

# ANNUAL REPORT 1998-1999

SATYENDRA NATH BOSE NATIONAL CENTRE  
FOR BASIC SCIENCES

CALCUTTA



# ANNUAL REPORT 1998-99

(PART A)

Satyendra Nath Bose National Centre  
for Basic Sciences

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## INTRODUCTION

As its regular readers will notice, the Annual Report has undergone a complete change of layout, style and, we hope, content. Part A now contains material that is almost entirely to do with the academic attributes of our Centre, while Part B contains a full account of financial and administrative information.

In Part A, we have tried to emphasise the academic and other achievements of every staff member of our Centre: for the first time, postdoctoral fellows have been given equal billing with those who are permanently employed here. Each staff member has contributed a personal profile balanced by an objective account of research activities such as publications and seminars given. While on the one hand we have given our staff members complete liberty to write about issues germane to their research, we have, on the other hand, here to write a disclaimer to the effect that the opinions expressed therein are *entirely* their own, and in no way reflect the collective opinions of our Centre or indeed, the Editorship of this Report. This emphasis on the individual is geared :

- first, towards acquainting prospective visitors/students to the Centre with those who might have scientific interests in common with them,
- second, to give the Report a greater depth of appeal, achievable only by converting that which was bland and collective into that which is individual and piquant!

On the issue of space, it is this alone that has prevented us from extending similar facilities of self-expression to our graduate students, who, as is well-known, provide the real lifeblood of any academic institution. We hope that next year's Report will allow for similar profiles for all members of our Centre, whether these be students or staff.

Last but not least, let me use this opportunity to thank the other members of the Annual Report Committee - Drs. Sugata Mukherjee and Anilesh Mohari and Mr A. K. Sarkar of our Accounts Department - for their assistance at various stages in the preparation of this Report. It is my particularly pleasant task also to thank the Dean, Prof. Abhijit Mookerjee, for his invaluable help in editing and compiling this Report, as well as generating the style file for its layout - all the more appreciated since his assistance was entirely voluntary, and devoid of all formal involvement with the Annual Report Committee.

We hope that this year's Report will generate interest in the scientific community for whom it is intended, and look forward to your feedback.

Anita Mehta  
Editor, Part A  
Annual Report 1998-99

## FOREWORD

The Satyendra Nath Bose National Centre for Basic Sciences (SNBNCBS) is a unique concept in this country in that it aims to bring cutting- edge research down to the level of young scholars. It aspires to do so by organizing various national and international conferences as well as supporting an active visitors' programme. Nothing can summarize better the goals of the SNBNCBS than what is already enshrined in the Founders' "Memorandum of Association". It states that the Department of Science and Technology of the Government of India has established the SNBNCBS with the expectation that it would :

- (i) foster, encourage and promote the growth of advanced studies in selected branches of basic sciences;
- (ii) conduct original research in theoretical and mathematical sciences in frontier areas, including challenging theoretical studies of future applications;
- (iii) provide a forum of personal contacts and intellectual interaction among scientists within the country and also between them and scientists abroad, and
- (iv) train young scientists for research in basic sciences.

With these (rather formidable) tasks assigned to us we have decided to concentrate on research work in those areas which are not pursued by other institutes, especially in the eastern region of the country. At the same time, we want to enter into a complementary role vis-a-vis other research centres; for instance, we want to promote collaborative projects actively in which our theorists can interact with experimentalists elsewhere, and of course also, with other theorists. This entails a major responsibility on our core faculty in that, besides being distinguished scientists in their chosen areas, the Faculty should have the willingness to cooperate with scientists of other areas, and if possible, contribute to interdisciplinary research activities. Two or three areas have emerged in our discussions as areas on which we should focus, keeping the above framework in mind. These are : (i) Complex Systems, which bring together physicists, chemists and importantly, biologists, (ii) Nanostructures - and Mesoscopic - Systems, in which micro-level quantum phenomena have significant implications for macro-level materials sciences, and (iii) Nonlinear Laser Optics, and its various applications, which are an off-shoot of Professor S.N. Bose's own epoch-making contributions.

In relation to the cherished goal of training young students for research in basic sciences, I am happy to report on certain initiatives we have taken. We are joining, this academic year, the ongoing post-M.Sc. teaching curriculum of the Saha Institute of Nuclear Physics. At the end of this activity, to which recruitment will be made through a common entrance examination, research scholars are expected to be inducted (with Fellowships) into our own

Ph.D. programme. We would like to enlarge the scope of this joint teaching endeavour of SINP and SNBNCBS in the coming years, as well as venture into a possible undergraduate teaching/training activity. Cooperation and sharing of resources is going to be our motto. In addition to teaching programmes, library is another sector in which we have entered into collaborative arrangement with neighbouring institutes. Also, the Centre supports student-training projects run by organizations such as the Jagadish Bose National Science Talent Search (JBNSTS) and the Indian Association for Physics Teachers (IAPT).

All in all, we have made a sound beginning and we hope to enter the next millennium with confidence that the Centre will be able to fulfill the objectives with which it was created.

S. Dattagupta  
Director

# REPORT FROM THE DEAN (ACADEMIC PROGRAMMES)

Research activity of the Centre concentrated on several thrust areas during 1998-99.

- First principles methodologies for study of the Physics of Materials have been developed. This included the study of electronic, magnetic and structural properties of transition metal alloys, surfaces and nano-clusters. There was extensive overlap with the statistical mechanics, quantum chemistry and experimental groups. Experimental work on magnetic alloys using X-ray scattering, positron life-time measurements and electrical and magnetic responses have been carried out.
- Various attempts have been made to understand the oxide superconductors and quasi-1D organic magnetic systems.
- Physics of granular media and soft condensed matter have been studied, which included the study of sandpiles, avalanches and atomic deposition. The work overlapped with studies of self-organized criticality, models of traffic flow and complex systems.
- Scattering properties of mesoscopic wires have been studied, both with disorder and with quasi-periodic order.
- Different aspects of duality invariance were pursued. Chern-Simons theories were reconsidered yielding novel interpretations and generalizations of existing results. Topological excitations were studied in some field theory and condensed matter models. The exact partition function of open Ising models in presence of a magnetic field was computed. The problem of renormalization and extraction of gauge invariant variables in certain non-Abelian gauge theories has been analysed. Universality in finite temperature lattice gauge theories has also been investigated.
- Quantum Field Theory and its applications to high energy physics and statistical mechanics have been studied.
- Black holes and their proper identification have been studied by the Astrophysics group. The group has studied accretion and flow in and around black holes extensively.
- The Applied Mathematics group have studied torsional and flexural vibrations in Flexible space structures and their controllability and stability.
- Cavity-QED and micromaser action have been studied using cold atoms. The micromaser has been used to study some of the foundation problems of quantum mechanics. Photonic band gap materials have also been studied.

There was extensive collaboration among the faculty, as well as between groups in our Centre and individuals and groups in other research centres, both in India and abroad. A data bank of astrophysical data with worldwide access was set up in the Centre. The Centre played a pivotal role in the Network Project set up by the International Centre for Theoretical Physics, Trieste, on Electronic structure. This included the participation of IIT, Kanpur and BARC, Mumbai, as well as the University of Dhaka, Bangladesh.

We had two Senior scientists formally associated with the Centre during this time.

Sixteen research scholars have been carrying out research for their Ph.D. degrees under the supervision of the Centre's faculty. Of these four have completed their research work and have submitted their Ph.D. theses :

1. Pradip Mukherjee, "Some aspects of three dimensional gauge theories"
2. Biplab Sanyal, "Multicomponent random alloys - a theoretical study"
3. Parthapratim Biswas, "Study of Electronic Structure of Random Alloys and Surfaces"
4. Ganesh Chandra Gorain, "Exact vibrational control and boundary stabilization of a hybrid internally damped elastic structure"

Our research scholars gave several lectures/seminars and presented posters on their work, both in India and abroad.

1. Tapas Kumar Das, on "Formation and Dynamics of Mass Outflow from Relativistic Matter Accreting onto Galactic and Extra-galactic Black Holes: A New Approach to Combine Inflow-Outflow Topologies", at the Michaelmas Term Colloquium of the Astrophysics Department, University of Oxford, Oxford, UK, November 1998.
2. Tapas Kumar Das, on "On the Fate of Matter Rushing Towards Compact Objects", in the Colloquium at Max Planck Institute für Radioastronomie, Bonn, Germany & Institute für Astrophysics, University of Bonn, December 1998.
3. Tapas Kumar Das, on "Mathematical Analysis of Mass Outflow from Relativistic Accretion onto Compact Objects", in the Fall Colloquium at Nicklaus Copernicus Astronomical Center, Warsaw, Poland, December 1998.
4. Tapas Kumar Das, on "On the Mass Outflow from Matter Accreting onto Compact Objects", at the Inter University Centre for Astronomy and Astrophysics (IUCAA) Pune, March 1999.
5. Tapas Kumar Das, on "Astrophysical Jets" , in the YATI conference. S. N. Bose National Centre for Basic Sciences, Calcutta, March 1999.

6. Tapas Kumar Das, on "Jets from Relativistically Accreting Matter", at Mini Workshop on Applied Mathematics, Bangladesh, 1998.
7. Subhradip Ghosh, on "Magnetic Properties Of Ni-Mo Single Crystal Alloys" in the summer workshop on "Behaviour Of Electrons In The Core Region: An All-Electron LAPW Calculation" at International Centre For Theoretical Physics, Trieste, Italy, June 1998.
8. Banibrata Mukhopadhyay, on "Nucleosynthesis in Advective Accretion Disk around Black Holes" at S. N. Bose National Centre for Basic Sciences, Calcutta, May 1998.
9. Banibrata Mukhopadhyay, on "Analytical Solution of Dirac Equation in Kerr Geometry", at Mehta Research Institute, Allahabad, 8 March 1999.
10. Banibrata Mukhopadhyay, on "Analytical Solution of Dirac Equation in Kerr Geometry", at Indian Institute Technology, Kanpur, 11 March 1999.
11. Banibrata Mukhopadhyay, on "Solution of Dirac Equation in Kerr Geometry", in the Mini Workshop on Applied Mathematics, Dhaka, Bangladesh, 1998.
12. Banibrata Mukhopadhyay, on "Nucleosynthesis Around Black Holes", and "Dirac Equation in Kerr Geometry", in the YATI conference, S. N. Bose National Centre for Basic Sciences, Calcutta, March 1999.
13. Biplab Sanyal, on "Electronic structure and magnetism of bulk disordered alloys and surfaces-an augmented space recursive approach" in the theoretical physics seminar circuit programme in Institute of Physics, Bhubaneswar, India, February 1999.
14. Biplab Sanyal, on "Augmented space recursive technique for bulk and surface properties" in the "Workshop on electronic structure of clusters and molecules" held at the S.N.Bose National Centre for Basic Sciences, Calcutta, India, November 1998.
15. Biplab Sanyal, on "The Study of magnetism on inhomogeneous overlayers" in "Workshop on TBLMTO" held in Strasbourg, France, October 1998.
16. Biplab Sanyal, on "Magnetism on rough overlayers-an augmented space recursive study" in "Workshop on computational material science" held in Cagliari, Italy, September 1998.

Single author papers were published by some of our research scholars :

1. T. K. Das, 1999, 'Computation of Mass Outflow Rate from Relativistic Spherical Accretion onto Black Holes'. *Monthly Notices of the Royal Astronomical Society* (In Press).
2. T. K. Das, 1999, *Ind. J. Phys.* 73B(1)(Rapid Communication) Pg. 1-7.

3. T. K. Das, 1999, 'Analysis of Mass Outflow from Pair-Plasma Pressure Mediated Shock Surfaces around Black Holes', *Proc. 19th Texas Symposium on Relativistic Astrophysics & Cosmology. Paris, France. (14 -18th Dec. '98)* (In Press).
4. Banibrata Mukhopadhyay, 1998, 'Nucleosynthesis in Advective Accretion Disks Around Galactic And Extra Galactic Black Holes', *Proc. in Observational Evidence for Black Holes in the Universe, Ed. S.K. Chakrabarti (Kluwer Academic: Holland)* Page 105.

In addition, short term Visiting scholars have been carrying out projects for their M.Sc/M.Phil degrees. These included two students from Bangladesh. The Faculty of the Centre have been involved with teaching M.Sc. Courses at the University of Calcutta and I.I.T. Kanpur. Several faculty members were involved in the Jagadish Bose National Talent Search examinations.

The Centre has arranged Workshops in Astrophysics, Condensed Matter Physics, Statistical Physics and Mathematics during the year, with participation from India and abroad.

Abhijit Mookerjee,  
Dean, Academic Programme

## THE ACADEMIC STAFF DURING 1998-99

### The Faculty

Name	Designation	Ph.D. at	Year
Chanchal Kumar Majumdar	Professor and Director (retired February, 1999)	Univ. of California (San Diego)	1965
Sushanta Dattagupta	Professor and Director (joined February, 1999)	Brookhaven Nat. Lab.	1973
Partha Ghose	Professor (retired March, 1999)	University of Calcutta	1968
Abhijit Mookerjee	Professor and Dean	University of Cambridge	1973
Sandip Chakrabarti	Associate Professor	University of Chicago	1985
Subodh Kumar Sharma	Reader	S.I.N.P. (Univ. of Calcutta)	1977
Nilkantha Nayak	Reader	I.I.T. Kharagpur	1978
Rabin Banerjee	Reader	S.I.N.P. (Univ. of Calcutta)	1988
Anita Mehta	Reader	University of Oxford	1986
Subhrangshu Sekhar Manna	Reader	S.I.N.P. (Univ. of Calcutta)	1987
Debashis Gangopadhyay	Reader	S.I.N.P. (Univ. of Jadavpur)	1988
Srilekha Banerjee	Reader	University of Calcutta	1982
Samir Kumar Pal	Fellow	I.O.P.B. (Utkal University)	1989
Rina Das	Scientific Officer	-	-
Manu Mathur	Fellow	I.M.Sc. (Univ. of Madras)	1993
Ranjan Chaudhury	Fellow	T.I.F.R. (Univ. of Mumbai)	1988
Pratip Mukhopadhyay	Fellow	I.I.Sc., Bangalore	1989
Partha Guha	Fellow	University of Oxford	1996
Anilesh Mohari	Fellow	I.S.I., Delhi	1992
Sugata Mukherjee	Fellow	Freie Universität, Berlin	1985
Amitabha Lahiri	Fellow	Syracuse University	1991
Avijit Mukherji	Fellow	University of Cambridge	1996
Gautam Gangopadhyay	Lecturer	I.A.C.S. (Jadavpur Univ.)	1993
Biswajit Chakrabarty	Lecturer	I.M.Sc. (Univ. of Madras)	1993
Kalyan Mandal	Lecturer	I.I.T., Kharagpur	1994

## Senior Scientists, Visiting Scientists and Research Associates

Manoj Kumar Pal	CSIR Senior Scientist (retired September, 1998)
Haridas Banerjee	INSA Senior Scientist
Rudra Prasad Malik	Visiting Reader
Prabhat Kumar Thakur	Visiting Scientist
Sarmistha Ghosal	Visiting Scientist
Archan Majumdar	Visiting Scientist
Jayashree Saha	Research Associate
Chandra Das	Research Associate (resigned November, 1998)
Govindarajan Pari	Research Associate (resigned December, 1998)
Debashis Banerjee	Research Associate

## Research Scholars

Indranil Bandopadhyay	Astrophysics
Atishdipankar Chakrabarti	Statistical Physics
Chhanda Basu Chaudhuri	Condensed Matter Theory
Parthapratim Biswas	Condensed Matter Theory and Statistical Physics
Nityananda Das	Condensed Matter Theory
Tapas Kumar Das	Astrophysics
Subhradip Ghosh	Condensed Matter Theory
Ganesh Chandra Gorain	Mathematics
Sarmistha Kumar	High Energy Physics
Sivaman G Manickam	Astrophysics
Tapas Kumar Mitra	Condensed Matter Theory
Pradip Mukherjee	High Energy Physics
Banibrata Mukhopadhyay	Astrophysics
Arnab Kumar Ray	Astrophysics
Biplab Sanyal	Condensed Matter Theory and Statistical Physics
Tomy Scaria	Mathematical Physics

## Visiting scholars

Sudipta Deb	University of Chittagong, Bangladesh
Kamal Krishna Saha	University of Dhaka, Bangladesh
G. Kalpana	Visiting Research Associate (Tamil Nadu Scholarship) (resigned November, 1998)
Debashis Das	Viswabharati University
Samik Dasgupta	Poona University

# SEMINARS AND TPSC ACTIVITIES

## List of seminars at the Centre in 1998-99

- *Spectral Aging in Powerful Radio Galaxies*, by S. Manickam of NCRA (Pune), on May 6, 1998;
- *Duality and String Theory*, by J. Maharana of Institute of Physics (Bhubaneswar), on May 19, 1998;
- *Computation of mass outflow from advective accretion disk around compact objects*, by Tapas K. Das of SNBNCBS on June 5, 1998;
- *The Influence of Nucleosynthesis on the Topology of Advective Flows on Black Holes*, by Arnab K. Ray of SNBNCBS on June 12, 1998;
- *Approximate field theories in magnetism with applications to garnets and spinels*, by Gautam Mukhopadhyay of IIT Mumbai on June 15, 1998;
- *Bethe-Peierls-Cines method for Blume-Emery-Griffiths hamiltonian*, by Gautam Mukhopadhyay of IIT Mumbai on June 16, 1998;
- *Netscaping and home page building*, by Tapas K. Das of SNBNCBS on June 22, 1998;
- *International Conference on Scientific Computing and Modelling*, July 9-11, 1998;
- *Interface of Science and Philosophy*, July 13, 1998;
- *Numerical solution of partial differential equations*, by S. K. Dey of Eastern Illinois University (Charleston, USA) on August 3 & 4, 1998;
- *Conference report on (i) Application of field theory to statistical physics at Bonn, and (ii) STATPHYS 20 at Paris*, by D. Gangopadhyay of SNBNCBS on August 10, 1998;
- *Recent Advances in coupled cluster methods for many-electron system – relaxation inducing transformations*, by D. Mukhopadhyay of Ramakrishna Mission Vidyamandir (Howrah) on August 21, 1998;
- *Liquid crystals - NMR studies in Cu complexes*, by M. Bose of SNBNCBS on August 25, 1998;
- *Magnetism at the Nanoscale*, by P. Jena of Virginia Commonwealth University (Richmond, USA) on October 21, 1998;
- *Workshop on Clusters and Molecules*, October 26 - November 6, 1998;

- *Artificial Neural Networks: An Application to Stellar Spectroscopy*, by R. Gupta of IUCAA (Pune) on November 30, 1998;
- *A Novel Abelian Gauge Invariance in Q. C. D.*, by M. Mathur of SNBNCBS on November 25, 1998;
- *Disease Diagnosis Using Raman Spectroscopy*, by R. R. Dasari of Massachusetts Institute of Technology (USA) on December 18, 1998;
- *Leonids-98: A Post-mortem*, on Dec 20, 1998;
- *Bose-Einstein Condensation in Dilute Atomic Gases*, by S. Sinha of IMSc (Chennai) on Jan 27, 1999;
- *Testing the Equivalence Theorem and the Effective Vector Boson Approximation at the CERN Large Hadron Collider*, by G. Bhattacharya of Institute of Physics (Bhubaneswar) on Feb 10, 1998;
- *Creating a Large Database System*, by G. Eichhorn of CfA, Harvard University on Feb 11, 1999;
- *Non-Universality of Gravitational Couplings in a Medium*, by Palash B. Pal of Saha Institute of Nuclear Physics (Calcutta) on Feb 18, 1999;
- *Gauge Theory on Compact Surfaces*, by Ambar N. Sengupta of Louisiana State University (Baton Rouge, USA) on Feb 24, 1999;
- *The Segal-Bargmann-Hall Transforms*, by Ambar N. Sengupta of Louisiana State University (Baton Rouge, USA) on Mar 17, 1999;
- *Landau Model of Rotator Phase Transitions*, by Prabir K. Mukherjee of Bar-Ilan University (Israel) on Mar 24, 1999.

Amitabha Lahiri  
Seminar Secretary

## The Theoretical Physics Seminar Circuit, 1998-99

The TPSC has nine main centres and ten associate centres under various main centres. Calcutta is one of the main centres and Shantiniketan and North East Consortium (operating from IIT, Guwahati) are its two associate centres. The Calcutta Centre operates from the SNBNCBS and it also coordinates the entire activities of the Circuit. Professor Sushanta Dattagupta is the Chairman and Dr. N. Nayak is the Convener of the National Committee of

the TPSC. Dr. N. Nayak and Dr. M. Mathur are the co-conveners of the Calcutta Centre. The following TPSC visitors delivered talks at the SNBNCBS.

1. Avijit Ganguly, CTS, Bangalore: Pre-Equilibrium Evolution of QGP (May 26, 1998).
2. Sushan Konar, IUCAA, Pune: Magnetic Field of Neutron Stars and Quark Stars (November 24, 1998).
3. P. K. Ghosh, IMSc, Chennai: Novel Classical Ground States of a Many Body System in Arbitrary Dimensions (December 8, 1998).
4. Abhik Basu, IISc, Bangalore: Some Recent Advances in Magnetohydrodynamic Turbulence (December 22, 1998).
5. D. Choudhury, MRI, Allahabad: Some Rare B-Decays, CP Violation and All That (December 29, 1998).
6. S. Dattagupta, JNU, New Delhi (Now at SNBNCBS): Magneto-Optic Piston Effect (January 14, 1999).
7. Bhanu P. Das, IAP, Bangalore: New Directions in Atomic Parity Violation (February 9, 1999).
8. V. Subrahmanyam, IIT, Kanpur: Chiral Operators in Spin-Ladder Antiferromagnets (March 4, 1999).
9. R. Godbole, CTS, Bangalore: Why Do We Need Next Generation Collidors ? (March 11, 1999).
10. Arundhati Dasgupta, IMSc, Bangalore: Near Horizon Geometry and Hawking Emission from Black Holes (March 16, 1999).
11. Vipin Srivastava, University of Hyderabad: How Brain Learns, recognises and Discriminates? (March 24, 1999).
12. A. R. Rao, TIFR, Mumbai: Indian X-ray Astronomy Experiment (IXAE) Observations of Black Holes Candidate Source in Our Galaxy (March 26, 1999).

Nilkantha Nayak  
Secretary, TPSC

## CONFERENCES AND WORKSHOPS AT THE CENTRE

### Workshop on the Electronic Structure of Clusters and Molecules (30 October - 10 November, 1998)

The Workshop was organized by Prof. A. Mookerjee for a fortnight in November 1998. It was attended by twenty-five participants from various parts of India and Bangladesh. The participants were young faculty and senior research students. The workshop provided a fertile meeting ground of physicists and quantum chemists and the participants were involved with hands-on projects using the state of the art molecular dynamical methods.

### Conference on Leonids 98: A Postmortem (Dec. 20, 1998)

The conference was organized by Prof. S.K. Chakrabarti jointly with Geological Survey of India (GSI) and Confederation of Indian Amateur Astronomers (CIAA). It was attended by over 130 participants. The basic theme was to discuss the reasons which might have caused the Leonid meteor shower (16-17th November, 1998) to be disappointing. After presenting detailed analysis, scientists from GSI announced in this meeting that the rock samples collected in various parts of India were *not* meteorites.

### The International Conference on Statistical Physics, Statphys - Calcutta III (4 - 9 January, 1999)

In total there were ninety seven registered participants. The seminars were on different current research topics of Statistical Mechanics. The major themes of the conference were : mechanical fracture, breakdown and earthquakes.

### Conference on 'Young Astrophysicists of Today's India (YATI)' ( 24 - 27 March, 1999)

The Conference was organized by Prof. S.K. Chakrabarti. About thirty young graduate students and post-doctoral fellows from all over India participated to talk about their research, while experts presented review talks. The conference proceedings are being published as a special issue of the Indian Journal of Physics.

# FACILITIES

## Computer Centre

The computer Centre of S.N. Bose National Centre extends state-of-the-art facilities to its users round the clock. The facilities include DEC-Alpha, SGI-Indigo-2 and HP-9000 715 workstations, all connected to the local area network. Moreover, there are several PCs, ascii-terminals and a X-terminal in the network. All machines are connected to the Internet through a Cisco router and 64 kbps link to VSNL. The power is supplied through a 15 KVA UPS. Postscript laser-printers and a colour scanner are also available. The Centre provides e-mail, text-editing and web-browsing facilities to all members and visitors.

The Centre is building a Data Bank (mostly sponsored by ISRO) where satellite data relating to high energy Astrophysics and some Astrophysics literature would be stored.

Sugata Mukherjee,  
Computer Systems Administrator

## Library

The Centre's library has undergone major changes this year. The following has been initiated :

- Reallocation of Library premises to the ground floor.
- Extending library opening hours.
- Direct subscription to the APS package.
- Procurement of several new journals : *Journal of Statistical Physics*, *Journal of Chemical Physics*, *Journal of Physics B*, *Journal of Physics: Condensed Matter*, *Classical and Quantum Gravity*.
- Beginning a process with neighbouring institutions with the ultimate aim of sharing library resources.

Debashis Gangopadhyay,  
Acting Librarian

## Laboratory

Facilities in the Low-temperature Laboratory include :

1. 4 probe ac/dc resistivity measurement cryostat, operable down to about 60K.
2. A.C. magnetic susceptibility measuring cryostat, operable down to about 80K.
3. High temperature capacitance measuring apparatus, operable upto about 250C.
4. Dielectric polarization and hysteresis measuring system - with electric fields upto about 5kV/mm.

Pratip Mukhopadhyay,  
Low Temperature Laboratory.

## Infrastructure

- Campus beautification has been initiated. A project has been given to the NBCC for developing the land, work on which has already commenced.
- An EPABX system has been installed.
- A complete revamping of the guest house was undertaken.
- Laminated Identity Cards were issued to members of the Centre.
- Service books for the Centre's permanent members were prepared.
- The Centre has hired a 16 seater bus for transport of its members to and from work.
- A canteen service has been started at the Centre.

Rabin Banerjee,  
Acting Administrative Officer.

# FACULTY PERSONAL PROFILES FOR 1998-99

## Haridas Banerjee

### Current research interests

My general area of interest has been High Energy Physics with particular emphasis on lattice formulations of fermions, and chiral anomalies on lattices. A theorem, proved recently, provides a convenient framework for calculating the U(1) axial anomaly in nonabelian gauge theories of fermions on lattices.

### List of Publications for 1998-99

#### *Publication in conference proceedings*

H. Banerjee and Asit K. De, 1998, 'Fermions on Lattice and Chiral Invariance' Communications in Mathematical and Theoretical Physics 1, pp.162–174

### Invited seminar

Invited seminar on 'Fermions on Lattice' at the Fifth Chittagong Conference on Mathematical Physics, (Jan.23–25, 1999), Chittagong University, Bangladesh.

### Invitations to conferences

1. 'Recent Developments in Theoretical Physics' – Tata Institute of Fundamental Research, Bombay (Jan.2–5, 1999). Chaired one session.
2. 'Fifth Chittagong Conference on Mathematical Physics' – Chittagong University, Bangladesh (Jan.23–25, 1999), Chaired one session.

### Awards and other organisational achievements

1. Member Board of Editors, Indian Journal of Physics
2. Convenor, Steering Committee of the meeting on 'Higher Education and Research in Science and Technology' - organised by Calcutta Chapter of INSA (12-14 August, 1998).

## Rabin Banerjee

### Current research interests and ongoing collaborations

The relevance of the chiral oscillator, in studying different problems was highlighted (with S. Ghosh). Specific applications included the role of duality symmetry in quantum mechanics and a simple derivation of the Zeeman effect.

A general method given by us earlier for computing the spin of vortices in relativistic theories with the Chern-Simons term was extended to the non-relativistic case (with P. Mukherjee).

A detailed analysis of the constrained structure of the duality invariant form of free Maxwell's theory was done both in the Hamiltonian (Dirac) and Lagrangian (symplectic) approaches.

We have pursued our investigations on the soldering mechanism, extending the original formalism so as to solder models with distinct parameters (with S. Kumar). A novel feature of our analysis was to establish a complete correspondence between the topological quantum mechanical models and certain odd-dimensional field theories.

Together with B. Chakraborty we have reconsidered the issue of duality symmetry in arbitrary even-dimensional free field gauge theories involving anti-symmetric tensor fields.

### List of Publications for 1998-99

1. R.Banerjee and P.Mukherjee, (1998), Galilean symmetry in a nonabelian Chern-Simons matter system, *Ann. Phys.(NY)*, 264 30.
2. R.Banerjee and C.Wotzasek, (1998), Bosonisation and duality symmetry in the soldering formalism, *Nucl. Physics*, B527, 402.
3. R.Banerjee and S.Ghosh, (1998), The chiral oscillator and its applications in quantum theory, *J. Phys. A: Math. Gen.* 31, L603.
4. R.Banerjee, (1999), On the constrained structure of duality symmetric Maxwell theory, *J. Phys. A: Math. Gen.* 32, 517.
5. R.Banerjee and E.C.Marino, (1999), A new approach for bosonisation of massive Thirring model in three dimensions, *Mod. Phys. Lett. A*, in press.
6. R.Banerjee and B.Chakraborty, (1999), Mode analysis and duality symmetry in different dimensions, *J. Phys. A: Math. Gen.* , in press.
7. R.Banerjee and P.Mukherjee, (1999), Some comments on the spin of Chern-Simons vortices, *Prog. Theor. Phys.*, in press.

## Invited seminars

1. "Bose symmetry and two dimensional fermionic determinants" Mathematics. Department, Dhaka University, Bangladesh, August 1998.
2. "Some aspects of duality symmetry in quantum mechanics and field theory", School of Physics, Hyderabad University, September 1998.
3. "The chiral oscillator in quantum mechanics" at conference organised by the Alexander von Humboldt foundation at Hyderabad, September 1998. (one of only six Humboldt awardees selected to give a colloquium from a pan-Indian population)

## Conferences attended

1. Topics in Mathematics and Mathematical Physics organised at Dhaka/Shahjalal University, Sylhet, August 1998.
2. Alexander von Humboldt conference, Hyderabad, September 1998.

## Awards

Humboldt awardee for 1998-99.

## Educational activities

Gave two popular talks for teachers participating in a refresher program organised by the Council of Central Schools held at the Central School, Labony, Salt Lake, Calcutta, June 1998.

## Srilekha Banerjee

### Current research interests and ongoing collaborations

- *Study of the effects of confinement on the ordering of Liquid Crystal molecules in complex geometries:* To get a better understanding of the behaviour of nematic liquid crystals inside a cavity and their response to an external field, simulation studies have been carried out of the effects of variation of the types of cavity, the droplet size, the external field and the anchoring strength at the interface, on the order parameter and other thermodynamic functions. The simulation results, obtained so far, were in qualitatively good agreement with experimental observations on LC in confinement.
- *Simulations of Accretion Flows around Black Holes :* Research also included numerical simulation of accretion flows around black holes in collaboration with the Astrophysics group of the Centre. In addition, I have been engaged in building a Data-Bank, comprising a large Data-Base containing observational data from satellites and some astrophysics literature.

### List of Publications for 1998-99

S. Banerjee , V. A. Barker, K. Mogensen and E. Stenby , (1999), 'Comparison of iterative methods for computing the pressure field in a dynamic network model', *Transport in Porous Media*, accepted for publication.

### Invited talks at conferences

Presented a paper on 'Effect of confinement on ordering in Nematic Polymer Dispersed Liquid Crystals' held at Goa from November 29-31,1998.

### Conferences attended

1. Attended 'Theoretical Physics Today: Trends and Perspectives', held at IACS, Calcutta from April 22-24, 1998.
2. Attended 'International Conference on Scientific Computing and Modelling', held at S N Bose National Centre for Basic Sciences from July 9-11, 1998.
3. Attended 'National Seminar on Liquid Crystals ', held at Goa University from November 29-31, 1998.

### *Membership of organizing committees of conferences*

Shared organizational responsibilities as a member of LOC for the 'International conference on scientific computing and modelling', held at SNBNCBS (July 9-11, 1998).

## Sujit Kumar Bose

### Current research interests

I was a professor of Mathematics at this Centre, and retired in October 1998. I have been currently, in collaboration with Prof. D. Chattoraj, (Mathematics Department, Presidency College, Calcutta) engaged in writing a book on Analytical Mechanics.

### List of Publications for 1998-99

1. G.C. Gorain and S.K. Bose, 1998 "Exact Controllability and Boundary Stabilization of Torsional Vibrations of an Internally Damped Flexible Space Structure" *Journal of Optimization Theory and Applications*, 99, 423–442.
2. G.C. Gorain and S.K. Bose, 1998 "Exact Controllability of a Linear Euler-Bernoulli Panel" *Journal of Sound and Vibration*, 217, 637–652 .
3. S.K. Bose and G.C. Gorain, 1998 "Stability of the Boundary Stabilized Internally Damped Wave Equation  $y'' + \lambda y''' = c^2(\Delta y + \mu \Delta y')$  in a Bounded Domain in  $R^n$ " *Indian Journal of Mathematics*, 40 1–15.
4. G.C. Gorain and S.K. Bose, 1999 "Exact Controllability and Boundary Stabilization of Flexural Vibrations of an Internally Damped Flexible Space Structure" *Applied Mathematics and Computation*, in press.

### Thesis supervised

1. Ganesh Chandra Gorain on "Exact Vibration Control and Boundary Stabilization of a Hybrid Internally Damped Elastic Structure"

## Sandip Kumar Chakrabarti

### Current research interests and ongoing collaborations

The major thrust of my research has been the study of various physical phenomena associated with hydrodynamic and hydromagnetic flows around black holes and the nature of the radiations that emerge out of the flow. Current research included the study of (a) nucleosynthesis in matter accreted on black holes and its effect on flow stability (b) contamination of galactic metallicity due to modified composition of in-falling matter, (c) computation of outflow rate from disks around black holes and its effect on emitted X-ray spectra, (d) radiative acceleration of jets and winds, (e) time-dependent behaviour of matter accreting on black holes, (f) steady and quasi-periodic oscillations of X-rays from black hole and neutron star candidates, (g) relativistic wave equations in curved space-time around black holes, (h) evolution of molecular clouds, star formation and the formation of proto-planetary disks, and (k) particle dynamics inside planetary rings. To have easy access to the complete set of observational results and to be able to fit them with theoretical models, a Data Bank is also being created using ISRO funding. Here, high energy X-ray and *gamma*-ray data on black hole and neutron star candidates from all the satellites are being kept.

### List of Publications for 1998-99

#### *Refereed Publications in Journals/Books*

1. G. Lanzafame, D. Molteni, & S.K. Chakrabarti, 1998, "Smoothed Particle Hydrodynamic Simulations of Viscous Accretion Discs Around Black Holes", *Mon. Not. Royal Astron. Soc.*, 299, 799-805.
2. S.K. Chakrabarti, 1998, "Identification of Astrophysical Black Holes" (Review), *Ind. J. Phys.*, 72B, 183-233.
3. S.K. Chakrabarti & B. Mukhopadhyay, 1999, "Neutron Disks Around Black Holes", *Astronomy & Astrophysics*, 344, 105-110.
4. S. K. Chakrabarti, 'Spectra'l Softening due to Winds in Accretion Disks' (Rapid" Communications), 1998, *Ind. J. Phys.*, 72B, No. 6, 565-569.
5. T.K. Das & S.K. Chakrabarti, 1999, "Analysis of Mass Outflow Rate from Advective Accretion Disks around Galactic and Extra-Galactic Black Holes", *Proc. 19th Texas Symposium on Relativistic Astrophysics & Cosmology*, Paris, France. (in press).

#### *Edited Proceedings*

S. K. Chakrabarti, "Observational Evidence for Black Holes in the Universe", 1998, (Kluwer Academic Publishers, Holland).

*Papers Published in Proceedings*

1. S.K. Chakrabarti, 1998, "Recent Progresses of Accretion Disk Models Around Black Holes", Proceedings of the 18th Texas Symposium, Ed. J. Frieman, A. Olinto & D.N. Schramm, (New York Acad. Sci.: New York) 229-232
2. S.K. Chakrabarti, 1998, "Accretion and Winds Around Galactic and Extragalactic Black Holes", in *Black Holes: Theory and Observation* ed. F. Hehl (Springer Verlag: Heidelberg), 80-110.
3. S.K. Chakrabarti, 1998, "Accretion Disk Models Around Black Holes: Twenty Five Years Later", in *Observational Evidence for Black Holes in the Universe*, ed. S.K. Chakrabarti (Kluwer Academic Publishers, Holland), 19-48
4. S.K. Chakrabarti, 1998, "Accretion processes around black holes and neutron stars: advective disk paradigm", in *High Energy Astronomy and Astrophysics*, ed. P.C. Agrawal & P.R. Vishwanath, 75-87.
5. S.K. Chakrabarti, 1998, "Global Inflow and Outflow Solutions (GIOS) around a Black Hole", Proceedings of a mini-workshop on Applied Mathematics, Ed. A. Hossain (in press).
6. B. Mukhopadhyay & S.K. Chakrabarti, 1998, "Solution of Dirac Equations in Kerr Geometry", in Proc. International Mini Workshop on Applied Mathematics, Bangladesh, Ed. A. Hossain (in press).

*Scientific publications in newspapers/journals*

1. 'Full of Holes' a letter to the Editor of 'The Telegraph' (10.4.98)
2. 'Big Bang-II?' a letter to the Editor of 'The Anandabazar Patrika' (16.7.98)

**Invited seminars given at:**

1. 'Our Galactic Center' , M.N. Lahiri Memorial Lecture at Presidency College, Calcutta
2. 'The Universe', a set of two lectures at the Kendriya Vidyalaya for the Post-Graduate In-service Course Meeting, Salt Lake
3. 'Astrophysical Flows around Black Holes' at the Dept. of Mathematics of Dhaka University, Bangladesh
4. 'Identification of Astrophysical Black Holes' at Mehta Research Institute, Allahabad

## Invited talks at conferences

1. 'Mathematical properties of Black Hole Accretion' at the Mini-Workshop on Applied Mathematics at Dhaka University, Bangladesh, September 1998
2. 'Uncertainties in Astrophysics: from large scale to small' at the one day symposium on 'Leonids-98: A Postmortem' at the S.N. Bose National Centre for Basic Sciences, December 1998

## *Conferences attended*

1. 'Databases, Data Visualization and Image Processing' at IUCAA, November 1998
2. 'International Mini-Workshop on Applied Mathematics' at Dhaka University, September, 1998
3. 'Young Astrophysicists of Today's India (YATI)', SNBNCBS, March, 1999
4. 'International Conference on Scientific Computing & Modeling', SNBNCBS, Calcutta, July, 1998

## *Invitations to conferences:*

1. Third Workshop of International Centre for Research in Astrophysics at Rome, Italy, (July 12-22, 1999)

## Awards and organizational achievements

### *Membership of editorial boards of journals*

Elected as a sub-Editor of the Astrophysics Section of the Indian Journal of Physics

### *Membership of organizing committees of conferences*

1. Co-convenor of 'Leonids-98: A Postmortem' at the S.N. Bose National Centre for Basic Sciences, December 20th, 1998
2. Convenor of 'Young Astrophysicists of Today's India (YATI)' at the S.N. Bose National Centre for Basic Sciences, March 23-26th, 1999

*Projects started during 1998-1999*

1. "Quasi-Periodic Oscillations of X-rays from Black Holes' (ISRO)
2. "Creation of a Space Astronomy Data Bank for the Study of compact Objects" (ISRO)
3. "Analytical and Numerical studies of astrophysical flows around black holes and neutron stars" (DST)

*Other scientific/educational projects*

1. 'Black Holes in the Sky': A ten minute television programme made with Doordarshan (broadcast in April, 1998).
2. 'Mysterious Black Holes'; A ten minute programme on black hole physics completed with Educational Media Research Centre (EMRC) for broadcasting during the UGC Programme on Doordarshan. (June, 1998)
3. Nationwide broadcast of interviews of Prof. S.K. Chakrabarti by Doordarshan regarding (a) discovery of high Red-shift galaxy, (April, 1998) (b) Possibility of Leonids meteor shower (November 1998) and (c) Actual observation of the shower (November 1998).

## Sonali Chakrabarti

### Current research interests and ongoing collaborations

I have been working on a CSIR Project on the detection and identification of biomolecules in space. The search for biological molecules boils down to searching for its monomeric subunits. The latest Astronomy data base shows that seventy organic molecules along with twenty inorganic molecules have already been detected in the interstellar medium. Our interest has been to study the evolution of the molecular clouds and star forming regions and find out if during this process complex molecules could be formed. Our recent study showed that DNA damage due to metabolic activities and as well as that due to radiation, can be understood on the same footing.

### List of Publications for 1998-99

#### *Refereed Publications in Journals/Books*

S. Chakrabarti, 1999, 'Theoretical Comparison of the Energy made Available for Producing Damages to the DNA, Between Electromagnetic Radiations and Metabolic Processes', *Ind. J. Phys.* (in press)

#### *Publications in Proceedings*

S. Chakrabarti: 'Search for Pre-Biotic Molecules in Space' in Proceedings of 'Young Astrophysicists of Today's India', *Ind. J. Phys.* (in press)

### Invited talks at conferences

'Search for Pre-Biotic molecules in Space' in 'Young Astrophysicists of Today's India', SNBNCBS, March, 1998

### Membership of Organizing Committees of Conferences

Member of the Organizing Committee of 'Young Astrophysicists of Today's India (YATI)', SNBNCBS

### Conference Attended

Attended 'Young Astrophysicists of Today's India (YATI)', SNBNCBS, March, 1999

## Biswajit Chakraborty

### Current research interests and ongoing collaborations

I have, in collaboration with A. S. Majumdar of SNBNCBS, carried out a gauge-independent Hamiltonian analysis of the nonlinear sigma model coupled to the Hopf term in the  $CP^1$  formulation. Although our analysis was confined to the classical level, we have argued, using dimensional analysis, that any fractional spin that may emerge upon Dirac quantization of the model must involve Planck's constant. We demonstrate the problems of quantization in the Dirac scheme. We also show that if the Chern-Simons(CS) term is added instead of the Hopf term, then the model ceases to be a  $CP^1$  model.

I have also, in collaboration with A. S. Majumdar of SNBNCBS, considered a gauged  $CP^1$  model obtained by gauging the global  $(SU(2))$  group of the  $CP^1$  model and adding a corresponding CS term. This model admits a 'new' kind of solitonic configuration. Subsequently, we have also carried out a Reduced Phase Space analysis of the model. This model too admits solitonic configurations, but the corresponding Hopf term vanishes.

A new type of duality symmetry has been introduced in momentum space. Exploiting the complex nature of the mode amplitudes, it has been shown that the corresponding duality group is both  $Z_2$  and  $SO(2)$  for all even dimensions. The connection with the conventional duality symmetry, has also been established. This new duality symmetry in momentum space, unlike its conventional counterpart, holds for any model irrespective of dimensionality, provided the model system is chosen to be an assembly of decoupled (complex) oscillators. This work has been done in collaboration with R. Banerjee, of SNBNCBS.

### Publications list for 1998-99

1. B.Chakraborty and A.S.Majumdar,(1998), " Hamiltonian Analysis of the gauged  $CP^1$  model, the Hopf term and Fractional Spin", *Phys. Rev. D* 58, 125024.
2. B.Chakraborty and A.S.Majumdar ,(1999), "On Fractional Spin in the  $CP^1$  model coupled to the Hopf term", *Acta.Phys.Pol.B*,30, 247.
3. B.Chakraborty and A.S.Majumdar,(1999), " Effects of gauging on Symplectic Structure, the Hopf term coupled to  $CP^1$  model and Fractional Spin", *Int.J.Mod.Phys.A.*, in press.
4. R.Banerjee and B. Chakraborty,(1999). "A new type of Duality Symmetry in the theory of  $N$ -form Abelian fields", *J. Phys. A: Math. Gen.* , in press.

### Invited seminars given at:

1. " Fractional Spin in 2+1 dimensions", Ganit Bibhag, Dhaka University, Dhaka, Bangladesh, August 1998.

2. " Effects of gauging on Symplectic Structure and Fractional Spin in models involving Nonlinear Sigma Model", Institute of Mathematical Sciences, Madras (4 March 1999)
3. " Effects of gauging on Symplectic Structure and Fractional Spin in models involving Nonlinear Sigma Model", Centre for Theoretical Studies, Indian Institute of Science, Bangalore (8 March 1999)

#### Workshop attended:

Attended a Mini Workshop on Applied Mathematics, held at Dhaka University, and organized by Shahjalal University of Science and Technology, Sylhet, Bangladesh in Aug' 98.

#### Educational/scientific activities:

Delivered two popular level talks on "Some recent developments in Theoretical Physics" in the Central School, Salt Lake, Calcutta in June 1998, as a part of summer training for the Physics teachers of Central Schools all over India.

## Ranjan Chaudhury

### Current research interests and ongoing collaborations

My current research interests have been in the areas of Superconductivity, Magnetism, Many-body Physics and Statistical Mechanics.

I have explored the possible existence of topological excitations in the anisotropic quantum Heisenberg model by the 'coherent state method', in collaboration with S.K.Paul (SNBNCBS). Our theoretical results find possible applications to the neutron scattering experiments in the insulating (antiferromagnetic) phase of layered oxide superconductors and many other quasi-1D organic ferromagnetic and antiferromagnetic systems.

I have started studying the effect of phase fluctuations in the ordered state of an anisotropic layered BCS superconductor after successfully completing the mathematical formulation for the isotropic layered case.

I have in collaboration with B.K.Chakraverty (LEPES, CNRS, Grenoble, France) been critically analyzing results obtained for fermionic bound state formation in 2D and layered materials in vacuum and in the presence of Fermi sea. The results obtained so far, seem to have a very interesting impact on some of the proposed microscopic theories of high temperature superconductivity.

I have in collaboration with D.Gangopadhyay (SNBNCBS) extended the application of Van-der-Waerden's colouring theorem to the case of 3 colours. Our work finds a very interesting application to the case of a ternary alloy.

### List of Publications for 1998-99

R. Chaudhury and S. K. Paul, (1998), 'Possible Existence of Topological Excitations in Quantum Spin Models in Low Dimensions', *Physical Review B*, in press.

Conferences attended:

- 'International Conference on Scientific Computing and Modelling'– held at SNBNCBS during 9-11 July 1998.
- 'LEONIDS 98: A Postmortem'– held at SNBNCBS on 20 December 1998.

Membership of organizing committees of conferences

Member of the organizing committee for 'Condensed Matter Days (in Eastern India)', 1999, in August 1999.

## Rina Das

### Research interests

During 1998-99 the replication task as recommended by the Technical Advisory Committee of Project BRAILESCRIPT has been continued. The electromagnetic actuation system has been thoroughly studied and several alternate designs carried out. The electromagnetic actuators have been made more powerful, the retraction system improved and made uniform and better materials have been used for higher longevity.

A good part of this period has been spent in giving field trials to the system and in improving the software system as well.

On a request from the Managing Director, Webel, I was given the permission to act as a Consultant to the PATSER project of DSIR (under the Ministry of Science and Technology, Govt. of India) at Webel Mediatronics Limited where the production prototype for the Computerized Braille Transcription System is currently being fabricated. A new actuation system made in the form of rockers driven by reversible fractional h.p. motors has been tried in this prototype which will further reduce the bulk and cost of the system and will increase the speed of operation as well.

The PATSER scheme was formulated with transcription of additional Indian Languages through development of newer software packages. Marathi and Kannada have been identified for the first phase of development. Of these the alpha- version of the Marathi transcription package has been given a field demonstration at the National Association for the Blind, Mumbai.

There are some suggestions from blind individuals and institutions to develop a software package, if possible, to enable large-print display of texts of different languages on normal monitors and a preliminary feasibility study on this has been carried out during the period of this report.

## Debashis Gangopadhyay

### Current research interests and ongoing collaborations

- *Quantum Field Theory*: I have been studying the Lagrangian formulation of duality, in collaboration with Rajsekhar Bhattacharyya, Jadavpur University. Starting from Lagrangian field theory and the variational principle we have given a *new* method to obtain duality by introducing explicit space-time dependence in the Lagrangian. The Dirac string solution, the Dirac quantization condition and the t'Hooft-Polyakov monopole solutions followed naturally in our formalism. We have also given a procedure for obtaining *new* classical solutions of Yang-Mills theory.
- *Statistical Mechanics and Field Theory*: We have applied field theory techniques to condensed matter physics and statistical mechanics problems, in which my collaborators were R.Chaudhury and S.K.Paul, SNBNCBS. We have shown that there is a breakdown of the Fermi Liquid picture in two dimensions.

Van der Waerden's Colouring Theorem (a Number Theoretic result) has been shown to have potential physical applications e.g. to infinite 1-D Ising chains, complex lattices and ternary alloys.

- *Gravitation and String Cosmology*: We have studied the cosmology of maximally symmetric space-times with torsion. My collaborator was S.Sengupta, Dept. of Physics, Jadavpur University. We have generalized the concept of maximal symmetry in the presence of space-time torsion and shown that isotropy and homogeneity are not jeopardized provided the torsion fields satisfy mutually consistent constraints. Solving the constraint equations exactly, we have obtained examples of metrics, killing vectors and torsion, which show that even a flat metric can accommodate torsion. In the context of string theory, we have shown that our generalized maximal symmetry can be preserved under certain conditions. This has tremendous significance for string related cosmological backgrounds.

### List of Publications for 1998-99

D.Gangopadhyay and S.Sengupta, 1999, "Duality Invariance of Cosmological Solutions with Torsion", *Int. J. Mod. Phys. A*, in press.

### Conferences Attended

- Participated in "Application of field theory to Statistical Physics", Bonn, Germany, July 15 - July 18, 1998.

- Participated in "STATPHYS 20", Paris, France, 20-24 July 1998 and presented a poster on "A new approach to disordered lattices via Van der Waerden's Colouring Theorem"

Invitations to conferences (unable to attend):

Invited to speak at: "Workshop on Cosmology : Observations Confront Theories", IIT Kharagpur, 11-17 January 1999.

Theses examined

Conducted the Ph.D. Examination, (Calcutta University) of Mr. A. Rehman, student of Prof. P. Mitra (SINP), on 10 June 1998.

Other scientific/educational projects

Taught course on *Quantum Statistical Mechanics* to M.Sc. Part II students of Dept. of Physics, Calcutta University and M.Sc. Part II students of Presidency College between December 1998 and April 1999.

## Gautam Gangopadhyay

### Current research interests and ongoing collaborations

One of my main interests has been the theoretical study of linear and nonlinear quantum optical systems. The study consisted of coherent and incoherent interaction between radiation and matter.

- *Quantum/Classical Dissipative Systems* : Based on quantum/classical system-heat bath interaction we have studied the effect of dissipation and diffusion on various phenomena.
- *Effect of long-time correlated noise in spectroscopy* : Based on system-bath models we have constructed the modified Bloch equation for colored bath, obtaining a temperature dependent splitting on the spectral profile. This is exemplified through the transient linear absorption and in resonance fluorescence and weak field absorption of the driven system.

In a driven dissipative two-state system we found the effect of stochastic frequency modulation by a fractal noise.

- *System in contact with a non-equilibrium bath* : We have explored a classical microscopic model to simulate a thermally activated rate process where the associated bath is not in an equilibrium state. We have calculated the barrier dynamics in the steady state and in the nonstationary regime. We derived the dressed time-dependent Kramer's escape rate in the nonstationary regime exhibiting a strong non-exponential decay in the reaction co-ordinates.

We have extended the quantum theory of dissipation when the system is attached to a non-equilibrium bath. We have given a generalization of the fluctuation- dissipation relation in this case.

- *Molecular Processes* : I have studied electronic and vibrational motion of a model molecular system. These studies will help to understand the dynamical aspects of driven, dissipative molecular systems and to study various transport phenomena of intra- and inter- molecular systems.
- *Bandshape/Franck-Condon transition in model molecular systems* : We have initiated some studies on bandshape and Franck-Condon factor calculations for model molecular electronic states.

### List of Publications 1998-99

1. G. Gangopadhyay and S. Ghosal, (1998), 'A thermal bath induced Rabi splitting on the profile of Mollow spectrum in single molecule spectroscopy', *Chem. Phys. Lett.*, 289, 287-297.

2. G. Gangopadhyay and Y. Tanimura, (1998), 'Absorption line shape of impurity molecule driven by a fractal noise', *Chem. Phys. Lett.*, 289, 97-104.
3. G. Gangopadhyay, J. Ray Chaudhuri, B. Deb and D. S. Ray, (1998), 'Quantum Theory of dissipation of a harmonic oscillator coupled to a nonequilibrium bath, Wigner-Weisskopf decay and Physical Spectra', *J. Phys. B: At. Mol. Phys.* , 31, 3859-3874.
4. G. Gangopadhyay, J. Ray Chaudhuri and D. S. Ray, (1998) 'Theory of non-stationary activated rate processes: non-exponential kinetics', *J. Chem. Phys.* , 109 5565-5575.
5. G. Gangopadhyay, (1998), 'A generating function for the product of Laguerre polynomials: Franck-Condon factor for multiphoton processes', *J. Phys. A: Math. Gen.* , 31, L771-L775.

### Invited seminar given

"Effect of long-time correlated noise in linear and nonlinear spectroscopy" at IACS, Jadavpur, Calcutta, India, on 13 May 1998.

### Conference Attended

Participated in the conference "StatPhys-III, Calcutta" on 4-8 January 1998 at SNBNCBS, Calcutta.

### Organizational activities

Member of the Local Organizing Committee of the International Conference on Statistical Physics, Statphys-Calcutta-III held on 4-9 January 1999, at S. N. Bose National Centre for Basic Sciences Calcutta.

## Sarmistha Ghosal

### Research interests

My main interest has been the study of the IR-RF Double Resonance lineshape of a multilevel molecular system with closely spaced energy levels. The close spacing of the energy levels gives rise to many interesting phenomena, such as enhancement of refractive index and transparency of IR radiation.

Considering the system-bath model we have constructed the modified Bloch equation for a colored bath and obtained a temperature-dependent splitting of the spectral profile. This manifested in a transient linear absorption, resonance fluorescence and weak field absorption of the driven system.

### List of Publications 1998-99

G Gangopadhyay and S Ghosal, 1998, A thermal bath induced Rabi splitting on the profile of Mollow spectrum in single molecule spectroscopy, *Chem. Phys. Lett.*, 289 287.

### Conference Attended

Attended the National Conference on 'Theoretical Physics Today: Trends and Perspectives', held at the Dept. of Theoretical Physics, IACS, Jadavpur, Calcutta.

### Educational activities

Delivered a course of lectures in 'Laser Physics' to the M.Sc. ( Physics ) students in Calcutta University for the session 1998-1999.

## Partha Ghose

### Research interests

I have been working mainly on the foundations of quantum theory. In particular, I have been trying to develop critical experimental tests to distinguish between standard quantum theory and the only surviving hidden variable theory, namely the de Broglie-Bohm theory.

I have also been working on the possibility that quantum theory may be a limiting case of classical statistical mechanics in which systems behave quantum mechanically only when completely isolated from their environment. As soon as their coupling to the environment is switched on, they behave classically. There is a fundamental difference between this view point and that of standard decoherence theory. It is possible to introduce a complex wave function to describe the classical system. The wave equation turns out to be the Schrödinger equation with an additional nonlinear term which destroys all coherence and quantum features. As this term is switched off, the equation reduces to the linear Schrödinger equation. It is impossible to generate the required nonlinearity starting from quantum theory, whereas it is natural to believe that a nonlinear term in classical theory can be effectively zero in some approximation. That is essentially the main motivation for this approach which, incidentally, also leads to a natural solution of the measurement problem which does not exist in classical theory. If there is any truth in this approach, it implies a real ontology in the same sense as in the de Broglie-Bohm theory.

### List of Publications for 1998-99

#### *Refereed Journals*

Partha Ghose, 1998, "Spontaneous Collapse vs Decoherence", *Proceedings of the Indian National Science Academy A* 64, 193-210.

#### *Conference Proceedings*

Partha Ghose, 1998, "Wave-particle Duality: The Mystery Keeps Unfolding", *Pramana* 51, 651-661.

#### *Books*

Partha Ghose, in press, Testing Quantum Mechanics on New Ground, *Cambridge University Press, UK*.

### Conferences attended

1. Workshop in the "Dialogue of civilizations" organized by the Centre for the Philosophy

and Foundations of Science and the Max Muller Bhavan, Dundlod, 23-24 December, 1998

2. International Symposium "From Duality to Unity" organized by the Centre for the Philosophy and Foundations of Science, New Delhi, 28-31 December, 1998 (delivered an invited talk and chaired one session)
3. International seminar on "Recent Developments in Theoretical Physics '99" organized by TIFR in honour of the sixtieth birthday of Professor V. Singh, 2-5 January, 1999 (chaired one session)
4. Indo-French Workshop on "Probing Fundamental Problems with Lasers and Cold Atoms", 1999, Indian Institute of Astrophysics, Bangalore, 6-8 January, 1999 (delivered an invited talk and chaired one session)

### Awards and organisational achievements

- Member, Integrated National Steering Committee for Physics, Chemistry and Biology for the Olympiad Programme, nominated by the Board for Research in Nuclear Sciences, Department of Atomic Energy, Government of India
- Nominated a member of the Executive Committee, Science City, Calcutta
- I have conceived, and continue to host, the popular science TV serial Eureka on Star Plus
- Conducted a workshop for science teachers of schools at the Teachers Centre, Doon School, Dehradun on 30 March, 1999

## Partha Guha

### Current research interests and ongoing collaborations

- *The orbit method and integrable systems.*  
I have studied the coadjoint orbits of certain infinite dimensional groups and its connection to integrable systems.
- *D-modules and Non-linear systems.*  
My goal has been to study how nonlinear partial differential equations are described by means of non-commutative algebras over certain field of constants  $C$ . I have also been interested in studying the role of differential Lie algebras in integrable systems.

### List of Publications for 1998-99

Partha Guha and Kanehisa Takasaki, 1998 "Dispersionless hierarchies, Hamilton-Jacobi theory and twistor correspondences" *Journal of Geom. Phys.* 25, 326-340.

### Visits to academic institutions

Visited Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, April 98 - June 98; August and September 98.

## Amitabha Lahiri

### Current research interests and ongoing collaborations

The abelian model is renormalizable and unitary, but there is no residual degree of freedom, i.e., no Higgs boson. This feature takes on a special significance if we remember that searches for a fundamental Higgs boson have been futile so far. If the Higgs boson (or anything similar) is never found in the real world, non-abelian extensions of such a theory can be considered as possible alternatives. Some time ago, I constructed an extension of the model which gives masses to non-abelian vector bosons. It possess the vector gauge symmetry present in the abelian model and there is no residual degree of freedom which looks like a Higgs boson.

I worked on constructing an algebraic proof of renormalizability of this model. The quantum symmetries of the theory were discovered starting from a BRST construction. Two previously unknown symmetries were found. One involves exchanging the roles of antighosts and their antifields, and is applicable to general gauge theories. The other symmetry is specific to tensor fields, and involves mixing between ghosts of gauge transformations with ghosts-of-ghosts of the vector gauge transformations. The most general quantum effective action obeying the corresponding quantum symmetries (not the same as the classical symmetries) as well as the known linear global symmetries has been found after a long and involved calculation. In particular, it follows that, contrary to accepted wisdom, it is possible to construct a renormalizable, unitary theory of massive vector bosons in four dimensions without a residual Higgs boson. A similar statement was known in lower dimensions, but this is the first time a proof has been given in four dimensions. The proof has been completed and will be published.

### Invited talks at conferences

- III Puri Workshop on Quantum Field Theory, Quantum Gravity and Strings, Puri, 9 - 19 December 1998;
- Workshop on Cosmology, Observations confront Theories, IIT Kharagpur, 11 - 17 January 1999.

## Rudra Prasad Malik

### Current research interests and ongoing collaborations

In the past one year, I have been able to provide a physical interpretation to the Hodge decomposition theorem for the free two-dimensional Abelian as well as non-Abelian gauge theories (having no interaction with matter fields). I have found a nilpotent co(dual)-BRST symmetry for the free two-dimensional gauge theories which is local, continuous and covariant. Within our work, the Hodge decomposition theorem found a physical interpretation in the language of symmetry properties and the corresponding Noether charges that generate these symmetries.

I have shown that the BRST and co-BRST symmetries are good enough to gauge away both the physical degrees of freedom of photon in two dimensions of space-time. Thus, this theory became topological in nature.

The upshot of the whole discussion was to capitalize on the insight gained in two-dimensional gauge theories and apply this to physical four-dimensional theories.

I, in collaboration with A. K. Mishra and G. Rajasekaran of IMSc, Chennai, have been able to develop a consistent  $q$ -deformed dynamics where the ordinary Lorenz- and quantum group  $GL_{q,p}(2)$  invariances are respected together.

### Publication list for R. P. Malik 1998-99

#### *Refereed publication in journal*

R. P. Malik, A. K. Mishra and G. Rajasekaran, 1998, 'Dynamics in a non-commutative phase space' *Int. J. Mod. Phys. A*13 4759-4775.

#### *Publications in conference proceedings*

R. P. Malik, 1998 'Aspects of cohomology in non-Abelian gauge theory' in Proc. of workshop on Quantum Chromodynamics (QCD-98) held at IMSc, Chennai (30 November - 8 December 1998), in press.

#### Invited seminars given at :

1. IMSc, Chennai, 'BRST cohomology in gauge theories' (May 1998)
2. SNBNCBS, Calcutta 'Dynamics in a noncommutative phase space', (September 1998)
3. SINP, Calcutta, 'Dynamics in a noncommutative phase space', (November 1998)

#### Invited talks at conference

1. IMSc, Chennai, Workshop on QCD (QCD-98,) "Aspects of cohomology in non-Abelian gauge theory"

*Conferences attended*

1. "Introductory school on string theory" held at The Abdus Salam ICTP, Trieste (Italy), (9-19 June, 1998).
2. "Summer school in high energy physics and cosmology" held at The Abdus Salam ICTP, Trieste (Italy), (July-August, 1998)
3. "Indo-Russian programme for long term collaboration in Science and Technology" held at JINR, Dubna, Moscow (Russia), (11-18 August 1998).
4. "Modern Developments in Quantum Field Theory' (PURI-WORKSHOP) held at PURI (Orissa) ( 9-18 December 1998).

## Subhrangshu Sekhar Manna

### Current research interests and ongoing collaborations

I have been studying sandpile models of self-organized criticality, both deterministic and stochastic. We have been working on a model for internally dissipative sandpiles. Our numerical studies indicated that this model is critical and that the critical behaviour is mean-field like. We have been working to devise a criterion to sort out whether a given dissipative model is critical or not.

Another topic of study has been the properties of spanning graphs. Recently we studied the minimal spanning tree graphs on 2-d Euclidean space, where geometrical distances occur with the weights of the edges. We have argued that this model could be used as a toy model for postal networks.

In another project, we have studied how the bulk of a granular material at rest in a bin responds to the external drive of repeated void creations. In granular matter at rest in a bin, different grains are at mutual force balance. When a grain is taken out at the bottom, the other neighbouring grains in contact become unstable. This creates an avalanche of internal grain displacements in the medium. We repeat this a large number of times and measure the avalanche size distributions in the steady state. A cellular automaton model, modeling the granular systems, shows that the avalanche sizes are power law distributed, indicating that the system attains a self-organized critical state. However, a hard disc model of the system, does not reveal power laws. We explain the difference in ongoing work. The collaborators in this project are H. J. Herrmann (Paris), D. V. Khakhar (Mumbai) and S. Roux (Paris).

### List of Publications for 1998-99

1. S. S. Manna, (1998), 'Abelian Cascade Dynamics in Bootstrap Percolation' *Physica A* 261, 351.
2. S. S. Manna and D. V. Khakhar, (1998), 'Internal Avalanches in a Granular Medium' *Phys. Rev. E* 58, R6935.
3. S. S. Manna, S. Krishnamurthy, V. Loreto, H. J. Herrmann, S. Roux, (1998), 'Self-structuring of Granular Media under Internal Avalanching' *Phys. Rev. Lett.*, in press.

### Invited talks at conferences

1. *Abelian Cascade Dynamics in Bootstrap Percolation*, at the Workshop on 'Soft Condensed Matter' at Saha Institute of Nuclear Physics, 17 February, 1998, Calcutta.
2. *Internal Avalanches in a Granular Medium*, at the International Conference on 'Flow, Friction & Fracture' at The American University of Beirut, 06 July, 1998.

3. *Abelian Cascade Dynamics in Bootstrap Percolation*, at the International Conference on 'Scientific Computing and Modeling' at S. N. Bose National Centre, 10 July, 1998.
4. *Internal Avalanches in a Granular Medium*, at the national meeting on 'Condensed Matter Days' at Bhagalpur University, August, 1998.
5. *Externally Driven Granular Systems*, at the International Conference on Statistical Physics, 'Statphys - Calcutta III', at S. N. Bose National Centre, 08 January, 1999.

## Organizational achievements

Secretary of the International Conference on Statistical Physics, "Statphys-Calcutta III".

Sponsored Projects:

I am presently involved in a joint project entitled, *Exploring Self-Organized Criticality in a Granular Medium*, funded by the Indo-French Centre for the Promotion of Advanced Research (IFCPAR).

## Archan S Majumdar

### Current research interests and ongoing collaborations

My research interests have ranged over the fields of quantum field theory, cosmology and physics of the early universe, fundamental aspects of quantum theory and quantum optics. A brief statement of my research activities during 1998-99 follows:

- *Fundamental aspects of quantum theory and quantum optics* : With D. Home of the J. C. Bose Institute I have provided an argument claiming that the reality of particle trajectories furnished by the Bohmian interpretation is necessary for drawing the inference of CP-violation in experiments involving the 'weakly' interacting  $K^0 - \bar{K}^0$  system of particle physics. The mechanism of Bohmian trajectories provides a precise prediction of tunnelling times for elementary particles. The Kemmer-Duffin formalism has been used (with P. Ghose of S.N. Bose National Centre) to compute Bohmian trajectories of bosons for certain particular experiments.

The theory of a Dicke micromaser has been studied in detail (with N. Nayak of S. N. Bose National Centre, and V. Bartzis of TEI, Athens, Greece). The influence of Dicke cooperativity leads to critical differences in the dynamics from the case of the conventional one-atom micromaser. It has been shown that with the introduction of one-photon detuning, this theory also describes a two-photon micromaser.

- *Gauge theories in 2+1 dimensions* : With B. Chakraborty of S. N. Bose National Centre, I have performed the constrained Hamiltonian analysis of several gauge theories in 2 + 1 dimensions, and studied their symplectic structure. We have seen that no fractional spin is revealed at the classical level for the case of the  $CP^1$  model coupled to the Hopf term, as opposed to the corresponding case of the  $O(3)$  nonlinear sigma model. Moreover, it is clear from dimensional arguments that any fractional spin at the quantum level in the former model is different in origin and structure from that of the latter model. We have also shown that the Hopf term can be altered using an identity involving a time derivative to reveal fractional spin given in terms of the soliton number. Further, we have studied a gauged  $CP^1$  model coupled to the Chern-Simons term where the  $SU(2)$  group is gauged. A reduced phase space analysis of this model leads to the generation of mass terms for gauge fields, *a la* the Higgs mechanism, in one particular physical sector. The solitonic configurations were obtained, and fractional spin computed for this model.

### List of Publications for 1998-99

#### *Refereed publications in journals*

1. B. Chakraborty and A. S. Majumdar, (1998), 'Hamiltonian analysis of the gauged  $CP^1$  model', *Phys. Rev.*, D 58, 125024.

2. B. Chakraborty and A. S. Majumdar, (1999), 'On fractional spin in the  $CP^1$  model coupled to the Hopf term', *Acta Phys. Pol. B*, 30, 247.
3. D. Home and A. S. Majumdar, (1999), 'On importance of the Bohmian approach for interpreting CP-violation experiments', *Foundations of Phys.*, 29, in press.
4. B. Chakraborty and A. S. Majumdar, (1999), 'Effects of gauging on symplectic structure, the Hopf term coupled to the  $CP^1$  model, and fractional spin', *Int. J. Mod. Phys. A*, in press.

#### *Conference Proceedings*

A. S. Majumdar, (1999), 'Inflationary Universe in Kaluza-Klein theories', (review talk delivered at the YATI meeting held at SNBNCBS, Calcutta, 24-27 March 1999), *Ind. J. Phys.*, in press.

#### Conferences attended

1. *Recent Developments in Theoretical Physics*, TIFR, Mumbai, 2-5 January 1999.
2. *Young Astrophysicists of Today's India*, SNBNCBS, Calcutta, 14-27 March 1999.

## Chanchal Kumar Majumdar

### Current research interest

I was involved in the Mössbauer spectroscopy of Fe-Cr nanocrystalline materials. With Prof. M. Bose, I was analyzing magnetic resonance data on metallo-mesogens.

### List of Publications in 1998-99

#### *In refereed Journals*

1. A. Hartridge, A.K. Bhattacharyya, C.K. Majumdar, D. Das and S.N. Chintalapudi, "A Mössbauer study of  $\text{Fe}_2\text{O}_3\text{-Cr}_2\text{O}_3$  nanocrystals dispersed in silica matrix", 1998, *J. Magn. Mater.*, 183, L1-4
2. M. Bose, C.K. Majumdar, K. Ohta and T. Sakurai, "Anomalies within alkyl and alkoxy substituted (1,3-diphenylpropane-1,3 dionate) Cu-II metallomesogens from X-ray and EPR studies", 1999, *MCLC*, 326, 229

#### *Conference proceedings*

D. Sarkar and C.K. Majumdar, "On the spin dynamics of superfluid ???" in International Conference of Mathematical Physics, Nagpur (January, 1999)

#### *Publication in newspapers*

C.K. Majumdar, "Man of delicate tastes", in *The Telegraph*, 2 November, 1998

### Invited talks

1. Conference on "Theoretical Physics Today - Trends and Perspectives" at the I.A.C.S. Calcutta (April, 1998)
2. VII Orientation Course at IUC-DAEF, Calcutta (June, 1998)
3. Workshop on "Correlation in Quantum Systems", at CTS, I.I.Y., Kharagpur (October, 1998)
4. Krishnan Memorial Conference, at University of Allahabad, Allahabad (December, 1998)
5. DST sponsored meeting on "Chemistry" at Bardhaman University, (December 1998)
6. Refresher Course on "Mathematics of biomolecules and biological processes" at S. Mookerjee Science Centre, Calcutta (December, 1998-January, 1999)
7. "Walter Kohn perspective" at I.A.C.S., Calcutta (January, 1999)

## Educational Activity

I gave lectures on "Collective Phenomena in Solids" and "Condensed Matter Physics" (Paper VIII) to the combined M.Sc. students of Presidency College and Calcutta University.

## Manu Mathur

### Current research interests and ongoing collaborations

- In order to explore the issue of color confinement in quantum chromodynamics via dual Meissner effect, an important problem is to re-write the  $SU(3)$  gauge theory as a dual superconductor, i.e, as an abelian gauge theory with magnetic monopoles. We have shown that  $SU(N)$  gauge theory coupled to adjoint Higgs can be explicitly re-written in terms of  $SU(N)$  gauge invariant dynamical variables with a novel compact  $U(1)^{(N-1)}$  gauge invariance. In this abelianized version the magnetic monopoles appear explicitly in the partition function. The gauge invariant electric and magnetic charges with respect to  $U(1)^{(N-1)}$  gauge groups are shown to be vectors in root and co-root lattices of  $SU(N)$  respectively. Therefore, the Dirac quantization condition corresponds to  $SU(N)$  Cartan matrix elements being integers. This work was in collaboration with Prof. Adriano Di Giacomo (University of Pisa, Italy).
- Faddeev and Niemi proposed an effective low energy action for pure  $SU(2)$  Yang Mills theory in 4 dimension to understand color confinement. In this theory, described in terms of a three component unit vector with a mass parameter and a dimensionless coupling constant  $e$ , the glueballs are expected to correspond to knot like solutions. However, its connection with the conventional picture of confinement via dual Meissner effect is still lacking. I chose yet another set of variables and related this model to a  $U(1)$  gauge theory with electric and magnetic charges of charge  $e$  and  $4\pi e^{-1}$  respectively. This theory after lattice regularization corresponds to the standard compact  $U(1)$  gauge theory coupled to electric charges.
- We have investigated the effect of  $Z_2$  magnetic monopoles and vortices on the finite temperature deconfinement phase transition in the fundamental - adjoint  $SU(2)$  lattice gauge theory. In the limit of complete suppression of the  $Z_2$  monopoles, the mixed action for the  $SU(2)$  theory in its Villain form was shown to be self-dual under the exchange of the fundamental and adjoint couplings. By further suppressing the  $Z_2$  vortices we have shown that the extended model reduces to the Wilson action with a modified coupling. The universality of the  $SU(2)$  deconfinement phase transition with the Ising model was therefore expected to remain intact in the entire plane of the fundamental-adjoint couplings in the continuum limit. The self-duality arguments related to the suppression of  $Z_2$  monopoles are also applicable to the Villain form of mixed action for the  $SU(N)$  theory with  $Z_N$  magnetic monopoles. This work is in collaboration with Prof. Rajiv V. Gavai (Tata Institute of Fundamental Research, Mumbai)

## List of Publications for 1998-99

1. Manu Mathur, Adriano Di Giacomo, 1998, 'Abelianization of SU(N) Gauge Theories with Gauge Invariant Dynamical Variables and Magnetic Monopoles', *Nucl. Phys. B* 531, 302-322
2. Manu Mathur, Rajiv V. Gaii, 1999, ' $Z_2$  Monopoles, Vortices and the Universality of the SU(2) Deconfinement Transition', accepted for publication in *Phys. Letts. B*

## Invited seminars given at:

1. PRL Ahmedabad, (TPSC, April 1998)
2. TIFR Bombay, (TPSC, April 1998)
3. IIT Bombay, (April 1998)
4. IOP Bhubaneswar, (TPSC, April 1998)
5. IMSc Chennai, (May 1998)
6. CTS Bangalore, (May 1998)
7. University of Hyderabad, (TPSC, August 1998)
8. SNBNCBS, Calcutta (November 1998)
9. IIT Kanpur, (TPSC, January 1999)
10. MRI Allahabad, (TPSC, January 1999)

## Invited talks at conferences

1. "Q.C.D color confinement" at Q.C.D. 98, I.M.Sc., Chennai, (30 November - 8 December 1998).
2. "A Novel Abelian Projection in Non-Abelian Gauge Theories" at III Puri Workshop on Quantum Field Theory, Quantum Gravity and Strings (9-19 December 1998)

## *Invitations to conferences:*

XVII International Symposium on Lattice Field Theory (Lattice 99) at Pisa, Italy.

## *Conferences attended:*

1. Attended "International Conference on Scientific Computing and Modelling" at SNBNCBS (9 July -11 July 1998)

## Awards and organizational achievements

### *Membership of organising committees of conferences*

Member of the organising committee of XVIII International Symposium on Lattice Field Theory (Lattice 00) to be held at Indian Institute of Science, Bangalore in August 2000.

### *Other scientific/educational projects*

1. Visited IMSc. Chennai for two months from April to June 1998 as a visiting scientist.
2. Taught part of the course on Particle Physics in preparatory SERC School at CTS Bangalore with Prof. J. Pasupathy from 18 to 22 May 1998.
3. Taught part of the Course "Solitons and Monopoles" at I.I.T-Kanpur with Dr. P. Jain. I gave 9 lectures from 30 March to 22 April 1999.

## Anita Mehta

### Current research interests and ongoing collaborations

The focus of my research interests has been that of complex systems: my current research in this context concerns traffic flow, models of societal learning, and importantly, the physics of granular materials on which I have specialized over the last decade. Most recently I have applied myself to the study of generalized surfaces and interfaces, with particular reference to epitaxial growth.

#### *The physics of granular media*

Following the formulation and analysis of coupled nonlinear stochastic equations via a two-species model (of intercluster and intracluster granular relaxation) to describe the dynamical evolution of sandpile surfaces, I have examined (in collaboration with Dr Gary Barker at the Institute of Food Research, Norwich, England) the smoothing of sandpile surfaces induced by avalanches, using a disordered cellular automaton approach that we pioneered some years ago. Dr Gary Barker and I were the first to predict the so called 'reversible branch' of compaction in shaken powders, which was subsequently seen in experiments at the University of Chicago. In collaboration with Dr. Gary Barker and Dr. Edmund Nowak, of the University of Delaware, USA, I have studied time-series analysis of density fluctuations in tapped granular media. I have a collaboration with Prof. Mariano Lopez de Haro of the Centro de Investigacion en Energia, Cuernavaca, Mexico to look at fundamental aspects of Edwards' compactivity parameter: I have also worked with Dr. Rebecca Hoyle of the Department of Applied Mathematics and Theoretical Physics, Cambridge, England, on the formation of sand ripples and dunes.

#### *Surfaces generated by molecular-beam epitaxy*

This work is part of a major programme to develop a holistic understanding of MBE surfaces, as part of which I have collaborated with Prof. A. Mookerjee of the S N Bose National Centre, Calcutta in a project that married statistical mechanics with electronic structure calculations. I have also collaborated with Prof. Roger Cowley of Oxford Physics, who heads one of the foremost experimental groups in the field of MBE, on the provision of a theoretical framework for x-ray scattering data from thin films.

#### *Models of societal learning*

I have formulated models of societal learning based on game-theoretic concepts, in an ongoing collaboration with Dr. Jean-Marc Luck of the Service de Physique Theorique, Saclay, France where we are presently analyzing a new phase of *oscillatory coarsening*.

### *Traffic flow*

This project, done in collaboration with Dr. Antonio del Rio of the Centro de Investigacion en Energia, Cuernavaca, Mexico involved the investigation of traffic flow in open systems; we have looked at the nature of the 'jamming' transition in these systems, as well as investigating useful analogies with my earlier work on granular flow.

### List of Publications for 1998-99

#### *Refereed publications in journals/books*

1. P. Biswas, A. Majumdar, Anita Mehta, and J K Bhattacharjee, 1998, "Smoothing of sandpile surfaces after intermittent and continuous avalanches - three models in search of an experiment", *Phys. Rev.* E58, 1266
2. Anita Mehta and G. C. Barker, 1999, "Smoothing of sandpiles after avalanche propagation", in *Dynamics of complex systems*, eds. R. A. Mashelkar *et al* , (Imperial College Press, London), in press
3. G. C. Barker and Anita Mehta, 1999, "Modelling avalanche flows", in *IMA Journal of Mathematics applied to Business and Industry* , in press
4. B. Sanyal, Anita Mehta and Abhijit Mookerjee, 1999, "A new class of coupled continuum equations for atomic growth on surfaces", *J. Phys.: Condens. Matter* 11, 4367
5. A. Mookerjee, B. Sanyal, and Anita Mehta, 1999, "Growth and electronic structure of rough overlayers", *Physica A*, in press

#### *Publications in monographs*

1. Anita Mehta, Biplab Sanyal and Abhijit Mookerjee, 1999, "Modelling the growth of rough surfaces: coupled continuum equations, electronic structure and magnetic properties", in *Electronic Structure of non-periodic solids: alloys, surfaces and clusters*, eds. A. Mookerjee and D D Sarma, (Gordon and Breach Science Publishers, Amsterdam), in press

#### *Monographs*

1. Anita Mehta, in progress. *The physics of granular materials*, (Cambridge University Press, Cambridge)

*Scientific publications in newspapers/journals*

1. Anita Mehta, "Gems at the cutting edge", in *The Times Higher Educational Supplement*, (London, 28 May 1998) (book review)
2. Anita Mehta, "Calculating Queen Dido", in *The Times Higher Educational Supplement*, (London, 30 October 1998) (book review)
3. Anita Mehta, "Journey through the minds of scientists", in *The Times Higher Educational Supplement*, (London, 11 December 1998) (book review)

## Invited seminars given at:

1. University of Texas at Austin, Texas, USA (April 1998)
2. Santa Fe Institute, Santa Fe, New Mexico, USA (April 1998)
3. Los Alamos National Laboratory, New Mexico, USA (April 1998)
4. Clarendon Laboratory, University of Oxford, UK (June 1998)
5. College de France, Paris, France (July 1998)
6. University of New Mexico, Albuquerque, New Mexico USA (July 1998)
7. University of Manchester, UK (October 1998)
8. Oxford Centre for Industrial and Applied Mathematics, University of Oxford, UK (November 1998)
9. Centro di Investigacion en Energia, Cuarnavaca, Mexico (February 1999)

## Invited talks at conferences

*Invitations (accepted) to conferences:*

1. International Workshop on "Excitations in Granular Materials " at University of New Mexico, Albuquerque, New Mexico, USA (July 1998)
2. CECAM Workshop on "Granular Geomorphology" at Lyon, France (September 1998)

*Other invitations to conferences (unable to attend):*

1. International Conference on "Collective Excitations in Condensed Matter" in Barbados (April 1998)
2. International Conference "Statphys III - Calcutta" in Calcutta ( January 1999)

## Awards and organizational achievements

### *Fellowships, associateships and visiting professorships awarded*

1. Speaker for the *Theoretical Physics Seminar Circuit*, India (1996-99)
2. *Senior Associate* of the *Centre for Mathematical Modelling and Computer Simulations*, Bangalore (1997-2000)
3. Awarded *Associateship* of the *International Centre of Theoretical Physics*, Trieste, Italy (1998-2004)
4. Awarded *Engineering and Physical Sciences Research Council Visiting Fellowship* to Physics Department, *Oxford University* (April 1998-April 1999)
5. *Visiting Research Professor* at *University of New Mexico, Albuquerque*, New Mexico, USA (June-July 1998)
6. *Visiting Professor* at *Centro de Investigacion en Energia*, Cuernavaca, Mexico (February 1999)

### *Theses examined*

1. Thesis examiner of T. Bouteux (Ph.D student of P. G. de Gennes) at *College de France*, Paris, France (July 1998)

### *Theses co-supervised*

1. Biplab Sanyal, thesis submitted to Jadavpur University
2. Parthapratim Biswas, thesis submitted to Jadavpur University

### *Membership of editorial boards of journals*

1. Member of Board of Editors for *Granular Matter*, (Springer-Verlag, Heidelberg) (1997-2000 )
2. Associate Editor of the *Indian Journal of Physics*, Calcutta (1997-99)

### *Membership of organizing committees of conferences*

1. Member of Scientific Advisory Committee of *Excitations in Granular Materials* at University of New Mexico, Albuquerque, Mexico, USA
2. Member of the Organizing Committee of *The Anatomy of Laughter*, an interdisciplinary conference on the theme of Laughter to be held at Oxford University in September, 2000

*Joint projects held with other centres*

Joint project on Nonequilibrium phenomena in traffic and granular flow held with Prof. M. Lopez de Haro and Dr. A del Rio of the Centro de Investigacion en Energia, Cuernavaca, Mexico, funded by DGAPA-UNAM, Mexico (1998-2000)

*Other scientific projects*

Specialist Consultant for Elementa, a science museum project in the state of Morelos, Mexico.

## Anilesh Mohari

### Current research interests and ongoing collaborations

My general interest has been in the field of non-commutative probability theory, specifically, on entropy change of an irreversible system.

In order to explain irreversible phenomena, we have to (1) modify the fundamental equation of motion in quantum mechanics, for instance, by adding some external effects such as noise, fluctuation to the reversible equation, or (2) introduce new concepts or criteria, apart from the entropy, to symbolize irreversibility. We have adopted (2) and considered an irreversible quantum mechanical system assumed to be governed by a quantum mechanical Fokker-Planck equation.

We have addressed ourselves to the questions, first, whether  $S(\rho) \leq S(\sigma_t(\rho))$  for any density operator  $\rho$ , and, second, in case  $\sigma_t(\rho) \rightarrow \rho_0$  as  $t \rightarrow \infty$  in a suitable sense, whether it is true that  $S(\sigma_t(\rho)) \rightarrow S(\rho_0)$  as  $t \rightarrow \infty$ . Motivated by Prigogine's work on irreversible dynamics, we have introduced the 'entropy of an observable in a given state'. Some answers could be found to the above questions when entropy was modified.

### Publication in Monographs

A. Mohari and L. Accardi, 1999, "Time reflected Markov processes" in 'Infinite dimensional analysis and QP' World Scientific, Singapore, in press.

## Kalyan Mondal

### Current research interest and ongoing collaborations

My research interest covered the following areas :

- *The study of magnetic nano-particles* : I have prepared (Mn-Zn)-ferrite nano-particles in a silicon matrix by the sol-gel method. Samples have been characterized by X-ray diffraction in Saha Institute of Nuclear Physics, Calcutta and by a Transmission Electron Microscope in the Regional Sophisticated Instrumentation Centre, J. C. Bose Institute, Calcutta.
- *The effect of alpha-particle irradiation on high-temperature superconductors* : I have prepared Bi-2212 and (Bi,Pb)-2212 high temperature superconductors to study the effect of alpha-particle irradiation on these samples in collaboration with Dr. Udayan De of Variable Energy Cyclotron Centre. The samples have been irradiated with 40 MeV alpha-particles with different doses in VECC, Calcutta.
- *The study of magnetic Barkhausen noise (MBN) and magnetic flux leakage (MFL) signals* : In collaboration with Professor D.L. Atherton, Queen's University, Canada, I have investigated the effect of stress on the magnetic Barkhausen noise and magnetic flux leakage signals from ferromagnetic steel samples.

### List of Publications in 1998-99

#### *In Journals*

1. K. Mandal and D.L. Atherton, 1998, "A study of magnetic flux leakage signals", *J. Phys. D: Appl. Phys.* 31, 3211 - 3217.
2. K. Mandal, D. Dufour, D.L. Atherton, 1999, "Use of magnetic Barkhausen noise and magnetic flux leakage signals for analysis of defects in pipeline steels", *IEEE Transaction on Magnetics*, in press

#### *Conference Proceedings*

1. K. Mandal, 1998, "Study of stress concentration by Barkhausen noise measurements", in *Proc. of DAE Solid State Physics Symposium*,
2. K. Mandal, 1998, "The effect of stress and annealing on the magnetic properties of amorphous magnetic materials" in *Proceedings of Young Physicists' colloquium*"
3. K. Mandal, D. Sanyal, Udayan De and C.K. Majumdar, 1999, "Study of conductivity fluctuation in alpha-particle irradiated high-temperature superconductors" in *Proc. of seventeenth national symposium on cryogenics*

## Invited seminars

“The effect of stress and annealing on the magnetic properties of amorphous magnetic materials” at the Young Physicists’ Colloquium, at Saha Institute of Nuclear Physics, Calcutta, August 21, 1998.

## Conferences attended

- Young Physicists’ Colloquium, Calcutta (August, 1998)
- DAE solid state physics symposium at Kurukshetra University, Kurukshetra, (December, 1998).
- International Conference on Statistical Physics- STATPHYS- Calcutta III, Calcutta. (January,1999)

## Awards and organizational achievements

- . The paper “A study of magnetic flux leakage signals” by K. Mandal and D.L. Atherton, *J. Phys. D: Appl. Phys.* has been selected as the featured article of the journal.
- I have been given a one-year Fellowship by the Ministry of Education and Culture, Spain to work in the Instituto de Magnetismo Aplicado, Madrid, Spain.

## Abhijit Mookerjee

### Current research interests and ongoing collaborations

#### *Electronic structure and phase stability of binary alloys*

Our group at the Centre has developed the TB-LMTO-ASR package based on the augmented space theorem proposed earlier by me, to study the electronic structure and phase diagrams of binary alloys. The methodology incorporates configuration fluctuations capable of describing short-ranged ordering, clustering and local lattice distortions. We have used the technique to study magnetic alloys and their phase stabilities. Major collaborators include Prof. Rajendra Prasad of the Indian Institute of Technology, Kanpur; Dr. G. P. Das of the BARC and Prof. Mesbahuddin Ahmed of the University of Dhaka, Bangladesh. The formalism was developed in collaboration with Dr. Indra Dasgupta and Dr. Tanusri Saha of the Max-Planck Institut für Festkörperforschung, Stuttgart, Germany. In collaboration with Dr. P. K. Mukhopadhyay of the S. N. Bose National Centre, Calcutta and Dr. Dipankar Das of the Inter University Consortium, Calcutta we have been analyzing data from experiments probing spin glass alloys with positrons and X-rays, as well as linear and non-linear susceptibility probes.

#### *Electronic structure of transition metal clusters*

We have been using the LMTO based molecular dynamics to study the electronic properties of small Cu and Ni clusters. This work was in collaboration with Prof. Ashok Bhattacharyya of the Centre for Catalysis and Materials studies, University of Warwick, UK and was funded by Warwick University.

#### *Growth and magnetism in rough overlayers*

We have been modelling the growth and roughness of deposited overlayers and the influence of electronic structure on growth characteristics. This work was in collaboration with Dr. Anita Mehta of the S N Bose National Centre, Calcutta. We have been studying magnetism and magnetization profiles on rough surfaces.

### List of Publications for 1998-99

#### *Refereed publication in journals*

1. B. Sanyal, P. Biswas, A. Mookerjee, H. Salunke, G. P. Das and A. K. Bhattacharyya, (1998), "An augmented space study of rough epitaxial overlayers", *J. Phys. Condens Matter*, 10 5767-5779
2. B. Sanyal and A. Mookerjee, (1998), "Magnetism and magnetic asphericity in NiFe alloys", *Phys. Lett.* , A 246 151-156

3. S. Ghosh, N. Das and A. Mookerjee, (1998), "Magnetism in Ni-Mo single crystal alloys: Theory and Experiment", *J. Phys. Condens Matter*, 10 11773-11780
4. G. Kalpana, G. Pari and A. Mookerjee, (1998), "An ab-initio electronic structure calculation for BeS, BeSe and BeTe", *Int. J. Mod. Phys. B* 12 1975-1980
5. P. Biswas, B. Sanyal, T. Saha-Dasgupta, A. Mookerjee, M Ahmed, A. Huda, Nasreen Chaudhury and A. Halder, (1999), "Electronic and Magnetic Structure of AuFe alloys" *J. Phys. Condens Matter*, 11 1833-1846
6. B. Sanyal, A. Mehta and A. Mookerjee, (1999), "A new class of coupled continuum equations for atomic growth on surfaces", *J. Phys. Condens Matter*, 11 4367-4380
7. G. Pari, Vijay Kumar, A. Mookerjee and A. K. Bhattacharyya, (1999), "Electronic structure of bulk and layers of alkaline earths (Be - Ba)" *Phys. Rev. B*, in press
8. A. Banerjea, R. P. Datta, A. Mookerjee and A. K. Bhattacharyya, "The Determination of the ground state geometries of Copper Clusters by simulated annealing", (1999), *Int J Mod Phys B*, in press
9. A. Mookerjee, B. Sanyal and A. Mehta, 1999, "Growth and electronic structure of rough overlayers", *Physica*, in press
10. S. Ghosh, N. Das and A. Mookerjee, (1999), "TBLMTO-Recursion For Random Binary Alloys: A Tractable Representation", *Int. J. Mod. Phys. B* (Accepted)
11. A. Roy, P. Das, S. K. Das, S. K. Sethi, C. Basu Chaudhuri, A. Mookerjee, and G. Pari, (1999), "Changes of decay rate of  $^7\text{Be}$  in Au and  $\text{Al}_2\text{O}_3$  and its impact on the solar neutrino problem", *Physics Lett A*, in press

#### *Publication in Monographs*

1. Abhijit Mookerjee.(1998), " Study of Phase Formation and Phase Transitions in Binary Alloy Systems", in *Electron Correlations in Atoms and Solids*, eds. A.N. Tripathi and I. Singh, *Phoenix Publishing House Pvt. Ltd., New Delhi*
2. Abhijit Mookerjee, (1998), "Growth and Magnetism of Rough Transition Metal Overlayers" in *Frontiers in Materials Modelling and Design*, eds. Vijay Kumar, Surajit Sengupta and Baldev Raj, *Springer Verlag, Berlin, Heidelberg*
3. Abhijit Mookerjee, (a) "Introduction to augmented space methods", (b) "Application of the augmented space recursion to the study of electronic structure and phase stability of disordered alloys", (1999), in *Electronic Structure of Alloys, Surfaces and Clusters*, eds. Abhijit Mookerjee and D. D. Sarma, Gordon and Breach Science Publishers, Amsterdam

4. Anita Mehta, Biplab Sanyal and Abhijit Mookerjee, "Modelling the growth of rough surfaces : coupled continuum equations, electronic structure and magnetic properties, (1999), in *Electronic Structure of Alloys, Surfaces and Clusters*, eds. Abhijit Mookerjee and D. D. Sarma, Gordon and Breach Science Publishers, Amsterdam

### *Editing Monographs*

Abhijit Mookerjee and D. D. Sarma, (1999), "Electronic Structure of Alloys, Surfaces and Clusters", *Gordon and Breach Science Publishers, Amsterdam*

### *Scientific publications in newspapers/journals*

Abhijit Mookerjee, "A pretty useful cluster" *The Telegraph* (Calcutta, 3 November 1998)

### Invited seminars given at:

1. Department of Physics, University of Dhaka, Bangladesh (April 1998)
2. International Centre for Theoretical Physics, Trieste, Italy (May 1998)

### Invited talks at conferences

#### *Invitations as speakers (accepted) to conferences:*

1. Network workshop on *Response functions in disordered systems* at University of Dhaka, Bangladesh (April 1998)
2. Workshop on *Electronic Structure of clusters and molecules* at S. N. Bose National Centre, Calcutta, India (November 1998)
3. *K S Krishnan Centenary Workshop* at University of Allahabad, India (December 1998)
4. *Statphys III - Calcutta* at S. N. Bose National Centre, Calcutta (January 1999)

#### *Other invitations to conferences (unable to attend):*

1. Conference on *Mathematical Physics* at Sylhet, Bangladesh (October 1998)

### Awards and organizational achievements

#### *Academic administration*

Appointed *Dean, Academic Programme* of the S. N. Bose National Centre, Calcutta (February 1999)

*Theses examined*

1. Thesis examiner of Surinder Pal Singh (Ph. D. student of Prof. P. Singh) of Pantnagar University (August 1998)
2. Thesis examiner of Prosenjit Sen (Ph. D. student of Prof. Avinash Singh) of the Indian Institute of Technology, Kanpur (December 1998)
3. Thesis examiner of Saurabh Basu (Ph. D. student of Prof. Avinash Singh) of the Indian Institute of Technology, Kanpur (April 1999)
4. Thesis examiner of Girish Gupte (Ph. D. student of Prof. Rajendra Prasad) of the Indian Institute of Technology, Kanpur (April 1999)

*Supervised theses completed*

1. Biplab Sanyal, submitted thesis to Jadavpur University
2. Parthapratim Biswas, submitted thesis to Jadavpur University

*Membership of editorial boards of journals*

1. Editor of the *International Journal of Modern Physics B* and *Modern Physics Letters B*, World Scientific, Singapore
2. Editor of the *Indian Journal of Physics*, Calcutta

*Membership of organizing committees of conferences*

1. Convenor of the *Workshop on Electronic Structure of Clusters and Molecules* at the S. N. Bose National Centre, Calcutta (October-November 1998)
2. Member of Organizing Committee of *Statphys III - Calcutta* at S. N. Bose National Centre, Calcutta (January 1999)
3. Convenor of the *1st S.E.R.C. School on Electronic Structure and Physics of Materials* to be held at the S. N. Bose National Centre, Calcutta in November 1999
4. Member of the Organizing Committee of *Foundations of Quantum Mechanics* to be held at the S. N. Bose National Centre, Calcutta in January 2000.
5. Member of the Advisory Committee of the *Psi-k Conference* to be held in Gmünd, Germany in August 2000.

*Joint projects held with other centres*

1. Project on Electronic Structure of transition metal clusters held with Prof. A. K. Bhattacharyya, Centre for Catalysis and Materials Research, University of Warwick, funded by the University of Warwick, U. K.
2. Network project on Electronic Structure of metals and alloys held with Prof. Mesbahuddin Ahmed, University of Dhaka, Bangladesh, funded by International Centre for Theoretical Physics, Trieste, Italy

## Avijit Mukherjee

### Current research interests and ongoing collaborations

My research area is *Theoretical High-Energy Physics* and in particular I am interested in the formal mathematical aspects of string theory and gauge theories (supersymmetric or otherwise). In the past I have worked on Seiberg-Witten gauge theories and dualities in field theory and my present interests are a continuation and extension of these topics to duality of strings and branes, and F-theory. I am also studying certain geometrical properties of the moduli spaces of D-branes. My recent research work included :

1. Mirror symmetry and its applications to Calabi-Yau 3-folds and elliptically fibered Calabi-Yau's and its applications to the moduli spaces of D-branes in M and F theory
2. Analyzing the *integrability* aspects of Seiberg-Witten gauge theories via the spectral curve constructions and Hitchin's results on integrable systems. I have used methods from both algebraic-geometry as well as recent knowledge gained from analysis of D-branes in M and F theory to obtain informations about the moduli spaces of these objects.

### List of Publications 1998-99

Avijit Mukherjee and J-M Isidro, J P Nunes, H J Schnitzer, (1998), "A Note on the Picard-Fuchs Equations for  $N = 2$  Seiberg-Witten Theories" *Int. J. Mod. Phys. A*13, 233-250

### Fellowships awarded

I have been awarded a JSPS (Japan Society for Promotion of Sciences) Fellowship as a Visiting Guest Researcher to work with Prof. T. Eguchi and his group in the High Energy Physics Sector of the University of Tokyo.

## Sugata Mukherjee

### Current research interests and ongoing collaborations

My research interests lie in the area of first-principles total-energy and electronic structure calculations, based on local density-functional theory and nonlocal pseudopotentials and also using semi-empirical linear-combination-of-atomic-orbital (LCAO) methods and their application in atomic clusters, molecules and in extended non-periodic systems, like fullerenes. I also have an interest in surface physics and in surface and bulk electronic properties of metal alloys. Our first-principles molecular-dynamics calculations have shown that  $\text{Si}_{33}$  cluster has a fullerene-like spherical shape, with an outer cage containing 28 atoms encapsulating a small 5-atom inside cage. This novel structure exhibited a remarkable lowering of chemical activity.  $\text{Si}_{45}$  cluster was also found to have similar two-shell geometry. Calculations on multiply-charged coinage metal dimers showed interesting metastability in the binding energy curve. These results were in agreement with recent experiments on Si clusters.

We have studied the surface segregation properties of bimetallic alloys Cu-Ru and Cu-Os to try to understand their size dependent miscibility properties. To this effort, the surface segregation was investigated (with B. Sanyal) in Cu-Ru and in Cu-Os alloys. Preliminary results indicated strong segregation of Cu at the surface of these alloys, which is in accordance with experimental data.

### List of Publications 1998-99

#### *Refereed publications in Monographs*

1. S. Mukherjee, A.P. Seitsonen and R.M. Nieminen, "Stability of Molecules and Clusters studied through First-principles total energy Calculations", in *Frontiers in Materials Modelling and Design*, Eds. V. Kumar, S. Sengupta and B. Raj (Springer-Verlag, Berlin, 1998) pp 187-192.
2. S. Mukherjee "Structure and Properties of Atomic Clusters" (review article), to appear in *Trends in Atomic and Molecular Physics*, Ed. K.K. Sud (Plenum, New York, 1999).

### Conference participation

#### *Invited talks at conferences*

1. *Workshop on Electronic Structure of Clusters and Molecules, SNBNCBS, 26 October - 6 November 1998*  
Structure and Properties of Elemental Microclusters.
2. *XII National Conference on Atomic and Molecular Physics, Udaipur, 29 December 1998 - 2 January, 1999*  
Structure and Properties of Atomic Clusters.

*Contributed presentations at conferences*

1. B. Sanyal and S. Mukherjee, "Surface Segregation in Cu-Ru and Cu-Os Alloys" *5th International Union of Materials Research Society's International Conference in Asia, I.I.Sc., Bangalore, 13 - 16 October 1998*

*Conferences attended*

1. *International Conference on Scientific Computing and Modelling*, SNBNCBS, July 9 - 11, 1998.
2. *India-Italy Workshop on Utilisation of Elettra Synchrotron*, SINP, Calcutta, 10 - 13 November, 1998 Participated by invitation.

## Pratip Kumar Mukhopadhyay

### Current research interests and ongoing collaborations

- Non-equilibrium flux dynamics in trapped vortices, especially with respect to high energy ion bombardments, on high temperature superconductors. The collaborator has been Dr. D. Kanjilal of NSC, New Delhi.
- Study of NiMo random alloys with low Mo concentration. This is a project from the Third World Academy of Sciences, ICTP, Trieste, Italy. Part of the sample preparation and low temperature resistivity measurements has been done in collaboration with *Prof. A.K.Majumder* and *Dr. G.D.Mukherjee* at I.I.T., Kanpur ; the Mössbauer spectroscopy and positron annihilation studies have been done with *Dr. D.Das* and his students at the Inter University Consortium, Calcutta Centre, while theoretical investigations have been carried out by *Prof. A.Mookerjee* and his group at SNBNCBS.
- With *Dr.P.Roychowdhury* (Emeritus, National Chemical Laboratory, Pune), we have studied relaxor ferroelectric ceramics of the type  $Pb(B'_{1/3}Nb_{2/3})O_3$  where  $B' = Mg, Zn$  etc. and their solid solutions with barium titanate and/or lead titanate near the morphotropic phase boundary, with a view to using them in multilayer ceramic capacitors using high silver palladium electrodes.

### Publications in conference proceedings

Positron annihilation study on NiMo system in the critical region - P.K.Mukhopadhyay, D.Das, Viresh Kumar, N.S.Pattabiraman, G.D.Mukherjee, A.K.Majumder, S.N.Chintalapudi and A.Mookerjee, DAE symposium on Solid State Physics, Department of Physics, Kurukshetra University, Kurukshetra, 1998, in press

### Invited seminars given at:

1. Superconductivity from past to present - given at Kendrya Vidyalaya, Salt Lake, June 11, 1998
2. Spin glass and other random magnetic systems - given at IUC, Calcutta, June 25, 1998

## Nilkantha Nayak

### Current research interests and ongoing collaborations

My research interests concern Quantum Optics and Laser Physics. For the last few years, I have been emphasizing on cavity quantum electrodynamics in my investigations. There has been growing interest in the cavity QED due to possibilities of verification of its results in its experimental realizations, the micromaser and microlaser. My work on micromaser reproduced the experimental results of the Max-Planck Institut, Munich and MIT, to a very good accuracy. It further pointed out the difficulties in generating trapped states in the existing setup. We have also investigated the optical counterpart of the micromaser, the microlaser. important. We have derived an expression for the photon statistics of the cavity radiation field. We have studied the threshold characteristics of laser action and have shown that the field can be nonclassical in nature away from laser thresholds.

In collaboration with V. Bartzis (TEI, Athens, Greece) and A. S. Majumdar (SNBNCBS), we have completed an investigation involving a micromaser model in which atoms are pumped in pairs. The model is also capable of describing a two-photon micromaser (atom emitting two photons while jumping from the upper to the lower level via an intermediate level) which has been demonstrated at the Ecole Polytechnique, Paris.

I have studied cavity-QED and micromaser action using cold atoms. The micromaser, described above, can be used to study the foundations of quantum mechanics. We plan to analyse Bell's inequality and quantum mechanical complementarity using our theory of micromasers.

In addition, we have initiated the study of laser action in a novel system, the so-called photonic band gap materials, an optical analogue of semiconductors. Because of its band structures in the allowed modes of frequencies of optical radiation, the emission probabilities of atoms change drastically. We have incorporated these aspects in our analysis and we are now studying conditions

### List of Publications for 1998-99

N. Nayak, "Effect of dissipative forces on the theory of the single atom micromaser", 1999, *Opt. Lett.* 14,13-15

### Invited talks at conferences

1. "Lasing action in photonic band gap materials" at the Seminar on Selected Topics in Theoretical Physics at the University of Hyderabad (September, 1998)
2. "Microlasers : One atom lasing action at optical frequencies" at the National Laser Symposium at IIT, Kanpur (December, 1998)

3. "Microlasers" at the Indo-French Workshop on Probing Fundamental Problems with Lasers and Cold atoms, Bangalore (January, 1999)

### Conferences attended

- Seminar on Selected Topics in Theoretical Physics at the University of Hyderabad (September 15-17, 1998).
- National Laser Symposium at the IIT, Kanpur (December 14-16, 1998).
- Indo-French Workshop on Probing Fundamental Problems with Lasers and Cold Atoms at the Indian Institute of Astrophysics, Bangalore (January 4-8, 1999).

### *Membership of editorial boards of journals*

Associate Editor (Honorary) of the Indian Journal of Physics for two years 1999 and 2000.

## Manoj Kumar Pal

### Current research interests and ongoing collaborations

I have been interested in the study of exotic nuclei with a large neutron-excess or proton-excess near the respective drip-lines. I have been writing a text-book at the graduate level delineating general theory of Relativity and its application to Astrophysics and Cosmology.

### List of Publications for 1998-99

1. M. K. Pal, "Antisymmetrized treatment of halo nuclei", 1998, *J. Phys. G: Nucl. Part. Phys.* 24 1513-1517.
2. M.A.Khan, S.K. Datta, T.K. Das and M.K. Pal, "Hyperspherical three-body calculation for neutron drip-line nuclei", 1998, *J. Phys. G: Nucl. Part. Phys.* 24 (1998) 1519-1525

### Publication on popular science

'Science and Spirituality', published serially in *eight* installments, Bull. Ramakrishna Mission Institute of Culture, June–October, 1998 and December, 1988 – February, 1999.

### Invited seminars given at :

1. 'Astronomy in ancient civilizations' - invited lecture under the auspices of Samanta Chandrasekhar Amateur Astronomers' Association, Bhubaneswar, delivered on 20 December, 1998.
2. 'History of Old Civilizations (Egypt, Sumer, Babylonia, Crete, India, China, Greece) and development of Science' – semi-popular evening lecture delivered at IOP, Bhubaneswar, 31 December, 1998.
3. 'Exotic Nuclei and profor radioactivity' – lecture delivered in the Physics Department, Utkal University, Vani Vihar, 9 January, 1999.

### Lecture courses given :

A course of *eight* lectures on 'General theory of Relativity- Astrophysics and Cosmology' on various dates between 15 December, 1998 - 14 January, 1999 at the Institute of Physics, Bhubaneswar.

## Samir Kumar Pal

### Current research interests and ongoing collaborations

My research interest has been in the areas of statistical mechanics, quantum spin models in low dimensions and the geometrical properties associated with them :

- The exact partition function of the open Ising model in the presence of a magnetic field, is calculated for a finite number  $n$  of Fibonacci generations. We have established the presence of order within the disorder in inflated the Ising model on Fibonacci chains. Our motivation was to solve quasi-periodic systems using these techniques. This work has been done in collaboration with Susanta Bhattacharya (R.S.College , Howrah).
- The possibility of the existence of topological excitations in the anisotropic quantum Heisenberg model in one and two spatial dimensions has been studied using a coherent state method. It was found that a part of the Wess-Zumino term contributed to the partition function, as a topological term in the long wavelength limit in both one and two dimensions. In particular, the XY-limit of the two-dimensional anisotropic ferromagnet was shown to retain topological excitations, as expected from the quantum Kosterlitz-Thouless scenario.

This work has been done in collaboration with Ranjan Chaudhury (SNBNCBS) .

### List of Publications 1998-99

R. Chaudhury and S. K. Paul, (1998), 'Possible Existence of Topological Excitations in Quantum Spin Models in Low Dimensions', *Physical Review B*, in press.

#### Invited seminars given :

"Symmetries and Gauge Theories", at University of Calcutta during the One Day Seminar on Applied Mathematics (March 25,1999)

#### Invited participation at conferences

Winter School on "Transformation Groups", at STAT-MATH division, Indian Statistical Institute, Calcutta, 8-26 December 1998

## Jayasree Saha

### Current research interests and ongoing collaborations

Liquid crystalline systems show a multiplicity of phases. The phase transitional behaviour of liquid crystal molecules depends in a delicate manner on molecular structure and external conditions. My work in this area has had three main thrusts:

1. I have in collaboration with C. D. Mukherjee of SINP, developed a mean field model for the phase alternation between homologues, as observed in the case of a liquid crystalline series with a bulky terminal phenyl ring. This is possibly the first calculation where the generally observed feature of the cinnamate homologous series, namely the phase alternation, is well reproduced
2. In the next piece of work, done in collaboration with S. Banerjee and C. K. Majumdar, a comprehensive analysis of effects of various external conditions on a system of nematic liquid crystal molecules, confined in a Polymer Dispersed Liquid Crystal droplet has been carried out using Monte-Carlo simulation techniques.
3. Finally, I have, in collaboration with B. Sanyal and A. Pal of JU, investigated the effect of non-mesogenic impurities on the nematic-isotropic transition.

### Refereed publications in journals/books

1. J.Saha and C.D.Mukherjee, 1998, 'Phase alternation in liquid crystals with terminal phenyl ring', *Ind. J. Phys.* 72A, 427-431

### Invited seminars given at:

1. Monte-Carlo simulation of thermotropic liquid crystals : TPSC talk at Institute of Physics, Bhubaneswar, 17 February 1999.

### Conferences attended, with contributed talks being given:

1. "Potential modelling for disc-like molecules": talk at the Spring College on Statistical mechanics and dynamics of soft condensed matter (4 May - 5 June, 1998) at ICTP, Trieste, Italy.
2. "Effect of confinement on ordering in nematic polymer dispersed liquid crystals" : Paper presented at the National Seminar on Liquid Crystals (29-31 October, 1998) at Goa University.

## Subodh Kumar Sharma

### Current research interests and ongoing collaborations

My main research interests concern light scattering in various contexts, e.g. from aerosols, hydrosols, a variety of fibres and various particles of astrophysical and biological interests. The main emphasis of my research has been on developing and examining methods for the analysis of light scattered by such particles. New methods are being developed for the analysis of scattering patterns and the efficacy of these methods as a diagnostic tool is being examined. My research interests also include exploring suitable calculation methods to predict the interaction of electromagnetic radiation with emulsified and slurry drops. The points of interest are the radiative properties in combustion situations, especially in furnaces, and those light scattering properties which could be suitable for diagnostic purposes.

### List of Publications for 1998-99

#### *Refereed publications in journals/books*

1. S K Sharma, Ashim Roy and D J Somerford, 1998 "New approximate phase functions for scattering of unpolarized light by small and large particles", *J. Quant. Spectrosc. Rad. Transf.*, 60, 1001.
2. S K Sharma and A K Roy, 1999 "New approximate phase functions: test for non-spherical particles" *J. Quant. Spectrosc. Rad. Transf.*, in press.

### Invited talks at conferences

Parametrized phase functions for the scattering of light by spherical and nonspherical particles, at Workshop on Light Scattering by Small Particles and its Applications to Astrophysics, organised by IUCAA, at Bhavnagar, Gujrat (August 18-20, 1998).

### Fellowships, associateships and visiting professorships awarded

Visiting Fellowship at Imperial College, London from 1 January - 31 December 1999.

## Prabhat Kumar Thakur

### Current research interests and ongoing collaborations

I have, for the past few years, been investigating numerically electron localisation and delocalisation aspects in imperfect quasi-periodic chains as well as random chains in the presence of constant electric fields. This work has been done in collaboration with Parthapratim Biswas, a Ph.D student of this institute.

My current research interests are in the following areas:

- Electronic states and transport in mesoscopic ballistic systems
- The nature of the electronic states in disordered polymers, ie whether localised or delocalised
- Magnetic field-dependent localisation properties in totally random as well as correlated systems
- Electronic states in the presence of locally random electric fields in random and Fibonacci superlattices.

My collaborators in these projects are, variously, Ranjan Chaudhury, Sugata Mukherjee, Abhijit Mookerjee, Ashim Ray (ISI), Tapas K Mitra and Parthapratim Biswas.

### Refereed publications in journals/books

1. Prabhat K. Thakur and Parthapratim Biswas, 1999, Multifractal scaling of electronic transmission resonances in perfect and imperfect Fibonacci  $\delta$ -functions potentials, *Physica A*, 265, 1-18
2. Parthapratim Biswas and Prabhat K Thakur, 1999, Electron delocalisation and multifractal scaling in electrified random chains, *Physics Letter A*, in press.

## LIST OF PUBLICATIONS IN REFEREED JOURNALS

1. R.Banerjee and P.Mukherjee, 1998, "Galilean symmetry in a nonabelian Chern-Simons matter system", *Ann. Phys.(NY)*, 264 30.
2. R.Banerjee and C.Wotzasek, 1998, "Bosonisation and duality symmetry in the soldering formalism", *Nucl. Physics*, B527, 402.
3. R.Banerjee and S.Ghosh, 1998, "The chiral oscillator and its applications in quantum theory", *J. Phys. A: Math. Gen.* 31, L603.
4. R.Banerjee, 1999, "On the constrained structure of duality symmetric Maxwell theory", *J. Phys. A: Math. Gen.* 32, 517.
5. R.Banerjee and E.C.Marino, 1999, "A new approach for bosonisation of massive Thirring model in three dimensions", *Mod. Phys. Lett. A*, in press.
6. R.Banerjee and B.Chakraborty, 1999, "Mode analysis and duality symmetry in different dimensions", *J. Phys. A: Math. Gen.* , in press.
7. R.Banerjee and P.Mukherjee, 1999, "Some comments on the spin of Chern-Simons vortices", *Prog. Theor. Phys.*, in press.
8. S. Banerjee , V. A. Barker, K. Mogensen and E. Stenby , 1999, "Comparison of iterative methods for computing the pressure field in a dynamic network model", *Transport in Porous Media*, in press
9. G.C. Gorain and S.K. Bose, 1998 "Exact Controllability and Boundary Stabilization of Torsional Vibrations of an Internally Damped Flexible Space Structure" *Journal of Optimization Theory and Applications*, 99, 423-442.
10. G.C. Gorain and S.K. Bose, 1998 "Exact Controllability of a Linear Euler-Bernoulli Panel" *Journal of Sound and Vibration*, 217, 637-652 .
11. S.K. Bose and G.C. Gorain, 1998 "Stability of the Boundary Stabilized Internally Damped Wave Equation  $y'' + \lambda y''' = c^2(\Delta y + \mu \Delta y')$  in a Bounded Domain in  $R^n$ " *Indian Journal of Mathematics*, 40 1-15.
12. G.C. Gorain and S.K. Bose, 1999 "Exact Controllability and Boundary Stabilization of Flexural Vibrations of an Internally Damped Flexible Space Structure" *Applied Mathematics and Computation*, in press.

13. B.Chakraborty and A.S.Majumdar, 1998, " Hamiltonian Analysis of the gauged  $CP^1$  model, the Hopf term and Fractional Spin", *Phys. Rev. D* 58, 125024.
14. B.Chakraborty and A.S.Majumdar, 1999, "On Fractional Spin in the  $CP^1$  model coupled to the Hopf term"; *Acta.Phys.Pol.B*,30, 247.
15. B.Chakraborty and A.S.Majumdar, 1999, " Effects of gauging on Symplectic Structure, the Hopf term coupled to  $CP^1$  model and Fractional Spin"; *Int. J. Mod. Phys. A*, in press.
16. G. Lanzafame, D. Molteni, & S.K. Chakrabarti, 1998, "Smoothed Particle Hydrodynamic Simulations of Viscous Accretion Discs Around Black Holes", *Mon. Not. Royal Astron. Soc.*, 299, 799-805.
17. S.K. Chakrabarti, 1998, "Identification of Astrophysical Black Holes" (Review), *Ind. J. Phys.* , 72B, 183-233.
18. S.K. Chakrabarti & B. Mukhopadhyay, 1999, "Neutron Disks Around Black Holes", *Astronomy & Astrophysics*, 344, 105-110.
19. S. K. Chakrabarti, "Spectra Softening due to Winds in Accretion Disks" , 1998, *Ind. J. Phys.* , 72B, 565-569.
20. S. Chakrabarti, 1999, "Theoretical Comparison of the Energy made Available for Producing Damages to the DNA, Between Electromagnetic Radiations and Metabolic Processes" , *Ind. J. Phys.* (in press)
21. R. Chaudhury and S. K. Paul, 1998, "Possible Existence of Topological Excitations in Quantum Spin Models in Low Dimensions", *Phys. Rev. B* , in press.
22. D.Gangopadhyay and S.Sengupta, 1999, "Duality Invariance of Cosmological Solutions with Torsion", *Int. J. Mod. Phys. A* , in press.
23. G. Gangopadhyay and S. Ghoshal, 1998, "A thermal bath induced Rabi splitting on the profile of Mollow spectrum in single molecule spectroscopy", *Chem. Phys. Lett.*, 289, 287-297.
24. G. Gangopadhyay and Y. Tanimura, 1998, "Absorption line shape of impurity molecule driven by a fractal noise", *Chem. Phys. Lett.*, 289, 97-104.
25. G. Gangopadhyay, J. Ray Chaudhuri, B. Deb and D. S. Ray, 1998, "Quantum Theory of dissipation of a harmonic oscillator coupled to a nonequilibrium bath, Wigner-Weisskopf decay and Physical Spectra", *J. Phys. B: At. Mol. Phys.* , 31, 3859-3874.
26. G. Gangopadhyay, J. Ray Chaudhuri and D. S. Ray, 1998 "Theory of non-stationary activated rate processes: non-exponential kinetics", *J. Chem. Phys.* , 109 5565-5575.

27. G. Gangopadhyay, 1998, "A generating function for the product of Laguerre polynomials: Franck-Condon factor for multiphoton processes", *J. Phys. A: Math. Gen.* , 31, L771-L775.
28. Partha Ghose, 1998, "Wave-particle Duality: The Mystery Keeps Unfolding", *Pramana* 51, 651-661.
29. Partha Guha and Kanehisa Takasaki, 1998 "Dispersionless hierarchies, Hamilton-Jacobi theory and twistor correspondences" *Journal of Geom. Phys.* 25, 326-340.
30. A. Hartridge, A.K. Bhattacharyya, C.K. Majumdar, D. Das and S.N. Chintalapudi, "A Mössbauer study of  $\text{Fe}_2\text{O}_3$ - $\text{Cr}_2\text{O}_3$  nanocrystals dispersed in silica matrix", 1998, *J. Magn. Magn. Mater.* , 183, L1-4
31. M. Bose, C.K. Majumdar, K. Ohta and T. Sakurai, "Anomalies within alkyl and alkoxy substituted (1,3-diphenylpropane-1,3 dionate) Cu-II metallomesogens from X-ray and EPR studies", 1999, *MCLC*, 326, 229
32. R. P. Malik, A. K. Mishra and G. Rajasekaran, 1998, "Dynamics in a non-commutative phase space" *Int. J. Mod. Phys. A*13 4759-4775.
33. S. S. Manna, 1998, "Abelian Cascade Dynamics in Bootstrap Percolation" *Physica A* 261, 351.
34. S. S. Manna and D. V. Khakhar, 1998, "Internal Avalanches in a Granular Medium" *Phys. Rev. E* 58, R6935.
35. S. S. Manna, S. Krishnamurthy, V. Loreto, H. J. Herrmann, S. Roux, 1998, "Self-structuring of Granular Media under Internal Avalanching" *Phys. Rev. Lett.* , in press.
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## BUDGET SUMMARY 1998-99

The funds come from the Department of Science & Technology, New Delhi. The following is the summary of the budget estimates for the year 1998-99.

	Actuals	Budget estimate	Revised estimate
	<i>1997-98</i>	<i>1998-99</i>	<i>1998-99</i>
Non-Plan	38.50	46.32	22.66*
Plan	148.49	391.64	160.00*
Total	186.99	437.96	182.66

\* Sanctioned by DST Plan Rs.240 lakhs, Non-Plan Rs.34 lakhs but released as under :

### Non Plan

- Sanction Letter No. AI/SNB/003/98 dt. 20.04.98 Rs. 11.33 lakh  
Sanction Letter No. AI/SNB/003/98 dt. 03.08.98 Rs. 11.33 lakh  
Rs. 22.66 lakh

### Plan

- Sanction Letter No. AI/SNB/003/98 dt. 17.04.98 Rs. 80.00 lakh
- Sanction Letter No. AI/SNB/003/98 dt. 03.08.98 Rs. 80.00 lakh  
Rs. 160.00 lakh

Total Rs.182.66 lakhs

# What connects sandpiles, shares and weather?

What do earthquakes, sandpiles, forest fires, the weather and fluctuations in the stock market have in common? Very little, apart from their innate complexity.

This thorny statement is, however, at the heart of recent developments in theoretical physics: 'complex systems' is a rapidly expanding and rather fashionable field, whose constituent systems are unified only by their complexity.

Many events, both small and large, normally contribute to the overall nature of the system, for example although an earthquake is usually viewed as a single large event, closer scrutiny suggests that it is the result of many subsidiary slips between tectonic plates in the earth's crust. Some of these slips are dramatic, and others are barely detectable, but all of them form part of the quake. To take another example, the price of shares on the stock market can be influenced by individual acts of insiders trading as well as by the outbreak of wars—events which are clearly of very different scales. This complexity makes prediction extremely difficult, and precise mathematical analysis almost impossible.

Traditional methods of analysis of such systems emphasise the elimination of complexity, this is accomplished by identifying and dealing with only the most 'important' elements in each problem. However, this identification is impossible for the examples mentioned above; rare and apparently insignificant events can be just as important in the long run.

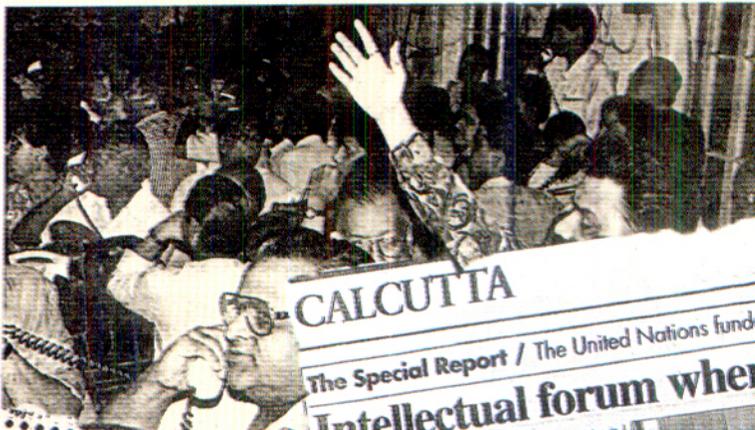
physics. The topics discussed at what turned out to be a very stimulating and lively meeting ranged from sand to glass, traffic jams to earthquakes, sequences in DNA to chaos, models of economics to models of disorder. To such a general discussion on diverse subjects was possible under one umbrella,

Complexity, claims Anita Mehta elsewhere to produce earthquakes; similarly, individual transactions between brokers produce apparently haphazard stock market fluctuations, resulting eventually in they occur close to each other in space and irrespective of the time interval between them.

to traverse the mean free path. In contrast, for SMC systems, the hypothesis is that all lengths and times are equally important. The smallest disturbance can grow to a catastrophe; for example, a hand-shake between financiers, could result in a takeover bid and cause a major upheaval in the stock market. There is thus no separation between which two parts of the whole are immune from each other's behaviour, and every scale of length and time has to be considered if any theoretical analysis is to predict the response of the system.

This intriguing and original theory has led to a large body of work, both on the mathematics of the theory itself and on the physics of the complex systems which were

ter than one formed by draining sand through a hole. This memory is a result of very special properties of matter in the granular state, the most important of these is that powders are 'athermal'. Simply put, it means that grains of sand are too big to move spontaneously in response to the ambient temperature. The consequence of this memory is that characteristics scales of length and time stand out, corresponding roughly to the 'memory bank' within the sandpile that keeps track of its past history. Experiments have been carried out all over the world, but most notably at the University of Chicago under the direction of Prof Sidney Nagel, which have demonstrated this; and in our theoretical model, my colleagues in Cambridge, Norwich and Paris and I have tried this in with a picture of low grains beside at the microscopic level, to do exactly what we would expect important



CALCUTTA The Special Report / The United Nations funded S.N. Bose Centre for Basic Sciences

## Intellectual forum where scientists meet, interact

# A pretty useful cluster

S.N. BOSE NATIONAL CENTRE FOR BASIC SCIENCES Oct. 26 - Nov 6

H MONDAY 21 DECEMBER 1995

### Leonid samples not meteorites

BY A STAFF REPORTER

Calcutta, Dec. 20: Experts from the Geological Survey of India have revealed that the Leonid showers collected after the state's various parts of the state were not meteorite fragments but "some form of burnt-out coal". This was disclosed at a "post-mortem" on last month's celestial phenomenon held at the S.N. Bose National Centre for Basic Sciences today. The one-day symposium also talked about the uncertainties of such an event, because of which the shower had turned out to be a disappointment. Observers from all over the country participated.

netic and mechanical properties are reasonably well understood. If we succeed in preparing small clusters of the same material, its dimensions will be less than a hundred nanometers; one in a hundred lakh divisions of a centimeter. Novel materials exhibit properties which are sometimes different from their bulk. Study of these nanoscale objects is of great interest to understanding cluster properties of atoms.

atively harmless gases use the metal palladium which is extremely expensive. From the synthesis of ammonia in the preparation of fertiliser emulsion coatings to prevent rusting and corrosion, the hunt is on for suitable cluster catalysts. Theoretical research with accurate predictive power is essential if we are to lift this search from planned, scientific procedure.

Director of the Indian Association for the Cultivation of Sciences, described the experimental work in trying to understand the novel properties of nano-structures and nano-composites which are being done in his laboratory in Calcutta. The state-of-the-art theoretical computational techniques of studying such materials were presented by Prof. Jorge Kohnoff.

## Withholding no atom's atom

Anita Mehta explains the method by which scientists stumbled onto a new state of matter, the Bose-Einstein condensate

The huge gap between theory and practice is nowhere more apparent than in the world of particle physics. And nowhere does the gap more border the mystical than when one is dealing with the works of Albert Einstein. The recent observation of Bose-Einstein condensation at a laboratory in Colorado in the United States, has all the ingredients of a scientific fairy tale. There was an early theoretical prediction which as seemingly impossible to serve experimentally due to difficulties in attaining a temperature as close as possible to absolute zero, that is 273.15 degrees Celsius, theoretically lowest temperature attainable in the universe. The



eral decades. The members of the Colorado team put their heads together, brought the temperature sufficiently low and finally managed to settle an old score. The story of this breakthrough is in itself a beautiful example of the cooperative and innovative nature of good old modern science. The cooperation involves the glueing together of two established techniques—laser cooling and evaporative cooling—to holdy reach temperatures that would have been impossible to achieve with either one alone.

would never be able to leak out again. On June 5 this year the results of the team's efforts appeared on the video screens. Two thousand atoms had condensed to form a single entity. This was what the condensation looked like in real life. And at temperatures reaching about 180 billionths of a degree above absolute zero, the Cornell team had boldly gone to temperatures where no man had gone before.

At first, the magnitude of their work did not sink in. Like all good scientific discoveries, it was something that was so real that it was hard to believe. The team's work was a triumph of science over nature.

## Wrong calculations

As yet there are gaps in knowledge about comets and meteoroids in particular, and the universe in general. Hence, astronomers' methods of making predictions. For instance, the sun is the source of most comets and meteoroids. As they approach us, they are deflected by the sun's gravity. The deflection is predicted correctly to the second order, but the third order is not. This is the prediction gap. The prediction gap is the difference between the predicted path and the actual path. The prediction gap is the difference between the predicted path and the actual path. The prediction gap is the difference between the predicted path and the actual path.

## Our galaxy is in state of relative inaction

Our galaxy is in a state of relative inaction, according to a study by astronomers. The study found that the galaxy is not moving as fast as previously thought. The study found that the galaxy is not moving as fast as previously thought. The study found that the galaxy is not moving as fast as previously thought.

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Block JD, Sector III, Salt Lake, Calcutta 700091