

## FOREWORD

This gives me great pleasure to forward to you the Annual Report for the year 2008-2009. Preparation of the annual report is an important exercise of the centre because this gives us the opportunity to do a “stock checking” of what we have really done. I am pleased to note that the centre has shown an all round growth in this financial year. From the next year (i.e., 2009-2010) the budget received from the Department of Science and Technology will be linked to the performance and annual growth rate. The preparation of annual report and analysis of our growth thus becomes even more important. There is no substitute to look at the output in terms of hard numbers. However, we also admit that there are other subjective parameters for measuring quality research. It is a pleasure to note that some of our faculties have reached a very high standard of publications. I would expect that the standard is reached by our other faculty members.



Starting from June 13, 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. It is important that we matter to Science and the Nation.

The center, as a part of its growth in research, has decided to increase its intake for PhD students. I am happy to note that increasing number of our students are getting NET qualification. This is a national bench mark that our students need to have. Increased number of students not only increases our output, it also a part of our mandate to produce highly trained manpower in advanced areas. We will be maintaining the trend in coming years.

Like other years the centre was also active in the area of scientific conferences and seminars. A number of academics/scientists have visited the centre under EVLP programme. I am happy to note that we also had a number of student visitors and students from other institutions/universities visiting us for their project work.

We were extremely fortunate to have Prof. W. Ketterle, Noble Laureate, visit us and deliver the S. N. Bose Memorial lecture. To have Prof. Ketterle visit us is indeed a dream come true given that he obtained the Noble Prize for experimentally achieving the Bose-Einstein Condensation, an effect predicted more than seven decades ago by Prof. S. N. Bose. The front cover of this year's annual report thus has a historic value.

Prof. Peter Littlewood, FRS, Head of the Department of Physics, University of Cambridge delivered the C. K. Majumdar Memorial Lecture. Prof. Littlewood showed how one can have quantum matter from Excitons. Prof. Asok Sen, FRS also delivered the S. N. Bose Memorial Lecture. He spoke on the issue of entropy of Black Holes. Prof. Sen's presence is always inspiring, in particular, to younger researchers.

One important development that has happened in the centre over the last few years and in particular in year 2008-2009, is our focus on sponsored projects. From the administration side we have a facilitation cell as "Project cell" to help in the submission process and also for transparent project administration. It has been realized that obtaining sponsored projects from different financial and extramural funding agencies through a competitive peer review project is not only financially helpful it is also academically most rewarding. A good number of the faculty members are now applying for and have successfully obtained sponsored projects. The centre will encourage this development and will urge more activity in this direction. This allows one to have a focused output and also brings in vibrancy in our research. It is my personal belief that our shift towards the culture of earning sponsored projects will help us to avoid the pitfall of self-complacency.

At the end I would like to thank and express my deep gratitude 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 and guidance from these various committees, it will be indeed difficult for us to perform. 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.

My sincere thanks and best wishes to the students and faculty colleagues for putting us on a path of high rate of growth. We are looking forward to a rewarding year to come.

Arup Kumar Raychaudhuri

Director

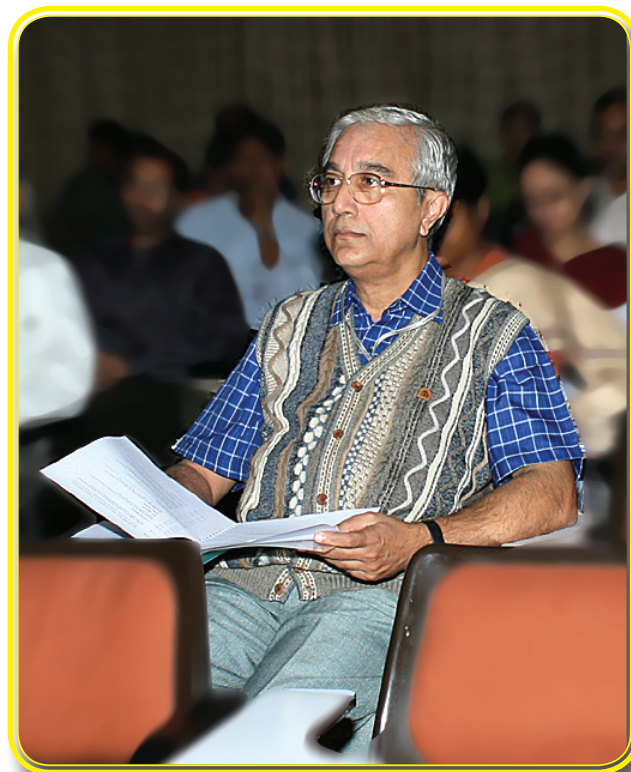
## REPORT FROM THE DEAN (Faculty)

It is heartening to report that the publication profile of our Centre has been continually improving over the last five years. The total number of publications in reputed refereed journals rose from 86 in 2004-05 to 140 in 2008-09. Per faculty this number rose from 2.61 in 2004-5 to 4.44 in 2008-09. The quality of publication as reflected in the total impact factor and total citations rose from 288 and 2094 in 2004-05 to 372 and 2654 in 2008-09 respectively. These point towards a healthy academic performance during the last year. However, we must guard against complaisance lest these figures saturate and the positive slope flattens. We should also guard against uneven performance since there has been stagnation in some areas of research.

Prof. Sandip K Chakrabarti became a Senior Professor and seven colleagues became Associate Professors during the year. Three of our colleagues left us to join other sister institutions. Dr. Anilesh Mohari joined MatScience in Chennai, Dr. Subhasis Sinha migrated to IISER, Kolkata and Prof. Surajit Sengupta went on lien to IACS, Kolkata. Dr. Chhayabrita Biswas joined the Materials Science Department and Dr. Kingshuk Acharyya joined the Astrophysics Department as Bose Fellows. Four new Post Doctoral Fellows and a Faculty Fellow joined us during the year.

Our faculty has worked in 23 sponsored projects worth Rs 4.65 lakhs per faculty. Our collaborative projects with EU, UK, Germany, Sweden, South Africa and the US continued throughout the year. Four of our Research Fellows spent up to three months working with the Materials Theory group in Uppsala University.

Our main aim in the coming year would be to maintain the momentum gained in first rate research and carry it to higher levels.



Abhijit Mookerjee



## REPORT FROM THE DEAN (Academic Programme)

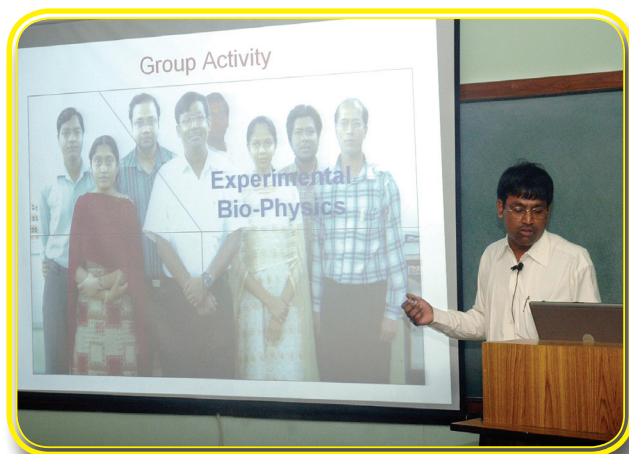
The Centre continued to attract a large number of students and visitors over the past year. The Post B.Sc programme saw an increased intake over the past year and this lively batch of students have made the teaching program worth while. The Post M.Sc intake shows the strength of the research program and the increase in the number of applicants with NET fellowships points to the attractiveness of the research profile. Professor Wolfgang Ketterle of MIT, USA (Nobel Laureate) was the most distinguished visitor of the academic year. He spent more than a week in the Centre and interacted with all the faculty members, post doctoral fellows and students. The conferences and workshops saw a very high degree of participation of students of different age groups. We have introduced the process of video taping the workshops and schools and putting it on our website. So that the proceedings can benefit a large number of students and researchers. The video of Professor Ketterle's Bose Memorial Lecture is also available on our website.



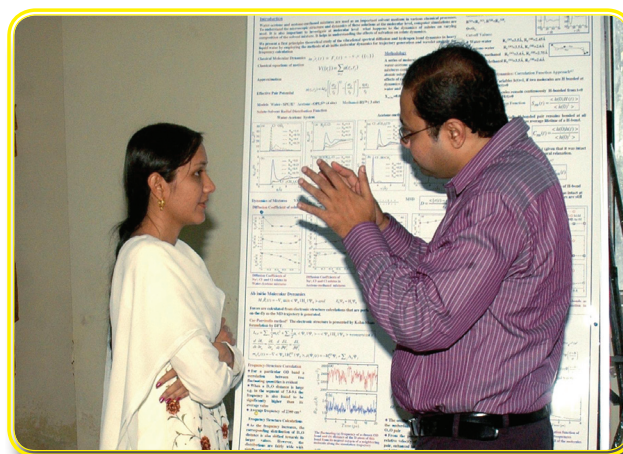
### Conferences/ Workshops/ Symposia organized by the Centre

Conference on Future Direction of Ultra fast Spectroscopy: A guideline on 17th November 2008 at SNBNCBS.

Organizers/ Organizing Committee : Dr. Samir Kumar Pal and Dr. Rajib K Mitra, SNBNCBS.



Dr. S.K. Pal delivering a talk



Poster Presentation by Dr. Rajib K Mitra

Workshop on Future Directions of Ultrafast Spectroscopy held in SNBNCBS on 17th November, 2008



International Conference on Exchange of Ideas and Cooperation between Indian Universities and Singapore, 2009 (ICEIUS – 2009) during 6th to 8th January 2009 at SNBNCBS.

Organizers/ Organizing Committee : Dr. P. K. Mukhopadhyay, SNBNCBS.

4th Advanced School on Nanoscience and Technology during 12th to 24th January 2009 at SNBNCBS.

Organizers/ Organizing Committee : Professor A. K. Raychaudhuri and Dr S. K. Pal, SNBNCBS.



A Group Photograph of the Participants of 4th Advanced School  
on Nano Science and Technology

Conference on “Magnetic Nanomaterials and their Applications” during 27th and 28th January 2009 at SNBNCBS.

Organizers/ Organizing Committee : Dr Kalyan Mandal, SNBNCBS.



Professor Kannah M Krishnan delivering the  
IEEE Magnetics Society Distinguished Lecture



Poster Session

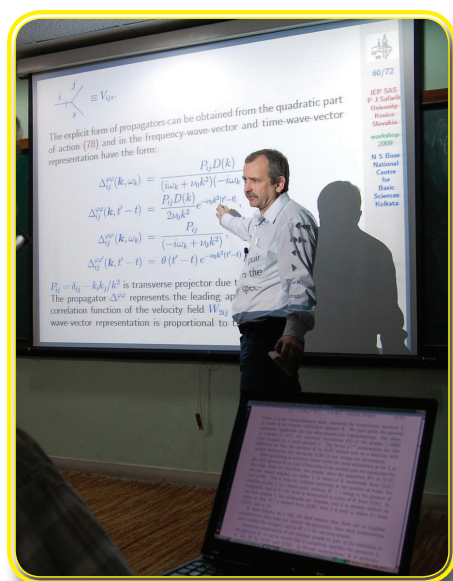
Workshop on “Magnetic Nanomaterials and their Applications” held in SNBNCBS during 27-28 January, 2009.

20th Annual General Meeting of the Material Research Society of India (MRSI) & the Theme Symposium on “New Generation Composites and Hybrid Materials – Concepts to Applications” during 10th to 12th February 2009, Venue - SINP.

Organizer - Materials Research Society of India (Kolkata Chapter), with partial support.

Conference on “Tools of Theoretical Physics and the Problem of Turbulence” during 16th to 20th February 2009 at SNBNCBS.

Organizers/ Organizing Committee : Conveners - Professor J K Bhattacharjee, Dr. Partha Guha, SNBNCBS, Other Members - Prof. S. K. Sharma, Prof. R. Banerjee, Dr. B. Chakraborty, Dr. A. S. Majumdar from SNBNCBS, Prof. K. Ray from IACS, Prof. P. S. Majumdar, from SINP



A Lecture Session



Group photo of the participants

Workshop on Tools of Theoretical Physics and the problems of Turbulence at S.N.B.N.C.B.S. in February, 2009

Conference on “Physics and Chemistry of Oxide Materials” during 23rd to 26th February 2009 at SNBNCBS.

Organizers/ Organizing Committee : Dr. Tanusri Saha Dasgupta, SNBNCBS.



Participants of the Conference on Physics and Chemistry of Oxide Materials.



Conference on “Recent Trends in Strongly Correlated Systems” in collaboration with IACS during 2nd to 4th March 2009.

Organizers/ Organizing Committee : Prof. Indra Dasgupta, IACS, Dr. Priya Mahadevan, SNBNCBS.

“National Review and Co-Ordination Meeting 2009 – Nano Mission DST” during 12th to 14th March 2009 at Vedic Village. Kolkata.

Organizers/ Organizing Committee : DST & SNBNCBS. (Prof. A.K. Raychaudhuri and Dr. S.K. Pal from SNBNCBS).



From Right to Left : Prof. C. N. R. Rao, Prof. A. K. Raychaudhuri, Prof. D. D. Sarma, Dr. T. Ramasami, Dr. V. Rao Aiyagari at the National Review and Co-ordination Meeting of Nano Mission Council held at Vedic Village during 12-14 March, 2008

### Summer Research Project Students – 2008

1. Bidyut Mallick (IIT-Roorkee), ‘Stability and Bulk – Modules of Large Clusters of Noble and Transition Metal’, supervised by Dr. Sugata Mukherjee.
2. Brajesh Gupt (BIT, Meshra), ‘Smoothing of Sandpiles: Looking through equations’, supervised by Prof. Anita Mehta & Dr. Biswajit Chakrabarty.
3. Darla Yagnaja (Indian Academy of Sciences), ‘Hard Sphere Lithography for Nano Fabrication’, supervised by Prof. Arup Kumar Raychaudhuri.
4. Kinshuk Bandopadhyay (Pune University), ‘First Principle Calculation of Electronic Structure of  $\text{Sr}_3\text{NiPtO}_6$  Compound’, supervised by Dr. Tanusri Saha Dasgupta.
5. Mahamed Shahid C (CUSAT), ‘Simple and Basic Aspects of Radiative Properties of Non Absorbing Particles’, supervised by Prof. Subodh K Sharma.



6. Megha N Dubey (University of Pune - Indian Academy of Sciences), 'Photoconductivity study & Impedance spectroscopy of ZnO based Devices', supervised by Prof. Arup Kumar Raychaudhuri.
7. Mr. Sudipta Kumar Bera (IIT-Kharagpur), 'Ferromagnetic Shape Memory Alloy', supervised by Dr. Pratip Kr Mukhopadhyay.
8. Niladri Bihari Sahoo (Utkal University, Bhubaneswar), 'Reintroduction to the General Theory of Relativity', supervised by Dr. Archan S Majumdar.
9. Prabir Mondal (IIT, Kharagpur), 'Quantum Entanglement and spin squeezing', supervised by Prof. Nilkantha Nayak.
10. Ujjal Kumar Dey (Jawahar Lal Nehru Centre for Advanced Scientific Research), 'A collidal Particle embedded in a Modulated Liquid', supervised by Dr. Jaydeb Chakrabarti.
11. V. Suryanarayana (University of Hyderabad), 'Investigation of Nonperturbative Methods to solve Nonlinear Klein – Gordon Equation', supervised by Dr. Biswajit Chakraborty.

### Courses offered at the Centre during 2008- 2009.

#### Post B. Sc Courses

##### 1st Year 1st Semester

SUBJECT	FACULTY
Classical Dynamics	Jayanta K Bhattacharjee
Mathematical Methods I	Samir Kumar Paul
Quantum Mechanics I	Amitabha Lahiri
Electromagnetic Theory I	Biswajit Chakraborty
Computational Methods in Physics I	Subhrangsu S Manna
Basic Laboratory I	P K Mukhopadhyay

##### 1st Year 2nd Semester

SUBJECT	FACULTY
Statistical Mechanics	Jayanta K Bhattacharjee
Mathematical Methods II	Samir Kumar Paul
Quantum Mechanics II	Binayak DuttaRoy
Electromagnetic Theory II	M Sanjay Kumar, Manu Mathur
Computational Methods in Physics II	Priya Mahadevan
Basic Laboratory II	Kalyan Mandal

## 2nd Year 1st Semester (Over all 3rd Semester)

SUBJECT	FACULTY
Quantum Mechanics III	Binayak DuttaRoy
Condensed Matter Physics	Prasenjit Singha Deo & Abhijit Mookerjee
Nuclear & Particle Physics	Asim K Ray
Project Based Courses	Manu Mathur, J K Bhattacharjee, Samir K Paul
Methods of Experimental Physics	Kalyan Mandal, P K Mukhopadhyay & A K Raychaudhuri

2<sup>nd</sup> Year 2<sup>nd</sup> Semester (Over all 4th Semester)

SUBJECT	FACULTY
Project Based Course	N Nayak, J K Bhattacharjee, Samir K Paul
Seminar Course – Electives I, II, III	Asim K Ray
Advanced Statistical Mechanics	Jayanta K Bhattacharjee
Advanced Quantum Field Theory	Partha Sarathi Majumdar
Advanced Mathematical Methods	Samir K Paul
Quantum Optics (Reading Course)	Nilakantha Nayak

## Post M.Sc. Courses

## Post M.Sc Programme In Physical Sciences

Quantum Physics	D Gangopadhyay
Statistical Physics	A K Raychaudhuri & J K Bhattacharjee

## Post M.Sc Programme for Dept. of Chemical, Biological &amp; Macromolecular Sciences

Physical Chemistry	Ranjit Biswas
Fundamentals of Biophysics	Rajib Mitra
Stochastic Process in Chemical Physics	Gautam Gangopadhyay
Mathematical Methods in Chemical Physics	Gautam Gangopadhyay
Numerical Methods	Jaydeb Chakrabarti
Instrumental Methods of Analysis	Samir Kumar Pal

Project Based Course – Sem I &amp; Sem II

J. K. Bhattacharjee

## REPORT ON ADMINISTRATIVE MATTERS

The administrative and technical staff members of the Centre have very professionally and sincerely carried out their duties for making the various activities of the Centre in 2008-2009 successful. Staff comprising of strength of approximately 21 in permanent, 13 in temporary and 43 in contractual category as on 31st March 2009, have functioned effectively under the able leadership of the Director and Registrar. The smooth running of the day to day activities of the Centre including 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 programmes 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 made functional 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 2008-2009. The Centre has also adhered to the norms of the Right to Information Act and so far has received only one case under the said Act.



Sugata Mukherjee  
Acting Registrar



## WELFARE MEASURES AND LANGUAGE POLICY

The Centre paid emphasis on implementation of the Official Language in the year 2008-09. According to Rajbhasha Act, reply to hindi letters were given in Hindi only. Most of the registers and forms are in bilingual format. Office Orders and Notices are circulated in Hindi also. 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. This year 13 members enrolled for 'Paveen' course and 10 for 'Pragya' Course under the Hindi Teaching Scheme. All, barring 3 have passed both the examinations. Majority of the administrative staff now possess working knowledge of hindi. The year also saw Hindi Diwas being celebrated in great zeal, with the month of September being declared as Hindi month. Quiz, debate, screening of hindi movie and a hindi play were organised as part of 'Hindi Pakhwara'. The Centre also deputed some staff members for attending 'Rajbhasha Sammelan' in Dalhousie, Himachal Pradesh.

Sugata Mukherjee  
Acting Registrar

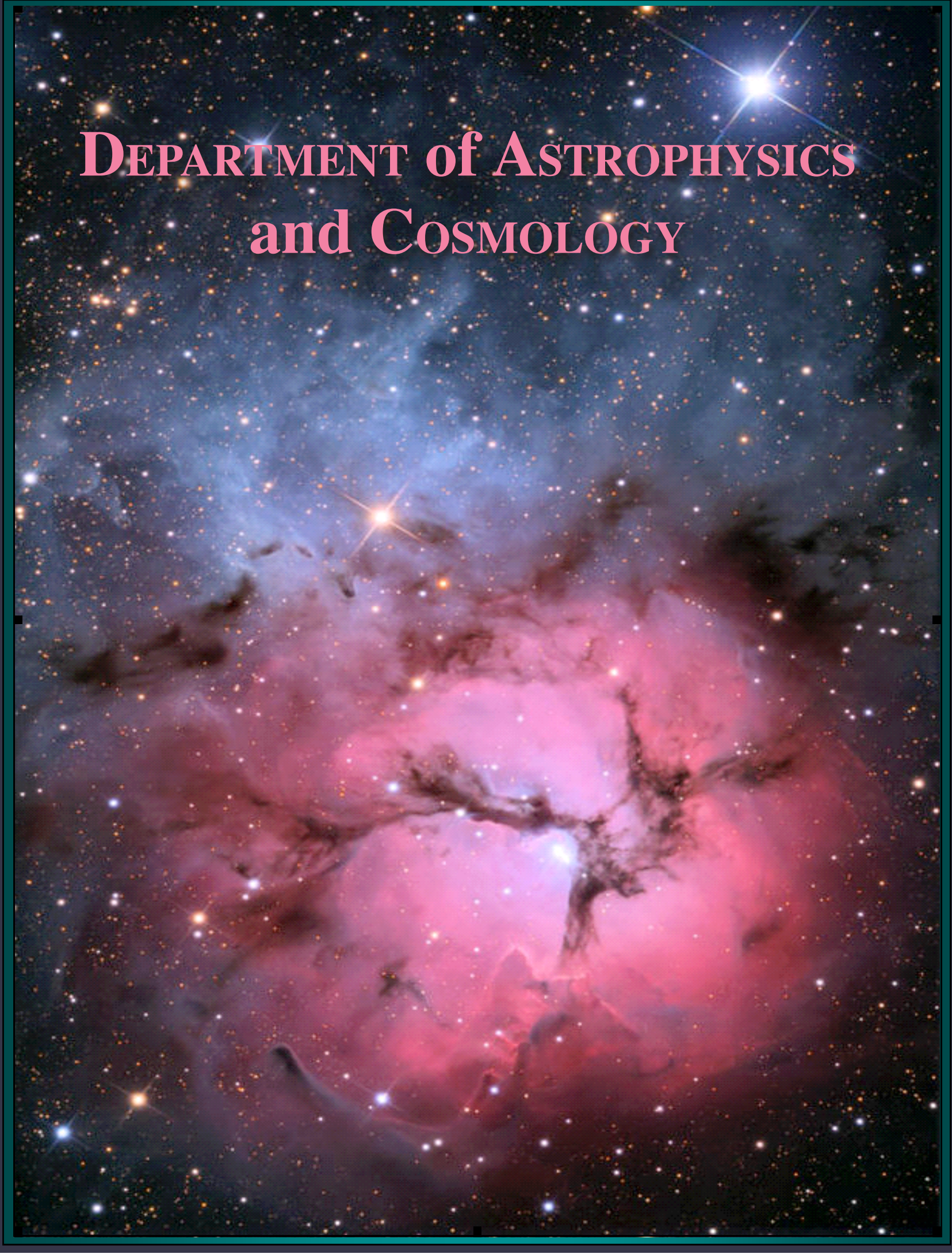


Staff members of the Centre attending 'Rajbhasha Sammelan' in Dalhousie, HP





# DEPARTMENT of ASTROPHYSICS and COSMOLOGY







## Report from the Department of Astrophysics and Cosmology

### Highlights of activities in Astrophysics and Cosmology

The department had been very active in 2008-2009 and pushed forward significantly the frontier research work in the subject.

In Astrobiology, formation of water and methanol in the dense cloud conditions was studied on grain surfaces to find the dependence of its production rate on the binding energies, reaction mechanisms, temperatures, and grain site number. The effective grain surface area available for chemical reaction and the effective recombination timescales as functions of grain and gas parameters were obtained using a Monte Carlo simulation. An experimental setup has been finalized to study the surface reactions in extreme conditions of molecular clouds.

In black hole astrophysics, progress has been made to understand the evolution of the Quasi-Periodic Oscillations in transient black hole sources. The phenomenon of rapidly rising QPOs in outburst sources has been identified in two black hole candidates, namely, GRO J1655-40 and XTE J1550-564 and this was explained by oscillating shocks propagating towards the black hole at the rising phase of the outbursts. These shocks which are solutions of the governing equations for sub-Keplerian flows around black holes, are also responsible for Compton scattering of low energy photons, outflows, and spectral and timing properties of any black hole candidate.

A unified view of dark matter and dark energy was obtained and results for all relevant cosmological parameters were found to be in excellent agreement with observations. For this, a Lagrangian for the  $k$ -essence field was set up with canonical kinetic terms by a redefinition of variables and incorporating a scaling relation.

The single qubit Hadamard and Phase Shift quantum logic gates and the two qubit CNOT (controlled NOT) quantum logic gate have been shown to be realizable with  $q$ -deformed oscillators thereby establishing an alternative formalism for quantum computation and opening up possibilities in the realm of quantum cryptography.

A formalism for characterizing and quantifying the quantum entanglement of Gaussian states in the presence of position space non-commutativity has been developed. Using this formalism it was shown that non-commutativity leads to the reduction of entanglement at short distances.

**Total number of refereed publications over the last one year : 16**

**Total number of Ph.D students on role : 9**

**Total number of Ph.D students submitted thesis : 1**

**Total number of students received Ph.D award : 1**

**Name and Designation :**

**Kinsuk Acharyya  
Bose Fellow**

**Significant research output including sponsored projects :**

We have studied the formation of water and methanol in the dense cloud conditions to find the dependence of its production rate on the binding energies, reaction mechanisms, temperatures, and grain site number. We wish to find the effective grain surface area available for chemical reaction and the effective recombination timescales as functions of grain and gas parameters. We used a Monte Carlo simulation to follow the chemical processes occurring on the grain surface. We carried out the simulations on the Olivine grains of different sizes, temperatures, gas phase abundances and different reaction mechanisms. We consider H, O, and CO as the accreting species from the gas phase and allow ten chemical reactions among them on the grains. We compute the abundance of water and methanol and show that the results strongly depend on the density and composition in the gas phase, as well as various grain parameters. In the rate equation, it is generally assumed that the recombination efficiencies are independent of the grain parameters, and the surface coverage. Presently, our computed parameter  $\alpha$  for each product is found to depend on the accretion rate, the grain parameters and the surface coverage of the grain. We compare our results obtained from the rate equation and the one from the effective rate equation, which includes  $\alpha$ . A comparison of our results with the observed abundance shows very good agreement. Presently, We are trying to use parallel computation so that we can handle more species and study multi-layer grain mantle growth using above mention technique.

**Publications :**

**In refereed journals :**

1. A. Das, K. Acharyya, S. Chakrabarti & S. K. Chakrabarti, **"Formation of water and methanol in star forming molecular clouds"**, Astronomy & Astrophysics, **486**, (2008), 209.

**Other publications :**

1. A. Das, K. Acharyya, S. Chakrabarti & S. K. Chakrabarti, In the proceedings of International Astronomical Union, IAU Symposium **"Methanol formation: A Monte Carlo study"**, IAUS, **251**, (2008), 0121.

**Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :**

Seminar Lecture on "Laboratory studies of Interstellar Ice Analogs", at the Inter-University Centre for Astronomy and Astrophysics, Pune, India, July, 2008.

**Other academic / educational activities :**

**Membership of Committees :**

- a) Member of Technical Cell
- b) Member of Newsletter committee



**Name and Designation :**

**Sandip K. Chakrabarti**  
**Senior Professor**

**Significant research output including sponsored projects:**

In transient black hole sources, the accretion of matter is abrupt and the propagating shock emits high energy radiation while oscillating at higher and higher frequency. This behaviour is known as the Quasi-Periodic Oscillations (QPOs). This phenomenon of rapidly rising QPOs in outburst sources has been identified in two black hole candidates, namely, GRO J1655-40 and XTE J1550-564. In fact, in GRO J1655-40, it was found that the shock abruptly disappeared as the flow entered behind the horizon. These works were carried out with B. G. Dutta, D. Debnath and P. S. Pal. The presence of the sub-Keplerian flow is also evident in the most massive black hole M87 as fitting its spectrum does not seem to require any Keplerian flows. This work was done with S. Mandal. Monte-Carlo simulations in sub-Keplerian flows around black holes clearly showed evidence of Comptonized power-law component in the spectrum. The effect of bulk motion Comptonization in a realistic flow is observed in the simulation. This work is done with H. Ghosh.

Very Low Frequency (VLF) study of the ionosphere has been progressing with great success. It appears that the sun-rise and sun-set terminators may be affected by the ionospheric disturbances, whether terrestrial or extra-terrestrial. The effect of the bond-energy released into the ionosphere during the cracks of the tectonic plates just prior to earthquakes may have been observed in more than 60% of the dates in which strong earthquakes take place. This requires further investigation with more receiving antenna setups. A campaign was launched to obtain the VLF signals from all over the country and a theoretical model is being developed to understand the behaviour of the signals received throughout the day at various locations. A similar campaign is planned for the upcoming solar eclipse in July 2009. These works are done with S. Sasmal, S. Mondal, T. Basak and S. Pal.

In the field of astro-biology, a considerable work has been done on Monte-Carlo-simulations of reactions on the grain surfaces in collapsing molecular clouds in the star forming regions. So far, hydrogen, water, methanol etc. have been produced on grains. Chemical evolutions of the gas phase along with time dependent cloud collapse is being carried out. These works are done with A. Das, K. Acharyya and S. Chakrabarti.

**Publications :**

**In refereed journals :**

1. S. K. Chakrabarti, D. Debnath, A. Nandi and P. S. Pal, 2008, **"Evolution of Quasi-Periodic Oscillation Frequency in GRO J1655-40 – Implications on Accretion Disk Dynamics"**, Astronomy and Astrophysics, **489L**, (2008), 41.
2. K. Chakrabarti, M. M. Majumdar and S. K. Chakrabarti, **"Accretion onto compact objects viewed as a flow in converging-diverging ducts"**, International Journal of Modern Physics, **17(5)**, (2008), 799.
3. P. Basu, S. Mondal, S. K. Chakrabarti, **"Gravitational wave emission from a massive companion black hole in presence of an accretion disk around a super-massive Kerr black hole"**, Monthly Notices of Royal Astronomical Society, **388**, (2008), 219.
4. A. Das, K. Acharyya, S. Chakrabarti, S. K. Chakrabarti, **"Formation of Water and Methanol in Star forming Molecular clouds"**, Astronomy & Astrophysics, **486**, (2008), 209.

5. S. Das and S. K. Chakrabarti, "**Dissipative accretion flows around a rotating black hole**", Monthly Notices of Royal Astronomical Society, **389**, (2008), 371.
6. D. Debnath, S. K. Chakrabarti, A. Nandi and S. Mandal "**Spectral and Timing evolution of GRO J1655-40 during its outburst of 2005**", Bulletin of Astronomical Society of India, **36**, (2008), 151.
7. S. Mandal and S. K. Chakrabarti, "**Spectrum of an accretion disk around a super-massive black hole: an application to M87**", Astrophysical Journal, **689**, (2008), 17.

**Other publications :**

1. S. K. Chakrabarti and A. S. Majumdar (Eds), "**OBSERVATIONAL EVIDENCE FOR BLACK HOLES IN THE UNIVERSE**": Proceedings of the 2nd Kolkata Conference on Observational Evidence for Black Holes in the Universe held in Kolkata India, 10 - 15 February 2008 and the Satellite Meeting on Black Holes, Neutron Stars, and Gamma-Ray Bursts held 16 - 17 February 2008 (AIP).
2. A. Das, K. Acharyya, S. Chakrabarti, S. K. Chakrabarti, , "**Methanol formation: A Monte Carlo study by 2008, in Organic Matter in Space**", Proceedings of the International Astronomical Union, IAU Symposium, **251**, 121 (CUP).
3. S. K. Chakrabarti, D. Bhounik, D. Debnath, R. Sarkar, A. Nandi, V. Yadav, A. R. Rao, "**CSPOB-Continuous Spectrophotometry of Black Holes**", in AIP Conf. Proc. **1053**, (2008), 409, (AIP).
4. S. Palit, S. K. Chakrabarti, D. Debnath, V. Yadav, A. Nandi, "**Fresnel zone plates for Achromatic Imaging Survey of X-ray sources**", in AIP Conf. Proc., **1053**, (2008), 391 (AIP).
5. H. Ghosh, S. K. Chakrabarti, P. Laurent, "**Inverse Comptonization in a Two Component Advective Flow: Results of a Monte Carlo simulation**", in AIP Conf. Proc., **1053**, (2008), 373 (AIP).
6. S. Das, S. K. Chakrabarti, "**Standing accretion shock waves around rotating black holes in presence of cooling**", in AIP Conf. Proc., **1053**, (2008), 373 (AIP).
7. S. K. Chakrabarti, "**Black Hole Accretion: From Quasars to Nano-Quasars**", in AIP Conf. Proc., **1053**, (2008), 325 (AIP).
8. R. Sarkar, S. K. Chakrabarti, A. Nandi, "**X-ray Observation of SWIFT J1753.5-0127 with RXTE & XMM-Newton**", in AIP Conf. Proc., **1053**, (2008), 215 (AIP).
9. Partha S. Pal, A. Nandi, S. K. Chakrabarti, "**Dynamical Nano Quasar GRS 1915+105**", in AIP Conf. Proc., **1053**, (2008), 209 (AIP).
10. D. Debnath, A. Nandi, P. S. Pal, S. K. Chakrabarti, "**QPO Evolution in 2005 Outburst of the Galactic Nano Quasar GRO J1655-40**", in AIP Conf. Proc., **1053**, (2008), 171 (AIP).
11. Broja G. Dutta, Sandip K. Chakrabarti; Partha S. Pal, "**Evolution of QPOs in XTE J1550-564 in 1998 outburst: a Case of Quasi Outburst?**", in AIP Conf. Proc., **1053**, (2008), 171 (AIP).
12. S. K. Chakrabarti, A. K. Choudhury, A. K. Chatterjee, W. Bari, "**Live Coverage of Class Transitions in the Nano Quasar GRS 1915+105**", in AIP Conf. Proc., **1053**, (2008), 161 (AIP).

13. Prasad Basu, Sandip K. Chakrabarti, **“Gravitational wave emission from a companion black hole in presence of an accretion disk around a super-massive Kerr black hole”**, in AIP Conf. Proc., **1053**, (2008), 161 (AIP).
14. S. K. Chakrabarti, S. K. Mondal, S. Sasmal and D. Bhowmick, **“Detailed lightcurves of ICSP VLF observation of SGR/AXP 1E1547.0-5408”**, Gamma Ray Burst Circular Network, (2009), 8900.
15. S. K. Chakrabarti, S. K. Mondal, S. Sasmal and D. Bhowmick, **“ICSP VLF observation of the signatures of SGR/AXP 1E1547.0-5408 bursts”**, Gamma Ray Burst Circular Network, (2009), 8881.

### Supervision of Research :

#### i. Ph.D. Students (including Project students) : 8

- a) Himadri Ghosh (ISRO Project)
- b) Sujoy Pal
- c) Kinsuk Giri
- d) Sudip Garain
- e) Tamal Basak
- f) Arnab Sen
- g) Broja Gopal Dutta (ICSP)
- h) Dipak Debnath (ICSP)

#### Ph.D. Thesis Submitted : 1

- a) Ankan Das on ‘Hydrodynamic Simulation of the formation of protostars during molecular cloud collapse and the chemical evolution in these processes’ to Calcutta University.

#### Ph.D. Degree Received : 2

- a) Soumen Mondal on ‘Accretion processes around Kerr black holes’ from Jadavpur University.
- b) Prasad Basu on ‘Effects of Massive Accretion flows on Gravitational Wave Emission from Binary Systems’ from Jadavpur University.

### Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :

1. May, 2008: ‘Accretion processes of black holes’ at George Mason University, Louisiana State University, University of Texas at Arlington and 212th American Astronomical Society meeting in St. Louis.
2. August, 2008: ‘Evolution of pre-biotic molecules during collapse of Interstellar clouds’ and ‘Monte Carlo Simulation of Water and Methanol on Grain Surfaces’ at the 15th ISSOL meeting, Florence and ICRANET, Pescara.
3. March, 2009: ‘Study of the correlation between ionosphere activities with earth quakes by monitoring Very Low Frequency (VLF) signals’ and ‘Analytical Modeling and Numerical

Simulations of the Quasi-Periodic Oscillations of Black Hole Candidates' at the ISRO RESPOND meeting in PRL, Ahmedabad

**Other academic / educational activities :**

- a) Gave a series of 12 lectures to the M.Sc students of R. K. M. College on High Energy Astrophysics and Cosmology
- b) Visited University of Paris (January, 2009) as an external Examiner of HDR Professorship
- c) Editorial board of Indian Journal of Physics (Springer) and Open Astronomy and Astrophysics journal (Bentham Publication).
- d) Member , Governing Board of Studies, M.Sc , R. K. M. Residential College, Naredrapur.

**Name and Designation :**

**Debashis Gangopadhyay**  
**Associate Professor**

**Significant research output including sponsored projects :**

- A. A lagrangian for the k- essence field was set up with canonical kinetic terms by a redefinition of variables and also incorporating a scaling relation. A unified view of dark matter and dark energy was obtained and results for all relevant cosmological parameters were in excellent agreement with observations.
- B. The single qubit Hadamard and Phase Shift quantum logic gates and the the two qubit CNOT (controlled NOT) quantum logic gate have been shown to be realizable with q-deformed oscillators. Thus all the three gates necessary for universality are realisable with q-deformed oscillators. So an alternative formalism for quantum computation has been established and this opens up enormous possibilities in the realm of quantum cryptography.

**Publications :**

**In refereed journals :**

1. Debashis Gangopadhyay and Somnath Mukherjee, **"Logarithm of the Scale Factor as a Generalised Cordinate in a Lagrangian for Dark Matter and Dark Energy"** Phys. Lett. **B665**, (2008),121.
2. Debashis Gangopadhyay, **"The CNOT Quantum Logic Gate Using q-Deformed Oscillators"**, Int. Jour. Quant. Inform. **6**, (2008), 471.
3. A. S. Majumdar, Debashis Gangopadhyay, L. P. Singh, **"Evolution of primordial black holes in Jordan-Brans-Dicke Cosmology"**, Monthly Notices of the Royal Astronomical Society **385**, (2008),1467.

**Supervision of Research :**

**i. Post B.Sc. / Post M.Sc. / Others : 2**

- a) Oindrila Ganguly of the Post-B.Sc.-Integrated Ph.D. (2006-2008) SNBNCBS 4th Semester project on "Some aspects of quantum field theory in curved spacetime".



- b) Nilok Bose of the Post-B.Sc. Integrated Ph.D. (2006-2008) SNBNCBS 4th Semester project on “A study of k-essence involving covariant derivatives”.

**M.Sc. Project on “Dark matter and Dark Energy” (Bose Institute, Kolkata)**

- a) Parama Guha
- b) Kinkar Saha
- c) Sudipa Upadhyay

**ii. Ph.D. Students (including Project students) : 3**

- a) Somenath Mukherjee (external student)
- b) Gautam Manna (Bose Institute, Kolkata)
- c) Oindrila Ganguly (SNBNCBS)

**Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :**

Invited lecture in the Indo-Singapore joint Physics symposium [Jan 2009]

**Other academic / educational activities :**

- a) M.Sc. Programme of Bose Institute - St. Xavier’s College (under aegis of Calcutta University). Taught Special Relativity, Group Theory, Quantum Field Theory.
- b) Taught a course entitled “Review Problems in Quantum Mechanics” to Post M.Sc. students of SNBNCBS.
- c) Member of Board of Judges in “Young Physicists’ Colloquium” (Indian Physical Society), 2008, held at Saha Institute of Nuclear Physics.

**Name and Designation :**

**Archan S. Majumdar**  
**Associate Professor**

**Significant research output including sponsored projects :**

**A. Cosmology :**

We have constructed k-essence models which generate the features of inflation in the early universe, and subsequently account for the dark matter and dark energy densities at late times within a unified framework.

**B. Quantum information and foundations :**

We have developed a formalism for characterizing and quantifying the quantum entanglement of gaussian states in the presence of position space non-commutativity. Using this formalism we have shown that non-commutativity leads to the reduction of entanglement at short distances.

**Publications :**

**In refereed journals :**

1. D. Gangopadhyay, A. S. Majumdar, and L. P. Singh, “Evolution of primordial black holes in

- Jordan-Brans-Dicke cosmology"** Mon. Not. Roy. Astron. Soc. **385**, (2008),1467.
2. B. Ghosh, A. S. Majumdar and N. Nayak, "**Atomic entanglement mediated by a squeezed cavity field**", Int. Jour. Theor. Phys. Group Theor. & Nonlinear Opt. **13**, (2009),86.
  3. S. Adhikari, B. Chakraborty, A. S. Majumdar and S. Vaidya , "**Quantum entanglement in a non-commutative system**", Phys Rev. A **79**, (2009), 042109.
  4. N. Bose and A. S. Majumdar, "**A k-essence model of inflation, dark matter and dark energy**", Phys. Rev. D **79**, (2009),103517.
  5. N. Mukherjee and A. S. Majumdar, "**Rotating braneworld black hole lensing in the strong deflection limit**", Gravitation & Cosmology , **15**, (2009), 263.

#### Other publications :

1. A. S. Majumdar, "**Primordial black holes as dark matter, in Observational Evidence for Black Holes in the Universe**", eds. S. K. Chakrabarti and A. S. Majumdar (AIP 2008), 129.
2. A. S. Majumdar, "**Primordial black holes as dark matter in alternate gravity theories**", EAS Publication Series (eds. E. Pecontal et al.) **36**, (2009), 187.
3. A. S. Majumdar, "**Cosmology with primordial black holes motivated from extra-dimensional theories**", in "Black holes in General Relativity and String theory", Proceedings of Science, ed. L. Bonora (2009), 017.
4. A. S. Majumdar , "**Black holes in extra dimensional theories**", Proceedings of the Workshop on Physics of Warped Extra Dimensions, IIT Kharagpur, ed. S. Kar, (2009), 125.
5. S. K. Chakrabarti and A. S. Majumdar (Eds), "**OBSERVATIONAL EVIDENCE FOR BLACK HOLES IN THE UNIVERSE**": Proceedings of the 2nd Kolkata Conference on Observational Evidence for Black Holes in the Universe held in Kolkata India, 10 - 15 February 2008 and the Satellite Meeting on Black Holes, Neutron Stars, and Gamma-Ray Bursts held 16 - 17 February 2008 (AIP).

#### **Supervision of Research :**

##### **i. Ph.D. Students (including Project students) : 2**

- a) Nilok Bose
- b) Tanumoy Pramanik

##### **Ph. D Thesis submitted : 1**

- a) Nupur Mukherjee on "Gravitational lensing by black holes in higher dimensional theories" to Jadavpur University

##### **ii. Post doctoral research scientists : 1**

- a) Satyabrata Adhikari

##### **iii. Independent publications of students/ PDF : 2**

- a) S. Adhikari, N. Ganguly, I. Chakrabarty, B. S. Choudhury, "**Quantum cloning, Bell's inequality and teleportation**", J.Phys. A: Math.Theor. **41**, (2008), 415302.

- b) S. Adhikari, S. Gangopadhyay, “A study of the efficiency of the class of W-states as a quantum channel”, Int. J. Theor. Phys. **48**, (2009), 403.

**Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :**

1. “Primordial black holes as dark matter in alternate gravity theories”, in CRAL-IPNL Conference on Dark Matter and Dark Energy, Univ. Lyon, France, July 2008.
2. “Cosmology with primordial black holes motivated from extra-dimensional theories”, in Black Holes in General Relativity and String theory, Veli Losinj, Croatia, September 2008.
3. “Applications of Quantum Information Science”, in DST meeting of Autonomous Scientific Institutes, ARCI Hyderabad, January 2009.
4. “Braneworld Gravity”, Session Chair in the IAGRG meeting, SINP Kolkata, January 2009.
5. “Cosmology with black holes -- beyond the standard paradigm”, IISc Colloquium, Physics Department, IISc Bangalore, February 2009.
6. “Cosmology with black holes: probe of new physics” in National Seminar on Advances in Physics and Astrophysics, NBU Siliguri, March 2009.

**Other academic / educational activities :**

**Membership of Committees :**

- a) Library Committee
- b) Students’ curriculum and research evaluation committee

**Name and Designation :**

**Srikant Sinha**  
**Visiting Faculty Fellow**

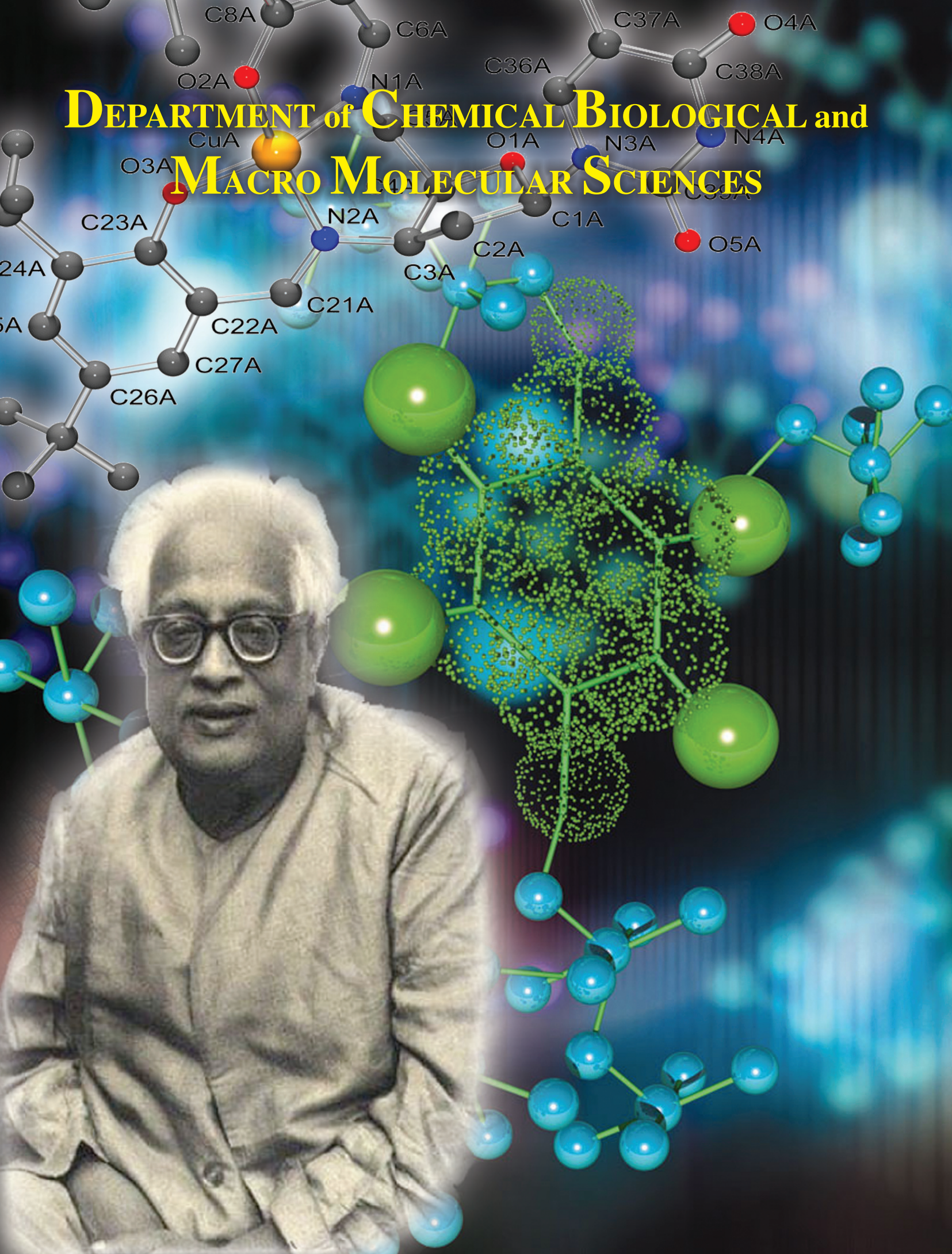
**Significant research output including sponsored projects :**

Estimation of Detector Background in Space-borne Si(PIN) and CdTe Detectors and the Signal-to-Noise Ratios for the Detection of Solar X-ray Flares.





# DEPARTMENT of CHEMICAL BIOLOGICAL and MACRO MOLECULAR SCIENCES









## Report from the Department of Chemical, Biological and Macro Molecular Sciences

### Significant research output of CBMS Department

**Dr. S K Pal's** group has worked on to reveal that the binding affinity of one of the drugs ethidium bromide (EB) to the plant DNAs extracted from *M. Indica* (mango) and *R. communis* L. (castor bean) is much weaker electrostatic type compared to that of any animal DNAs, His study on the ultrafast spectroscopic studies on the DNAs have distinctly distinguished the nature of molecular recognition of the plant DNAs from that of the animal DNAs, wherein all are just made of only four fundamental bases namely A,T,G,C.

**Prof. Surajit Sengupta** has main contribution on Non-affine zones and microstructure selection in solids, Non-local strain compliances of solids and Structural transitions in low dimensional systems. They have looked at various soft matter systems like colloids confined to a solid strip with patterned walls and colloids confined in two dimensional layers. They have found interesting structural transformations involving the creation of defect lattices.

**Dr. Rajib Mitra** has studied to understand the effect of hydrogen bonding on the dynamics of water in small clusters of binary mixtures. He impregnate a well known molecular magnet V15 into the cavity of a transport protein HSA and found that the magnetic moment of the molecule increases substantially upon incorporation into the protein.

**Dr. Ranjit Biswas** and his group worked on to study solvation dynamics in four imidazolium cation based room temperature ionic liquids (RTIL) by using a molecular hydrodynamic theory that uses dielectric relaxation data as input. They have explored environment effects (both static and dynamic) on photo-induced intramolecular charge transfer (ICT) reactions in electrolyte solutions [3], binary mixtures and confined environments [4]. Their study has predicted significant dynamic medium effects on ICT reactions in substituted benzonitril derivatives.

**Dr. Gautam Gangopadhyay** and collaborators have made a detailed study on the conjugated polymer aggregates and its luminescence properties including the properties of symmetry of the aggregated interchain dressed states.

**Dr. P Singha Deo** has tried to explain several unexplained experimental results in mesoscopic systems. It has mainly to do with magnetization of mesoscopic rings but their work can explain many other experimental data.

**Dr. Jaydeb Chakraborti** has worked on Nonequilibrium response of colloids and the effective interaction between two such dressed particles. They have used all -atom Molecular Dynamics simulations of DNA sequences using the CHARMM force field. They have used periodic boundary conditions along the length of the DNA to ensure that the end-effects are minimal. Different aspects of the DNA structure have been looked into details.

**Total number of refereed publications over the last one year : 37**

**Total Number of Ph.D students on role : 11**

**Total Number of Ph.D students submitted thesis : 2**

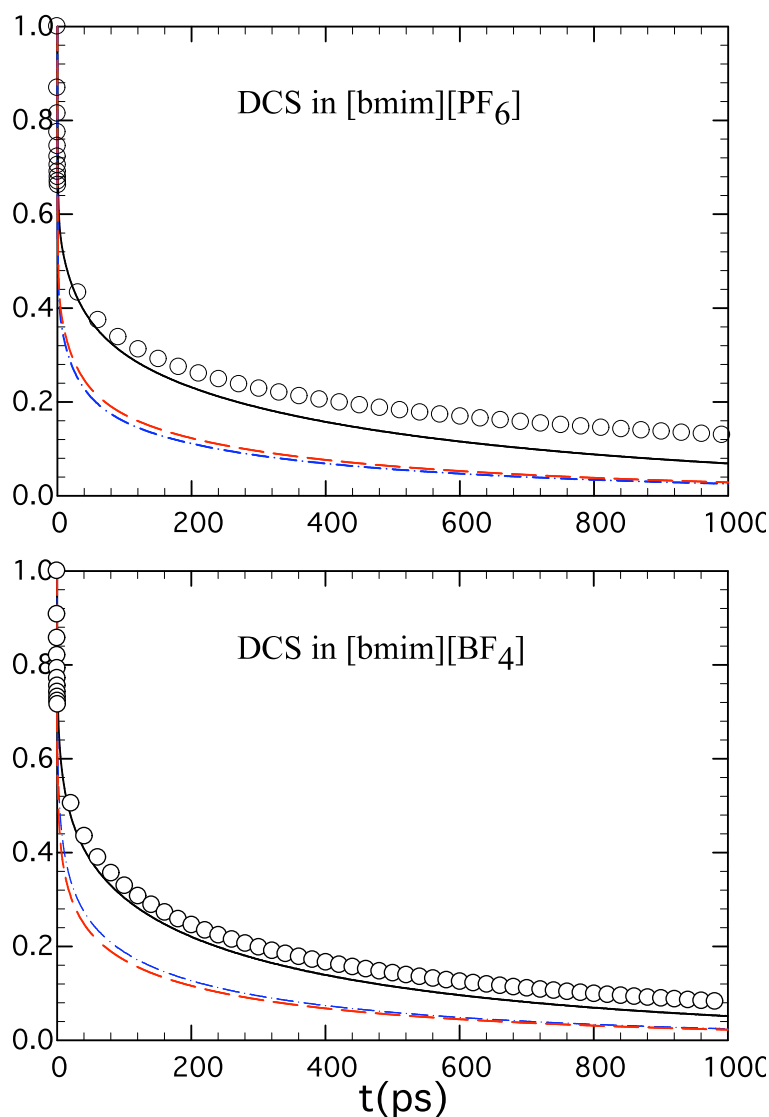
**Total Number of students received Ph.D award : 2**

Name and Designation :

Ranjit Biswas  
Associate Professor

### Significant research output including sponsored projects:

Recently, we have studied solvation dynamics in four imidazolium cation based room temperature ionic liquids (RTIL) by using a molecular hydrodynamic theory that uses dielectric relaxation data as input [1]. Common solvation probes were used for this study and solvation energy relaxation due only to the dipole-dipole interaction is considered. The calculated decays of the solvent response function for these RTILs have been found to be biphasic and the decay time constants agree well with the available experimental and computer simulation results. Subsequently, the interaction components contributing to the measured dynamic Stokes' shift in several dipolar and non-dipolar ionic liquids are separated. Relevant calculation reveal that ~60-70% of the observed shift originates from the interaction of the dipolar solute with the surrounding ions [2]. This part of the shift shows a slow dynamics and is responsible for the break-down of the existing theories of polar solvation dynamics (see Fig. 1). Such a study for solvation dynamics in ionic liquids is done for the first time.



We have explored environment effects (both static and dynamic) on photo-induced intramolecular charge transfer (ICT) reactions in electrolyte solutions [3], binary mixtures and confined environments [4]. Our study has predicted significant dynamic medium effects on ICT reactions in substituted benzonitril derivatives. Temperature dependent studies have shown that ICT reaction in these molecules in less-polar solvents may take a different course from that in strongly polar solvents [5]. In addition, the estimated activation energies have been found to be in close agreement with the predicted values. Solvent isotope effects appear to be insignificant as the effects of slow solvent dynamical modes appear to be nullified by the modulation of the barrier height [6]. Studies in binary solvent mixtures reveal that solution structural aspects influence the reaction through the coupling with the reactive mode [7].

Fig. 1: Validity test of the dynamic continuum model for solvation energy relaxations of DCS in imidazolium ionic liquids. Solvation response functions calculated from the dynamic continuum model are represented by dashed lines (red) for [bmim][PF<sub>6</sub>] (upper panel) and

[bmim][BF<sub>4</sub>] (lower panel). The experimental results are shown by circles. Predictions from the present theory for these liquids by considering only the  $k\sigma \rightarrow 0$  mode of the solvent polarization relaxation are shown by the dot-dashed (blue) lines. Solid lines in these two panels represent the calculations of  $S_{sd}(t)$  after incorporating contributions from all solvent modes. Note the close agreement between the continuum model predictions and the present theory at the proper limiting condition.

## Publications :

### In refereed journals :

1. Hemant Kashyap and Ranjit Biswas, **"Dipolar Solvation Dynamics in Room Temperature Ionic Liquids: An Effective Medium Calculation Using Dielectric Relaxation Data"**, Journal of Physical Chemistry, **B112**, (2008), 12431.
2. Tuhin Pradhan and Ranjit Biswas, **"Intramolecular Charge Transfer Reaction of 4-(1-azetidiny) benzonitrile in Solution of Low Electrolyte Concentration: A Novel Interplay Between Friction and Solvation"** by, Journal of Solution Chemistry, **38**, (2009), 517.
3. Ranjit Biswas, Nashiour Rohman, Tuhin Pradhan and Richard Buchner, **"Intramolecular Charge Transfer Reaction, Polarity, and Dielectric Relaxation in AOT/Water/Heptane Reverse Micelles: Pool Size Dependence"**, Journal of Physical Chemistry, **B112**, (2008), 9379.
4. Tuhin Pradhan and Ranjit Biswas, **"Twisted Intramolecular Charge Transfer Reaction in Deuterated Solvents: Isotope Effects"**, Journal of Chemical Sciences, **121**, (2009), 95.
5. Susmita Kar, Ranjit Biswas and J. Chakrabarti **"Solvent Density Mode Instability in Non-polar Solutions"**, PRAMANA, **71**, (2008), 211.

## Supervision of Research :

- i. **Post B.Sc. / Post M.Sc. / Others** : 2 (summer project – sponsored by JNCASR, Bangalore)
  - a) Pratyush Raj Singh
  - b) Jyoti Ranjan Beuria
- ii. **Ph.D. Students (including Project students)** : 4
  - a) Hemant Kashyap
  - b) Harun Al Rasid Gazi
  - c) Biswajit Guchhait
  - d) Snehasis Das Chakrabarti

### *Ph.D. Thesis Submitted* : 1

- a) Tuhin Pradhan

## Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :

1. Invited Talk in the Indo-Japan meeting on *Frontiers in Molecular Spectroscopy and Theory in Indian Association for Cultivation of Science (IACS)* during March 07 – 09, 2009.



2. Invited Talk in the '*Indo-Singapore Joint Physics Symposium*', Kolkata during January 05 – 08, 2009.
3. Invited Talk in the International Conference on '*Disorder, Complexity and Biology II*' in Benaras Hindu University during January 05 – 08, 2009.
4. Oral Presentation in the *Theoretical Chemistry Symposium* in Bangalore during January 18 – 22, 2009.

#### Other academic / educational activities :

##### Teaching activities :

- a) Delivered FOUR lectures in a workshop on '*Concepts in Chemistry II*' during [February 01-03, 2008] in Krishnath College, Murshidabad
- b) Delivered THREE lectures in a workshop on '*Foundations of Chemistry*' during [March 06-09, 2008] in Durg , Chhatisgarh

#### Name and Designation :

Jaydeb Chakrabarti  
Associate Professor

#### Significant research output including sponsored projects :

##### A. Nonequilibrium response of colloids :

In equilibrium, colloidal particles in a subcritical liquid suspension get surrounded by a drying layer, if the colloid has solvophobic interaction. Using Brownian dynamics computer simulations, we investigate the non equilibrium response of this layer to a strong external driving force. We find that the driven colloidal particle dresses itself with more particles than in the equilibrium drying layer. The effective interaction between two such dressed particles exhibits a deep drive-induced attraction due to a stretched joint gas bubble.

##### B. All-atom simulations of sequence specific DNA structure :

We have used all -atom Molecular Dynamics simulations of DNA sequences using the CHARMM force field. We have used periodic boundary conditions along the length of the DNA to ensure that the end-effects are minimal. Different aspects of the DNA structure have been looked into details. In particular we identify the sequence dependent properties. It turns out that the groove dimensions along with the counter-charge and the water distributions are sensitive to the DNA sequence.

#### Publications :

##### In refereed journals :

1. J. Chakrabarti and H. Loewen, "**Dressing of colloidal particles in a subcritical liquid**". J. Chem, Phys, **129**, (2008), 134507.
2. S. Kar, R. Biswas and J. Chakrabarti, "**Solvent density mode instability in nonpolar solutions**", Pramana, **71**, (2008), 211.

3. S. Samanta, S. Mukherjee, J. Chakrabarti and D. Bhattacharya ,**“Structural properties of polymeric DNA from Molecular Dynamics simulations”**. J. Chem Phys., **130**, (2009),115103.

### Supervision of Research :

**Ph.D. Students (including Project students) : 1**

- a) Amit Das (JRF)

**Ph.D. Thesis Submitted : 1**

- a) Sudipta Samanta submitted thesis during Jan'09

**Talks/ Lectures delivered at conferences/ seminars/ colloquia/ symposia/ visits etc. :**

Invited lecture in the Indo-Singapore joint Physics symposium [Jan 2009]

### Name and Designation :

**Sumita Dutta**  
**Visiting Faculty Fellow**

### Significant research output including sponsored projects :

- A. Energies and relativistic corrections for ground and excited states of atoms and molecules using high quality trial functions-( under DST Women-Scientist scheme)**

In this work starting from a novel set of explicitly correlated trial wavefunctions that produce a nonrelativistic energy with an accuracy of a microhartree or better, we were able to calculate most of the relativistic corrections to two or more significant figures for the three lowest states of helium and hydrogen molecule. In addition to this, we also calculated energies for hydrogen molecule by Feynman- Kac path integral method.

The advantage of a Monte Carlo calculation is that the techniques described here can easily be applied to larger atoms and molecules and wavefunctions that are not easily integrable.

- B. Diffusion Monte Carlo study of spin polarized Fermi gas**

Spin polarized cold Fermi gas is an atomic analogue of superconductor and in this context cold lithium gas can be used as a quantum simulator. A fortran code has been developed to calculate the energy, density etc for spin polarized Li gas employing Quantum Monte Carlo method . Search for the exotic phases of superconductors is under way using Lithium gas as a quantum simulator.

### Publications :

#### In refereed journals :

1. S. Datta, **“Thermodynamic properties of a trapped Bose gas: a diffusion Monte Carlo study”**, Int J Mod Phys, B **22**, (2008), 4261.

### Supervision of Research :

**Post B.Sc. / Post M.Sc. / Others : 1**

- a) Anustuv Pal , M. Sc Physics, University of Pune in the summer 2008. In the project entitled ‘ Solving the Schroedinger Equation by the Finite Difference Time Domain(FDTD) Method’.