and trimer chain aggregates*, Phys. Rev. B, 2010, **81**, 035307.
3. Biswajit Das and Gautam Gangopadhyay, *Master equation approach to single oligomeric enzyme catalysis: mechanically controlled further catalysis*, J. Chem. Phys., 2010, **132**, 135102.

SUPERVISION OF STUDENTS

Ph. D. Students: Kinshuk Banerjee, Biswajit Das.

LECTURES DELIVERED

1. *Aggregation of a Network of Polymer Chains: Spectral Aspect*, Santiniketan, Viswabharathi University, August, 2009.
2. *On The Aggregation Of Conjugated Polymers*, Delhi University, November, 2009.
3. *On molecules, aggregates and molecular materials*, Burdwan University, March, 2010.

PARTICIPATION IN COMMITTEES

Internal: CAC, SAC, Project Cell.

Jaydeb Chakrabarti

Associate Professor

- Application of statistical mechanical theories to problems of biological and chemical interest.

I am interested in the application Statistical Mechanics in chemical and biological systems. There are few specific areas in which I have been working in recent times:

Effective interaction in soft matter systems: We calculate the interaction between different complex bodies dressed by the presence of solvent molecules in a medium. We apply computer simulations and analytical mean field theories to calculate such interactions.

Rotation of solutes in a solvent: We analyze the effect of the solvent structure on the rotation of a solute through generalization of the celebrated Stokes-Einstein-Debye model. This generalization enables one to understand the rotational motion of a solute when the solvent undergoes phase transition.

DNA-Protein specific interaction: We show from detailed bio-informatics data how the thermodynamic properties of DNA base-pairs change under complexation with proteins. The changes are specific to the base-pair locations in the DNA fragment which gives rise to specificity of the interactions. We are working out model to explain the kinetics of such complex formation.

PUBLICATIONS IN JOURNALS

1. S. Samanta, J. Chakrabarti and D. Bhattacharya, *Changes in thermodynamic properties of DNA in protein-DNA recognition*, J. Biol. Structure and Dynamics, 2009, **71**, 1.
2. J. Dzubiela, J. Chakrabarti and H. Loewen, *Tuning colloidal interactions in subcritical solvent by solvophobicity: Explicit vs implicit modeling*, J. Chem. Phys, 2009, **130**, 115103.

SUPERVISION OF STUDENTS

Ph. D. Students: Amit Das, Injamamul Areif.

Prasenjit Singha Deo

Associate Professor

- Some problems in mesoscopic physics. Particularly it has been seen that the role of evanescent modes can drastically change some known results.

Since 1998 till date a series of experiments show that phase of electron wavefunction can be measured just like the phase of classical waves. So now both scattering cross section and scattering phase shift can be measured for a mesoscopic system like a quantum dot. Side by side with these experiments we were probing what information can be obtained from scattering phase shift. The well known theorems related to scattering phase shifts are all semiclassical in nature and cannot be apriori applied to mesoscopic systems. We had shown that evanescent modes play an important role in these experiments. These evanescent modes arise due to the presence of the boundary. Very counterintuitively, semiclassical formulas become exact at the resonances due to the presence of these modes. The resonances are also not Breit-Wigner type but they are Fano resonances. Evanescent modes are also responsible for this. We have looked at semiclassical formulas like Friedel sum rule and Wigner delay time at the Fano resonances. The exact density of states at the resonance and the exact life time of the resonances can be obtained from these semiclassical formulas which are much simpler than their rigorous quantum mechanical versions. Hence this can be of great help to experimentalists as well as theoreticians. While earlier we had taken some specific examples this year we could generalize our results to some extent. We have shown that our results are valid for any potential that has mirror symmetry in the propagating direction.

Another series of experiments done since 1991 has to do with the magnetic response of quantum rings. A large ensamble of semiconductor or metallic rings are taken in a plane and a magnetic field is applied perpendicular to the plane. The response is found to be strongly diamagnetic and also of half flux quantum periodicity. Theories predict much smaller paramagnetic values with half flux quantum periodicity. We have shown that there is a large diamagnetic contribution made by the evanescent modes to the orbital magnetization in quantum rings. Once again these evanescent modes arise because the rings have a finite thickness. This diamagnetic contribution ignored so far can naturally explain the experimental results provided they ensamble average to give a periodicity of half flux quantum. For this only some intuitive arguements were given that can cause this periodicity.

PUBLICATIONS IN JOURNALS

1. P. Singha Deo, *Friedel sum rule at Fano resonances*, Journ. of Phys.: Condensed Matter, 2009, **21**, 285303.
2. Sheelan Sengupta Chowdbury, P. Singha Deo, A. M. Jayannavar, and M. Manninen, *S-matrix formulation of mesoscopic systems and evanescent modes*, Journ. of Phys.: Condensed Matter, 2010, **22**, 015601.

SUPERVISION OF STUDENTS

Ph. D. Students: Sreemoyee Mukherjee, Ashutosh Kumar Yadav, Urbashi Satpathi.

POST DOCTORAL RESEARCHERS

Dr. Sanjay Gupta

SPONSORED PROJECTS

Transport and thermodynamic properties of mesoscopic systems.

Rajib Kumar Mitra

Bose Fellow

- Ultrafast time resolved fluorescence spectroscopy and high frequency (THz) spectroscopy of biomolecules (including proteins, nucleic acids, enzymes etc.) and bio-mimicking systems (including micelles, reverse micelles, lamellae, vesicles etc.) with special reference to the related water dynamics.

A molecular magnet V_{15} (a polyoxovanadate) has been encapsulated in the hydrophobic cavity of a transport protein HSA (human serum albumin). V_{15} shows high stability inside the protein cavity even at elevated temperatures. A huge overlap between the absorption spectrum of V_{15} and the emission spectrum of the tryptophan moiety of the protein signifies a Froster Resonance Energy Transfer (FRET) and the calculated distance between the donor (tryptophan) and acceptor (V_{15}) shows temperature dependency as it can track the thermal unfolding pathway of the protein.

A simple chemical reaction (solvolysis of benzoyl chloride) is studied in a confined nanopool of water entrapped in AOT reverse micelle (RM). The reaction rate inside RM is very slow compared to that in bulk and the presence of surface bound water molecules inside RM waterpool is responsible for the slow kinetics. The activation energy of the reaction has been found to be a cumulative effect of the energy associated with the transition of bound to free water (measured from temperature dependent solvation dynamics study using a fluorescent probe) and the energy associated with the diffusion of free water to the reaction site (calculated using the Kramer's theory).

Addition of a crowding agent (an inert solute that only creates an osmotic stress without direct interaction) to an enzyme retards its efficiency and osmometric, densimetric, time-resolved fluorescence spectroscopy reveals the dehydration of the solvation shell of the enzyme to be responsible for this 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.

Caffeine can act as a strong antimutagenic agent that can exclude model drug/ligand (like ethidium bromide) from nucleic acids.

Hydration shell water structure is considerably perturbed on thermal denaturation of proteins as evidenced from the change in the absorption signal obtained in the THz frequency region.

PUBLICATIONS IN JOURNALS

1. R. K. Mitra, P. K. Verma, D. Wulferding, D. Menzel, T. Mitra, A. M. Todea, P. Lemmens, A. Mueller and S. K. Pal, *A Molecular Magnet Confined in the Nanocage of a Globular Protein*, Chem. Phys. Chem, 2010, **11**, 389 (Cover article).
2. P. K. Verma, R. K. Mitra and S. K. Pal, *A Molecular Picture of Diffusion Controlled Reaction: Role of Microviscosity and Hydration on Hydrolysis of Benzoyl Chloride at a Polymer Hydration Region*, Langmuir, 2009, **25**, 11336.
3. P. K. Verma, A. Makhal, R. K. Mitra and S. K. Pal, *Role of Solvation Dynamics in the Kinetics of Solvolysis Reactions in Microreactors*, Physical Chemistry Chemical Physics, 2009, **11**, 8467.

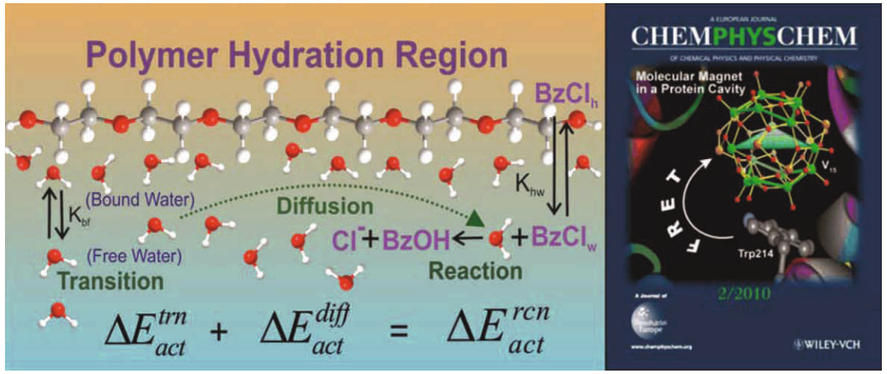


Fig. 1: Cumulative contribution of transition and diffusion of water on the overall reaction in a confined system (Left). A molecular magnet entrapped in the hydrophobic cavity of a protein (Right).

LECTURES DELIVERED

1. *Time Resolved Fluorescence Spectroscopy*, Ruhr University, Germany, September, 2009.
2. *Application of THz Spectroscopy in Life Sciences*, Ruhr University, Germany, January, 2010.

PARTICIPATION IN COMMITTEES

Internal: Member of Technical Cell, Member of Housing Allotment Committee.

ACADEMIC VISITS

Worked on THz Spectroscopy at the Ruhr University, Germany for the period of 31st March 2009 to 25th January 2010 as a BOYSCAST fellow (a fellowship awarded by the DST).

Ranjit Biswas
Associate Professor

Experimental Studies of Solvation Processes and Chemical Reactions in

- Ionic Liquids.
- Electrolyte Solution.
- Binary and Ternary Solvent Mixtures.
- Confined Environments.
- Supercritical Fluids.

Theoretical and Computer Simulation Studies on

- Solvation in Ionic Liquids.
- Solvation in Non-polar Bulk Media.
- Dielectric Relaxation and Diffusion in Multi-component Mixtures.
- Diffusion in Ion Channels.

The research works of the research group of R. Biswas are based upon the theme of developing a molecular level understanding of the structure and dynamics of various complex media and their relationship to simple chemical events occurring in them. For this, an integrated approach, based upon experiment, theroy and simulation, have been adopted. This approach is reflected in various research papers published from Biswas's laboratory during the last few years. Recently, a molecular level explanation for the fast component detected by solvation dynamics experiments in room temperature ionic liquids has been provided [A1]. It was shown that much of the dynamics in these liquids could be understood in terms of polar solvation dynamics in neat polar solvents. This work was followed up by a further investigation [3] where the ion-dipole and dipole-dipole contributions to the dynamics are separated out and a general framework is constructed to quantitatively understand the experimental data, regardless of the identity of the ionic liquid. The ionic liquid work from this group may be regarded as a fundamental contribution to the overall understanding of the liquid phase dynamics in general and of ionic liquids in particular. In a recent work Biswas' group has investigated the 'mixed alkali effects' and medium dynamics in non-aqueous electrolyte solutions of acetamide with sodium and potassium thiocyanates near the eutectic temperature by using both the fluorescence spectroscopy and a classical theory. The first semi-quantitative estimate of dielectric constant of confined water and a few other polar solvents has emerged from their continuing interest in self-assembled bio-mimetic systems. In collaboration, Biswas's group has been able to provide a semi-quantitative explanation for the experimentally observed non-monotonic density dependence of solute rotation in supercritical polar fluids. In addition, ion-specific effects and systems made of surfactant mixtures and polar solvents are investigated to unravel the role of ion-solvent interactions on chemical dynamics. Biswas's group is also investigating various aspects of transport properties in bulk media and ion channels by employing simulation methods.

[A1] Hemant Kashyap and Ranjit Biswas, J. Phys. Chem. B. 2008, **112**, 12431.

PUBLICATIONS IN JOURNALS

1. H. K. Kashyap and R. Biswas, *Solvation Dynamics in Imidazolium and Phosphonium Ionic Liquids: Effects of Solute Motion*, Indian Journal of Chemistry, 2010, **49A,** 685.
2. B. Guchhait, H. A. R. Gazi, H. K. Kashyap and R. Biswas, *Fluorescence Spectroscopic Studies of (Acetamide + Sodium/ Potassium Thiocyantes) Molten Mixtures: Composition and Temperature Dependence,* Journal of Physical Chemistry B, 2010, **114**, 5066.
3. H. K. Kashyap and R. Biswas, *Separation of Dipole-Dipole and Ion-Dipole Interaction Contributions to Solvation Energy Relaxation in Room Temperature Ionic Liquids*, Journal of Physical Chemistry B, 2010, **114**, 254.
4. T. Pradhan, H. A. R. Gazi and R. Biswas, *Excited State Intramolecular Charge Transfer Reaction in Non-aqueous Electrolyte Solutions: Temperature Dependence,* Journal of Chemical Physics, 2009, **131**, 054507.

SUPERVISION OF STUDENTS

Ph. D. Students: Tuhin Pradhan, Hemant Kumar Kashyap, Harun Al Rasid Gazi, Biswajit Guchhait, Snehasis Daschakrabarty, Tamisra Pal, Sujit Sarkar, Anuradha Das; **Project Students:** Kaustubh Srimali, Bibek Ranjan Samanta, Tushita Mukhopadhyay, Pratyush Raj Singh, Jyoti Ranjan Beuria.

LECTURES DELIVERED

1. *Experimental and Simulation Studies of Non-aqueous Electrolyte Systems* in the symposium entitled, "Chemistry in the 21st Century: Challenges and Opportunities", Kalyani University, May 28, 2010.
2. *Reaction Dynamics in Nano-scopic Solvents: How Different Are They?* in the International Conference on "Emergent Properties and Novel Behavior at the Nanoscale", JNCASR, Bangalore, April 27 - 28, 2010.
3. *Stokes Shift Dynamics in Ionic Liquids: Temperature Dependence* in the "special session on ionic liquids" of the ACS National Meeting, San-Francisco, California, March 21 – 25, 2010.
4. *Dynamic Stokes' Shift in Ionic Liquids: A Theory* in the International Conference on "Of Molecules and Materials", IISER-Kolkata, Mohanpur Campus, Nadia, December 27 - 28, 2009.
5. *Diffusion in Aqueous Mixtures of Tertiary Butanol: A Simulation Study* in the Indo-French meeting on "Diffusion in Nanoporous and Dense Media", IISc, Bangalore, April 02 – 05, 2009.
6. *Electrolyte Solutions to Ionic Liquids: An Integrated Theory* in BOSEFEST, at the S. N. Bose National Centre for Basic Sciences, April 01 – 02, 2009.
7. *Dynamic Stokes' Shift in Mixed Solvent + Electrolyte Systems: Experiment and Theory* in the "Indo-Japan meeting on Frontiers in Molecular Spectroscopy and Theory", Indian Association for Cultivation of Science (IACS), March 07 – 09, 2009.

ACADEMIC VISITS

Pennsylvania State University, USA (Collaborative Research), March 26 - April 01.

COURSES TAUGHT

CB524, Theory and Experiments in Physical Chemistry, Fall semester.

PARTICIPATION IN COMMITTEES

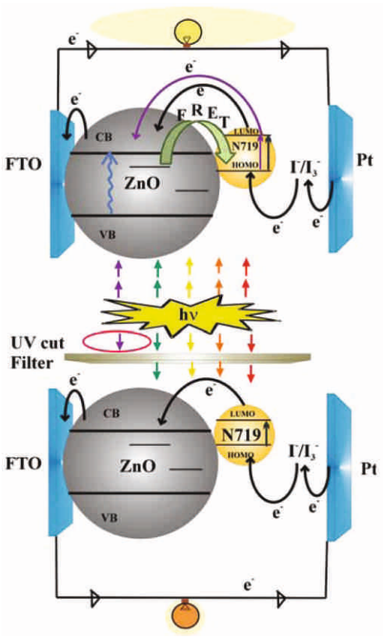
Internal: SCRE Committee.

Samir Kumar Pal

Associate Professor

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

The system consists of a fluorinated tin oxide (FTO) on which semiconductor ZnO nanoparticle (NP) (gray big circle) is febricated. The sensitizer dye N719 (small yellow circle) is bound to ZnO NP by surface adsorption. The entire structure is immersed in a liquid redox electrolyte (I^-/I_3^-). In regular DSSC, light is directly absorbed by the SD, exciting an electron from the HOMO to the LUMO level. In the proposed configuration that contains a semiconductor having an appreciable amount of defect states, an additional "indirect excitation" of N719 is introduced by using the sensitivity of FRET. In the FRET-based cell, the semiconductor NP is found to be excited in the presence of UV light, by which an electron is promoted from the valence band to the conduction band, followed by energy transfer from the excited states of semiconductor to SD N719 via FRET. Thereafter, charge separation occurs exactly as it does in regular DSSC and an electron is injected from the excited state of the dye into the conduction band of the semiconductor electrode and the electron is thus transported to the charge collector. In the presence of a UV cut filter the FRET-based cell performs like a regular DSSC as no energy transfer from ZnO NP to SD takes place due to the absence of UV light.



PUBLICATIONS IN JOURNALS

1. A. Makhal, S. Sarkar, S. Baruah, T. Bora, J. Dutta, A.K. Raychaudhuri and S. K. Pal, *Dynamics of light harvesting in ZnO nanoparticles, Nanotechnology*, 2010, **21**, 265703.
2. P. K. Verma, A. Giri, N. TK, Thanh, L. D. Tung, O. Mondal, M. Pal, S. K. Pal, *Superparamagnetic Fluorescent Nickel-Enzyme Nanobioconjugates: Synthesis and Characterization of a Novel Multifunctional Biological Probe*, J. Material Chemistry, 2010, **20**, 3722.
3. A. Makhal, P. Kumar, P. Lemmens and S. K. Pal, *Manipulation of Spontaneous Emission Dynamics of Organic Dyes in the Porous Silicon Matrix*, J. Fluorescence, 2010, **20,** 283.
4. R. K. Mitra, P. K. Verma, D. Wulferding, D. Menzel, T. Mitra, A. M. Todea, P. Lemmens, A. Müller and S. K. Pal, *A Molecular Magnet Confined in the Nanocage of a Globular Protein*, Chem. Phys. Chem., 2010, **11,** 389 (Cover article).
5. A. Makhal, H. Yan, P. Lemmens and S. K. Pal, *Light Harvesting Semiconductor Core-Shell Nanocrystal: Ultrafast Charge Transport Dynamics of CdSe-ZnS Quantum Dots*, J. Phys. Chem. C, 2010, **114,** 627.
6. D. Banerjee, A. Makhal and S. K. Pal, *Sequence dependent femtosecond-resolved hydration dynamics in the minor groove of DNA and Histone–DNA complexes*, J. Fluorescence, 2009, **19**, 1111.
7. S. Sidharth, B. Radha, P. K. Verma, P. Bhyrappa, G. Kulkarni, S. K. Pal, T. Pradeep, *Functionalized Au22 clusters: Synthesis, characterization and patterning*, ACS Applied Materials & Interfaces, 2009, **1**, 2199.
8. P. K. Verma, R. K. Mitra and S. K. Pal, *A Molecular Picture of Diffusion Controlled Reaction: Role of Microviscosity and Hydration on Hydrolysis of Benzoyl Chloride at a Polymer Hydration Region,* Langmuir, 2009, **25**, 11336.
9. D. Banerjee, P. K. Verma and S. K. Pal, *A Temperature Dependent Femtosecond-Resolved Hydration Dynamics of Water in Aqueous Guanidinium Hydrochloride Solution*, Photochem. Photobiol. Sci., 2009, **8**, 1441.
10. M. A. Habeeb Muhammed, P. K. Verma, S. K. Pal, R. V. Omkumar and T. Pradeep, *Clusters from Clusters: Three Distinct NIR Emitting Gold Clusters from Au25SG18 Precursor,* Chemistry: A European Journal, 2009, **15**, 10110.
11. P. K. Verma, A. Makhal, R. K. Mitra and S. K. Pal, *Role of Solvation Dynamics in the Kinetics of Solvolysis Reactions in Microreactors*, Physical Chemistry Chemical Physics, 2009, **11**, 8467.

OTHER PUBLICATIONS

R. K. Mitra, P. K. Verma, D. Banerjee and S. K. Pal, *Hydrogen Bonding Barrier Crossing Dynamics at Bio-mimicking Surfaces,* in "Excited-State Hydrogen Bonding and Hydrogen Transfer" Edited by Ke-Li Han and Guang-Jiu Zhao, John Wiley 2010, Chapter 11.

SUPERVISION OF STUDENTS

Ph. D. Students: Shankara Narayan, Abhinandan Makhal, Anupam Giri, Soumik Sarkar, Soma Banerjee, Nirmal Goswami, Surajit Rakshit, Tanumoy Mondol, Ranajay Saha, Debapriya Banerjee, Pramod Kumar Verma and Subrata Batabyal.

POST DOCTORAL RESEARCHERS

Dr. Priya Rajdev.

PARTICIPATION IN COMMITTEES

Internal: In charge, Technical Cell; Convener, Technical Committee; Chairman, Pest Control Committee and Security Monitoring Committee

PATENTS AWARDED

1. *A simple biophysical route for quantitative detection of aqueous gold ion (au^{3+}) in sub-ppm level*, Indian Pat. Appl. (2007), IN 2007KO01656.
2. *A method and system for non-invasive quantitative estimation of Billirubin in human body,* Indian Pat. Appl. (2009), 467/KOL/2009 dated 17th March, 2009.
3. A *method and system for non-invasive quantitative estimation of Hemoglobin in human blood,* Indian Pat. Appl. (2009), 466/KOL/2009 dated 17th March, 2009.
4. *A method and system for non-invasive quantitative estimation of Oxygen content in human blood*, Indian Pat. Appl. (2009), 465/KOL/2009 dated 17th March, 2009.
5. *A method and system for non-destructive characterization of Gemstones*, Indian Pat. Appl. (2009), 546/KOL/2009 dated 27th March, 2009.
6. *A method and system for non-destructive characterization of Organic Gems*, Indian Pat. Appl. (2009), 545/KOL/2009 dated 27th March, 2009.

SPONSORED PROJECT

Study of Biomolecular Recognition with Time-resolved Optical Spectroscopy

Sumita Datta
Visiting Faculty Fellow

- Application of Quantum Monte Carlo Techniques to atom, molecules and condensed matter Physics.
- Lowest order relativistic correction for Helium.
- The lowest order Relativistic corrections for the Hydrogen Molecule.
- Σ, Π and Δ wavefunctions for the Hydrogen Molecule.
- The lowest order Relativistic corrections for several Homonuclear Diatomics.
- Quantum simulation of Anderson localization of the cold atoms in 3d.

In a recent paper we used Variational Monte Carlo methods and compact, explicitly correlated trial wavefunctions to compute the lowest order relativistic effects for several states of the helium atom. Here we apply these same techniques to the ground state of the Σ, Π and Δ states of hydrogen molecule. Our values are in excellent agreement with earlier calculations on the X, B states. For the others, this work provides the first evaluation of these properties. We also have computed the ground state energies for the above symmetries for hydrogen molecule using Feynman-Kac path integral method and high quality trial functions. Our results for in this case also show very good agreement with the best nonrelativistic values for these systems.

We study the effect of Anderson localization on a Bose-Einstein Condensate in 3d in a disordered potential(quasi-periodic and speckle) by Feynman-Kac path integral technique. Simulations are performed in continuous space using a canonical ensemble. Owing to the high degree of over most of the system parameters, we also study the interplay of disorder and interaction in the system. We numerically compute the localization length, mobility edge and density of the condensate. We observe that as the interaction strength increases, the wave functions become more and more delocalized (Fig. 1).

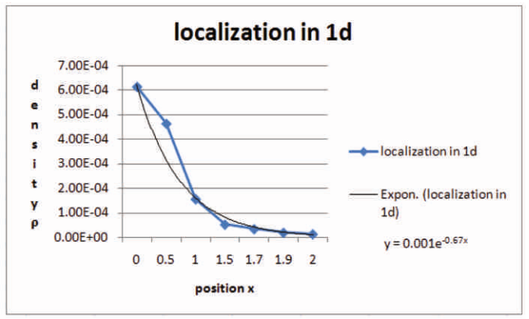


Fig. 1: Anderson Localization in 1-*d*

PUBLICATIONS IN JOURNALS

1. S. Datta, *Feynman Kac path integral approach to the energy spectrum of many boson systems*, Physics Education, 2009, **26**, 103.
2. S. A. Alexander, S. Datta and R. L. Coldwell, *Lowest order Relativistic Corrections of Helium Computed Using Monte Carlo Methods,* Phys. Rev. A, 2010, **81**, 032519.

SPONSORED PROJECTS

1. Energies and relativistic corrections for atoms and molecules by variational Monte Carlo method.
2. Quantum simulation of ultracold gases (Bose, Fermi and dipolar).

Surajit Sengupta
Professor

- Statistical mechanics of materials, Non-equilibrium properties of materials, microstructure selection, arrested state and slow dynamics in materials, equilibrium and non-equilibrium aspects of phase transitions, coarsening and pattern formation, colloids, freezing and melting, confined colloids, dynamical transitions in driven solids.

Early time events during nucleation and micro-structure selection in solids: The detailed dynamics of atoms during initial stages of solid-solid nucleation is largely unknown. Atomic mismatch, always present in such systems, can be accomodated in a variety of ways, e.g. in ferrite, where the atoms move in a disorderly manner, and *twinned martensite*, with atoms moving in a coordinated way. Using a model solid, which exhibits a transition from martensitic and ferritic microstructures, we show that accommodation of interfacial mismatch occurs by the appearance of specific dynamical heterogeneities, defined as a cluster of moving or *active* particles. We describe this sharp transition in terms of a thermodynamics of space-time trajectories of the 'faster'; active particles moving in the potential energy topography set by the 'slower'; inactive particles.

Colloidal self assembly: While large, well-ordered arrays of latex particles find many useful technological applications, the ordering mechanisms are of interest being examples of ordering in systems driven far from equilibrium. A particularly popular preparation strategy for two-dimensional of colloid arrays is the evaporation of a solution containing latex particles on a hydrophilic substrate. Here we show that by careful substrate preparation, one can produce extremely large crystalline arrays of silica particles controlling only the initial solvent density and drying time. We show that the ordering mechanism in this case is essentially a competition between the processes of drying and jamming.

Non-local elasticity and non-affine displacements in elastic solids: In soft matter systems the local displacement field can be accessed directly by video microscopy enabling one to compute local strain fields and hence the elastic moduli use a coarse-graining procedure. We study this process for a simple triangular lattice of particles connected by harmonic springs in two-dimensions. Coarse-graining local strains obtained from particle configurations in a Monte Carlo simulation generates non-trivial, non-local strain correlations (susceptibilities), which may be understood within a generalized, Landau type elastic Hamiltonian containing up to quartic terms in strain gradients.

PUBLICATIONS IN JOURNALS

1. Yu-Hang Chui, Surajit Sengupta, Ian K. Snook, and Kurt Binder, *The observation of formation and annihilation of solitons and standing strain wave superstructures in a two-dimensional colloidal crystal*, J. Chem. Phys. 2010, **132**, 074701.
2. Yu-Hang Chui, Surajit Sengupta, Ian K. Snook, and Kurt Binder, *Effective interactions and melting of a one-dimensional defect lattice within a two-dimensional confined colloidal solid*, Phys. Rev. E 2010, **81**, 020403.

SUPERVISION OF STUDENTS

Ph. D. Students: Jayee Bhattacharya, Tamoghna Das, Arya Paul; **Project Students:** Srimoy Chakraborty, Arup Bhowmick.

LECTURES DELIVERED

Drying Induced Ordering of Colloids, Startup conference for Indo-EU project MONAMI, 22-26 November, MPI-Stuttgart, Germany; *Interaction, Instability, Transport and Kinetics: Glassiness and Jamming* (IITK:Glassiness and Jamming), February 4-8, 2010, IIT-Kanpur.

ACADEMIC VISITS

Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur, Bangalore (August, 2009); Universities of Mainz and Konstanz and the Max Planck Institute, Stuttgart, Germany (November, 2009); Indian Institute of Technology, Kanpur (February, 2010).

COURSES TAUGHT

Finite size scaling, School on "Understanding Molecular Simulations", 17-28 August, JNCASR, Bangalore; CH524 *Physics and Chemistry of Polymers* for Post B. Sc. Chemistry at IACS, Kolkata.

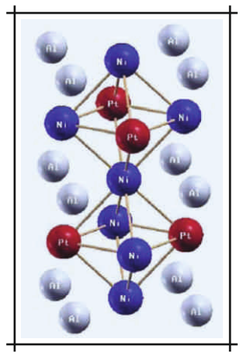
THE ANNUAL IN-HOUSE ACADEMIC MEETING
BOSE FEST - 2010

27 - 28 JANUARY, 2010






DEPARTMENT OF MATERIAL SCIENCES



DMS

DEPARTMENT OF MATERIAL SCIENCES

The Department of Material Sciences has been continuing its research activities in the areas of theoretical, computational and experimental aspects to design and understand materials and their properties. We shall give an overview of the outstanding features.

Experimental contributions came from the groups of A. K. Raychaudhuri, P. K. Mukhopadhyay, K. Mandal, A. Barman and A. K. Majumdar with their students and post-doctoral fellows.

Raychaudhuri has analyzed the electrical resistivity of single crystalline Ni nanowires and showed intrinsic differences in the transport mechanisms in such nanowires. His group has also looked at the heat transport in nanofluids containing nanoparticles of ZnO and observed unusual frequency dependence. They have also observed pressure induced metallization of the ferromagnetic insulating phase of manganites for pressures higher than 6GPa.

Mukhopadhyay and his group have been working on the various aspects of various ferromangnetic Shape Memory Alloys. They are also trying to develop thin films and melt spun ribbons of some of the materials. A magneto-optical Kerr effect setup to study various magnetic interactions in these materials is also coming up.

Mandal and his group have been working on magnetic, magneto-caloric and magneto-transport properties of NiFeGa compounds. They have also studied Co nanowires and Co doped SnO_2 dilute magnetic semi-conductors.

Majumdar and his group have continued their work on bulk and thin films of FeNiMo and FeNiW alloys. They have also been studying GMR in ion-beam sputtered FeCr multi-layers. Barman has successfully developed and tested time resolved MOKE microscope with sub 80-fs and sub-micron temporal and spatial resolutions respectively. His group wishes to study femto and pico second spin dynamics in magnetic thin films, nano-structures and muti-layers.

Theoretical and computational studies have involved R. Chaudhury, P. Mahadevan, T. Saha-Dasgupta, S, Mukherjee and A. Mookerjee and their respective groups.

Chaudhury has been able to unify the many-body based approaches for weakly and strongly correlated systems in order to understand the role of electrons in superconducting pairing. In collaboration with Prof. M. P. Das from Canberra he has been able to gain a deeper understanding of Kohn anomalies in superconductors. Again in collaboration with Dr. S. K. Paul of our Centre he has given a complete field theoretic description of quantum spin models on lattices. He has been able to analyze inelastic neutron scattering data on layered magnets which exhibit features like the Kosterlitz-Thouless transition.

Mahadevan has studied insulating ferromagnets like $K_2Cr_8O_{16}$. Her group have been looking at unconventional magnetism in oxides without any magnetic element. They have suggested p-shell magnetism in such materials.

Saha-Dasgupta and her group have studied $FeCr_2S_4$ to understand the origin of its insulating behaviour.They suggested enhanced spin-orbit coupling operative within the Fe-d manifold. They have also investigated the possible role of structural distortions and their effect on the optical properties of these compounds.

Mukherjee is currently working on electronic properties of Carbon and Boron Nitride based materials with plane wave pseudo-potential method. He has worked on electronic structure and stability of transition metal and noble metal nanoparticles.

Mookerjee and his group have been studying magnetism in binary and ternary alloys using their ASR technique. They have been looking at manipulation of magnetism in clusters doped with a magnetic element by co-doping with n- and p-type co-dopants. In collaboration with I. Dasgupta (IACS) his group has been studying the effect of disorder on superconductivity.

The Departmental members were involved in two major institutional projects: the Unit for Nano-science and technology (UNANST) and Advanced Materials Research Unit (AMRU).

The Department has 10 Faculty including an Emeritus Scientist. There were 53 publications in refereed journals from our department, which gives a healthy picture of our research activities. Our faculty guided 41 research students for their Ph. D. 15 project students also carried out their research under their guidance. The Department hosted 9 Post-doctoral Fellows and 3 Visiting Faculty. Apart from the Institutional projects (UNANST and AMRU) our faculty worked on 30 odd individual projects. International collaboration was strong with Institutions and individuals in Japan, Brazil, Germany, Austria, USA, Sweden, Nepal, Bangladesh, UK, Italy, Poland, France and Australia.

Abhijit Mookerjee
Head, Department of Material Sciences

Abhijit Mookerjee
Distinguished Professor

- The electronic and magnetic properties of and phase stability and phase transformations in disordered binary and ternary alloys.
- Magnetic and catalytic properties of metallic and multicomponent clusters.
- Effect of disorder on superconductivity in the multi-band attractive Hubbard model.

The tight-binding linear muffin-tin orbitals based augmented space recursion (TB-LMTO-ASR) package has been developed by us for the study of disordered alloys. The technique can take us beyond the single-site mean-field approximations and take into account effects of clustering, short-ranged ordering and local lattice distortions due to size effects of components. The recursion part can handle non-collinear magnetism and spin-orbit coupling. The approach is fully self-consistent within a Density Functional approach. We have used the TB-LMTO-ASR to study complex pseudo-binary and ternary alloys with many-atoms per unit cell (Fig. 1). The technique has been extended to the study of response functions in disordered alloys. Optical response of a class of alloys has been successfully studied. We have been studying the effect of doping and co-doping of clusters to tune in desired properties. We have successfully studied the effect of doping II-VI clusters with transition metal atoms and then stabilizing ferromagnetism by co-doping with C and N. It was shown how we can tune magnetism in MnO clusters by doping with 2p elements.

We had earlier studied the effect of disorder on superconductivity in binary systems. The augmented space vector recursion developed by us allows us to study the effect of off-diagonal disorder on superconductivity. We have successfully generalized the technique to enable us to study multi-band attractive Hubbard models. We are in a position to quantitatively study realistic systems.

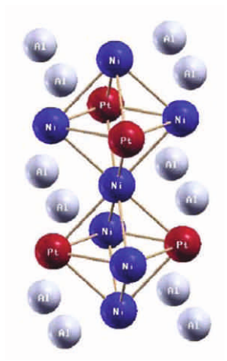


Fig.1: Superstructure in NiPtAl Alloys.

PUBLICATIONS IN JOURNALS

1. S. Datta, M. Kabir, T. Saha-Dasgupta, A. Mookerjee, *Structure, reactivity and electronic properties of V-doped Co clusters*, Phys. Rev. B, 2009, **80**, 085418.
2. M. K. Yadav, B. Sanyal and A. Mookerjee, *Tuning magnetism of MnO by doping with 2p elements*, J. Magn. Magn. Mater., 2010, **322**, 253.
3. A. Alam, T. Saha-Dasgupta, A. Mookerjee, *Ab-initio augmented space recusrion to study complex multicomponent materials: applications to the pseudobinary alloy* $Ni_{1-x}Pt_xAl$, Phys. Rev. B, 2010, **81**, 054201.
4. R. Banerjee and A. Mookerjee, *Augmented space recursion code and application in simple binary metallic alloys*, Int J. Mod. Phys. C, 2010, **21**, 205.

OTHER PUBLICATIONS

A. Mookerjee, T. Saha-Dasgupta, I. Dasgupta, *Quantum transmission through random media,* Lecture Notes in Physics (Springer-Verlag), 2009, **762**, 83.

SUPERVISION OF STUDENTS

Ph. D. Students: Manoj K. Yadav, Moshiour Rahaman, Santosh Roy (joint: S. Chatterjee SINP), Shreemoyee Ganguly, Rudra Banerjee, Prashant Singh, Ambika P. Jena, Rajiv K. Chouhan, Prajna Mukherjee (joint: T. Saha-Dasgupta), Mitali Banerjee (joint: A. K. Majumdar).

LECTURES DELIVERED

1. *Green Functions: Applications*, ISNA, Kolkata, October, 2009.
2. *Non-Collinear Magnetism in bulk disordered alloys and rough surfaces*, MSM-09, Kolkata, November, 2009.
3. *Green's functions in Solid State Theory,* One day workshop organized by ISNA, 27 March, 2010.

ACADEMIC VISITS

University of Hyderabad, February, 2010.

COURSES TAUGHT

PHY402, Advanced Statistical Mechanics (WBSU Barasat), Winter semester.

PARTICIPATION IN COMMITTEES

a. **External:** Examination/moderation Committee, Lady Brabourne College; Executive Committee of Science Museum/Training Centre; Governing Body Member, JBNSTS; Chairman, Executive Committee, Kendriya Vidyalaya III Salt Lake; President, Indian Physical Society; President, Indian Society of Non-linear Analysts.

b. **Internal:** Member Consultative Advisory Committee (CAC).

SPONSORED PROJECTS

NET-56 Network Project of ICTP with S. Shenoy (UHYD), N. Adhikari (TU, Kathmandu), K. Hassan (Dhaka University); DST Project on Random alloys with Subhradip Ghosh (PI) (IITG).

Alak Kumar Majumdar

Emeritus Scientist

- Structural and magnetic characterization of nanometer size NiFeMo alloy films.
- Magnetic order in nickel rich Ni-Mn alloys near the multicritical point.
- Temperature dependence of the giant magneto- resistance in Fe-Cr multilayers.

PLD grown thin films of soft ferromagnetic $Ni_{83.2}Fe_{3.3}Mo_{13.5}$ and $Ni_{83.1}Fe_{6.0}Mo_{10.9}$ alloys were studied for finding the size dependence of structural and magnetic properties. The highly textured films show grain size increasing with thickness. The composition in the films is very close to that of the bulk target. XRR data indicate that instead of a uniform density there are effectively three layers with density gradient across the thickness. Magnetization data show spin-glass-like features coming from both compositional and structural disorder. The Curie temperature T_C, spin wave stiffness constant, coercive field, and saturation magnetization are higher than their bulk counterparts.

$Ni_{100-x}Mn_x$ ($15 \leqslant x \leqslant 37$) phase diagram was obtained near the multi-critical point (MCP, $x = 25, T = 100$ K) as well as far away from it. From M (T, H) and ac susceptibility $\chi(\omega, T)$ data we find a double transition, one from a paramagnetic to a ferromagnetic long range order (LRO) at T_c and then another to a ferro-spin-glass mixed phase at T_{SG} for $x \leqslant 25$. T_c decreases with increasing x and meets the ascending line of T_{SG} at the MCP. Then a spin-glass state appears which gradually evolves to an anti-ferromagnetic (AF) state in the intermediate composition, and then an AFLRO around 37 at.% Mn.

The field and temperature dependence of giant magneto resistive (GMR) ion-beam sputtered Fe-Cr multi layers of varying Cr thickness show that the decrease in GMR with temperature is related to the decrease in sub-lattice magnetization due to thermal excitation of magnons in the anti ferromagnetic (AF) configuration. The intralayer and interlayer exchange energies, J_p and J_z, thus obtained vary systematically as Cr thickness increases. The corresponding decrease in the measured H_{sat}, the saturation field, further supports our interpretation leading to a better understanding of the physics of GMR.

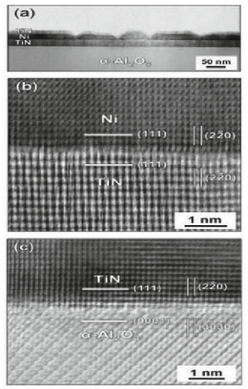


Fig. 1: STEM-Z image of epitaxial Ni/TiN film.

OTHER PUBLICATIONS

Mitali Banerjee, A. K. Majumdar, R. J. Choudhary, D. M. Phase, S. Rai, Pragya Tiwari, and G. S. Lodha, *Structural Characterization of PLD-grown Nanometer Size Ferromagnetic NiFeMo films*, Fall Meeting of the Materials Research Society, Boston, Mass. USA, Nov 30 - Dec 4, 2009; Mater. Res. Symp. Proc., 2010, 1200, G-09-05.

SUPERVISION OF STUDENTS

Ph. D. Students: Mitali Banerjee (joint: A. Mookerjee), Pampa Pal; **Project Students:** Sukla Pal (2 projects), Atanu Nath.

LECTURES DELIVERED

1. *Structural characterization of PLD-grown nanometer size ferromagnetic NiFeMo films*, 2009 Fall Meeting of the Materials Research Society, Boston, Mass, USA, November 30 - December 4, 2009.
2. *Low temperature physics and cryogenics, Annual Day Celebration*, CSR, Indore, December 23, 2009.
3. *Structural and magnetic characterization of nanometer size NiFeMo* ,11th Joint MMM-Intermag Conference, Washington DC, USA, January 18-22, 2010.
4. *Magnetic order in nickel rich Ni-Mn alloys*, 4th Seeheim Conference on Magnetism, Frankfurt, Germany, 28 March–1 April, 2010.
5. *Temperature dependence of giant magnetoresistance in Fe-Cr multilayers – intralayer and interlayer exchange energies*, 4th Seeheim Conference on Magnetism, Frankfurt, Germany, 28 March–1 April, 2010.

COURSES TAUGHT

PHY302, Condensed Matter Physics, Fall semester.

PARTICIPATION IN COMMITTEES

a. **External:** Member, Board of Editors, Indian Journal of Physics (IACS & Springer); Chairman, Expert Committee on "Magnetoencephalogram project at IGCAR, Kalpakkam" of the Dept. of Science & Technology, Govt. of India (DST), 2007-2010

b. **Internal:** Member of Technical Cell

Anjan Barman
Associate Professor

- Ultrafast magnetization and spin dynamics by time-resolved magneto-optical Kerr effect.
- Investigation of quasistatic magnetization reversal behaviours in single nanomagnets and arrays.
- Patterned magnetic dot and anti-dot arrays.
- Single and multicomponent magnetic nanowires with large aspect ratio and multilayered nanowires.
- Magnetic nanoparticles: growth, morphology, self assembly and dynamics.
- Magnonic Crystals: investigation and control of magnonic band structures in spatially modulated magnetic structures.
- 3-D time-dependent micro-magnetic simulations using finite difference and finite element methods.
- Monte Carlo simulations of Ising and Heisenberg spin systems.

We have successfully developed and tested a time-resolved MOKE microscope with sub-80 fs temporal and sub-micron spatial resolutions to study the femto- and pico-second spin dynamics in magnetic thin films, micro- and nano-structures and multilayers.

We have experimentally observed morphology dependent magnetization reversals in chains and clusters of exchange coupled magnetic nanoparticles. Micromagnetic simulations showed that the magnetization reversals in these samples occur through the formation of different local domain states including vortices, fanning- and curling-like modes, depending upon the cluster geometry. The constituent nanoparticles reverse by the quasi-coherent rotation of magnetization but the incoherence between the nanoparticles in the cluster causes the observed domain structures.

We have experimentally demonstrated the coherent suppression of picosecond magnetization precession in $Ni_{81}Fe_{19}$ (permalloy) micro stripes in presence of a number of spin wave modes by magnetic field pulse shaping. Pulses of little under or overwidth cause the precession to continue at a slightly different frequency suggesting that the spin wave modes are not truly localized but have overlapping regions.

We have performed a systematic micromagnetic simulation study of magnonic modes in cobalt nanohole arrays. In particular, we investigate the effects of the areal density and symmetry of the array and defects introduced in the array. The magnonic modes are strongly dependent on the density and the symmetry of the array but are weakly dependent on the defects. We also proposed a tailored array to tune the magnonic band structures in future magnonic crystals.

PUBLICATIONS IN JOURNALS

1. M. Agrawal, B. Rana and A. Barman, *Magnetization reversal in chains and clusters of exchange coupled Ni nanoparticles,* J. Phys. Chem. C, 2010, **114**, 11115.
2. B. Rana, M. Agrawal, S. Pal and A. Barman, *Magnetization reversal dynamics in clusters of Ni nanoparticles*, J. Appl. Phys., 2010, **107**, 09B513.
3. A. Barman, *Controlled magnonic spectra in Co nanohole arrays: effects of density, symmetry and defects*, J. Phys. D: Appl. Phys., 2010, **43**, 195002.
4. S. Barman, A. Barman and Y. Otani , *Dynamics of one-dimensional chains of magnetic vortices in response to local and global excitations,* IEEE Trans. Magn., 2010, **46**, 1342.
5. A. Barman and S. Barman, *Dynamic dephasing of magnetization precession in arrays of thin magnetic nanoelements*, Phys. Rev. B, 2009, **79**, 144415.
6. A. Barman, T. Kimura, Y. Fukuma, and Y. Otani, *Coherent suppression of magnetization precession in presence of spin waves in a $Ni_{81}Fe_{19}$ microwire*, IEEE Trans. Magn. , 2009, **45**, 4104.
7. S. Sharma, A. Barman, M. Sharma, L. R. Shelford, V. V. Kruglyak and R. J. Hicken, *Structural and magnetic properties of electrodeposited Co nanowire arrays*, Solid State Commun., 2009, **149**, 1650.
8. A. Barman, H. Sakata, T. Kimura, Y. Fukuma, and Y. Otani, *Coherent suppression of picosecond magnetization precession in presence of spin waves in a $Ni_{81}Fe_{19}$ microstripe*, J. Appl. Phys., 2009, **106**, 043906.

SUPERVISION OF STUDENTS

Ph. D. Students: Bivas Rana, Semanti Pal, Milan Agrawal, Dheeraj Kumar, Bipul Kumar Mahato; **Project Students:** Tanmoy Goswami, Arnab Ganguly

POST DOCTORAL RESEARCHERS

Dr. Anupam Mukherjee

LECTURES DELIVERED

1. *Nanoscale Magnonics,Nanomagnetism Workshop*, LNMIIT, Jaipur, February, 2010.
2. *Spin Dynamics at the nanoscale: excitation, detection and control*, JNC Research Conference, January, 2010.
3. *Investigation of nanomagnet dynamics by time-resolved Kerr microscopy*, JST-DFG workshop, RIKEN, Saitama, Japan, October, 2009.
4. *Ultrafast excitation, detection and control of magnetization dynamics in single and arrays of nanomagnets, Magnonics: from fundamentals to applications*, MPIPKS, Dresden, Germany, August, 2009.
5. *Dynamics of one dimensional chains of magnetic vortices in response to local and global excitations*,11th Joint MMM-Intermag Conference, Washington, D.C., USA, January, 2010.
6. *Magnetization reversal dynamics in clusters of Ni nanoparticles*, 11th Joint MMM-Intermag Conference, Washington, D.C., USA, January, 2010.
7. *Coherent suppression of magnetization precession in presence of spin waves in a $Ni_{81}Fe_{19}$ microwire*, IEEE International Magnetics Conference (INTERMAG2009), Sacramento, USA, May, 2009.
8. *Bench-top time-resolved magneto-optical Kerr magnetometer*, IEEE International Magnetics Conference (INTERMAG2009), Sacramento, USA, May, 2009.
9. *Structural and magnetic properties of electrodeposited Co nanowire arrays*, IEEE International Magnetics Conference(INTERMAG2009), Sacramento, USA, May, 2009.
10. *Picosecond Dynamics of Individual Cylindrical Nanomagnets with Varying Aspect Ratio: Simulation Study*, JNC Research Conference, January, 2010.

ACADEMIC VISITS

Quantum Nanoscale Magnetic Laboratory, RIKEN-ASI, Wako-shi, Saitama, Japan, October, 2009.

Max-Planck Institute for Physics of Complex Systems, Dresden, Germany, August, 2009.

PARTICIPATION IN COMMITTEES

a. **External:** Coordinator of India EU collaborative project "DYNAMAG".

b. **Internal:** Member of Technical Cell. Member of Road Map Committee.

SPONSORED PROJECTS

1. Quasistatic and Ultrafast Magnetization Dynamics in Nanomagnet Arrays, Nano-Mission, DST.
2. Spin-wave and domain wall dynamics in vertical magnetic nanowires, UKIERI-DST.
3. Advanced computational studies of dynamic phenomena in magnetic nano-materials, India-EU.
4. Magnonic Crystals: New paradigm towards microwave communications, JST-DST.

MEETINGS ORGANIZED

Jointly organized JNC Research Conference "Physics of New Materials", Kolkata in January, 2010;

Convener of "DYNAMAG Internal Meeting" in September, 2009.

Arup Kumar Raychaudhuri
Director

- Science of Nanomaterials including nanofabrication and nanolithography.
- Physics of electronic transport and magnetism in correlated oxides.
- Some of the specific problems investigated include: Transport and noise in Ni nanowires, Heat transport in Nanofluids, CDW transition in nanowires.
- Pressure induced metallization of ferromagnetic insulators.
- Dynamics of microcantilevers, Langmuir-Blodget Films.

Electrical resistivities of ferromagnetic single crystalline Ni nanowires (single wires and array) with diameter down to 13 nm, were measured in the temperature range of 3K–300 K (Fig. 1). The data analyzed quantitatively showed intrinsic differences in the transport mechanisms in such nanowires. The resistance fluctuations arising from the spin fluctuations in such wires increases by an order of magnitude when the diameter of the wires is reduced below the domain wall width of nickel It occurs due to thermally activated magnetization reversal and the associated domain wall motion.

We observed an unusual frequency dependent enhancement of the heat transport parameter of a nanofluid containing ZnO nanoparticles of an average size of 10 nm in ethanol. The enhancement at low frequency is substantial. and decreases as the frequency is increased. The effect cannot be explained by the classical effective medium theory. We have suggested local aggregation as the likely cause.

We observed static pressure induced metallization of the ferromagnetic insulating phase of manganites at a pressure of 1 GPa. For pressure more than 6GPa, the high temperature polaronic state also crosses over to a metallic behavior. The material shows a coherence temperature where a highly resistive incoherent metal crosses over to a less resistive band type metal.

We observed that the force spectroscopy curve taken in an atomic force microscope is significantly modified due to intrinsic cantilever instability which occurs as a result of its movement in a nonlinear force field collection. A proposed model explained the data quantitatively.

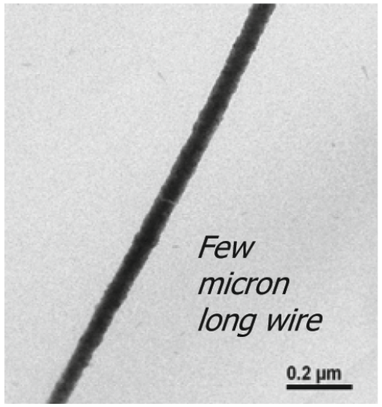


Fig.1: A 35nm Single Crystalline Ni Nanowire grown by electro deposition.

PUBLICATIONS IN JOURNALS

1. Sunandan Baruah, Sudarson Sekhar Sinha, Barnali Ghosh, Samir Kumar Pal, A. K. Raychaudhuri, and J. Dutta, *Photoreactivity of ZnO nanoparticles in visible light: Effect of surface states on electron transfer*, Journal of Applied Physics, 2009, **105**, 074308.
2. M. Venkata Kamalakar and A.K.Raychaudhuri, *Low temperature electrical Transport in ferromagnetic Ni Nanowires,* Physical Review B, 2009, **79**, 205417.
3. Barnali Ghosh, Dipten Bhattacharya, A. K. Raychaudhuri and S. Arumugam, *Large magnetocapacitance effect in single crystal bilayer manganite $Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$ near the Neel temperature*, Journal of Applied Physics, 2009, **105**, 123914.
4. S. Arumugam, Barnali Ghosh, A. K. Raychaudhuri, N. R. Tamil Selvan, T. Nakanishi, H. Yoshino, K. Murata and Ya. M. Mukovskii, *Hydrostatic Pressure ($P \leqslant 8GPa$) induced metallization of ferromagnetic insulating $La_{0.79}Ca_{0.21}MnO_3$*, J. Appl. Phys., 2009, **106**, 023905.
5. Rajesh Kumar Neogy and A. K. Raychaudhuri, *Frequency dependent enhancement of heat transport in nanofluid with ZnO nanoparticles*, Nanotechnology, 2009, **20**, 305706.
6. M. Venkata Kamalakar, A. K. Raychaudhuri, Xueyong Wei, Jason Teng and P. D Prewett, *Temperature dependent electrical resistivity of a single crystalline ferromagnetic nanowire*, Applied Physics. Letts., 2009, **95**, 013112.
7. Manoranjan Ghosh, Nita Dilawar, A. K. Bandyopadhyay, and A. K. Raychaudhuri, *Phonon dynamics of $Zn_{1-x-y}Mg_xCd_yO$ alloy nanostructures and their phase segregation*, Journal of Applied Physics, 2009, **106**, 084306.
8. T Phanindra Sai and A K Raychaudhuri, *Observation of Peierls transition in nanowires (diameter ~130nm) of charge transfer molecule TTF:TCN*, Nanotechnology, 2010, **21**, 045703.
9. Soma Das, A. K. Raychaudhuri, P. A. Sreeram, Dirk Dietzl, *The effect of intrinsic instability of cantilever on static mode atomic force spectroscopy*, Nanotechnology, 2010, **21**, 045706.
10. Tapati Sarkar, M. Venkata Kamalakar, and A. K. Raychaudhuri, *Transport Properties of Nanoparticles of Complex Oxides: Likely Presence of Coulomb Blockade at Low Temperature*, Journal of Nanoscience and Nanotechnology, 2009, **9**, 5315.
11. Sudeshna Samanta, M. Venkata Kamalakar, and A. K. Raychaudhuri, *Investigation of Very Low-Frequency Noise in Ferromagnetic Nickel Nano wires*, Journal of Nanoscience and Nanotechnology, 2009, **9**, 5243.
12. M. Venkata Kamalakar and A. K. Raychaudhuri, *Critical Phenomena in Magnetic Nanowires*, Journal of Nanoscience and Nanotechnology, 2009, **9**, 5248.
13. Barnali Ghosh and A. K. Raychaudhuri, *Synthesis and Physical Properties of Ordered Arrays of Nanowires of Complex Functional Oxides*, Journal of Nanoscience and Nanotechnology, 2009, **9**, 5533.
14. Soma Das and A. K. Raychaudhuri, *Growth of Atomically Smooth Films of Metal-Arachidates by Langmuir-Blodgett Technique*, Journal of Nanoscience and Nanotechnology, 2009, **9**, 5362.
15. D. Mohanta, S. S. Narayanan, S. K. Pal and A. K. Raychaudhuri, *Time-resolved photoluminescence decay characteristics of bovine serum albumin-conjugated semiconduct*, Journal of Experimental Nanoscience, 2009,**4**,177.

SUPERVISION OF STUDENTS

Ph. D. Students: Tapati Sarkar, Sudeshna Samanta, Rajesh Neogy, M. Venkata Kamalakar, Shanewz Mandal, Manotosh Chakravorty, Rajib Nath, Rabeya Basori, Putul Malla Chowdhury.

POST DOCTORAL RESEARCHERS

Dr. Kaustuv Das, Dr. Anindya Das.

LECTURES DELIVERED

1. *Joy of Small things*, NISER, Bhubaneswar, April, 2009.
2. *Pressure induced metallization in low hole doped manganites: Centenary Symposium*, IISC, Bangalore, May, 2009.
3. *Template based synthesis of nanowires and nanotubes of metal, oxide and molecular materials and experiments on singlenanowires*, Strasbourg, France, September, 2009.
4. *Nanowires and nanotubes of metal and molecular materials at low temperatures*, IIT, Kanpur, September, 2009.
5. *Synthesis, structure and properties of nanostructured manganites*, JNC Research Coneference, Munnar, October, 2009.
6. *Exploring Nanomaterials at low temperatures and high magneticfield*, Jadavpur University, November, 2009.
7. *Synthesis of nanowires and nanotubes of different materials and experiments on single nanowires*, ICAN 2009, IIT, Guwahati, December, 2009.
8. *Resistive switching in nanoscale*, DAE, SSP Symposium, Baroda, December, 2009.
9. *Does precision physical measurements carry any value?*, Golden Jubilee, IIT Kanpur, February, 2010.
10. *Growth and Physical measurements on multifunctional nanowires*, ICONSAT-2010 Satellite, TIFR, Mumbai, February, 2010.

ACADEMIC VISITS

1. University of Birmingham, Birmingham, August, 2009.
2. Institute of Laue Langevin , Grenoble, September, 2009.
3. University of Birmingham, Birmingham, February, 2009.

COURSES TAUGHT

PHY104, Electromagnetic Theory-1, Fall semester; PHY391, Experimental Physics Project, Fall semester; MS691, Research Methodology, Winter semester.

PARTICIPATION IN COMMITTEES

a. **External:** Member, Science and Engineering Research Council, Department of Science and Technology Member, Nanosciennce Advisory Group of Nanomission, Visitors nominee in Selection Committee for Faculty at IIT/ Guwahati, IIT/Kharagpur, Chairman, Project Advisory Group of two projects in Department of InformationTechnology.

b. **Internal:** Member, Governing Body, Chairman-Finance Committee, Building Committee, Medical Committee, Selections and Assessment committees for Faculties.

SPONSORED PROJECTS

1. Unit for Nano Science & Technology.
2. Centre for Nano Technology.
3. Development of cryostats and electronic measurement units for physical properties measurements.
4. Design and Fabrication of Nanomachined Thermal Sensorsusing FIB.
5. Synthesis of nanostructures by asymmetric self organization of nano-particles and its applications.

Barnali Ghosh (Saha)
Visiting Faculty Fellow

- Growth, characterization and study of resistive switching in multi-functional perovskite oxide systems. (work under external project, DST sponsored).
- Neutron diffraction investigation of magneto-elastic effect in nanostructured (30-100nm) $LaMnO_3$ (Neutron beam time allocated at ILL, Grenoble, France).
- Frequency dependent dielectric measurement in bilayer manganite $Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$.

We have observed pressure induced metallization of ferromagnetic insulating magnanite: Application of hydrostatic pressure makes the ferromagnetic insulating phase of $La_{0.79}Ca_{0.21}MnO_3$ metallic at a pressure of ~1 GPa. On further increase in pressure ~6GPa, the high temperature polaronic state also crosses over to a metallic behavior. The application of the pressure also shifts the ferromagnetic T_C of the material to higher temperature.

We report observation of a genuinely "frequency-dependent multiferroicity"––shift in the anomaly in intrinsic dielectric constant over a temperature window of T_f ~40 K around T_N ~150 K in a single crystal of bilayer manganite $Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$ compound, where ferroelectricity originates from rotation of charge/ orbital stripes (an electronic phase) with respect to the crystallographic structure. The anomaly originates primarily from the capacitive component of the overall dielectric response ruling out the dominance of the resistive effect.

We have synthesized ordered arrays of nanowires of complex oxides (size~50nm) using template based chemical solution deposition technique. The wires thus prepared are single crystalline in nature and show good structural properties. They are expected to retain their functionality as nanowires and thus can be used for a number of applications in nanoelectronic devices.

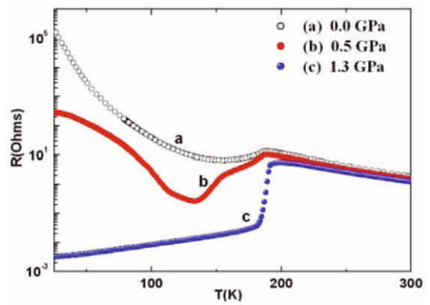


Fig. 1(a): Resistance of single crystal LCMO (x=0.21) as function of temperature taken at different pressures in the piston-cylinder type cell (can go up to 3GPa).

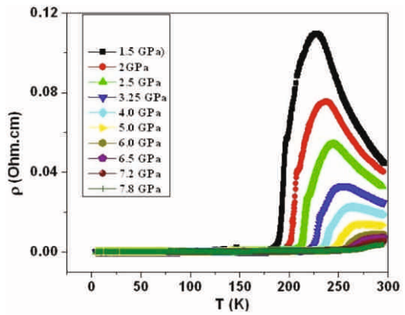


Fig. 1(b): Resistivities of single crystal LCMO (*x*=0.21) as function of temperature taken at different pressures in the cubic anvil cell (can go up to 10GPa). The resistivity is plotted in linear scale taken to 2.5K to establish that no turn over to insulating state occurs at low temperature. Below 175K all the curves more or less merge.

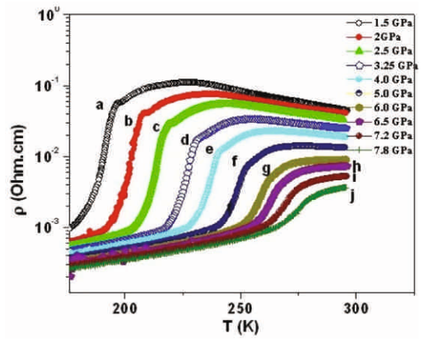


Fig. 1(c): Same resistivity (r) data as a function of temperature at different pressures up to 7.8GPa as shown in Fig. 1(b). The data down to 175K are shown in log scale for ρ. Curves: a=1.5GPa, b=2.0GPa, c= 2.5GPa, d= 3.3GPa, e=4.0GPa, f=5.0 GPa, g= 6.0GPa, h= 6.5GPa, i= 7.2GPa, j=7.8GPa.

PUBLICATIONS IN JOURNALS

1. Sunandan Baruah, Sudarson Sekhar Sinha, Barnali Ghosh, Samir Kumar Pal, A. K. Raychaudhuri, and Joydeep Dutta, *Photoreactivity of ZnO nanoparticles in visible light: Effect of surface states on electron transfer*, J. Appl. Phys., 2009, **105**, 074308.
2. Barnali Ghosh, Dipten Bhattacharya, A. K. Raychaudhuri, and S. Arumugam, *Frequency dependence of dielectric anomaly around Neel temperature in bilayer manganite* $Pr(Sr_{0.1}Ca_{0.9})_2Mn_2O_7$, J. Appl. Phys., 2009, **105**, 123914.
3. S. Arumugam, Barnali Ghosh, A. K. Raychaudhuri, N. R. Tamil Selvan, T. Nakanishi, H. Yoshino, K. Murata and Ya. M. Mukovskii, *Hydrostatic Pressure ($P \leqslant 8GPa$) induced metallization of ferromagnetic insulating* $La_{0.79}Ca_{0.21}MnO_3$, J. Appl. Phys., 2009, **106**, 023905.
4. Barnali Ghosh and A. K. Raychaudhuri, *Synthesis and Physical Properties of Ordered Arrays of Nanowires of Complex Functional Oxides*, J. NanoScience and Nanotechnology, 2009, **9**, 5533.

LECTURES DELIVERED

Pressure induced metallization of ferromagnetic insulating Manganite, APS March meeting, Oregon Convention Centre, Portland, Oregon, USA, March 15-19, 2010.

ACADEMIC VISITS

1. Institut Laue-Langevin, Grenoble, France, September, 2009.
2. Asian Institute of Technology, Thailand, November, 2009.

PARTICIPATION IN COMMITTEES

a. **External:** Referee of Journal of Material Science and Engineering B and Journal of Applied Physics.

b. **Internal:** Technical cell; Various purchase committees; Clean room committee.

SPONSORED PROJECTS

Project under Women Scientist Scheme (DST).

MEETING ORGANIZED

Workshop on Application of Dual Beam Scanning Electron Microscope and Environmental Scanning Electron Microscope, 8-9 October, 2009, Satyendra Nath Bose National Centre for Basic Sciences, Kolkata, India.

Chhayabrita Biswas
Bose Fellow

- Experimental electronic structure investigation of thin films of Al grown on W(110), Co nanodots on vicinal Au(887) surface and Ni based Heusler alloys exhibiting martensitic transformation.
- The study of structural, transport and magnetic properties of Ni based Heusler alloys with martensitic transitions.

Light quantum films of Al on W(110): The long-standing question whether a large spin-orbit splitting can be induced in a light quantum film by a substrate effect has been investigated. It is shown that quantum-well states in Al films on W(110) display large spin-orbit splittings up to at least 10 monoatomic layers (ML) in angle-resolved photoemission measurements with and without spin resolution.

Co nanodots on Au(887): Uniform Co islands have been grown on stepped Au(887) at 300 K and 140 K growth temperature. The development of the sp-derived L-gap surface state of Au is studied as a function of Co coverage by angle-resolved photoemission for samples characterized with scanning tunneling microscopy. At 0.4 ML Co coverage the superperiodic potential of Au(887) along the steps is modified and is realized as changes in the free-electron-like dispersion, band minimum and effective mass. Taking advantage of the Au 5d Cooper minimum, it is observed that the exchange split states of Co 3d indicates a bulk like local magnetic moment at all Co coverages.

$Ni_{50}Mn_{35}Sn_{15}$ Heusler Alloy: The changes in the valance band and core-levels as a function of temperature in austenitic and martensitic phase have been probed by photoelectron spectroscopy. The band width, band filling of the valance band and 3d-core hole coulomb interaction explains the changes between the two phases. The change in valance band at 9K can have a magnetic origin implying increase in ferromagnetic phase with the decrease in temperature within martensitic phase.

SUPERVISION OF STUDENTS

Ph. D. Student: Sandeep Singh;
Project Student: Soumyadipta Pal (2 projects).

LECTURES DELIVERED

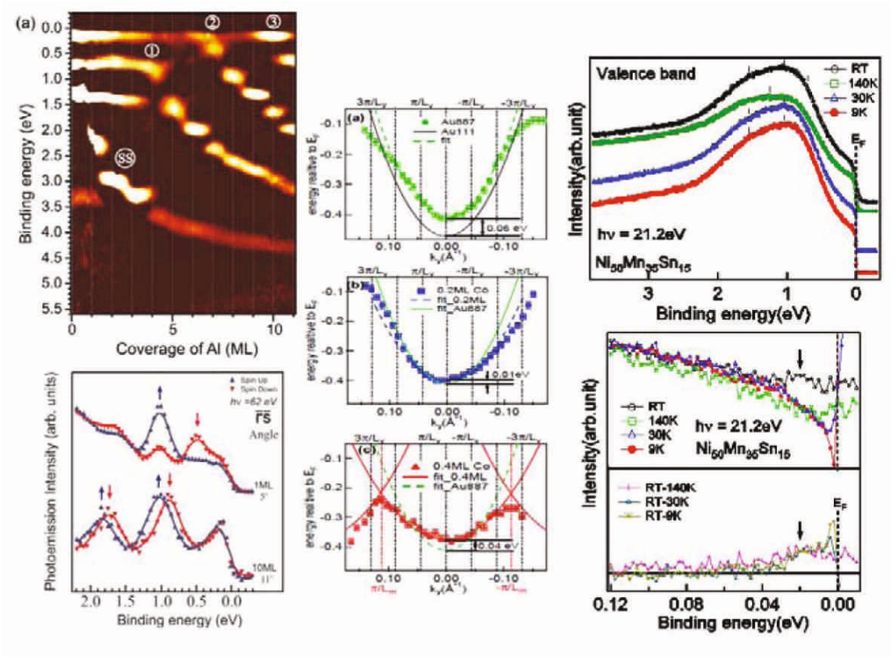
Dirac cone and Rashba splitting in Au-intercalated graphene on Ni, Kolkata, November 2009.

ACADEMIC VISITS

1. UGC-DAE Consortium for Scientific Research, Indore, October 2009.
2. Tata Institute of Fundamental Research, Mumbai, December 2009.

PARTICIPATION IN COMMITTEES

Internal: Technical Cell, Newsletter, Various interview and thesis committees.



Panel 1: Angle-resolved photoelectron spectra at photon energy 62 eV taken in normal-emission geometry from Al/W(110) at various coverages. Spin- and angle-resolved photoemission spectra for off-normal angles for different Al coverages on W(110).

Panel 2: Au surface state dispersion for (a) Au(887) (b) 0.2 ML Co coverage and (c) 0.4 ML Co coverage. The surface state dispersion is fitted with free-electron-like parabola. The black dotted lines show the Au surface induced reconstruction periodicity. The red dotted line in (c) shows the modified superperiodicity due to the Co nanodots.

Panel 3: Valance band of $Ni_{50}Mn_{35}Sn_{15}$ at 21.2.eV photon energy as a function of temperature. Difference spectra between RT and low temperatures near Fermi edge.

Kalyan Mandal
Associate Professor

Magnetism and Magnetic Materials including:

- Magnetic, magnetocaloric and magnetotransport properties of Heusler alloys.
- Preparation and study of magnetic nanowires.
- Magnetic semiconductors.

Magnetic, magnetocaloric and magnetotransport properties of $Ni_{73-x}Fe_xGa$= (x=17, 18, 19, 20, 21, 22) have been investigated up to a magnetic field of 8T and within a temperature range of 4.2 - 325K. It has been observed that the MR in austenite state is higher than that of martensite state irrespective of the composition of the sample. A large negative MR (~9% at 8T) was obtained for the sample $Ni_{54}Fe_{19}Ga_{27}$ at 300K which is very close to the martensitic transition temperature as well as the Curie temperature. The maximum entropy change was observed in the alloy (x=19) where martensite-austenite structural and ferro-para magnetic transitions are very close to each other.

Room temperature magnetic behavior of two dimensional arrays of cobalt nanowires with diameter 50, 150 and 275 nm were studied in details. The arrays of nanowires were prepared by dc electrodeposition technique. The anisotropy field of the nanowires was estimated using ferromagnetic resonance measurements.

Transition metal (TM) Co doped SnO_2 dilute magnetic semiconductor in both nano and bulk state were prepared by solvothermal and mechanosyhtesis route respectively. Contraction in unit cell volume of tetragonal rutile SnO_2 after Co doping and redshift in energy band gap compared to that of undoped SnO_2 ensures the incorporation of smaller Co^{2+} ions replacing larger host cations Sn^{4+}. Vibrating sample magnetometer measurements show that paramagnetism is the intrinsic magnetic property in single-phase $Sn_{1-x}Co_xO$ whereas non-DMS related ferromagnetism is associated only with the corresponding nanostructures. Paramagnetism is also confirmed by thermal dependence of magnetization M (T) and magnetic susceptibility (χ) measurement in between $80 \leqslant T \leqslant 350K$.

PUBLICATIONS IN JOURNALS

1. S. Mitra, S. Das, S. Basu, P. Sahu, K. Mandal, *Shape- and field-dependent Morin transitions in structured α-Fe_2O_3*, Journal of Magnetism and Magnetic Materials, 2009, **321**,2925.
2. M. Mandal, B. Das and K. Mandal, *Synthesis of Co_xPt_{1-x} alloy nanoparticles of different phase by micellar technique and their properties study*, Journal of Colloid & Interface Science, 2009, **335**, 40.
3. M. Mandal and K. Mandal, *Synthesis of Snowball Flower-like Ni Nanoparticles by Negatively charged micelles,* Chemistry Letters, 2009, **38**, 768.
4. M. Mandal and K. Mandal, *Synthesis of DNA templated trifunctional electrically conducting, optical and magnetic nanochain of Ni_{core}- Au_{shell} for biodevice*, Journal of Applied Physics, 2009, **106**, 026101.
5. M. Mandal, D. Pal and K. Mandal, *Negatively charged micelles directed synthesis of snow-ball flower like superparamagnetic Ni nanoparticles and investigation of their properties*, Colloids and Surfaces A: Physicochemical and Engineering aspects, 2009, **348**, 35.
6. A. Chaudhuri, M. Mandal and K. Mandal, *Preparation and study of $NiFe_2O_4$/ SiO_2 core-shell nanocomposites*, Journal of Alloys and Compounds, 2009, **487**, 698.
7. A. Chaudhury, S. Mitra, M. Mandal and K. Mandal, *Nanostructured bismuth ferrite synthesized by solvothermal process*, Journal of Alloys and Compounds, 2010, **491**, 703.

OTHER PUBLICATIONS

1. S. Sinha, B. Das and K. Mandal, *Magnetization dynamics in wire-shaped amorphous magnetic materials*, Proceedings of the conference on Soft Magnetic Materials, 2009, D1-09.
2. A. Chaudhury and K. Mandal, *Magnetic properties of SiO_2 coated $NiFe_2O_4$ nanoparticles*, Proceedings of the conference on Soft Magnetic Materials, 2009, E1-05.
3. D. Pal, K. Mandal and O. Gutfleisch, *Large negative magnetoresistance in nickel-rich Ni-Mn-Ga Heusler alloys*, Proceedings of 11 Joint MMM Intermag conference, 2010, HH-10.

SUPERVISION OF STUDENTS

Ph. D. Students: Bipul Das, Debabrata Pal, Arka Chaudhury, Shyamsundar Ghosh, Debashis Sarkar, Rajasree Das; **Project Students:** Debashis De Munshi, Progna Banerjee.

POST DOCTORAL RESEARCHERS

Dr. Madhuri Mandal.

LECTURES DELIVERED

1. *Study of nanostructured iron oxides*, Department of Physics, Durham University, UK, 26 March 2010.
2. *Magnetic properties of ferrite nanoparticles*, A conference on Magnetic Materials and their applications, Madurai, India, 20 January 2010.
3. *Our activities on magnetism and magnetic materials*, DRC Meeting, S. N. Bose National Centre for Basic Sciences, Salt Lake, Kolkata, India, 05 August 2009.
4. *Study of ferrite nanoparticles*, DST Programme Advisory Committee meeting, Kolkata, India, 23 February, 2010.

ACADEMIC VISITS

1. Universität Duisburg-Essen, Duisburg, Germany, September-October, 2010.
2. Istituto Nazionale di Ricerca Metrologica, Torino, Italy, September, 2009.
3. Durham University, Durham, UK, March, 2010.

COURSES TAUGHT

PHY191, Basic Laboratory, Fall semester; PHY413, Magnetism and Superconductivity, Winter semester; PHY410, Advanced Experimental Techniques, Winter semester; PHY391, Experimental methods, Winter semester.

PARTICIPATION IN COMMITTEES

Internal: SCRE Committee; Admission Committee; Lecture Hall III Committee; Annual Report - 2009 Committee; Generator Committee; Placement Awareness cell.

SPONSORED PROJECTS

1. Study of ferrite nanoparticles.
2. Development of a vibrating sample magnetometer using a superconducting magnet.
3. Contacting 3D electrodeposited nanowires: new opportunities for spintronics technology.
4. Preperation and study of magnetic nanowires.
5. Study of magnetocaloric effect in iron rich materials.

AWARDS / RECOGNITIONS

Received Humboldt fellowship (Follow-up programme) to work in Universität Duisburg-Essen, Duisburg, Germany.

Kuntal Chakrabarti

Visiting Faculty Fellow

- Synthesis and Purification of different types of nanotubes and nanofibers.
- Interaction of nanotubes, nanofibers and nano particles with microwave radiation and blood platelet.
- Electrical transport mechanism in composites.

We have successfully lowered the graphitization temperature of PAN based carbon fiber and synthesized fibers of several other materials of interest. Of particular importance are the first hydrogen free synthesis route of Cobalt nanofiber by electrospining and the synthesis of manganite fiber like LCMO. We have evaluated the evolution of microwave response of Poly(acrylonitrile) based carbon fiber during heat treatment. This is very important for the choice of material for preparing radar absorption paint. Apart from these, we have studied the blood platelet - single wall carbon nanotube/ Au nanoparticle interaction and suggested some mechanism for that. We have studied the resistance minima in conductor-insulator matrix in the light of thermal expansion and Weibull distribution (Fig. 1).

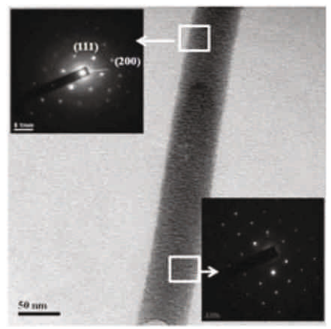


Fig.1: High resolution transmission electron micrograph of a cobalt nanofiber prepared by an electrospinning technique. Selected area diffraction (inset) shows large uniformity of the sample.

PUBLICATIONS IN JOURNALS

K. Chakrabarti, *Controlled lowering of graphitization temperature of electrospun poly(acrylonitrile) based carbon fiber by carbon nanotube embedment*, Materials Letters, 2010, **64**, 1607.

SUPERVISION OF STUDENTS

Project Students: Srimoy Chakraborty.

LECTURES DELIVERED

1. *Techniques of Laser Ablation and its Applications*, Jadavpur University, Kolkata, December, 2009.
2. *JNCASR Research Conference - Physics of New Materials (Poster presented)*, Fortune Park Panchawati, Kolkata, January, 2010.

PARTICIPATION IN COMMITTEES

Internal: Member of the Patent committee.

Pratip Kumar Mukhopadhyay
Associate Professor

- The focus area of our work is on ferromagnetic shape memory alloys. We are engaged in making various alloys, in bulk and thin films, and making different measurements with them. We also worked on thin film that would lead to thin film batteries.

We continued the work on thin film making of CoNiAl alloys. There are few reports on these materials in thin film form besides us, and therefore we are 'walking alone' (Fig. 1).

We also tried to work on synthesis of magnetic alloy nano particles of Ni and Co by chemical sol-gel technique. After a lot of trial and error, we have been successful in making alloys of these two metals in desired compositions and then we characterized them under various techniques.

Dynamic elastic property measurements under magnetic field were started and continuing and the data are under analysis. Mapping of the coil generated magnetic field was continuing.

Magneto-Optical Kerr effect setup was almost completed during this time and data acquisition would start soon. The precision optical components took a long time to make and test.

We also collaborated with various external laboratories for different measurements.

We also continued our work on thin film of MoO_3 type oxides, and the work on WO_3 oxide thin film was just concluded.

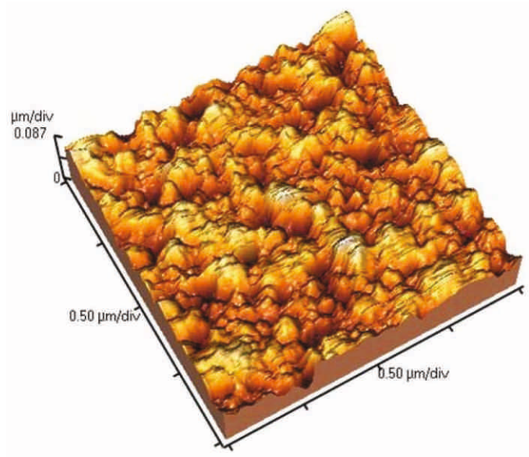


Fig. 1: AFM of CoNiAl alloy – thin film (3-D)

PUBLICATIONS IN JOURNALS

1. B. Rajini Kanth, N. V. Ramarao, A. K. Panda, R. Gopalan, A.Mitra and P. K. Mukhopadhyay, *Effect of annealing on the Martensitic transformation of a CoNiAl Ferromagnetic*, Journal of Alloys and Compounds, 2010, **491**, 22.
2. B. Rajini Kanth, D. Bhattacharjya and P. K. Mukhopadhyay, *Fabrication and Magnetic properties of CoNiAl Ferromagnetic Shapememory Alloy*, Materials Science Forum, 2010, **635**, 167.
3. K. Srinivasa Rao, B. Rajini Kanth and P. K. Mukhopadhyay, *Optical and IR studies on r. f. Magnetron Sputtered Ultra-thin MoO_3 film*, Applied Physics A, 2009, **96**, 985.
4. Rajeev Ranjan, Sanjay Singh, Hans Boysen, Dmytro Trots, S. Banik, A. M. Awasthi, P. K. Mukhopadhyay and S. R. Barman, *Compeating tetragonal and monoclinic phases in $Ni_{2.2}Mn_{0.8}Ga$*, Journal of Applied Physics, 2009, **106**, 033510.

5. S. Banik, Sanjay Singh, R. Rawat, P. K. Mukhopadhyay, B. L. Ahuja, A. M. Awasthi, S. R. Barman and E. V. Sampathkumaran, *Variation of magnetoresiststance in $Ni_{2+x}Mn_{1-x}Ga$ with composition*, Journal of Applied Physics, 2009, **106**, 103919.

SUPERVISION OF STUDENTS

Ph. D. Students: Sandeep Agarwal, Sudipta Bera; **Project Students:** Syamanta Kumar Goswami, Laxman Arun; Sanjib Ghosh, Kalpu Kalpana; **Summer Project Student:** Papori Gogoi.

POST DOCTORAL RESEARCHERS

Dr. Bhogoju Rajini Kanth, Dr. Kotari Srinivasa Rao.

LECTURES DELIVERED

1. *Fabrication and Magnetic properties of CoNiAl Ferromagnetic Shape memory Alloy thin films*, ICFSMA 09, Bilbao, Spain, July 1-3, 2009.
2. *Stress Induced Martensitic Transformation in CoNiAl Ferromagnetic Shape memory Alloys*, CMDays 09, Jadavpur University, Kolkata, August 26-28, 2009.
3. *A Novel method for the preparation of Al rich CoNiAl alloy thin films*, Thiagarajar College of Engineering, Madurai, January 20-21, 2010.
4. *Evidence of premartensites in an Ferrmgagnetic Shape Memory Alloy through neutron diffraction and elastic measurements, BUET*, Dhaka, Bangladesh, March 3-7, 2010.
5. *Frequency dependant susceptibility study for a ferromagnetic shape memory alloy*, APS March meeting, Portland, Oregon, USA, March 15-19, 2010.

COURSES TAUGHT

PHY391, Methods of Experimental Physics, Fall semester; PHY191, Basic Laboratory, Fall semester; *Advanced Condensed Matter Physics*, Department of Physics, Manipur University, Imphal, June.

PARTICIPATION IN COMMITTEES

a. **External:** Council Member, IPS; Governing Body Member, Magnetic Society of India; Centre Co-ordinator, Kolkata Centre of Entrance exam of JNCASR; External Member, purchase committee of Physical Property Measurement System and others, Department of Physics, Tezpur University; Journal reviewer for Indian and overseas Physics journals, including European Physics Journal, Journal of Physics (condensed matter), Pramana etc.

b. **Internal:** Convener, PPR Committee; Convener, Project Cell; Member, Clean Room Committee; Indenter, Liquid Helium plant; In-charge, Mechanical Workshop.

SPONSORED PROJECTS

1. Study of dynamics of twin structures in different ferromagnetic shape memory alloys
2. Elastic Property measurements on ferromagnetic shape memory alloy system $Ni_{1-x}Co_xAl_y$
3. National High Magnetic field facility – a multi-institutional project with Satyendra Nath Bose National Centre for Basic Sciences, UGC-DAE Consortium for Scientific Research, Kolkata Centre, Indian Association for the Cultivation of Science and Variable Energy Cyclotron Centre, Kolkata.

Priya Mahadevan
Associate Professor

- The origin of ferromagnetism in an insulating oxide $K_2Cr_8O_{16}$.
- The dimensional dependent metal-insulator transition in films of $SrRuO_3$.
- Magnetism and orbital ordering in p-shell systems.
- Absence of rippling in graphene grown on a substrate.
- Bulk modulus enhancement in nanocrystals of semiconductors.
- Band offset modifications in semiconductor superlattices - role of cation d states.

Usually ferromagnetism is accompanied by metallicity. $K_2Cr_8O_{16}$ was recently found to represent a rare example of a ferromagnetic insulator. What was even more unusual was that the system underwent the metal-insulator transition in the ferromagnetic state - very different from all the classic examples of magnetic insulators. Our analysis shows that it is a charge ordering transition that drives the system insulating and ferromagnetic. Analysis of the resistivity data shows that the system shows activated behavior above the so-called metal-insulator transition temperature and therefore belongs to the usual examples of magnetic insulators that we know of. This has appeared in Phys. Rev. Lett. A lot of interest in recent times has focussed on oxides that do not have any conventional magnetic elements. Magnetism in such cases are examples of p-shell magnetism and the origin is usually defect induced - a process which is very difficult to control experimentally. We embarked on a search of compounds of p-shell magnetism and uncovered an entire class of oxides. Not only did we find magnetism in these materials but other features of strong correlation physics - such as orbital ordering (Fig. 1) was also found. This work has just been accepted in Phys. Rev. Lett.

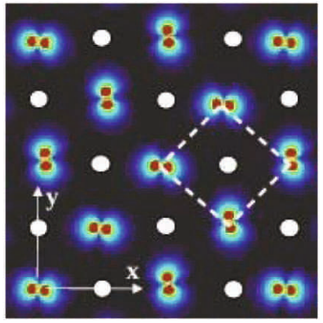


Fig.1: Orbital ordering found in KO_2

PUBLICATIONS IN JOURNALS

1. Priya Mahadevan, Abhinav Kumar, Debraj Choudhury and D. D. Sarma, *Charge ordering induced ferromagnetic insulator: $K_2Cr_8O_{16}$*, Phys. Rev. Lett., 2010, **104**, 256401.

2. Priya Mahadevan, F. Aryasetiawan, A. Janotti and T. Sasaki, *Evolution of the electronic structure of a ferromagnetic metal - case of $SrRuO_3$*, Phys. Rev. B, 2009, **80**, 035106.

3. Roby Cherian, Priya Mahadevan and Clas Persson, *Role of Coulomb interactions in semi-core Ga d levels of GaX semiconductors: Implication on band offsets*, Solid State Comm., 2009, **149**, 1810.

4. S. Raj, T. Sato, T. Takahashi, D. D. Sarma and P. Mahadevan, *Metal-insulator transition of Na_xWO_3 studied by angle resolved photoemission spectroscopy*, Modern Physics Letters B, 2009, **23**, 2819.

5. D. D. Sarma, A. Nag, P. Santra, A. Kumar, S. Sapra and P. Mahadevan, *Origin of enhanced photoluminescence from semiconductor CdSeS nanocrystals*, Journal of Physical Chemistry Letters, 2010, **1**, 2149.

OTHER PUBLICATIONS

Priya Mahadevan and Kapil Gupta, *In search of a two-dimensional metallic oxide*, Functional Metal Oxide Nanostructures (Springer Verlag), edited by J. Wu, W. Han, H. Kim, A. Janotti and J. Cao.

SUPERVISION OF STUDENTS

Ph. D. Students: Ashis Nandy, Hirak Kumar Chandra, Abhinav Kumar, Kapil Gupta, Saikat Debnath, Ruma Das; **Project Students:** Arup Bhowmick

POST DOCTORAL RESEARCHERS

Dr. Bipul Rakshit.

LECTURES DELIVERED

1. *In search of p-shell magnets*, IISc Centenary conference, Department of Physics, IISc, Bangalore, May, 2009.
2. *Models for ferromagnetism in dilute magnetic semiconductors: Insights from ab-initio calculations* an, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil, June, 2009.
3. *Growth of semiconductor nanocrystals*, Discussion meeting on Statistical and Condensed Matter Physics, Guwahati, India, October, 2009.
4. *Orbital ordering in a p-shell system: Case of KO_2*, Magnetism, Superconductivity and Phase Transitions in Novel and Complex Materials, Kolkata, India, November, 2009.
5. *What is spintronics all about?* Gurudas College, Kolkata, November, 2009.
6. *Band offset concepts revisited,* Indo-UK Second Networking conference on low carbon futures, Kolkata, December, 2009.
7. *Doped oxides: Is a rigid model ever applicable?* ICTS conference on Condensed Matter, Mahabaleshwar, December, 2009.
8. *New candidates for orbital ordering - p band oxides*, JNCASR research conference on Physics of Materials, Kolkata, January, 2009.
9. *Charge ordering induced ferromagnetic insulator: $K_2Cr_8O_{16}$*, Recent trends in strongly correlated electron systems, Guwahati, January, 2009.
10. *New candidates for orbital ordering - p band oxides*, International workshop on frontiers in electronic structure calculations: techniques and application, February, 2009.

ACADEMIC VISITS

1. Universidade Federal de Rio de Janeiro (UFRJ), Rio de Janeiro, Brazil, June, 2009.
2. Tata Institute of Fundamental Research, Mumbai, India, October, 2009.
3. Harishchandra Research Institute, Allahabad, India, November, 2009.
4. Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India, December, 2009.
5. Harishchandra Research Institute, Allahabad, India, January, 2010.
6. National Chengchi University / National Taiwan University, Taipei, March, 2010.

COURSES TAUGHT

PH105, Computational Methods in Physics, Fall semester.

PARTICIPATION IN COMMITTEES

Internal: In-charge computer centre; Hostel warden; Member - SAC committee; Member canteen committee; Member Vision committee; Member HPC committee; Member computer-centre shifting committee; Co-convener JEST 2010.

SPONSORED PROJECTS

1. On charge and orbital ordering.
2. Dilute magnetic semiconductors: Bulk and nano.
3. Advanced theories of functional oxides.
4. Functional oxides (Indo-Taiwan collaborative project).

Ranjan Chaudhury
Reader

- My research work in the areas of superconductivity, magnetism and strongly correlated electronic systems have continued. In particular, theoretical investigation of superconducting pairing in low-dimensional systems in both weakly correlated and strongly correlated phases have been carried out. Besides, topological spin excitations in quantum spin models on low-dimensional lattices have also been studied.

The many-body based approaches as used for the weakly correlated and the strongly correlated systems, have been unified, for investigation of the possible role of the electronic mechanism for superconducting pairing. It is found that an optimum enhancement of spin fluctuations and charge fluctuations help superconducting pairing in both weakly and strongly correlated systems. For layered systems of both weakly and strongly correlated type, in the superconducting phase there exists a very clear possibility of the coexistence of fermion pairs and the pseudo-bosons. These theoretical results can be very useful for the microscopic understanding of superconductivity in the Cuprates and in the Oxypnictides. Important property of the electronic polarizability functions have been extracted for a deeper understanding of Kohn Anomaly in the superconductors, in collaboration with M. P. Das (ANU, Canberra). In collaboration with S. K. Paul (SNBNCBS) a complete field theoretic description of quantum spin models on lattices has been done. In particular, for both XY-anisotropic Heisenberg ferromagnetic and anti-ferromagnetic spin models on two-dimensional square lattice, our formulation manifests the existence of topological excitations of "meronic" type. Furthermore, the relevant topological term (known as Wess-Zumino term) in the effective action is found to behave as a "topological charge measuring quantity" and can identify a large class of vortices (anti-vortices). Our results are extremely important to analyse the results from the inelastic neutron scattering experiments performed on various layered magnets which exhibit features analogous to Kosterlitz-Thouless scenario.

PUBLICATIONS IN JOURNALS

R. Chaudhury, S.K. Paul, *Physical realization and possible identification of topological excitations in quantum Heisenberg antiferromagnet on a two-dimensional lattice*, European Physical Journal B, 2009, **69**, 491.

SUPERVISION OF STUDENTS

Ph. D. Students: Soumi Roychowdhury, Shyam Sundar Ghosh;
Project Students: Soumyadipta Pal, R. Periyasamy.

PARTICIPATION IN COMMITTEES

Internal: Visitors' Programme Coordinator, EVLP, Chairman, Housing Allotment Committee, Member of Medical Committee, Member of PF Trustee Board, Joint convener, BOSEFEST 2010 Organizing Committee.

OTHER INFORMATION

1. Became a Visiting Professor at AUST (Abuja) under NMI (Washington DC, USA) and taught a course on Statistical Mechanics and gave lectures on Superconductivity to the M.Sc. students of AUST for 5 weeks from October 1, 2009.
2. Received an invitation for delivering a talk at ICSM 2010 to be held in Antalya (Turkey).
3. Selected for being a member of ACS (American Chemical Society).

Sarathi Kundu
Visiting Faculty Fellow

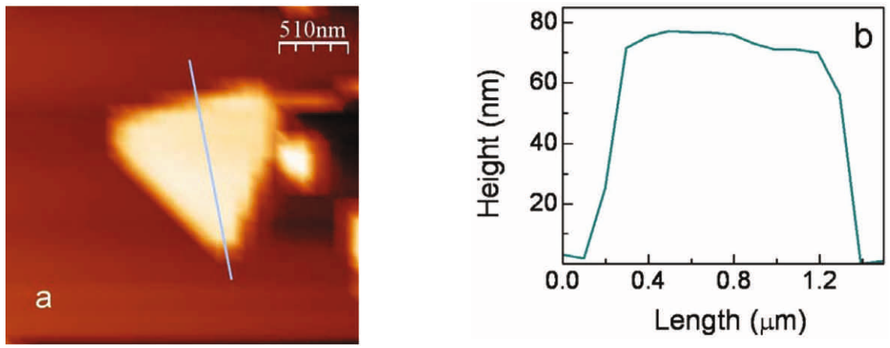
- Growth and structures of organic thin films and membranes, lipid/surfactant-DNA interactions and lipid-drug interactions by using X-ray scattering techniques, neutron reflectivity, AFM, BAM and FTIR spectroscopy.
- Nanoparticle growth and nanopattern formation at the interfaces.

Growth of Langmuir-Blodgett (LB) films of nickel arachidate (NiA) on differently passivated (H-/Br-/O-passivated) Si(001) substrates and their structural evolution with time have been investigated by X-ray reflectivity (XRR) technique. Structure of the film on oxide covered Si (001) is consistent with the growth of the LB film on hydrophilic surface, the structure of which is quite stable. The structure of LB film on H-passivated Si (001) is similar to the growth of the LB film on hydrophobic surface. This structure changes significantly with time. However, for Br-passivated surface, the structure shows intermediate behavior. Both the hydrophilic and hydrophobic nature is observed simultaneously for the film deposited on such Br-passivated Si surface.

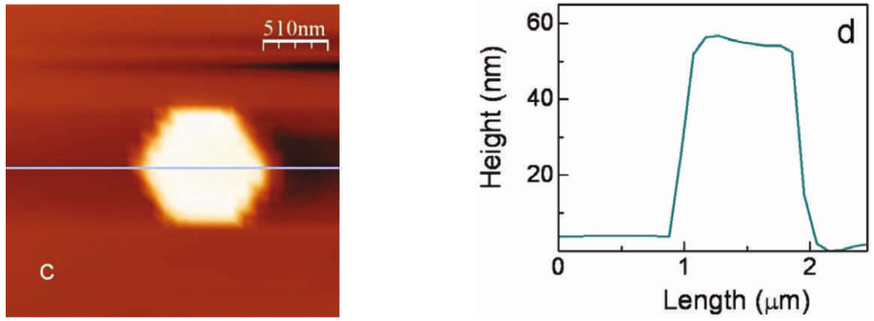
NiA LB films have been deposited on hydrophilic Si (001) substrates by three and five stokes. All the preformed LB films were then used to go through the air-water interface. Structural information obtained from the XRR studies show that mainly the top layer density decreases after passing through the air-water interface but the layered structure remains the same.

Ferric stearate LB film when reacts chemically with H_2S forms iron poly sulphide in such microenvironment but in bulk forms both mono and poly sulphide.

Langmuir monolayer of octadecylamine in presence of aqueous $HAuCl_4$ subphase produces nanocrystals (NCs) of Au at the air-water interface. SEM gives the in-plane shape variation of Au NCs. Mainly worm-like single or collected nanoparticles become globular and gets crystal structure with time. AFM height profile indicates that these NCs are disc like.



a. Atomic force microscopy image of a triangular nanocrystal formed at the air-water interface.
b. The corresponding line profile.



c. Atomic force microscopy image of a hexagonal Au nanocrystal formed at the air-water interface.
d. The corresponding line profile.

PUBLICATIONS IN JOURNALS

1. Sarathi Kundu, *Collapse of preformed cobalt stearate film on water surface*, Colloids and Surfaces A: Physicochem. Eng. Aspects, 2009, **348**, 196.
2. J. K. Bal, S. Kundu and S. Hazra ,*Growth and stability of Langmuir-Blodgett films on OH-, H- or Br-terminated Si(001),* Phys. Rev. B, 2010, **81**, 045404.
3. Sarathi Kundu, *Polyeletrolytes-surfactant complexes on solid surface,* Journal of Colloid and Interface Science, 2010, **344**, 547.

Saswati Barman
Visiting faculty fellow

- Propagation of local excitation along chains of magnetic vortices.
- Gyrotropic mode splitting in magneto-statically coupled vortices.
- Magnetization precession in arrays of thin magnetic elements.
- Hysteresis loop of Ni nanowires and Co-Pd patterned multilayers.
- Monte Carlo Simulation of Ising spins.

We have shown efficient manipulation of the transfer of low GHz energy and speed of transfer of this energy through one dimensional chains of magnetostatically coupled magnetic vortices. We have used a localized rotating magnetic field to resonantly excite the gyrotropic oscillation of a single vortex at one end of the chain and simulated the time evolution of magnetization of every individual disks in that chain. The efficiency of the propagation, depends on the intrinsic and extrinsic properties of the vortex chain, including polarization, chirality and shape of the disks. The velocity of propagation is also affected by the above parameters and the optimum values of transmittance and velocity of propagation occur for a particular shape with some geometric asymmetry and magnetic configuration of the vortex chain. We have shown ways to control the propagation of localized low GHz resonant excitation by shape engineering and by varying the asymmetry related to polarization and chirality within the chain of nanodisks. We found that due to the introduction of geometric asymmetry for D-shaped disks, larger amount of magnetic charges appear at the surface compared to the perfectly circular nanodisks. These larger amounts of magnetic surface charges and absence of any asymmetry related to vortex polarity and chirality facilitates the propagation of energy along the chain of nanodisks. Efficient control of the transmittance and the velocity of propagation of magnetic excitation in physically separated magnetic nanodisks are important for the design of high frequency spin logic systems and magnonic crystals. Fig. 1 shows the time and frequency domain dynamics of linear chains of magnetic vortices. Type I and type II represent opposite core polarisation in alternate disks and same core polarisation with different chirality respectively. Type III and type IV represent same core polarisation with chirality change in the last disk and same core polarisation with same chirality respectively. Type V and type VI represent chain of D – shaped disks and chain of D – shaped disk placed in reverse order respectively. Type VII and VIII represent chain of D- shaped disks with flat end up and down in alternate disk and chain of D- shaped disks with flat end placed all in the up direction.

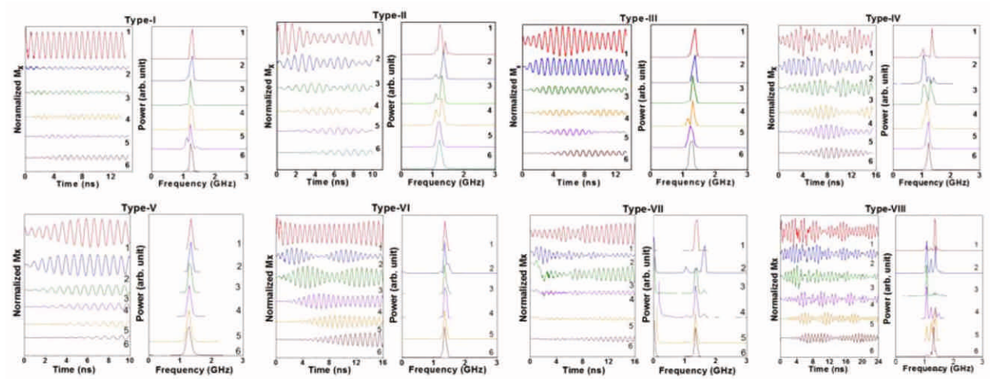


Fig. 1: Time and frequency domain dynamics of linear chains of magnetic vortices

PUBLICATIONS IN JOURNALS

1. A. AlShaikhi, S. Barman and G. P. Srivastava, *Theory of the lattice thermal conductivity in bulk and films of GaN*, Phys. Rev. B, 2010, **81**, 195320.
2. S. Barman, A. Barman and Y. Otani, *Dynamics of one dimensional chains of magnetic vortices in response to local and global excitations,* IEEE Trans. Magn. 2010, **46**, 1342.
3. A. Barman and S. Barman, *Dynamic dephasing of magnetization precession in arrays of thin magnetic nanoelements.,* Phys. Rev. B, 2009, **79**, 144415.

LECTURES DELIVERED

1. *Dynamics of one-dimensional chains of magnetic vortices in response to local and global excitations*, 11th Joint MMM-Intermag Conference, Washington, D.C., USA, January 2010.
2. *Controlled propagation of local magnetic excitation in one-dimensional chains of nanomagnets*, Nanomagnetism Workshop, LNMIIT, Jaipur, February 6, 2010.

SPONSORED PROJECTS

1. Investigation of static and dynamic magnetic properties of nanomagnetic systems, PI.
2. Computational studies of dynamic phenomena in magnetic nano-materials, Co-PI.

Sugata Mukherjee
Reader

- Groundstate properties of transitional-metal and noble-metal clusters using tight-binding simulations.
- Study of various electronic properties of Graphite, Graphene and hexagonal Boron Nitride using plane wave pseudopotential methods.

Planewave pseudopotential method has been used to calculated various groundstate properties of Graphite, Graphene and hexagonal Boron Nitride. These materials have widespread applications in nanotechnology and have been topic of intensive current interest. We have investigated the structural stability of these materials using various pseudopotentials in the local density approximation (LDA) and in the generalised gradient approximation (GGA) of exchange-correlation energies. The calculated structural parameters, exfoliation energy, cohesive energy, compressibility etc agree with experimental measurements within a few percentage. GGA calculations seem to correct the overestimated LDA results for cohesive energy. Our calculations also throw light on the choice of proper pseudopotential for these materials and also on the k-point sampling of the Brillouin zone.

Semi-empirical tight-binding simulation method has been used to study properties of transition-metal and noble-metal clusters of sizes ranging from few atoms upto nearly 20,000 atoms. These studies were found to be useful for size dependent trends of various electronic properties and their scaling with size. Calculations have been extended to binary nanoalloys to investigate their size and structure dependent miscibility and surface segregation properties, which are key to understand their fascinating catalytic properties (Fig. 1).

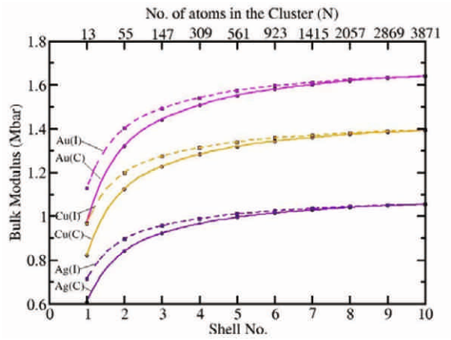


Fig. 1: Bulk Modulus of Au, Cu and Ag nanoclusters of Icoshadral (I) and Cubo-octahedral (C) shape calculated using semi-empirical tight binding method

OTHER PUBLICATIONS

S. Mukherjee, *Electronic Structure and Dynamics of Nanosctructured Materials*, in Proceedings of the 3rd Thailand Nanotechnology Conference 2009, Asian Inst of Technology, Bangkok, p 44.

SUPERVISION OF STUDENTS

Ph. D. Students: Thaneshwor Prashad Kaloni; **Project Students:** Thaneshwor Prashad Kaloni; **Summer Students:** Moumita Nandi

LECTURES DELIVERED

1. *Electronic Structure and Dynamics of Nanoclusters*, National Cheng Kung University, Tainan, Taiwan, Dec. 2009.
2. *Electronic Properties and Dynamics of Clusters, Conf. on Computational Physics*, Kaohsiung, Taiwan, Dec. 2009.
3. *Electronic Structure and Dynamics of Nanoclusters*, 3rd Thailand Conference on Nanosciences, AIT Bangkok, Thailand, Dec. 2009.

COURSES TAUGHT

MS612, Advanced Condensed Matter Physics, Winter semester.

PARTICIPATION IN COMMITTEES

a. **External:** Evaluation Committee, IACS, Kolkata

b. **Internal:** Convener, TPSC; Non-member Secretary of Governing Body; Secretary, Finance Committee and Building Committee; Member, Medical Committee; Member, Consultative Advisory Committee and member of various other committees as Acting Registrar.

Tanusri Saha-Dasgupta
Associate Professor

- Using first-principles DFT calculations we studied the polarization behavior in ultra-thin bi-component perovskite based suplattices.
- We studied the electronic structure of vacancy bearing Fesilicates.
- The electronic structure of pseudo-binary alloys was studied using extension of augmented space recursion.
- The evidence of Coulomb-enhanced spin-orbit coupling was discovered and studied in spinel compound, $FeCr_2S_4$.

The electronic structure of the spinel compound, $FeCr_2S_4$, was studied using density-functional-theory-based calculations. Our calculations provided a microscopic understanding of the origin of the insulating behavior of this compound, which turned out to be driven by Coulomb enhanced spin-orbit coupling operative within the Fe-d manifold. We also investigated the possible role of the structural distortions and compare the calculated optical property data with that of the experimental one [6].

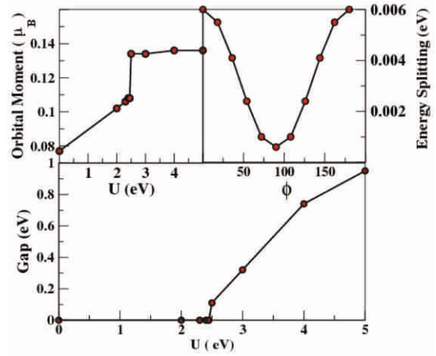


Fig. 1: Variation of Fe orbital moment (upper left panel) and band gap (lower panel) with U value applied on Fe site. The upper right panel shows the splitting between Fe z^2–x^2 and $3y^2$– r^2 levels in eV plotted as function of canting angle of the moment [6].

PUBLICATIONS IN JOURNALS

1. Hena Das, Nicola A. Spaldin, Umesh V. Waghmare, and T. Saha-Dasgupta, *Chemical control of polar behavior in bicomponent short-period superlattices*, Phys. Rev. B, 2010, **81**, 235112.
2. Swastika Chatterjee and Tanusri Saha-Dasgupta, *First-principles simulations of structural, electronic, and magnetic properties of vacancy-bearing Fe silicates*, Phys. Rev. B, 2010, **81**, 155105.
3. Aftab Alam, T. Saha-Dasgupta, and Abhijit Mookerjee, *Ab initio augmented space recursion to study complex multicomponent materials: Application to the pseudobinary alloy* $Ni_{1-x}Pt_xAl$, Phys. Rev. B, 2010, **81**, 054201.
4. F. Rodolakis, P. Hansmann, J.-P. Rueff, A. Toschi, M. W. Haverkort, G. Sangiovanni, A. Tanaka, T. Saha-Dasgupta, O. K. Andersen, K. Held, M. Sikora, I. Alliot, J.-P. Itié, F. Baudelet, P. Wzietek, P. Metcalf, and M. Marsi, *Inequivalent Routes across the Mott Transition in* V_2O_3 *Explored by X-Ray Absorption*, Phys. Rev. Lett, 2010, **104**, 047401.
5. Prabuddha Sanyal, Hena Das, and T. Saha-Dasgupta, *Evidence of kinetic-energy-driven antiferromagnetism in double perovskites: A first-principles study of La-doped* Sr_2FeMoO_6, Phys. Rev. B, 2009, **80**, 224412.
6. Soumyajit Sarkar, Molly De Raychaudhury, I. Dasgupta, and T. Saha-Dasgupta, *Electronic structure of* $FeCr_2S_4$*: Evidence of Coulomb enhanced spin-orbit splitting*, Phys. Rev. B (Rapid Commun), 2009, **80**, 201101.
7. S. Glawion, M. R. Scholz, Y.-Z. Zhang, R. Valentí, T. Saha-Dasgupta, M. Klemm, J. Hemberger, S. Hor, *Electronic structure of the two-dimensional Heisenberg antiferromagnet VOCl: A multiorbital Mott insulator*, Phys. Rev. B, 2009, **80**, 155119.
8. M. Aichhorn, T. Saha-Dasgupta, R. Valentí, S. Glawion, M. Sing, and R. Claessen, *Momentum-resolved single-particle spectral function for TiOCl from a combination of density functional and variational cluster calculations*, Phys. Rev. B, 2009, **80**, 115129.

9. Soumendu Datta, Mukul Kabir, Tanusri Saha-Dasgupta, and Abhijit Mookerjee, *Structure, reactivity, and electronic properties of V-doped Co clusters*, Phys. Rev. B, 2009, **80**, 085418.

OTHER PUBLICATION

1. A. Mookerjee, T. Saha-Dasgupta and I. Dasgupta, *Quantum and semi-classical percolation and breakdown in disordered solids*, Lecture Notes in Physics, Springer-Verlag Heidelberg, 2009, **83**, 762.
2. A. Toschi, P. Hansmann, G. Sangiovanni, T. Saha-Dasgupta, O. K. Andersen and K. Held, *Spectral properties of the Mott Hubbard insulator (Cr0.011V0.989)2O3 calculated by LDA+DMFT,* J. Phys.: Conf. Ser., 2010, **200**, 012208.

SUPERVISION OF STUDENTS

Ph. D. Students: Hena Das, Soumyajit Sarkar, Swastika Chatterjee, Swarnakamal Mukherjee, Santu Baidya, Prajna Mukherjee (joint: A. Mookerjee).

POST DOCTORAL RESEARCHERS

Dr. Jaita Banerjee

LECTURES DELIVERED

1. *World of Double Perovskites*, Hanoi, Vietnum (ACCMS conference), September 2009.
2. *Spinels: Interplay of charge, orbital and spin*, Kolkata, MSM09 conference, November 2009.
3. *Modeling of Complex materials,* MPI Stuttgart, kick-off meeting of MONAMI, November 2009.
4. *First-principles study of Double perovskites*, Mahabaleswar, December 2009.
5. *World of Double perovskites*, UCSB, Santa Barbara, February 2010.
6. *Quantum spin systems,* JNCASR, I2CAM conference, April 2010.

ACADEMIC VISITS

1. Max-Planck Institute, Stuttgart, November 2009.
2. University of Arizona, February 2010.
3. University of California, Santa Barbara, February 2010.

COURSES TAUGHT

MS612, Electronic Structure, Fall semester.

PARTICIPATION IN COMMITTEES

a. **External:** Member of the committee for IUSSTF-APS Professorships and Student Visitations between India and USA.

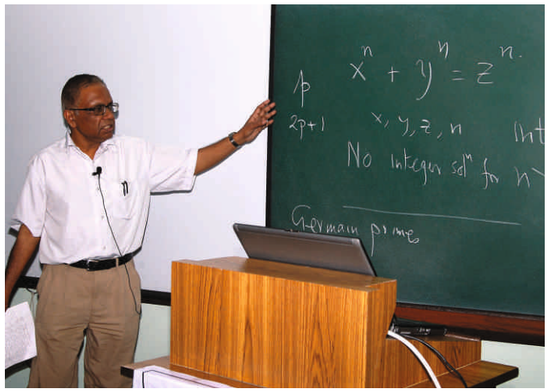
b. **Internal:** SCRE committee, Auditorium committee, Crèche committee.

SPONSORED PROJECT

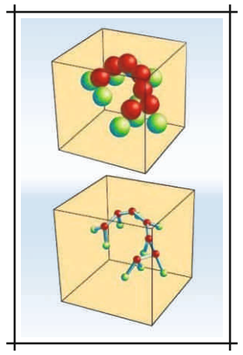
1. Advanced Materials Research Unit.
2. Swedish Research Link program.
3. Swarnajayanti Fellowship.
4. Indo-EU (MONAMI).
5. Indo-US RD network project.
6. Max-Planck-India partner group program.

NATIONAL SCIENCE DAY - 2010

28 FEBRUARY, 2010



DEPARTMENT OF THEORETICAL SCIENCES



DTS

DEPARTMENT OF THEORETICAL SCIENCES

The theory group was actively engaged in research and teaching. Significantly, the students of our department were able to publish independent papers in journals with high impact factors. The research carried out may be broadly classified under five headings. These are briefly summarised.

QUANTUM FIELD THEORY

Nonperturbative aspects of QFT related to duality and confinement in broken gauge theories were studied. Also, a reformulation of lattice gauge theories in terms of Wilson loops was done by using the prepotential approach.

Several topics in noncommutative geometry inspired physics were reviewed. The appearance of anomalous symmetries as a consequence of deformations effected by Drinfeld twists was revealed. The role of the Voros product vis-à-vis the Weyl-Wigner-Moyal product in noncommutative gravity was clarified.

Field theory techniques were applied to study the excitations in a two dimensional quantum spin system.

Finally, a superspace formulation of Yang-Mills theory on an n-dimensional sphere was developed by using super conformal Killing vectors.

GRAVITY AND BLACK HOLES

A detailed study of symmetries, both in Lagrangian and Hamiltonian approaches, for a general topologically massive gravity, was done. Cosmic strings in a gravity theory with positive cosmological constant were constructed. Alternatively, theories with negative cosmological constant were also considered, albeit in three dimensions and in the presence of a Barbero-Immirzi like parameter.

Several features of black hole thermodynamics including black hole spectroscopy were examined in the framework of the tunnelling formalism developed by our group. Specifically, a statistical origin of gravity was revealed. The blackbody spectrum and the corrections to the entropy and area law were found in higher derivative gravity theories. A unified description of Hawking-Unruh effect was presented. A connection of the singularity problem with the uncertainty principle was outlined.

MATHEMATICAL PHYSICS

The differential geometry of principal fibre bundles on path spaces was studied. Applications were considered.

The method of Kuperschmidt nonholonomic deformation was extended to a two component KdV system. Various aspects of nonlinear differential equations were analysed.

The role of the Jacobi multiplier in the Lagrangian formulation of these equations was investigated. Darboux polynomials in Abel equations and Darboux transformations in Raychaudhuri equation were discussed.

The connection of Lienard system of differential equations and renormalisation group was done.

Finally, irreducible SU(N) Schwinger bosons were constructed exploiting the symmetries of SU(N) Young tableaux.

STATISTICAL PHYSICS

Statistical physics of complex systems was studied. The phase diagram of a column of grains in the presence of frustration was obtained.

Applications of statistical physics problems involving rare events have been made in the field of fluid turbulence and fluctuation dissipation relations.

NONLINEAR PHYSICS

Nonlinear dynamical problems involving convective instability, astrophysical flows and two component Bose condensates were addressed.

Various networks were designed. Examples being useful networks for passenger traffic as well as for ecological evolution. A branching process in a stochastic external model was studied.

Using data analysis interstellar dust extinction was studied.

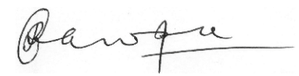
DEPARTMENTAL STATISTICS

Faculty strength: 11 (including one Emeritus scientist); **Number of Ph. D. Students:** 25; **Number of project students:** 5; **Number of Post doctoral Researchers:** 4.

Total number of publications: 40 (This number includes two commissioned articles, a review in Found. of Physics (Oct, 2009) and a feature in Physics Today (June 2009). Also, it includes 5 independent publications by our students).

Total number of projects: 3 (Indo-South African project on *Astrophysical and Cosmological implications in Noncommutative Spacetime;* DST project on *Generativity of Cognitive Networks; Interpretation of observed extinction in the optical-UV region from TAUVEX & ASTROSAT-UVIT satellite*).

For any specific detail concerning any specific faculty of the department, the reader should see the individual reports.



Rabin Banerjee
Head, Department of Theoretical Sciences

Amitabha Lahiri
Associate Professor

- Quantum Field theory: Duality and confinement in broken gauge theories.
- Mathematical Physics: Differential geometry on path spaces, applications of category theory in physics.
- Gravitation: Properties of black holes and cosmic strings in spacetimes with a positive cosmological constant.

I worked on three different problems this year. With my student Chandrasekhar Chatterjee, I studied non-perturbative quantum field theory. We constructed flux tubes in SU(2) Yang-Mills theory broken at two scales. At the higher scale, the symmetry is broken down to U(1) by an adjoint Higgs field, producing magnetic monopoles. At the lower scale, this U(1) is further broken by a Higgs field, either in the adjoint or in the fundamental representation, producing a flux tube. By dualizing the fields in the path integral, we found an explicit description of the flux tubes as charged strings interacting via an antisymmetric tensor gauge field. The monopoles remained attached to the ends of the strings, in a toy model of confinement. This is the first time an explicit description of monopole confinement in SU(2) gauge theory has been given. These results were published as two papers in the Journal of High Energy Physics. With my student Saikat Chatterjee, I worked on mathematical physics. Specifically, we studied the differential structure of principal fiber bundles on the space of paths. We constructed a connection and parallel transport operator on path space, and the gauge transformations of these objects, also the first time this has been done. With my student Sourav Bhattacharya, I worked on gravitation in the presence of a positive cosmological constant. We constructed cosmic strings threaded through the horizon of Schwarzschild-de Sitter black holes, the first time this has been done. Parts of these results have been announced at conferences.

PUBLICATIONS IN JOURNALS

1. Chandrasekhar Chatterjee and Amitabha Lahiri, *Monopoles and flux strings from SU(2) adjoint scalars*, JHEP, 2009, **0909**, 10.
2. Chandrasekhar Chatterjee and Amitabha Lahiri, *Flux dualization in broken SU(2),* JHEP, 2010, **1002**, 33.

OTHER PUBLICATION

Saikat Chatterjee, Amitabha Lahiri, Ambar N. Sengupta, *Path space forms and surface holonomy*, Proceedings of the 28th Workshop on Geometric Methods in Physics (XXVIIIWGMP), Bialowieza, Poland, 28 Jun - 4 Jul 2009, AIP Conf. Proc., 2009, **1191**, 66.

SUPERVISION OF STUDENTS

Ph. D. Students: Saikat Chatterjee, Chandrasekhar Chatterjee, Sourav Bhattacharya, Debmalya Mukhopadhyay; **Project Students:** Sanjib Ghosh.

POST DOCTORAL RESEARCHERS

Dr. Tae-Hun Lee

COURSES TAUGHT

PHY103, Quantum Mechanics I, Fall semester;
PHY203, Quantum Mechanics II, Winter semester.

PARTICIPATION IN COMMITTEES

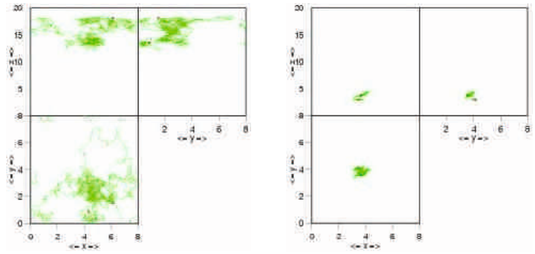
Internal: Computer In-charge; Students' Curriculum and Research Evaluation committee.

Anita Mehta
Professor

Statistical physics of complex systems in general. Particularly:

- Spatiotemporal heterogeneities in granular media.
- Models of synaptic plasticity.
- Encodings of NP-complete problems.
- Agent-based models of complex systems.
- Data analysis of eye tracking experiments in cognitive science.

With J. M. Luck (I PhT Saclay) I have obtained the full phase diagram of a column of grains in the presence of frustration. We have also constructed a model of metaplasticity in synapses which is currently being investigated. With P. F. Stadler and K. Klemm (Leipzig), I have investigated the facilitating role of encodings in number partitioning. With N. N. Thyagu (SNBNCBS and Rutgers) I have looked at the role of networks in a winner-takes-all model, and how advantageous networking leads to better survival probabilities. With G. Mahajan (SNBNCBS and Bremen), I have looked at the effect of self-interaction in models of competitive learning. With D. P. Shinde (SNBNCBS) I am analysing data on eye-tracking experiments with a view to exploring possible scale-invariance in their time traces.



Simulation results for the trajectories of a single particle (initially located in the middle of a box of grains) in the *x* - *y*, *y* - *z*, and *x* – *z* planes, as it exhibits dynamical heterogeneity via its spatial explorations. In the figure on the left, the particle inhabits the upper part of the box, whereas in the figure on the right, it has become localized in the lower regions. (From A. Mehta, G. C. Barker and J. M. Luck, PNAS, 2008, **105,** 8244).

PUBLICATIONS IN JOURNALS

A. Mehta, G. C. Barker and J. M. Luck, *Heterogeneities in granular materials*, Physics Today, 2009, **62**, 40.

SUPERVISION OF STUDENTS

Ph. D. Students: D. P. Shinde; **Project Students:** Swarnabha Sen, Debashis De Munshi.

POST DOCTORAL RESEARCHERS

Nirmal Thyagu, Gaurang Mahajan.

LECTURES DELIVERED

1. *Conflict management for sustainable development*, 14th Conference on Science, Statistics and Public Policy, Herstmonceux Castle, UK, April 2009.
2. *Heterogeneities in granular media*, Theory of Condensed Matter Group seminar at Cavendish Laboratory, Cambridge, UK, June 2009.

ACADEMIC VISITS

Institut de Physique Théorique, CEA Saclay, France (May - July 2009)

COURSES TAUGHT

PHY292, Project based course, Fall Semester

PARTICIPATION IN COMMITTEES

External: On Editorial Boards of **Granular Matter** and **CHAOS**; On Organizing Committee of Powders and Grains, Colorado (2009).

SPONSORED PROJECTS

DST project on Generativity of Cognitive Networks (continuing since 2009).

Bimalendu Bhusan Bhattacharya

INAE Distinguished Professor

- Audiomagneotelluric (AMT) and Magneotelluric (MT) studies to model the geothermal reservoir in Bakreswar Hot Spring region, Eastern India.
- Application of Particle Swarm Optimization (PSO) for electrical and electromagnetic methods in geophysics.

Phase tensor analysis of the AMT data of Bakreswar Hot Spring (BHS) shows that the region is broadly 2D. Rapid Relaxation Inversion (RRI) for both transverse-electric (TE) and transverse-magnetic (TM) modes has been carried out to obtain resistivity image of the subsurface. AMT results indicate that the location of the geothermal reservoir is deep and lies far beyond in the northwestern direction from the Hot Spring location.

Particle Swarm Optimization (PSO) has been applied to Self-potential (SP) data over near subsurface geophysical features. The result shows that it is an improvement over Very Fast Simulating Annealing (VFSA) and other established non-linear inversion techniques. Fig. 1 shows self-potential anomaly over KTB-Borehole, Germany along with amplitude of 2D analytical signal measured (AASM) anomaly and amplitude of 2D analytical signal computed (AASC).

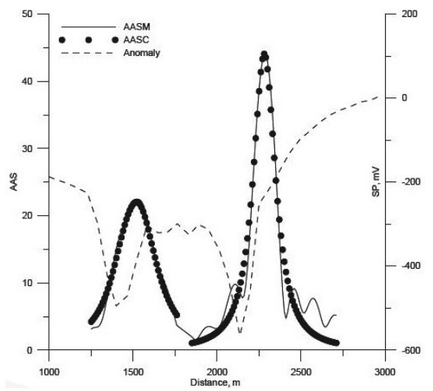


Fig. 1: Self-potential anomaly profile (broken line) over KTB-Borehole, Germany along with amplitude of 2D analytical signal measured (AASM) (solid line) and amplitude of 2D analytical signal computed (AASC) (solid circle).

LECTURES DELIVERED

Tsunami - a secondary effect of earthquake in dynamic Earth. Delivered at Central Mining and Fuel Research Institute (CMFRI), Dhanbad, March 5, 2010 (Science Day lecture).

STUDENTS

Summer Students: Arnab Ghosal, Vishal Das.

Biswajit Chakraborty

Associate Professor

- Rotational or Lorentz symmetries in Noncommutative Quantum theories. Although these symmetries can be restored through Drinfeld twist in a Hopf algebraic setting, it is difficult to define a rotationally invariant potential, particularly in three dimension. I worked on this problem by twist deforming the enveloping algebra, obtained from Heisenberg algebra. Besides, I also worked on the impact of Noncommutativity, arising from Berry curvature, on Cooper pairs in certain superconducting materials.

The important set of interesting results that we have obtained are summarised as follows: We have shown that whenever the coproduct is deformed through say, Drinfeld twist the adjoint action should also be deformed, thereby defining the deformed brackets, which closes if the original Lie algebra generators themselves are deformed and appropriately valued in the corresponding enveloping algebra.

These deformed brackets and the generators have the advantage that the noncommutative coordinates now transform covariantly under rotation, unlike their un-deformed counterparts and therefore should be used in constructing rotational invariant potentials.

Starting with certain standard rotationally invariant potentials in commutative case, we show, however, that these symmetries do not survive the deformation and become anomalous.

We have extended this analysis to supersymmetric case through an appropriately defined abelian twist and shown how this can lead to Cliffordization of the odd variables.

We have shown that the Cooper pairs can become relatively unstable and fragile, in presence of noncommutativity, in certain superconducting materials where the noncommutativity can arise out of the Berry curvature.

PUBLICATIONS IN JOURNALS

R. Banerjee, B. Chakraborty, S. Ghosh, P. Mukherjee and S. Samanta, *Topics in Noncommutative Geometry Inspired Physics*, Found. Phys., 2009, **39**, 1297.

SUPERVISION OF STUDENTS

Ph. D. Students: Debabrata Sinha, Biswajit Paul

LECTURES DELIVERED

1. *Spectrum of a particle, confined in an infinite spherical well potential in the Noncommutative plane*, National Institute of Theoretical Physics (NITheP), Stellenbosch, South Africa, May, 2009.
2. *Entanglement in Noncommutative Quantum System*, National Institute of Theoretical Physics (NITheP), Stellenbosch, South Africa, May, 2009.
3. *Deformed Hopf algebra in Noncommutative Quantum Mechanics and SO(3) rotation generators*, National Institute of Theoretical Physics (NITheP), Stellenbosch, South Africa, May, 2009.
4. *Entanglement in Noncommutative Quantum System*, Physics Department, IIT, Kanpur, India, August, 2009.
5. *Entanglement in Noncommutative Quantum System*, CBPF, Rio de Janeiro, Brazil, October, 2009.
6. *Entanglement in Noncommutative Quantum System*, Department of Mathematical Physics, Universidade de Sao Paulo (USP), December, 2009.
7. *Entanglement in Noncommutative Quantum System*, Universidade Federal do ABC (UFABC), Santo Andre, SP, December, 2009.
8. *Entanglement in Noncommutative Quantum System*, Physics Institute, Universidade Federal do Rio de Janeiro(UFRJ), Brazil, December, 2009.

ACADEMIC VISITS

1. CBPF, Rio de Janeiro, Brazil, under TWAS-UNESCO associateship appointment, Oct-Dec 09.
2. CHEP, IISc, Bangalore for collaborative work with Prof. F. G. Scholtz and Dr. S. Vaidya, February, 2010.
3. Lecture series in the International Workshop on 'Path Integrals, Coherent States and Noncommutative Geometry', at NITheP, Stellembosch, South Africa, May, 2009.
4. Participation at the national meeting on 'Nocommutative Quantum Field Theory' held at I. I. T. Kanpur, July-Aug., 2009.

PARTICIPATION IN COMMITTEES

Internal: co-organizer of the BOSEFEST 2010.

SPONSORED PROJECTS

Indo-South African project entitled '*Astrophysical and Cosmological implications Noncommutative space-time*' was approved for implementation in 2009.

Jayanta Kumar Bhattacharjee

Distinguished Professor

- *Statistical physics:* problems involving rare events, applications have been made in the field of fluid turbulence and fluctuation dissipation relations.
- *Nonlinear dynamics:* problems involving convective instability, astrophysical flows and two component Bose condensates.

A significant number of problems in Statistical Physics involve the dominance of rare events. In all such cases the Gaussian distribution is not a valid starting point. It is our contention that the simplest situation exhibiting large devaiation - the coin toss - can serve as a reasonable first approximation for such problems. With this in mind, we have explored the problem of multiscaling in fluid turbulence. The physicist's interest in turbulence stems from the short distance scaling behaviour of the velocity field correlations. One considers the difference of the same component of the velocity vector at two nearby spatial points, at a distance *r* apart.The moments of different powers of the velocity difference grows with spatial separation for small values of *r*. Scaling means the growth occurs as some characteristic power of *r*. The exponent for the scaling behaviour of the moment of *n*-th power of the velocity difference is a linear function of *n* in a simple scaling picture. The multiscaling behaviour implies a complicated function of *n*. The simple scaling relied on a picture developed by Kolmogorov. In this picture the steady state is characterized by a constant rate of energy input at large distance scales and an equal rate of dissipation by molecular velocity at short distance scales. It is assumed that the energy cascades through the intermediate scales without fluctuation. Multiscaling occurs if this assumption breaks down and the energy dissipation shows fluctuations at length scale *r*. These fluctuations are the rare events and we have modeled them by the large deviation form of the coin toss distribution for a biased coin. The resulting multiscaling exponents come out quite close to the accepted values and hence our claim that the coin toss is the 'Gaussian model' of phenomena involving rare events.

PUBLICATIONS IN JOURNALS

1. J. K. Bhattacharjee, A. Bhattacharya, T. K. Das, A. K. Ray, *Quasi viscous accretion flow- I. Equilibrium conditions and asymptotic behaviour,* Monthly Notices of The Royal Astronomical Society, 2009, **398**, 841.
2. K. S. Das and J. K. Bhattacharjee, *Universality in crossover function for convection in fluids with a free surface*, Physica B, 2009, **404**, 2285.
3. S. Chakraborty, A. Saha and J. K. Bhattacharjee, *Large deviation theory for coin tossing and turbulence*, Phys. Rev. E, 2009, **80**, 056302.
4. J. K. Bhattacharjee, I. Iwanowski and U. Kaatze, *Bulk viscosity universality and scaling function near the binary liquid consolute point,* J. Chem. Phys., 2009, **131**, 1745002.
5. D. Banerjee and J. K. Bhattacharjee, *Renormalisation group and Lienard system of differential equations*, J. Phys. A, 2010, **43**, 062001.
6. D. Banerjee and J. K. Bhattacharjee, *Analyzing jump phenomena and stability in non linear oscillators using renormalization group argument,* Am. J. Phys, 2010, **78**, 142.
7. S. Biswas, J. K. Bhattacharjee, D. Majumdar, K. Saha and N. Chakravarty, *Casimir force on an interacting Bose condensate,* J. Phys. B, 2010, **43**, 085305.

SUPERVISION OF STUDENTS

Ph. D. Students: Arnab Saha, Raka Dasgupta, Amartya Sarkar, Arghya Datta, Sukla Pal; **Project Students:** Sukla Pal, Debasish De Munshi.

POST DOCTORAL RESEARCHER

Dr. Analabha Roy

STUDENTS' PUBLICATIONS

1. Arnab Saha, Sourabh Lahiri, A. M. Jayannavar, *Entropy production theorems and some consequences*, Phys. Rev. E, 2009, **80,** 011117.
2. Raka Dasgupta, *Stability of the breached pair state for a two-species fermionic system in the presence of Feshbach resonance*, Phys. Rev. A, 2009, **80,** 063623.
3. S. Chakraborty, M. H. Jensen, Amartya Sarkar, *Two Dimensionalisation of three dimensional turbulence in shell models*, Euro. Phys. Jour. B, 2010, **73**, 447.

LECTURES DELIVERED

1. *Casimir Force*, IISc Bangalore, 75 years of physics department, May, 2009.
2. *Is Turbulence as Simple as Tossing a Coin*, Mech. Engg. Colloquium IIT Kanpur, September, 2009.
3. *Spherical model of turbulence*, Golden Jubilee Turbulence Workshop IIT Kanpur, December, 2009.
4. *Bose Einstein Condensates*, International School on Colds Atoms, IACS, Kolkata, January, 2010.
5. *Centre or Limit Cycle? RG as a probe*, J. C. Bose memorial lecture at Non equilibrium Statistical Physics Workshop, Golden Jubilee Celebration, January, 2010.
6. *Lectures on Stochastic Systems (6),* SERC School on Nonlinear Dynamics, Delhi, December, 2009.
7. *Pattern Formation in Nature*, Scottish Church College memorial lecture, September, 2009.

COURSES TAUGHT

PHY104, Electromagnetism (½), Fall semester; PHY201, Statistical Physics, Winter semester; PHY 404, Advanced Statistical Mechanics, Winter semester; Maths. M. Sc., Non linear Dynamics at Dept of Applied Maths, Calcutta University, Sept-Oct 2009; M. Phil. 2, Statistical Physics at Vivekananda University, Sept-Nov 2009; Maths M. Sc., Maths. Dept. Lady Brabourne College, Non linear Dynamics, Jan-March 2010.

PARTICIPATION IN COMMITTEES

a. **External:** DST PAC; DST West Bengal, Executive Committee.

b. **Internal:** Consultative Advisory Committee (CAC).

Manu Mathur
Associate Professor

- Mathematical Physics: We define SU(N) irreducible Schwinger bosons such that they carry all the symmetries of SU(N) Young tableaues. In terms of these all SU(N) irreducible representations are as simple as SU(2) irreducible representations in terms of SU(2) Schwinger bosons.
- SU(3) Lattice Gauge Theory: We reformulate SU(3) lattice gauge theory in terms of SU(3) prepotential operators which are SU(3) irreducible Schwinger bosons defined above.

SU(3) Hamiltonian lattice gauge theory in terms of SU(3) prepotentials: In order to reformulate lattice gauge theories in terms of Wilson loops without any gauge degrees of freedom, it is essential to solve all the Mandelstam constraints. The solutions of Mandelstam constraints are not known because they are highly non-local and therefore difficult to solve in the standard Kogut Susskind Hamiltonian formulation. On the other hand, in the prepotential formulation of lattice gauge theories proposed by us, the Mandelstam constraints become completely local and solvable. The explicit solutions have been obtained for SU(2) gauge group. In order to solve the Mandelstam constraints in lattice quantum chromodynamics, we completely reformulate SU(3) lattice gauge theory in terms of SU(3) prepotential operators leading to Mandelstam constraints which are completely local. We discuss the construction of all possible linearly independent SU(3) loop states which solve the SU(3) Mandelstam constraints. This prepotential formulation has enlarged SU(3)×U(1)×U(1) gauge invariance under which the prepotential operators transform like matter fields.

SU(N) Irreducible Schwinger Bosons: We construct SU(N) irreducible Schwinger bosons satifying certain SU(N) invariant U(N-1) contraints which implement the symmetries of SU(N) Young tableaues. As a result all SU(N) irreducible representations are simple monomials of (N-1) types of SU(N) irreducible Schwinger bosons. Further, we show that these representations are free of any multiplicity problems. Thus all SU(N) representations are made as simple as SU(2). This work is SU(N) extension of the SU(3) work done last year.

PUBLICATIONS IN JOURNALS

1. Ramesh Anishetty, Manu Mathur, Indrakshi Raychowdhury, *Irreducible SU(3) Schwinger Bosons*, Journal of Mathematical Physics, 2009, **50**, 053503.
2. Ramesh Anishetty, Manu Mathur, Indrakshi Raychowdhury, *Prepotential formulation of SU(3) lattice gauge theory*, Journal of Physics A, 2010, **43**, 035403.

SUPERVISION OF STUDENTS

Ph. D. Students: Indrakshi Raychowdhury

PARTICIPATION IN COMMITTEES

Internal: Chairman: Library Committee, Acting Librarian, Member: Hindi Implementation Committee.

Makhtedar Sanjay Kumar

Reader

- Semiclassical aspects of scattering and bound states in the attractive inverse square potential with a hard core.
- Statistical properties of light transmitted by a moving diffuser.

In the first problem, we have studied the quantum-classical correspondence in the case of a particle moving in an inverse-square potential. To regularize the problem we have considered a spherical core at the origin. The closed trajectories of the particle in the case of bounded motion exhibit interesting flowery shapes. The signatures of such bounded orbits in the quantum mechanical case are intriguing and we have been trying to understand these. The optical analogy (transition from wave to geometrical optics) is also interesting.

COURSES TAUGHT

PHY301, Quantum Mechanics III, Winter semester;
PHY204, Electromagnetic Theory II, Fall semester.

Partha Guha

Associate Professor

- Euler-Poincaré flows on infinite-dimensional groups and integrable systems.
- Symmetries and dynamical aspects of nonlinear ordinary differential equations.
- Topological and Hamiltonian aspects of fluid dynamics.
- Nonholonomic deformation of integrable systems.

We got several interesting results in various directions. (1) We extend the method of the Kupershmidt nonholonomic deformation to two component KdV equation and in this process we show that Kupershmidt's deformation is an infinite-dimensional analogue of the Euler-Poincare-Suslov method. Actually nonholonomic geodesic flows of left-invariant metrics are reduced to the Euler-Poincare-Suslov equations on the corresponding Lie algebras. (2) We say that for any differential equation a function is a first integral if the function is constant when evaluated along any solution of the differential equation. In various papers we obtain first integrals of several nontrivial nonlinear ordinary differential equations. We apply different methods to compute these first integrals. First integrals play several crucial roles in studies of dynamical systems. First integrals may confine the solution to a bounded region of phase space. In many systems, the first integrals are the only measures of the performance of the numerical method. (3) A classical dynamical system is called isochronous if it features in its phase space an open, fully dimensional sector where all its solutions are periodic in all their degrees of freedom with the same, fixed period. The hunting of isochronous systems is now a flourishing activity and certainly we do not want to stay from this activity. Using Jacobi's last multiplier we propose a method to identify isochronous systems. We propose a new reduction of real polynomial Cherkas system. (4) Around 1900, Paul Painlevé studied second order differential equations with no movable singularities. He found that up to certain transformations, every such equation of the form $y''=R(y',y,t)$ (with R being a rational function) can be put into one of fifty canonical forms (listed in Ince 1956). We use the Jacobi last multiplier to compute the Lagrangians of the Painlevé-Gambier type equations.

PUBLICATIONS IN JOURNALS

1. Partha Guha, *Nonholonomic deformation of generalized KdV-type equations,* J. Phys. A, 2009, **42**, 345201.
2. Sagar Chakraborty and Partha Guha, *On dynamics of velocity vector potential in incompressible fluids*, Phys. Letts A, 2009, **373**, 3764.
3. A. Ghose Choudhury, Partha Guha and Barun Khanra, *On the Jacobi last multiplier, integrating factors and the Lagrangian formulation of differential equations of the Painlevé-Gambier classification*, J. Math. Anal. Appl., 2009, **360**, 651.
4. J. F. Carinena, P. Guha and M. Ranada, *Higher-order Abel equations: Lagrangian formalism, first integrals and Darboux polynomials,* Nonlinearity, 2009, **22**, 2953.
5. A. Ghose Choudhury, Partha Guha and Barun Khanra, *Determination of elementary first integrals of a generalized Raychaudhuri equation by the Darboux integrability method*, J. Math. Phys, 2009, **50**, 102502.
6. Partha Guha, *Virasoro action on pseudo-differential symbols and (noncommutative) supersymmetric peakon type integrable systems*, Acta Appl. Math., 2009, **108**, 215.
7. A. Ghose Choudhury and P. Guha, *Isochronous Cases of the Cherkas System and Jacobi's Last Multiplier*, J. Phys. A, 2010, **43**, 125202.
8. P. Guha, A. Ghose Choudhury and B. Khanra, *On generalized Sundman transformation method, first integrals, symmetries and solutions of equations of Painlevé-Gambier type*, Nonlinear Anal. 2010, **72**, 3247.

SUPERVISION OF STUDENTS

Ph. D. Students: Barun Khanra

LECTURES DELIVERED

1. *Metriplectic structure in dissipative dynamics*, Department of Mathematics, Capital Normal University, November, 2009.
2. *Current trends in mathematical physics*, Yadava College, Madurai, November 2009.
3. *Nonholonomic deformations of KdV type equations and Euler-Poincar\'e-Suslov method*, Colloquium talk at Centre for Nonlinear Dynamics, Bharathidasan University, November 2009.
4. *Integrable Nonholonomic Dynamics on Loop Groups*, National Seminar on interdisciplinary problems in nonlinear dynamics: computational and other techniques, February 2010.

ACADEMIC VISITS

1. Mathematics in the Sciences, Leipzig, Germany Mathematics in the Sciences, Leipzig, Germany, May - July 2009.
2. Departamento de Fisica Teorica, Universidad de Zaragoza, July, 2009.
3. Department of Mathematics, Capital Normal University, Beijing, November, 2009.

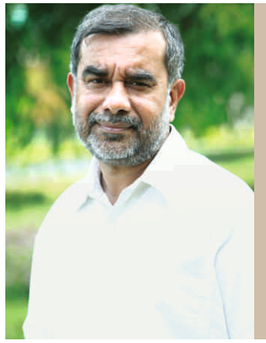
COURSES TAUGHT

PHY404, Advanced Mathematical Methods, Winter semester.

PARTICIPATION IN COMMITTEES

External: Editorial Board member of Advances in Mathematical Physics, Hindwai.

Internal: SCRE Committee and Joint co-coordinator JEST 2010.



Rabin Banerjee

Professor

- Worked on aspects of black holes. Their thermodynamic properties were studied in details.
- Lagrangian and hamiltonian analysis of Poincare gauge theories was done.
- Yang Mills theory on supersphere was developed.
- A generalised uncertainty principle was derived.

A statistical formulation of gravity was presented leading to a general form of the Smarr formula. A new type of embedding was discussed that could simultaneously analyse Hawking and Unruh effects for the most general gravity theory.

Recent approaches to noncommutative gravity, based on the coherent state formulation, were shown to be directly related to the Voros product rather than the usual Weyl Wigner star product.

Off shell generators for three dimensional models of gravity including torsion, Chern-Simons and cosmological terms were constructed.

PUBLICATIONS IN JOURNALS

1. Rabin Banerjee and Bibhas Ranjan Majhi, *Statistical origin of gravity*, Phys. Rev. D, 2010, **81**, 124006.
2. Rabin Banerjee and Sumit Ghosh, *Generalised Uncertainty Principle, Remnant Mass and Singularity Problem in Black Hole Thermodynamics*, Phys.Lett.B, 2010, **688**, 224.
3. Rabin Banerjee and Bibhas Ranjan Majhi, *A New Global Embedding Approach to Study Hawking and Unruh Effects*, Phys. Lett. B, 2010, **690**, 83.
4. Rabin Banerjee, Sunandan Gangopadhyay, Pradip Mukherjee and Debraj Roy, *Symmetries of the general topologically massive gravity in the hamiltonian and lagrangian formalisms*, JHEP, 2010, **2010**, 075.
5. Rabin Banerjee, Sunandan Gangopadhyay and Sujoy Kumar Modak, *Voros product, Noncommutative Schwarzschild Black Hole and Corrected Area Law*, Phys. Lett. B, 2010, **686**, 181.
6. Rabin Banerjee, Biswajit Chakraborty, Subir Ghosh, Pradip Mukherjee and Saurav Samanta, *Topics in Noncommutative Geometry Inspired Physics*, Found. Phys, 2009, **39**, 1297.
7. Rabin Banerjee and Sujoy Kumar Modak, *Quantum Tunneling, Blackbody Spectrum and Non-Logarithmic Entropy Correction for Lovelock Black Hole*, JHEP, 2009, **2009**, 073.
8. Rabin Banerjee, Bibhas Ranjan Majhi and Elias C. Vagenas, *Quantum tunneling and black hole spectroscopy*, Phys. Lett. B, 2010, **686**, 279.
9. Rabin Banerjee and Shinichi Deguchi, *A Superspace formulation of Yang-Mills theory on sphere*, J.Math. Phys., 2010, **51**, 052301.

SUPERVISION OF STUDENTS

Ph. D. Students: Saurav Samanta, Shailesh G. Kulkarni, Bibhas Ranjan Majhi, Sujoy Kumar Modak, Debraj Roy, Sumit Ghosh, Dibakar Roychowdhury; **Project Students:** Puja Dutta.

STUDENTS' PUBLICATIONS

1. Debraj Roy, *The Unruh thermal spectrum through scalar and fermion tunneling*, Phys. Lett. B, 2009, **681**, 185.
2. Bibhas Ranjan Majhi, *Hawking radiation and black hole spectroscopy in Horava-Lifshitz gravity*, Phys. Lett. B, 2010, **686**, 49.

LECTURES DELIVERED

1. *Hawking radiation, covariant anomalies and boundary conditions*, Univ. of Cologne, Germany, May, 2009.
2. *Black-hole thermodynamics*, I. I. T. Patna, March, 2010.
3. Introduction to constrained dynamics, West Bengal State Univ. Barasat, August, 2009.

ACADEMIC VISITS

1. Univ. of Helsinki, Finland, April, 2009.
2. Univ. of Cologne, May-June, 2009.

COURSES TAUGHT

PHY101, Mathematical methods I, Winter semester; QFT 1, Intoduction to quantum field theory (Special paper for M.Sc., West Bengal State Univ., Barasat), Fall semester.

Samir Kumar Paul
Reader

- Quantum Gravity in 2+1 dimensions.
- Some aspects of Geometric Quantization.
- Quantum Spin Systems in two dimensions.

A field theoretic formulation of vortex (anti-vortex) excitations in XY- anisotropic spin ½ quantum Heisenberg ferromagnet on a two dimensional square lattice , has been established . This holds in the medium wavelength regime and the formulation is similar to that of the antiferromagnetic case. This is one step forward to achieve a physical realization of meronic type of excitations in the two dimensional spin models. Our main motivation has been theoretical determination of the dynamical structure factor for low dimensional quantum anti-ferromagnets and ferromagnets , particularly in view of inelastic neutron scattering experiments. The work is done in collaboration with Dr. Ranjan Chaudhury (SNBNCBS).

We have constructed the finite dimensional Hilbert space of a 2+1 quantum gravity with a negative cosmological constant and a Barbero Immirzi-like parameter, for a toric spatial foliation . An explicit construction of the wave functions is done . The dimension of the Hilbert space depnds on the Barbero Immirzi-like parameter in an interesting way. This is done in collaboration with Rudranil Basu, SNBNCBS .

PUBLICATIONS IN JOURNALS

R. Chaudhury and S. K. Paul, *Physical realization and possible identification of topological excitations in quantum Heisenberg anti-ferromagnet on a two dimensional lattice*, European Physical Journal B, 2009, **69**, 491.

PARTICIPATION IN COMMITTEES

a. **External:** Moderation Board for 2nd and 3rd semester exams of M. Sc., Physics Programme by Bose Institute and St. Xavier's College.

b. **Internal:** Ph. D. Thesis Committees of some students.

SUPERVISION OF STUDENTS

Ph. D. Student: Rudranil Basu (joint: Parthasarathi Majumdar, SINP); **Project Student:** Atanu Nath.

Subhrangshu Sekhar Manna
Professor

- Designing an optimal network for passenger traffic.
- A stochastic Self-organized critical network for Ecological evolution.
- Weighted trade network in a model of mutual trades.

The optimal solution of an inter-city passenger transport network has been studied using Zipf's law for the city populations and the Gravity law describing the fluxes of inter-city passenger traffic. While the total traffic cost decreases, the total wiring cost increases with the density of links and at a certain link density the cost is optimal. Using this model the air-route network of India has been generated and an one-to-one comparison of the nodal degree values with the real network has been made (Fig. 1).

A stochastic version of the Bak-Sneppen (BS) model of ecological evolution has been studied. In this model, apart from the minimally fit site only one site is randomly selected from the neighboring sites in an annealed fashion. The critical behavior of this model is found to be the same as the BS model. However unlike BS model on the scale-free graphs the critical fitness value is non-zero but the critical behavior is mean-field like. We conjecture that our model defined on any arbitrary graph with any small branching ratio greater than unity will lead to a self-organized critical state.

The trade network among a collection of traders has been studied. Following the Chatterjee, Chakrabarti, Manna model of Econophysics here each trader saves a fraction of his wealth and makes bipartite transactions. The preferential selection rule distinguishing the rich and poor is incorporated using a pair of continuously tunable parameters. Numerical evidence shows that the associated critical exponents are continuous functions of the parameters. However, the wealth distribution has been observed to follow the well-known Pareto law robustly for all positive values of the tuning parameters.

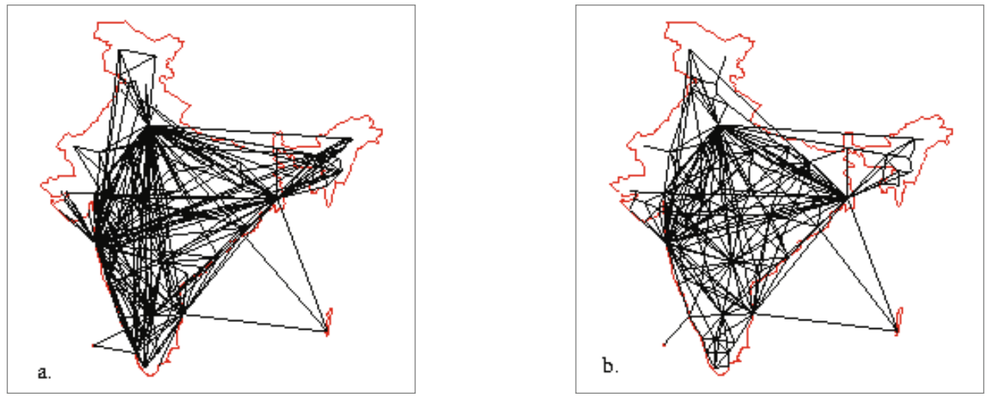


Fig. 1: Air route connection network of 80 civilian airports in India

(a): The real network of 265 links connecting different airports by all 12 airline companies active in India.

(b): The network obtained from our model using 2001 census data for the city populations of the associated Indian cities and using the Gravity law with $\alpha=\beta=1$ and $\theta=2$. This network also has 265 links.

PUBLICATIONS IN JOURNALS

1. Abhijit Chakraborty and S. S. Manna, *Weighted trade network in a model of preferential bipartite transactions*, Phys. Rev. E, 2010, **81**, 016111.
2. S. S. Manna, *Branching process in a stochastic extremal model*, Phys. Rev. E, 2009, **80**, 021132.
3. A. K. Nandi, K. Bhattacharya and S. S. Manna, *An optimal network for passenger traffic*, Physica A, 2009, **388**, 3651.

SUPERVISION OF STUDENTS

Ph. D. Students: Kunal Bhattacharya, Anjan Nandi, Abhijit Chakraborty.

LECTURES DELIVERED

1. *Explosive Percolation,* International Conference on Recent Advances in Physics 2010, University of Dhaka, Dhaka, Bangladesh, 29 March, 2010.
2. *International Trade Network*, Max Planck Institute for the Physics of Complex Systems, Dresden, April, 2010.
3. *Explosive Percolation,* UGC Sponsored one day seminar at Jogesh Chandra College, Kolkata, February, 2010.

ACADEMIC VISITS

Max Planck Institute for the Physics of Complex Systems, Dresden, Germany, Feb 2009 - Feb 2010.

COURSES TAUGHT

PH205, Computational Methods II (half course), Winter semester.

PARTICIPATION IN COMMITTEES

a. **External:** Member of the Advisory Committee of IUPAP, CCP2010: Conference on Computational Physics 2010, Trondheim, Norway, June 23-26, 2010.

b. **Internal:** Member of the committee of High Performance Computing.

Subodh Kumar Sharma
Emeritus Scientist

- Development of theoretical methods for Biomedical tissue characterization using light and ultrasound scattering.
- Study of interstellar dust extinction.

In the context of development of theoretical methods for a biomedical soft tissue characterization, we have studied the phase function of a biomedical tissue within the framework of a fractal distribution model. It was demonstrated that the size distribution of the scatterers in the tissue can be deduced from the knowledge of the slope of the near forward phase function. This could be a potentially useful method for early detection of cancer of soft tissues.

Frequency and size distribution dependence of extinction spectra for infrared, visible, ultra violet and far ultra violet regions of electromagnetic spectrum was analysed for astronomical silicate and graphite grains. Analytic formulas were obtained.

PUBLICATIONS IN JOURNALS

1. A. K. Roy, S. K. Sharma and R. Gupta, *A study of frequency and size distribution dependence of extinction for astronomical silicate and graphite grains*, Journal of Quantitative Spectroscopy and Radiative Transfer, 2009, **110**, 1733.
2. A. K. Roy, S. K. Sharma and R. Gupta, *Frequency and size distribution dependence of visible and infrared extinction for astronomical silicate and graphite grains,* Journal of Quantitative Spectroscopy and Radiative Transfer, 2010, **111**, 795.

LECTURES DELIVERED

Frequency and size distribution dependence of extinction for astronomical silicates and graphites, Vainu Bappu Observatory, Kavalur (Workshop on Physics and Astrophysics of Dust II: Probe, formation, September 2009).

ACADEMIC VISITS

IUCAA, Pune, June-July 2009

SPONSORED PROJECTS

Interpretation of observed extinction in the optical-UV region from TAUVEX & ASTROSAT-UVIT satellite

FACILITIES

LIBRARY

ABOUT LIBRARY

Library of Satyendra Nath Bose National Centre for Basic Sciences was established in the year 1986. Since the inception of the centre, the library took an active part in the promotion of teaching and learning activities. The library has been providing information support to all the faculty members, researchers and numerous professionals working on basic sciences throughout the country. Centre's library is a special library having rich collection of books and journals on basic sciences.

LIBRARY COLLECTION

The Library has a collection of more than 10700 books and 8000 bound volumes of journals. The Library subscribes a good number of reputed journals. In addition, being a member of National Knowledge Resource Consortium and also INDEST and FORSA consortia, library can access a wide range of important online journals. The library is also equipped with databases including web of science. Apart from books on basic sciences, the library has a varied collection of books on Hindi and Bengali literature, history, environmental sciences etc. There is also a wide collection of audio-visual materials. The Library has a separate magazine and newspaper reading section. For this section 25 popular magazines and 13 daily newspapers in different languages are subscribed. The library is enriched with a valuable archive of Satyendra Nath Bose. This archive includes rare books from his personal collection.

LIBRARY HOURS

The normal working hours of the library is 9:00 AM to 5:30 PM everyday except Sundays and national holidays. However, the library remains open to its members for reading purpose from 8:00 AM to 12:00 at night except Sundays and holidays.

SECTIONS AND ACTIVITIES

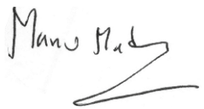
The library consists of the following important units:

- *Books Section:* Looks after the processing and maintenance of books.
- *Journals Section:* Looks after the renewal, processing, online access of journals and their maintenance.
- *Readers' Service Section:* This section takes care of all the library users and provides necessary services to them.
- *IT Section:* This unit is responsible for maintenance of Library automation system, online journals, computers, scanner, photocopy machines as well as e-documents available in SNB Library.
- *Administration Unit:* This unit looks after the overall library operation i.e. coordination with other sections of the Institute, maintenance of official records, correspondence, stock taking, correspondence with publishers and vendors etc.

LIBRARY SERVICES

- *Document Lending service:* Each member is entitled to issue 6 books and 2 bound volumes of journals at a time.
- *Reference service:* Library has a separate Reference collection with encyclopaedias, dictionaries, atlases, yearbooks etc.
- *OPAC & Web OPAC:* Library offers Online Public Access Catalogue (OPAC) and Web OPAC for accessing the library collection online.

- *Internet facility:* Library is well equipped with a good number of computers with internet connection and wireless networking facility for laptop users. Users can use the computers for any kind of academic purposes.
- *Reprographic Service:* Library has two photocopy machines. In addition, there are some laser printers including one colour laser printer.
- *Bibliometric Services:* Library helps to prepare various reports specially usage statistics, citation analysis, calculation of h-index of users whenever required.
- *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, Kolkata.



Manu Mathur
Acting Librarian

COMPUTER CENTRE

The Computer Centre on the third floor serves the computational needs of the members of Satyendra Nath Bose National Centre for Basic Sciences. At the end of the academic year 2009-2010, there were about 200 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 are being augmented.

The E-mail accounts are held in a mail server of the same specifications as above, which also hosts the webpages. The Centre has a 100Mbps internal network with an 8Mbps external (internet) link. In addition wireless facilities are available at several locations. Several laser printers are available for meeting printing needs.

Computational facilities include a parallel computing cluster built by SuperMicro was installed, containing 32 nodes (256 processors). Each node has four quad-core processors, 16GB RAM and 500 GB hard disk. In addition the cluster has a 2 Terabyte Network Access Storage device. Three smaller clusters, bought under individual research projects funded by the DST, were 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 is posted. The server also hosts web pages for on line booking of lecture halls and guest house internally. This year the Computer Centre also implemented on line admission application and online registration for new students. In addition all forms related to various administrative procedures are available in a downloadable format.

A senior computer engineer, Mr. Amitava Ghosh, and two junior computer engineers, Mr. Anjan Mukherjee and Ms. Dipanwita Das, help in the maintenance of the computers and networking of the Centre.

Priya Mahadevan
In-charge, Computer Centre

PROJECT CELL

The project cell was formed vide the order R1/Admn/Office Order/117 dated April 17, 2008. Its scope of work is basically to keep a central record of a project from its inception to completion. It comes into play whenever a new project is submitted to it, for getting endorsement from the Director. It assigns a unique number (PCR) to it for reference throughout its life. After the Director's signature is obtained, it is returned to the PI for his/her submission to the funding agency. At the same time a hard copy of the project proposal is kept in its file in the project cell. Website is: http://www.bose.res.in/~prjcell/.

After the project is sanctioned, it is given to the cell for further action. For example it coordinates in recruiting the manpower for the project – from advertisement stage till the appointment of the personnel. PCR number is needed to obtain financial concurrence to purchase project related capital equipments.

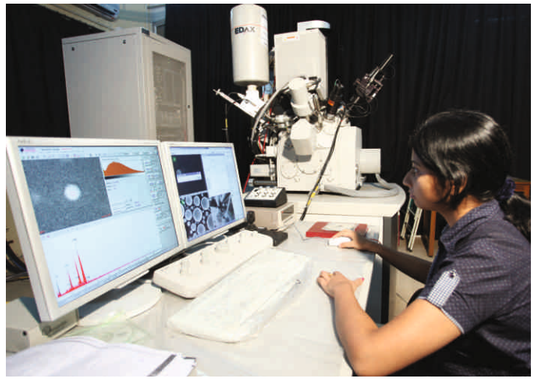
The following table summarizes the details of the externally funded projects in the centre, for the last five years.

Year	No. of projects	Amount Received (₹)
2005-06	16	65,26,723
2006-07	21	5,10,87,471
2007-08	25	6,07,13,160
2008-09	27	1,15,61,417
2009-10	39	5,51,44,887

The external funding agencies include DST, CSIR, DAE-BRNS, ISRO, Indo-German, Indo-Swedish, INAE, Indo-French, DST and SA, DST & European Union, DST-UKIERI among others. In addition there are 4 internally funded projects running at present.

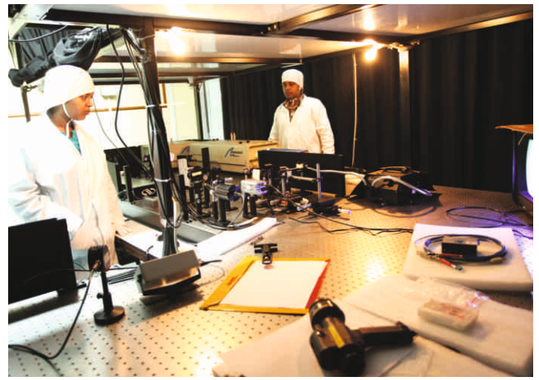
There are 13 project students/assistants/trainees and 6 RAs and 5 PDFs appointed in the projects.

Initially there were 5 members (3 faculty members and 2 members from administration for accounts related activities and secretarial activities) in the cell. Since this fiscal year, a representative each from the Office of Dean (F) and Academic Programmes has also been inducted for better coordination among the offices.



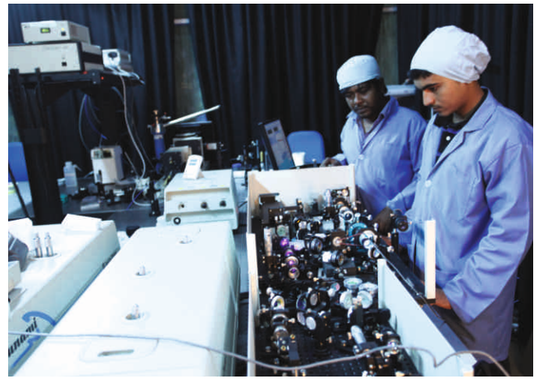
The following projects were running during 2009-2010 :

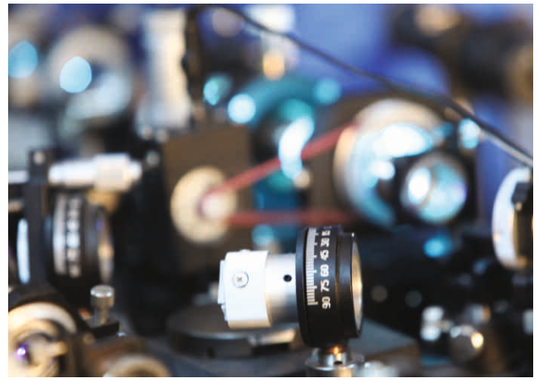
1. *Unit on Nano Science & Technology (UNANST)* by Prof. A. K. Raychaudhuri, funded by DST.
2. *Analytical Modeling and numerical simulations of the quasi periodic oscillations of black hole candidate* by Prof. S. K. Chakrabarti, funded by ISRO.
3. *Swarnajayanti Fellowship* by Dr. T. Saha Dasgupta, funded by DST.
4. *Understanding Physics and Chemistry of novel material using NMTO Wannier Functions* by Dr. T. Saha Dasgupta, funded by Indo-German.
5. *Integrated study of Correlated Electrons in Organic and Inorganic Materials* by Dr. T Saha Dasgupta, funded by DST.
6. *Advanced Materials Research Unit (AMRU)* by Dr. T. Saha Dasgupta, funded by DST.
7. *J. C. Bose Fellowship* by Prof. A. K. Raychaudhuri, funded by DST.
8. *Centre for Nano Technology* by Prof. A. K. Raychaudhuri, funded by DST.
9. *Development of cryostats and electronic measurement units for physical properties measurements using a zero-loss dewar* by Prof. A. K. Raychaudhuri, funded by DST.
10. *Utilization of Synchrotron Radiation Sources and Neutron Sources abroad* by Prof. A. K. Raychaudhuri, funded by DST.
11. *Elastic Property measurements on Ferro Magnetic shape memory alloy system* by Dr. P. K. Mukhopadhyay, funded by DST.
12. *Development of a vibrating sample magnetometer using a superconducting magnet* by Dr. K. Mandal, funded by DST.
13. *Study of ferrite nano particles* by Dr. K. Mandal, funded by DST.
14. *INAE (Emeritus Scheme)* by Prof. B. B. Bhattacharya, funded by INAE.
15. *Energies and relativistic corrections for ground and excited states of atoms and molecules using high quality with trial functions* by Dr. S. Datta, funded by DST.



16. *Electronic Magnetic and magneto-optical properties of surfaces, thin films and multilayers* by Dr. M. Dey, funded by DST.
17. *Solvation in near critical Fluids; Experiments and Simulations* by Dr. R. Biswas, funded by DST.
18. *INDO-FRENCH PROMOTION: Diluted magnetic semiconductors: Bulk and Nano* by Dr. P. Mahadevan, funded by Indo-French.
19. *Charge and orbital ordering* by Dr. P. Mahadevan, funded by DST.
20. *Synthesis of nanostructures by asymmetric self organization of nano-particles and its applications* by Prof. A. K. Raychaudhuri, funded by DST.
21. *Study of Biomolecular recognition with Time-resolved Optical Spectroscopy* by Dr. Samir Kr. Pal, funded by DST.
22. *Growth, characterization and study of resistive switching in multifunctional perovskite oxide systems* by Dr. Barnali Ghosh Saha, funded by DST (WOS-A).
23. *Electronic states and transport in mesoscopic systems* by Dr. Prasenjit Singha Deo, funded by DST.
24. *Astrophysical and cosmological implication of noncumulative space time* by Dr. Biswajit Chakraborty, funded by DST (Indo SA Jt. Proj).
25. *Symmetries of non-abelian two-form gauge theories* by Dr. Amitabha Lahiri, funded by DST.
26. *Quasistatic and Ultrafast Magnetization Dynamics in Nanomagnet Arrays* by Dr. Anjan Barman, funded by DST.
27. *DYNAMAG: Advanced Computational Studies of Dynamic Phenomena in Magnetic Nano-Materials* by Dr. Anjan Barman, funded by DST & European Commission.
28. *Fundamental Aspects of Quantum Theory and Quantum information: A Multidisciplinary Approach* by Dr. Archan S. Majumdar, funded by DST.
29. *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.

30. *Investigation of Static and Dynamic Magnetic Properties of Nanomagnetic Systems* by Dr. Saswati Barman, funded by DST (Fast Track).
31. *Spin wave and domain wall dynamics in vertical magnetic nanowires* (DST-UKIERI) by Dr. Anjan Barman, funded by DST.
32. *Generativity in Cognitive Networks* by Prof. Anita Mehta, funded by DST.
33. *Preparation and study of magnetic nanowires* by Dr. Kalyan Mandal, funded by BRNS (DAE).
34. *MONAMI – Modeling of NANO – Scaled Advanced Materials Intelligently* by Dr. Tanusri Saha Dasgupta, funded by DST (Int Div).
35. *Magnetism in organic materials* by Dr. Tanusri Saha Dasgupta, funded by Uppsala University Swedish Research Council (SRC).
36. *Design and Fabrication of Nanomachined Thermal Sensors using FIB (DST – UKIERI)* by Prof. A. K. Raychaudhuri, funded by DST.
37. *Contacting 3D electrodeposited nanowires: new opportunities for sprintonics technology (DST – UKIERI)* by Dr. Kalyan Mandal, funded by DST.
38. *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.
39. *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.





Pratip Kumar Mukhopadhyay
Convenor, Project Cell

TECHNICAL CELL

The technical cell looks after a number of high end and state of the art equipments, which are available for free to the centre's staffs and students and are made available to the external users on payment basis. The details are available on the centre's website http://www.bose.res.in/facilities/equipments.html.

At present the major equipments falling under technical cell are

1. X-ray Diffraction: This is a PANalytical X-PERT PRO XRD unit installed in 2005 and it has the capability of performing
   a. Powder diffraction
   b. Thin film reflectivity
   c. high resolution rocking curve analysis
   d. stress/texture analysis
   e. Small angle x-ray scattering (SAXS)

   The system has been upgraded in 2009 with high temperature (1500^{o}C) attachment and pixel detector.
2. Environmental SEM (ESEM): This is a FEI QUANTA 200 ESEM with W-filament and has a resolution of 2.4 nm under high vacuum and 3.0 nm under low vacuum. The system can be used in the EDAX mode for compositional analysis. The system has recently been upgraded with E-beam lithographic facility. The system serves both metallurgical and biological communities.
3. Vibrating Sample Magnetometer (VSM): This is a Lakeshore (Model no: 7407) VSM which presently works in the temperature range of 77 K to 1273 K and magnetic field range of ±1.6 Tesla. The current resolution of the system is 1.25 micro-emu.
4. Atomic Force Microscopy (AFM): This is a Veeco CPII system, which can be used as atomic, magnetic, conducting and scanning tunneling microscope. It has the capability of doing AFM lithography and also getting images under liquid environment.
5. TG-DTA: This is a Perkin Elmer made system by which the variation of weight and heat energy during phase transition of a material is measured in a variety of gaseous environment and in the temperature range of 50^{o}C to 1200^{o}C.
6. Dynamic Light Scattering (DLS): This is a Zetasizer system by which the hydrodynamic diameter of nanosize systems is measured and refers to how a particle diffuses within a fluid. The current system has a resolution of < 1nm and it does not require any special sample preparation and high concentration and turbid samples can be measured.
7. Spectroscopic Ellipsometer: This is WVASE32 system (J. A. Woollam Co. Inc.) primarily used for measurement of the thickness of thin films
8. Liquid Nitrogen Plant: This is a Stirlab 200 (Stirling made) system with a production capacity of 1.7 L/hour.
9. Sputtering/evaporation unit: This a HINDHIVAC made planar magnetron sputtering system equipped with dc and rf sputtering sources. The system can also be used in resistive evaporation mode with automated thickness control in different gaseous ambience. The system has substrate heating arrangement.
10. Pulsed Laser Deposition (PLD) Unit: This is a Pulsed Excimer Laser based thin film deposition unit. The Excimer laser (Compex Pro made by Coherent Inc.) delivers a maximum of 700 mJ power at the wavelengths of 193 nm (ArF) and 248 nm (KrF) with a repetition rate of 10 Hz. The deposition chamber (Ms. Excel Instruments) is equipped with turbo pump (base pressure ~ 10^{-7} mbar) and works under various gaseous environment. The substrate can be heated up to 900^{o}C and it has six automated target carousel.

The Technical Cell consists of the following members:

Dr. Samir Kumar Pal (In-charge), Ms. Shohini Majumder (Member), Dr. Kaustuv Das (Member), Dr. Kinshuk Acharyya (Member), Dr. Barnali Ghosh (Member), Dr. Chhayabrita Biswas (Member), Dr. Rajib Mitra (Member), Dr. Madhuri Mandal (Member), Dr. B. Rajanikanth (Member), Dr. Anjan Barman (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. Nasiruddin Mondal, Mr. Shakti Nath Das, Mr. Pallab Chakraborty, Ms. Piyali Bose, Mr. Surajit Mukherjee.

Anjan Barman

Anjan Barman
for Technical Cell

PLACEMENT AWARENESS CELL

Placement Awareness Cell (PAC) was constituted in April 2008 to aware our students regarding employment opportunities in their respective field. We collected information / advertisements from most of the daily newspapers, The Employment News, Current Science etc. and circulated them within the students of our centre through E-mails or posted them in our intranet web-page. We also invited the following eminent scientists to deliver a talk on research/academic activities and employment opportunities in their institutes.

1. Dr. H. S. Maiti (Director, Central Glass and Ceramic Research Institute, Kolkata) delivered a talk on *Research activities and employment opportunities in* CGCRI, Kolkata on 13 April 2009.
2. Professor Krishna N. Ganesh (Director, Indian Institute of Science Education and Research, Pune) delivered a talk on *Research / academic activities and employment opportunities in IISER, Pune* on 08 May 2009.

Our efforts will be successful if students are benefitted to some extent.

Kalyan Mandal

Kalyan Mandal
Convenor, Placement Awareness Cell

MECHANICAL WORKSHOP

The small mechanical workshop of the centre came into existence from about 2005. At that time, there was only a temporary staff appointed and there were only five major machines (including a lathe and a milling machine) available for working. It came up in one corner of the centre in a makeshift room. However, as the time passed by, the first person left and another person was appointed as a mechanic He also left around July 2009. After that, the present a new mechanic has joined from September 2009. Simultaneously, a lot more minor machines and accessories are purchased to facilitate workings in the workshop.

The workshop caters to most of the mechanical workshop needs of the centre. Apart from the regular assigned jobs of designing and making of mechanical contraptions for the laboratories, it also caters to the small demands from the pump house, guest house, ac plant etc.

During 2009 – 2010 fiscal, it has completed more than 40 jobs assigned to it, despite the break due to leaving of one mechanic and consequent delay in appointing a new person.

The arc furnace of the centre is also physically setup in one corner of the workshop.

Pratip Kumar Mukhopadhyay
In-charge, Mechanical Workshop

EXTENDED VISITORS' LINKAGE PROGRAMME

BOSE COLLOQUIUM

1. *Prof. Krishna N Ganesh*, IISER, Pune, *DNA Templated nanoassemblies*, 08.05.2009.
2. *Prof. Ram Ramaswamy*, JNU, Delhi, *The flavours of synchrony*, 19.06.2009.
3. *Prof. Shibaji Raha*, Bose Institute, Kolkata, *Climate Change and Cosmic Rays*, 03.07.2009.
4. *Prof. Khandker Abdul Muttalib*, University of Floreda, *Random systems: when the average is not good enough and the "Tail" can become the "Head"*, 17.07.2009.
5. *Prof. Abhirup Sarkar*, ISI, Kolkata, *Development and Displacement*, 14.08.2009.
6. *Prof. Prasanta Panigrahi*, IISER Kolkata, *Beauty of cold atoms*, 28.08.2009.
7. *Prof. Somendra M Bhattacharjee*, IOP, Bhuvaneswar, *Work, path and thermodynamics*, 11.09.2009.
8. *Prof. Mustansir Burma*, TIFR, Mumbai, *Ordered State with Giant Fluctuations*, 09.10.2009.
9. *Prof. Dipti Prasad Mukherjee*, ISI, Kolkata, *On exploiting image and video content*, 23.10.2009.
10. *Prof. Probir K. Bondyopadhyay*, Houston, Texas, *A Historian's Tribute to P.A.M. Dirac*, 20.11.2009.
11. *Prof. Diptiman Sen*, IISc Bangalore, *Quenching across quantum critical points and lines*, 11.12.2009.
12. *Prof. Sankar Pal*, ISI, Kolkata, *Machine Intelligence, Rough-Fuzzy Granules and Minig: Concepts, Features and Applications*, 08.01.10.
13. *Prof. Sugata Marjit*, Director, Centre for Social Sciences, *Game theoretic approach to the problem of displaced persons*, 12.02.10.
14. *Prof. Biswarup Mukhopadhyaya*, HRI, Allahabad, *The Large Hadron Collider and New Physics: Some Reflections on the Invisible and the Visible*, 05.03.10.

DISTINGUISHED LECTURES

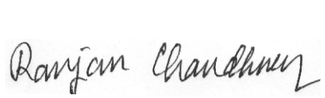
1. *Prof. Tapan Chatterji*, Science Division, Institut Laue-Langevin, France, *Neutron scattering: an introduction, Magnetic structures, Magnetic excitations, Diffuse magnetic scattering, Neutron scattering instruments and sample environments*, 12.01.10 – 14.01.10
2. *Prof. S M Yusuf*, Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai, *Neutron as a Probe to Investigate Structural and Magnetic Properties in Condensed Matter, Study of Short-range and Long-range Correlations using Neutron Scattering, Magnetic Correlations in Low Dimensional Spin Systems: A Neutron Diffraction Study*, 12.01.10 – 14.01.10

EVLP VISITORS

1. *Dr. Hemwati Nandan*, (Kinematics of Deformations and Flows in Diverse Contexts), 21.04.09.
2. *Dr. Sidhartha Sinha*, 27.04.09 - 24.07.09.
3. *Dr. Rukmini Dey*, 01.05.09 - 31.05.09.
4. *Prof. Biman Bagchi*, (1. Energy Landscape Value of Slow Dynamics in Complex Systems: From Supercooled Liquids to Liquid Crystals, 2. Mechanism of Nucleation near Gas-Liquid), 04.05.09 - 09.05.09.
5. *Dr. Santabrata Das*, 15.05.09 - 19.05.09.
6. *Dr. Mrinal Pal*, 16.05.09 - 24.05.09.
7. *Dr. Anindya Ghose Choudhury*, 18.05.09 - 29.05.09.
8. *Dr. Shalivahan*, 16.06.09 - 30.06.09.
9. *Dr. Dipankar Banerjee*, (Dynamics of the solar corona and the total solar eclipse), 30.06.09.
10. *Dr. Mrs. Sudha Singh*, 06.07.09 - 11.07.09.
11. *Mr. Swarnabha Sen*, 10.07.09 - 30.07.09.
12. *Dr. Sunandan Gangopadhyay*, (Path integral action of a particle in the non commutative plane), 13.07.09.

13. *Dr. N. Nirmal Thyagu*, 01.08.09 - 31.12.09.
14. *Dr. Kotari Srinivasa Rao*, 03.08.09 - 19.09.09.
15. *Dr. Tusar Kanti Dey*, (Effect Of Field Quantization On RABI Oscillation Of Four Level System), 04.08.09.
16. *Dr. Bijay Singh*, 21.09.09 - 26.09.09.
17. *Dr. Sunandan Gangopadhyay*, 30.09.09 - 20.10.09
18. Mr. Ankan Das, 01.10.09 - 31.12.09.
19. *Dr. Pradip Mukherjee*, 01.10.09 - 26.10.09.
20. *Dr. Jyotipritam Roychaudhuri*, 05.10.09 - 19.10.09.
21. *Dr. Uttam Kumar Bhui*, 17.10.09 - 22.10.09.
22. *Dr. Ashim Roy*, 01.11.09 - 31.12.09,
23. *Dr. Ch. Sivaji*, 25.11.09 - 26.11.09.
24. *Mr. Anup Pramanik*, 14.12.09 - 13.01.10.
25. *Prof. Joydeep Dutta*, (Zinc Oxide nanostructures- 21st century silicon?), 01.01.10 - 10.01.10.
26. *Dr. Alex Matzkin*, (Bohmian mechanics and the emergence of classicality), 15.02.10.
27. *Prof. Jnan Maharana*, (Unification of Fundamental Forces), 07.03.10 - 09.03.10.
28. *Dr. Abhijit Chakraborty*, 16.03.10 - 17.03.10.
29. *Prof. Ken J W Lynn*, 19.03.10 - 26.03.10.
30. *Prof. N D Hari Dass*, (Is there a Quantum threat to Special Relativity?), 29.03.10 - 31.03.10.

Titles of the seminars delivered are in the parenthesis.



Ranjan Chaudhury
Co-ordinator, EVLP

GUEST HOUSE

GUEST HOUSE

The Centre has its own modern guest house and cafeteria located within the premises. In the guest house there are five fully furnished air conditioned suites with attached baths and kitchenettes, three transit rooms similar as suites, four double-bed and twenty four single-bed air-conditioned fully furnished rooms. A small seminar room with sitting capacity of thirty (30) people has been developed within the guest house premises. Apart from serving regular meals to the staff members of the Centre as well as to the visitors, the cafeteria also serves as a venue for hosting lunches and hi-tea on special occasions, seminars, conferences etc. of the centre. The guest house provides 24 hours STD/ISD, Internet, laundromat, ATM, car parking facilities etc. The second and third floor of guest house comprising forty four single rooms and eight double rooms are used for accommodating students.

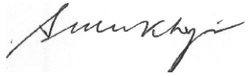
STUDENTS' HOSTEL

The Centre provides residential accommodation to around 130 students currently enrolled in various programmes. The second and third floor of guest house comprising forty four

single rooms and eight double rooms are used for accommodating students. The New Hostel Block provides accommodation for thirty students and the Essential Staff Quarters has accommodation for around twenty students. Rest of the students is provided accommodation in rented apartments located within close proximity to the Centre. The Centre is currently building a larger Hostel complex within the campus to accommodate all its students.

ESSENTIAL STAFF QUARTER

The Essential staff quarter building located within Centre's premises currently houses several scientists and one permanent staff. Rest of the rooms provides accommodation to the students.



Sugata Mukherjee
Acting Registrar

THEORETICAL PHYSICS SEMINAR CIRCUIT

ADVANCED RESEARCH WORKSHOP (ARW) – Sponsored by TPSC

1. *International Symposium on Complex Dynamical Systems and Applications*, Digha Science Centre, Digha, WB (Presidency College, Kolkata), December 4-6, 2009, (120 participants).
2. *Clusters and Nano-Structures*, Univ of Pune, February 15-18, 2010, (26 participants).
3. *Workshop on Electron Dynamics in Quantum Systems*, Vidyasagar University, Midnapore, WB, February 18-20, 2010, (119 participants).
4. *National Level TPSC Workshop on Non-Linear Physics: Theory, Experiments and Applications*, Nehru Memorial College, Puthanampatti, Tiruchirapalli (University of Pondicherry), March 29-31, 2010, (125 participants).

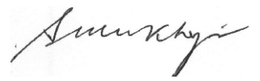
VISITORS UNDER COLLABORATIVE RESEARCH PROGRAMME AND SEMINAR

1. Professor S. Dutta Gupta, School of Physics, University of Hyderabad, 19.6.2009.
2. *A proposal for an electro-optic modulator at nano scales by* Professor Tapan Chatterji, Science Division, Institut Laue-Langevin, France (January 2010).

Neutron Scattering in Condensed Matter Science

Lecture 1 : Neutron scattering: an introduction
Lecture 2 : Magnetic structures
Lecture 3 : Magnetic excitations
Lecture 4 : Diffuse magnetic scattering
Lecture 5 : Neutron scattering instruments and sample environments

3. *Study of the chemical evolution of molecular clouds; to build a numerical code in order to explain the dynamic behavior of collapsing molecular cloud.* Dr. Ankan Das, Indian Centre for Space Physics, Kolkata, (January 2010).
4. *Physics of interface: Mott insulator barrier sandwiched between two metallic planes* by Dr. Tribikram Gupta, Institute of Mathematical Science, Chennai, (19th March 2010 to 18th April 2010).
5. *Some aspects of twisted quantization; Effects on Quantum Statistics, Super conductivity and Quantum entanglement* by Dr. Prasad Basu, Centre for High Energy Physics, IISc, Bangalore (March 15-19, 2010).



Sugata Mukherjee
Convenor, Theoretical Physics Seminar Circuit

CULTURAL PROGRAMMES

Throughout the year, the Centre organized a number of cultural events.

The Centre celebrated the 63rd Independence Day and the 61st Republic Day on 15th August 2009 and 26th January 2010 respectively. On both the occasions, the Director, Professor Arup Kumar Raychaudhuri hoisted the national flag, 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 116th birthday on 1st January 2010. The bust of Satyendra Nath Bose was garlanded by the Director and sweets were distributed on the occasion.

On the occasion of Bose Fest held during 27-28 January 2010, Family Day was celebrated on the evening of 28th January 2010. Famous Bangla band, 'Bhumi' performed popular band songs. The function was followed by a grand dinner. The programme was attended by friends and family members of staff and students and was a huge success.

For the first time, the students and staff of the Centre celebrated the birthday of Kabiguru Rabindranath Tagore. On 15th May 2009, a function was presented by them in the Centre's canteen consisting of songs, recitation, instrumental performances and a dance-drama called 'BARSHAMANGAL'. The function was attended by all the students and staff members of the Centre and was very successful.

The Centre also celebrated the month of September 2009 as the 'Hindi Mahina'. During the month, the administrative staff signed the attendance register in Hindi. Every day one Hindi word was written along with its English translation on a board kept in the lobby. Greeting cards with messages of best wishes conveyed in Hindi on behalf of the Director were sent to outside institutes and DST. The 'Hindi Day' was celebrated on 14th September 2009 where the Centre had invited dignitaries like Prof. Jagdeswar Chaturvedi, Calcutta University, Shri Narayan Saroj, Deputy Director, Hindi Training Programme, Shri Bipati etc. to deliver lectures. The Centre also organized a cultural evening at Eastern Zonal Cultural Complex, Salt Lake where members of Creative Dance Troupe performed. Hindi quiz and Hindi film show were also organized on the occasion.

Somajumder

Shohini Majumder
Deputy Registrar, Administration

PUBLICATIONS

LIST OF PUBLICATIONS

ASTROPHYSICS AND COSMOLOGY

1. A. S. Majumdar, D. Home and S. Sinha, *Dark energy from quantum wave function collapse of dark matter*, Phys. Lett. B, 2009, **679**, 167.
2. B. Nayak, L. P. Singh and A. S. Majumdar, *Effect of accretion on primordial black holes in Brans-Dicke theory,* Phys. Rev. D, 2009, **80**, 023529.
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4. T. Pramanik, S. Adhikari, A. S. Majumdar, D. Home, A. K. Pan, *Information transfer using a single particle path-spin hybrid entangled state*, Phys. Lett. A, 2010, **374**, 1121.
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6. S. Adhikari, A. S. Majumdar, S. Roy, B. Ghosh, N. Nayak, *Teleportation via maximally and non-maximally entangled mixed states*, Quant. Inf. Comm., 2010, **10**, 0398.
7. Debashis Gangopadhyay, *Estimating Temperature Fluctuations in the Early Universe,* Gravitation and Cosmology, 2010, **16**, 231.
8. S. K. Chakrabarti, S. Palit, D. Debnath, A. Nandi, V. Yadav, R. Sarkar, *Fresnel Zone Plate Telescopes for X-ray Imaging I: Experiments with a quasi-parallel beam*, Exp. Astronomy, 2009, **24**, 109.
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14. S. Palit, S. K. Chakrabarti, D. Debnath, A. R. Rao, A. Nandi, Vipin K. Yadav, V. Girish, *Fresnel Zone Plate Telescopes for X-ray Imaging II: Numerical simulations with parallel and diverging beams*, Exp. Astronomy, 2009, **27**, 77.
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16. H. Ghosh, S. Garain, S. K. Chakrabarti and P. Laurent, *Monte-Carlo Simulations in a Two component Flow in presence of Outflow*, IJMPD, 2010, **19**, 607.
17. S. Mandal and S. K. Chakrabarti, *On the Evolution of Accretion Rates in Compact Outburst Sources*, Astrophysical Journal Letters, 2010, **710**, 147.

CHEMICAL, BIOLOGICAL AND MACRO-MOLECULAR SCIENCES

18. Kinshuk Banerjee and Gautam Gangopadhyay, *Aggregation of a network of conjugated polymer chains : symmetry of the excitonic states and spectral features*, J. Phys. B, 2009, **42**, 165106.
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ACCOUNTS

ROY & BAGCHI
Chartered Accountants

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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 31st March, 2010 and also the **INCOME AND EXPENDITURE ACCOUNT** and **RECEIPTS AND PAYMENTS ACCOUNT** 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, evidences 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 and the Income and Expenditure Account 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 31st March 2010; and

   (ii) in the case of the Income and Expenditure Account, of the surplus for the year ended on that date.

For ROY & BAGCHI
Chartered Accountants

Sd/-
(Amit Mitra)
Partner

Kolkata
Dated: 03-08-2010

Satyendra Nath Bose National Centre for Basic Sciences
Block JD, Sector-III, Salt Lake, Kolkata – 700 098

BUDGET SUMMARY 2009-2010

The funds come from the Department of Science and Technology, New Delhi. The following is the summary of the budget estimates for the year 2009-2010.

Figure in Lakhs (₹)

	Actuals 2008-2009	Budget Estimate 2009-2010	Revised Estimate 2009-2010
Non-Plan	113.77	102.43	* 101.02
Plan	1718.88	2391.37	* 3267.20
TOTAL	1832.65	2493.80	3368.22

* Sanctioned by DST Plan ₹ 2945 lakhs, Non-Plan ₹ 30 lakhs and released as under :

Non-Plan

1. Sanction Letter No. DST/AI/Grants/003/1/2009 dated 15.04.09	₹	10.00 lakhs
2. Sanction Letter No. AI/SNB/003/2009 dated 28.07.09	₹	20.00 lakhs
	₹	30.00 lakhs

Plan

1. Sanction Letter No. DST/AI/Grants/003/1/2009 dated 30.04.09	₹	373.00 lakhs
2. Sanction Letter No. DST/AI/Grants/003/1/2009(i) dated 01.07.09	₹	93.66 lakhs
3. Sanction Letter No. AI/SNB/003/2009/02 dated 11.08.09	₹	373.34 lakhs
4. Sanction Letter No. AI/SNB/003/2009 dated 24.09.09	₹	360.00 lakhs
5. Sanction Letter No. AI/SNB/003/2009 dated 30.09.09	₹	1745.00 lakhs
	₹	2945.00 lakhs

TOTAL	₹	**2975.00 lakhs**

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

BALANCE SHEET AS AT 31ST MARCH 2010

	Schedule	Current Year	Previous Year
FUNDS AND LIABILITIES		₹	₹
Corpus/Capital Fund	1	595334394.38	431381536.24
Reserves and Surplus	2	–	–
Earmarked/Endowment Funds	3	87729719.75	79565843.75
Secured Loans and Borrowings	4	–	–
Unsecured Loans and Borrowings	5	–	–
Deferred Credit Liabilities	6	–	–
Current Liabilities and Provisions	7	39091197.69	16114013.65
TOTAL		**722155311.82**	**527061393.64**
ASSETS			
Fixed Assets	8	456263823.77	408329641.33
Investments-from Earmarked/Endowment Funds	9	27363302.00	17613668.00
Investments - Others	10	96442875.00	31063004.00
Current Assets, Loans, Advances etc.	11	142085311.05	70055080.31
Miscellaneous Expenditure (to the extent not written off or adjusted)			
TOTAL		**722155311.82**	**527061393.64**
Significant Accounting Policies	24		
Contingent Liabilities and Notes on Accounts	25		

Per our report of even date

Date: 03.08.10
Place: Kolkata

For ROY & BAGCHI
Chartered Accountants

Sd/-
(Amit Mitra)
Partner

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

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2010

	Schedule	Current Year	Previous Year
INCOME		₹	₹
Income from Sales/Services	**12**	1871922.50	1104671.00
Grants/Subsidies	**13**	121358146.00	121570686.00
Fees/Subscriptions	**14**	–	–
Income from Investments (Income on Investment	**15**	–	–
from earmarked/endowment Funds transferred to Funds)	-	–	
Income from Royalty, Publication etc.	**16**	–	–
Interest Earned	**17**	3685626.00	3379145.00
Other Income	**18**	1719808.96	289398.00
Increase/(decrease) in stock of finished goods and works-in-progress	**19**	–	–
TOTAL (A)		**128635503.46**	**126343900.00**
EXPENDITURE			
Establishment Expenses	**20**	64811226.00	56155279.29
Other Administrative Expenses etc.	**21**	60062447.76	67204187.84
Expenditure on Grants, Subsidies etc.	**22**	–	–
Interest	**23**	–	–
TOTAL (B)		**124873673.76**	**123359467.13**
Balance being excess of Income over Expenditure(A-B)		3761829.70	2984432.87
Prior period adjustments (Credit)		13177.00	677259.00
Transfer to/from Corpus / Capital Fund			
BALANCE BEING SURPLUS/(DEFICIT) CARRIED TO CORPUS/CAPITAL FUND		**3775006.70**	**3661691.87**
SIGNIFICANT ACCOUNTING POLICIES	**24**		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	**25**		

Per our report of even date

Date: 03.08.10
Place: Kolkata

For ROY & BAGCHI
Chartered Accountants

Sd/-
(Amit Mitra)
Partner

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES
RECEIPTS AND PAYMENTS ACCOUNTS

FOR THE YEAR ENDED 31ST MARCH 2010

RECEIPTS	Current Year (₹)	Previous Year (₹)	PAYMENTS	Current Year (₹)	Previous Year (₹)
I. Opening Balances			**I. Expenses:**		
a) Cash in hand	17216.00	32217.00	a) Establishment Expenses	62148523.00	39539187.29
b) Bank Balances :			b) Administrative Expenses	69012673.50	76739442.00
I. In current accounts	30764265.87	41889468.16			
ii. In deposit accounts			**II. Payments made against**	–	–
Schedule - 10	30063004.00	57661359.00	**funds for various Projects**		
Schedule - 11A	10401082.00	15867833.00			
iii. Savings accounts	18921338.00	37623751.00			
iv. Remittance-in-Transit	–	–			
II. Grants Received			**III. Investments and deposits made**		
a) From Government of India			a) Out of Earmarked/	9613409.00	2759906.00
			Endowment/Own funds		
- For the year	355602164.00	163861417.00	b) CPWD and NBCC Deposit	25782513.00	562690.00
- For the previous year	–	–	c) Bank Gurantee & LC A/C	33863360.00	214695.00
b) From State Government	–	–			
c) From Other sources (details)					
(Grants for capital & revenue exp.					
To be shown separately)					
			IV. Expenditure on Fixed Assets & Capital Work-in-Progress		
			a) Purchase of Fixed Assets	60010439.00	135513784.00
			b) Expenditure on	1775997.00	1460625.00
			Capital Work-in-Progress		

contd

continues

III. Income on Investments from					
a) Earmarked/Endow Funds	–	–			
b) Own Funds (Oth. Investment)	2605376.00	3736086.00	**V. Refund of surplus money/Loans**		
			a) To the Government of India	–	–
IV. Interest Received			b) To the State Government	–	–
a) On Bank deposits	1139702.00	1368925.00	c) To other providers of funds	–	–
			VI. Finance Charges (Interest)	–	–
V. Other Income	2631798.50	1472636.00			
			VII. Other Payments	26122152.00	16021002.00
VI Amount Borrowed	–	–			
			VIII. Closing Balances		
VII. Any other receipts	1975389.00	2662010.00	a) Cash in hand	12816.00	17216.00
			b) Bank Balances :		
VIII. Amount transferred to Current /			I. In current accounts	33310293.85	30764265.87
Savings Account from	41121988.00	35278049.00	ii. In deposit accounts		
Deposit Account					
			Schedule - 10	96442875.00	30063004.00
			Schedule - 11A	51523070.00	8876596.00
			iii. Savings accounts	25625202.02	18921338.00
			iv. Remittance-in-Transit	–	–
	495243323.37	**361453751.16**		**495243323.37**	**361453751.16**

Per our report of even date

Date: 03.08.10
Place: Kolkata

For ROY & BAGCHI
Chartered Accountants

Sd/
(Amit Mitra)
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 31.03.2010

	Current Year		Previous Year	
SCHEDULE 1 - CORPUS/CAPITAL FUND:	₹	₹	₹	₹
Balance as at the beginning of the year	431381536.24		413453253.09	
Add : Contributions towards Capital Fund	182141854.00		29029314.00	
Less: Depreciation for the year	21293601.21		14775018.72	
Add : Surplus during the year	3775006.70		3661691.87	
Add : Adjustment for Depreciation (Last Year)	5093064.38		12296.00	
Less : Adjustment for Last Year (Revenue Items)	5763465.73	595334394.38	–	431381536.24
BALANCE AS AT THE YEAR - END	**595334394.38**			**431381536.24**

	Current Year		Previous Year	
SCHEDULE 2 - RESERVES AND SURPLUS:	₹	₹	₹	₹
1. Capital Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
2. Revaluation Reserve:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
3. Special Reserves:				
As per last Account				
Addition during the year				
Less: Deductions during the year				
4. General Reserve:				
As per last Account	–		–	
Add : Surplus during the year				
TOTAL	**–**		**–**	

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

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2010

Amount (₹)

SCHEDULE 3 - EARMARKED/ENDOWMENT FUNDS	FUND-WISE BREAK UP				TOTAL	
	Project Fund	Medical Fund	Leave Salary	Gratuity Fund	Current Year	Prev. Year
a) Opening balance of the funds	49081617.75	713196.00	16319799.00	13451231.00	79565843.75	128994269.75
b) Additions to the Funds						
I) Donations/grants/ Contributions	51102164.00	409912.00	7602.00	0.00	51519678.00	14547025.00
ii) Income from investments made on account of funds	498092.00		996770.00	795675.00	2290537.00	3270134.00
iii) Other additions -Provision during the year			1876699.00	2461050.00	4337749.00	10245108.00
TOTAL (a + b)	**100681873.75**	**1123108.00**	**19200870.00**	**16707956.00**	**137713807.75**	**157056536.75**
c) Utilisation/Expenditure/Adjustment towards objectives of funds						
I) Capital Expenditure						
Fixed Assets	24501215.00				24501215.00	63255697.00
Others						
Total						
ii) Revenue Expenditure						
Salaries, Wages and allowances etc.	9831309.00				9831309.00	7419498.00
Rent						
Other Administrative expenses					–	
Other Payments	10539487.00		2035892.00	2076185.00	14651564.00	6815498.00
iii) Adjustment (Interest)	1000000.00				1000000.00	
TOTAL (c)	**45872011.00**	**–**	**2035892.00**	**2076185.00**	**49984088.00**	**77490693.00**
NET BALANCE AS AT THE YEAR-END (a+b-c)	**54809862.75**	**1123108.00**	**17164978.00**	**14631771.00**	**87729719.75**	**79565843.75**

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 31.03.2010

Amount (₹)

SCHEDULE 4 - SECURED LOANS AND BORROWINGS:	Current Year	Previous Year
1. Central Government		
2. State Government (Specify)		
3. Financial institutions		
a) Term Loans		
b) Interest accrued and due		
4. Banks:		
a) Term Loans		
Interest accrued and due		
b) Other Loans (Specify)		
Interest accrued and due		
5. Other Institutions and Agencies		
6. Debentures and Bonds		
7. Others (Specify)		
TOTAL	Nil	Nil

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 31.03.2010

Amount (₹)

	Current Year		Previous Year	
SCHEDULE 5 - UNSECURED LOANS AND BORROWINGS:				
1. Central Government				
2. State Government (Specify)				
3. Financial Institutions				
4. Banks:				
a) Term Loans				
b) Other Loans (Specify)				
5. Other Institutions and Agencies				
6. Debentures and Bonds				
7. Fixed Deposits				
8. Others (Specify)				
TOTAL	Nil	Nil	Nil	Nil

	Current Year		Previous Year	
SCHEDULE 6 - DEFERRED CREDIT LIABILITIES:				
a) Acceptances secured by hypothecation of capital equipment and other assets				
b) Others				
TOTAL	Nil	Nil	Nil	Nil

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

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31.03.2010

(Amount - ₹)

	Current Year		Previous Year	
SCHEDULE 7 - CURRENT LIABILITIES AND PROVISIONS				
A. CURRENT LIABILITIES				
1. Acceptances				
2. Sundry Creditors:				
a) For Capital expenditure	24576517.00			570222.00
b) Others - Revenue expend. (including Project Rs.30,000)	4596388.00			6412208.00
3. Advances Received				
4. Interest accrued but not due on:				
a) Secured Loans/borrowings				
b) Unsecured Loans/borrowings				
5. Statutory Liabilities:				
a) Overdue				
b) Others				
6. Other Current Liabilities	9847636.69			9056980.65
TOTAL (A)	**39020541.69**	**-**		**16039410.65**
B. PROVISIONS				
1. For Taxation				
2. Gratuity				
3. Superannuation/Pension				
4. Accumulated Leave Encashment				
5. Trade Warranties/Claims				
6. Others - Adhoc Bonus	70656.00			74603.00
TOTAL (B)	**70656.00**	**-**		**74603.00**
TOTAL (A + B)	**39091197.69**	**-**		**16114013.65**

ACCOUNTS

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 31.03.2010

Amount (₹)

SCHEDULE 8 - FIXED ASSETS

DESCRIPTION	GROSS BLOCK				DEPRECIATION				NET BLOCK	
	Cost/valuation As at begin. of the year	Additions during the year	Adjustment during the year	Cost/valuation at the year-end	As at the beginning of the year	Additions during the year	Adjustment during the year	Total up to the Year-end	Current year-end	Previous year-end
A. FIXED ASSETS:										
1. LAND:										
a) Freehold										
b) Leasehold	1,09,50,694.00	–	39.40	1,09,50,654.60	–	–	–	–	1,09,50,654.60	1,09,50,694.00
2. BUILDINGS:										
a) On Freehold Land										
b) On Leasehold Land	15,38,60,615.07	1,61,01,333.00	(39.79)	16,99,61,987.86	1,64,79,398.56	24,83,470.36	15,70,711.32	2,05,33,580.24	14,94,28,407.62	13,73,81,216.51
c) Ownership Flats/Premises										
d) Superstructures on Land not belonging to the entity										
3. PLANT MACHINERY & EQUIPMENT	12,68,70,739.50	2,93,34,337.00	12,50,742.28	15,49,54,334.22	1,11,78,487.46	75,06,222.37	19,00,496.78	2,05,85,206.61	13,43,69,127.61	11,56,92,252.04
4. VEHICLES	3,63,026.00	–	42,013.00	3,21,013.00	3,46,598.70	23,143.66	(50,087.17)	3,19,655.19	1,357.81	16,427.30
5. FURNITURE, FIXTURES	2,08,57,549.19	22,84,994.00	(6,87,136.03)	2,38,29,679.22	1,02,25,669.13	13,63,162.34	(20,68,362.94)	95,20,468.53	1,43,09,210.69	1,06,31,880.06
6. OFFICE EQUIPMENT	16,13,351.70	58,214.00	50,474.41	16,21,091.29	6,67,246.66	70,953.91	(3,10,501.92)	4,27,698.65	11,93,392.64	9,46,105.04
7. COMPUTER/PERIPHERALS	4,12,10,802.90	35,33,538.00	47,52,255.46	3,99,92,085.44	2,66,83,938.38	35,34,678.69	(52,52,223.11)	2,49,66,393.96	1,50,25,691.48	1,45,26,864.52
8. ELECTRIC INSTALLATIONS	25,69,482.00	30,20,033.00	2,10,457.00	53,79,058.00	7,91,243.79	2,44,303.10	5,85,546.31	16,21,093.20	37,57,964.80	17,78,238.21
9. LIBRARY BOOKS	12,93,78,528.61	53,78,364.00	1,44,660.00	13,46,12,232.61	2,38,23,759.35	60,63,721.65	(14,69,225.37)	2,84,18,255.63	10,61,93,976.98	10,55,54,769.26
10. TUBEWELLS & W. SUPPLY	–	–		–	–	–		–	–	–
11. OTHER FIXED ASSETS	84,225.55	–	–	84,225.55	22,140.16	3,945.91	580.94	26,667.01	57,558.54	62,085.39
TOTAL OF CURRENT YEAR	48,77,59,014.52	5,97,10,813.00	57,63,465.73	54,17,06,361.79	9,02,18,482.19	2,12,93,601.99	(50,93,065.16)	10,64,19,019.02	435,287,342.77	39,75,40,532.33
PREVIOUS YEAR	34,47,89,771.52	15,58,34,270.00	(1,28,65,027.00)	48,77,59,014.52	7,54,43,463.47	1,53,37,907.72	(5,62,889.00)	9,02,18,482.19	39,75,40,532.33	26,93,46,308.05
B. CAPITAL WORK IN PROGRESS	1,07,89,109.00	2,04,20,558.00	1,02,33,186.00	2,09,76,481.00	–	–	–	–	2,09,76,481.00	1,07,89,109.00
TOTAL (A + B)	49,85,48,123.52	8,01,31,371.00	1,59,96,651.73	56,26,82,842.79	9,02,18,482.19	2,12,93,601.99	(50,93,065.16)	10,64,19,019.02	456263823.77	40,83,29,641.33

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 31.03.2010

(Amount ₹)

SCHEDULE 9 - INVESTMENTS FROM EARMARKED/ENDOWMENT FUNDS	Current Year	Previous Year
1. In Government Securities		
2. Other approved Securities		
3. Shares		
4. Debentures and Bonds		
5. Subsidiaries and Joint Ventures		
6. Others - Fixed Deposit with Nationalised Banks		
Gratuity Fund Investment	12704930.00	7843505.00
Leave Salary Fund Investment	14658372.00	9770163.00
TOTAL	**27363302.00**	**17613668.00**

SCHEDULE 10 - INVESTMENTS - OTHERS	Current Year	Previous Year
1. In Government Securities		
2. Other approved Securities		
3. Shares		
4. Debentures and Bonds		
5. Subsidiaries and Joint Ventures		
6. Others - Fixed Deposit with Nationalised Banks (includes Project A/C)	96442875.00	31063004.00
TOTAL	**96442875.00**	**31063004.00**

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 31.03.2010

(Amount ₹)

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.	Current Year		Previous Year	
A. CURRENT ASSETS:				
1. Inventories:				
a) Stores and Spares		159872.18		185986.44
b) Loose Tools				
c) Stock-in-trade				
Finished Goods				
Work-in-progress				
Raw Materials				
Stock of Books				
2. Sundry Debtors:				
a) Debts Outstanding for a period exceeding six months				
b) Others				
3) Cash balances in hand		12816.00		17216.00
4) Bank Balances:				
a) With Scheduled Banks:				
On Current Accounts (including Project A/C Rs 23714862.73)		33310293.85		30764265.87
On Deposit Accounts (includes Project Rs. 8804710.00)		51523070.00		10401082.00
On Savings Accounts (includes Project A/C Rs. 23971754.02)		23971754.02		17986641.00
b) With non-Scheduled Banks:				
On Current Accounts				
On Deposit Accounts				
On Savings Accounts (includes Project A/C Rs. 118260.00)		1653448.00		934697.00
5. Remittance - in - Transit		–		1000000.00
6. Post Office-Savings Accounts				
TOTAL (A)		**110631254.05**		**61289888.31**

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

SCHEUDLES FORMING PART OF BALANCE SHEET AS AT 31.03.2010

(Amount ₹)

SCHEDULE 11 - CURRENT ASSETS, LOANS, ADVANCES ETC.(Contd.)	Current Year		Previous Year	
B. LOANS, ADVACNES AND OTHER ASSETS				
1. Loans:				
a) Staff including HBA ,Vehicle &PC Advance		3093010.00		3485933.00
b) Other Entitites engaged in activities/objectives similar to that of the Entity				
c) Other - Project A/c		–		
2. Advances and other amounts recoverable in cash or in kind or for value to be received:				
a) On Capital Account - CPWD and NBCC Deposit Account		23140890.00		2347251.00
b) Prepayments				
c) Others (Security Deposits)		92218.00		261118.00
d) Contractors & Suppliers		541941.00		91941.00
3. Income Accrued:				
a) On Investments from Earmarked/Endowment Funds		4200172.00		2543952.00
b) On investments - Others		385826.00		34997.00
c) On Loans and Advances				
d) Others				
4. Claims Receivable - Grant -in- Aid Receivable				–
TOTAL (B)		**31454057.00**		**8765192.00**
TOTAL (A + B)			**142085311.05**	**70055080.31**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES
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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2010

(Amount ₹)

SCHEDULE 12 - INCOME FROM SALES/SERVICES	Current Year	Previous Year
1) Income from Sales		
a) Sale of Finished Goods		
b) Sale of Raw Material		
c) Sale of Scraps		
2) Income from Services		
a) Labour and Processing Charges		
b) Professional/Consultancy Services		
c) Agency Commission and Brokerage		
d) Maintenance Services (Equipment/Property)		
e) Others	1871922.50	1104671.00
TOTAL	**1871922.50**	**1104671.00**

SCHEDULE 13 - GRANTS/SUBSIDIES	Current Year	Previous Year
(Irrevocable Grants & Subsidies Received)		
1) Central Government	121358146.00	121570686.00
2) State Government(s)		
3) Government Agencies		
4) Institutions/Welfare Bodies		
5) International Organisations		
6) Others		
TOTAL	**121358146.00**	**121570686.00**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES
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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2010

(Amount ₹)

SCHEDULE 14 - FEES/SUBSCRIPTIONS	Current Year	Previous Year
1) Entrace Fees		
2) Annual Fees/Subscriptions		
3) Seminar/Program Fees		
4) Consultancy Fees		
5) Others		
TOTAL	**Nil**	**Nil**
Note: Accounting Policies towards each item are to be disclosed		

(Amount ₹)

SCHEDULE 15 - INCOME FROM INVESTMENTS	Investment from Earmarked Fund		Investment - Others	
(Income on Invest. From	**Current Year**	**Previous Year**	**Current Year**	**Previous Year**
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				
TOTAL	**Nil**	**Nil**	**Nil**	**Nil**
TRANSFERRED TO EARMARKED/ENDOWMENT FUNDS	**Nil**	**Nil**	**Nil**	**Nil**

SATYENDRA NATH BOSE NATIONAL CENTRE FOR BASIC SCIENCES
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SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31.03.2010

(Amount - ₹)

SCHEDULE 16 - INCOME FROM ROYALTY, PUBLICATION ETC.	Current Year	Previous Year
1. Income from Royalty		
2. Income from Publications		
3. Others		
TOTAL	**Nil**	**Nil**

SCHEDULE 17 - INTEREST EARNED	Current Year	Previous Year
1) On Term Deposits:		
a) With Scheduled Banks	3444309.00	3331264.00
b) With Non-Scheduled Banks	54624.00	
c) With Institutions		
d) Others		
2) On Savings Accounts:		
a) With Scheduled Banks		
b) With Non-Scheduled Banks	19775.00	43,579.00
c) Post Office Savings Accounts		
d) Others		
3) On Loans:		
a) Employees/Staff	166918.00	4,302.00
b) Others		
4) Interest on Debtors and Other Receivables		
TOTAL	**3685626.00**	**3379145.00**

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 31.03.2009

(Amount - ₹)

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	1719808.96	289398.00
TOTAL	**1719808.96**	**289398.00**
SCHEDULE 19 - INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS	**Current Year**	**Previous Year**
a) Closing stock		
Finished Goods		
Work-in-progress		
b) Less: Opening Stock		
Finished Goods		
Work-in-progress		
NET INCREASE/(DECREASE) [a-b]	**Nil**	**Nil**
SCHEDULE 20 - ESTABLISHMENT EXPENSES	**Current Year**	**Previous Year**
a) Salaries and Wages	54610977.00	41008731.00
b) Other Allowances and Bonus	67025.00	119097.00
c) Contribution to Provident Fund	3447432.00	2642662.00
d) Contribution to Other Fund - Gratuity Fund Leave Salary Fund etc	4260224.00	10245258.00
e) Staff Welfare Expenses (Medical)	1464682.00	1426907.29
f) Expenses on Employees' Retirement and Terminal Benefits		
f) Others	960886.00	712624.00
TOTAL	**64811226.00**	**56155279.29**

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 31.03.2010

(Amount - ₹)

SCHEDULE 21 - OTHER ADMINISTRATIVE EXPENSES ETC.	Current Year	Previous Year
a) Extended Visitors Programme (Including Seminars & Workshops)	7090182.00	7439249.00
b) Academic Staff Research Expenses		
c)Library General Expenses	6500.00	100949.00
d) Electricity and Power	9368324.00	6241948.00
e) Laboratory Expenses	3929824.00	8715819.00
f) Insurance	5115.00	11535.00
g) Repairs and Maintenance	15435540.26	18508287.84
h) Excise Duty		
i) Rent, Rates and Taxes		
j) Vehicles Hire Charges	1036683.00	1699848.00
k) Postage, Telephone and Communication Charges	2221418.00	2192197.00
l) Printing and Stationary	734994.00	983274.00
m) Travelling and Conveyance Expenses	1683054.00	2267583.00
n) Subscription Expenses		
o) Expenses on Fees		
p) Auditors' Remuneration	29781.00	20225.00
q) Hospitality Expenses		
r) Professional Charges (Legal Charges)	30230.00	41214.00
s) Provision for Bad and Doubtful Debts/Advances		
t) Irrecoverable Balances Written-off		
u) Integrated Ph.D.	12976751.00	12966074.00
v) Import Clearing Expenses including Custom Duty	115891.00	295339.00
w) Distribution of Books		
x) Advertisement and Publicity	1462720.00	1608116.00
y) Others	3935440.50	4112530.00
TOTAL	**60062447.76**	**67204187.84**

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 31.03.2010

(Amount - ₹)

SCHEDULE 22 - EXPENDITURE ON GRANTS, SUBSIDIES ETC.	**Current Year**	**Previous Year**
a) Grants given to Institutions/Organisations		
b) Subsidies given to Institutions/Organisations		
TOTAL	**Nil**	**Nil**
SCHEDULE 23 - INTEREST	**Current Year**	**Previous Year**
a) On Fixed Loans		
b) On Other Loans (including Bank Charges)		
c) Others (specify)		
TOTAL	**Nil**	**Nil**






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

SCHEDULE 24 (2009-2010)

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.

5. DEPRECIATION

5.1 Depreciation on capitalization has been charged on the value determined / estimated at the time of take over and as and when on further items were added subsequently to Assets.

5.2 Depreciation is provided on straight-line method as per rates specified in the Companies Act, 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 ₹5000/- or less is not capitalized but charged in Accounts.

5.6 Adjustment regarding over/under charge of depreciation is to be made against Capital Fund as per Physical Verification Report.

6. FOREIGN CURRENCY TRANSACTIONS

6,1 Transactions denominated in foreign currency are accounted at the exchange rate prevailing at the date of transaction.

7. RETIREMENT BENEFITS

7.1 Liability towards gratuity payable on death/retirement of employees is computed on the assumption that employees are entitled to receive the benefit as at each year end.

7.2 Provision for accumulated leave encashment benefit to the employees is accrued and computed on the assumption that employees are entitled to receive the benefit as at each year end.

7.3 Liabilities under above accounts are invested separately in fixed deposit accounts with nationalized bank.

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

SCHEDULE 25 (2009-2010)

CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

1. CONTINGENT LIABILITIES

1.1 Claims against the Centre not acknowledged as debts – ₹ Nil (Previous year ₹ Nil).

1.2 In respect of

- Bank guarantees given by/on behalf of the Centre – ₹ 18,20,000 against 100% margin money by way of fixed deposit (Previous year ₹18,20,000).
- Letters of Credit opened by Bank on behalf of the Centre – ₹ 4,08,98,360 (Previous year ₹ 70,56,596) against 100% margin money by way of fixed deposit.
- Bills discounted with banks – ₹ Nil (Previous year ₹ Nil).

1.3 Disputed demands in respect of:

Income-tax	₹ Nil (Previous year ₹ Nil)
Sales-tax	₹ Nil (Previous year ₹ Nil)
Municipal Tax	: Amount indeterminate as no demand has come yet.

1.4 In respect of claims from parties for non-execution of orders, but contested by the Centre – ₹ Nil (Previous year ₹ 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 ₹ 2.10 Crores (Previous year ₹ 0.31 Crores).

2.2.1. ₹ 2,19,74,835.60 being depreciation on Fixed Assets and adjustment for writing off of assets charged to revenue for the year 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.

2.2.2 Capital work-in-progress as on 1st April, 2009 was ₹ 10789109, addition during the year is ₹ 20420558, totaling to ₹31209667, out of which ₹ 10233186 has been capitalized during the year, leaving balance of ₹ 20976481 which has been carried forward.

2.2..3 Current Assets, Loans and Advances

In the opinion of the Management, the current assets, loans and advances have a value on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet.

2.3 Taxation

In view of there being no taxable income under Income-tax Act 1961, no provision for Income tax has been considered necessary.

2.4 Foreign Currency Transactions

I) Expenditure in foreign currency:

a) Travel: Nil

b) Remittances and Interest payment to Financial Institutions/Banks in Foreign Currency: Nil

c) Other expenditure: Nil

- Commission on Sales
- Legal and Professional Expenses
- Miscellaneous Expenses
- Bank Charges

ii) Earnings:

Value of Exports on FOB basis: Nil

2.5 Physical Verification of Fixed Assets was conducted by a firm of Chartered Accountants and their report dated 06.07.2010 upto 31.03.2009 has been incorporated in the Financial Statements after necessary adjustments having been carried out.

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 ₹ 1123108 (previous year ₹ 713196) by the employees are appearing under Earmarked & Endowment Fund as on 31-03-2010.

2.8 An amount of ₹ 27953 is payable to P.F. Account appearing under Current Liabilities (previous year ₹ 393664).

2.9 Information from Vendors regarding their status under Micro, Small & Medium Enterprises Development Act, 2006 has not been received by the Centre and hence disclosures under the above Act like amount unpaid at the end of the year together with interest paid/payable have not been furnished.

2.10 Corresponding figures for the previous year have been re-grouped/re-arranged, wherever necessary.

Kolkata
Dated: 03-08-2010