होमी भाभा राष्ट्रीय संस्थान

HOMI BHABHA NATIONAL INSTITUTE

ANNUAL REPORT
2010-2011

Training School

Bhabha Atomic Research Centre

Anushaktinagar, Mumbai-400 094.

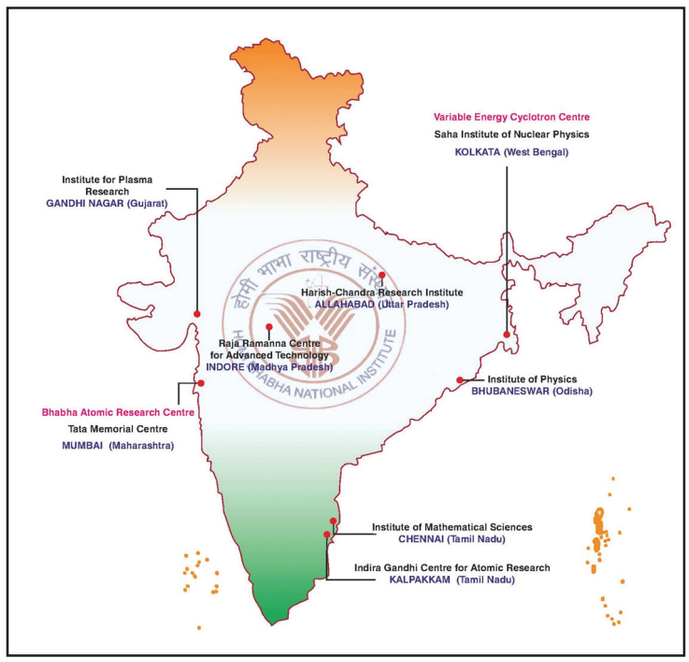
HOMI BHABHA NATIONAL INSTITUTE

ANNUAL REPORT 2010-2011

Training School Complex
Bhabha Atomic Research Centre
Anushaktinagar, Mumbai-400 094.

MANAGEMENT OF THE INSTITUTE

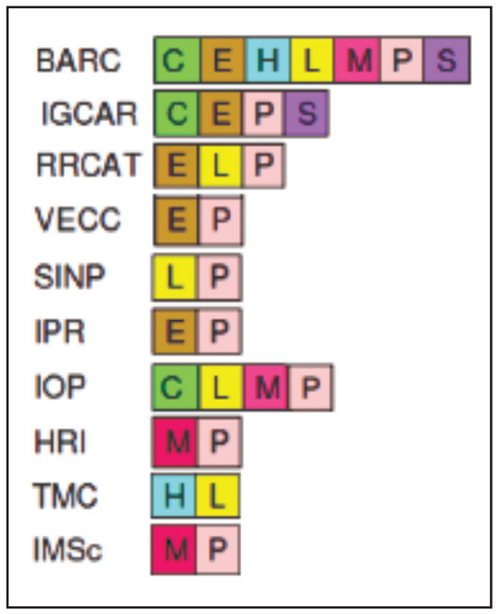
CONSTITUENT INSTITUTIONS OF HBNI



[Homi Bhabha National Institute (HBNI), is a deemed-to-be university under section 3 of the UGC Act, 1956 vide Notification No. F.9-5/2004-U.3, dated 3rd June, 2005 of the Government of India.]

The Council of Management is the principal organ for the management of the Institute. All academic issues are handled by an Academic Council which functions on the advice of the Board of Studies. There is a Board of Studies for every discipline as follows.

- Chemical Sciences (C)
- Engineering Sciences (E)
- Health Sciences (H)
- Life Sciences (L)
- Mathematical Sciences (M)
- Physical Sciences (P)
- Strategic Studies (S)



To manage the affairs of the Institute at the level of Constituent Institutions, each CI has one or more Deans-Academic and a university cell. CIs have also established a robust framework for admission, evaluation of performance and monitoring the progress of research by the students.

Composition of Bodies of the Institute is given in Annexure 1. *Composition of Standing Committees is given in Annexure 2.

*** It also lists officers of the Institute.**

From the Director

Number of doctorates in science and engineering produced by Universities in India is about 6000 every year and considering the size of the country, this number is very modest. Doctoral programme aims to train young minds in original research which is an important input for the present day economy. This has been highlighted by the National Knowledge Commission. In fact the opening sentence of the letter dated 06 November 2008 from Chairman, Knowledge Commission to Prime Minister reads, "It is widely recognized that a nation's transformation to a Knowledge and Skills Economy is critically dependent on the original research and development taking place within the country." It goes on to say that the growth in the number of doctorates has only been 20% in India in the period 1991-2001 compared to 85% in China. The letter recommends steps to improve the quality and quantity of Ph.D. students in the country.

One of the steps recommended is to "Enable research environment in the universities". Another way by which this objective can be achieved is to empower research laboratories, which have research environment, to host students. This is what is being done by Homi Bhabha National Institute. Excellent research infrastructure and capable scientific staff exists in the laboratories of the Department of Atomic Energy. Setting up of HBNI has provided them with an enabling mechanism to expand the doctoral programme and to add the element of a project to the BARC Training School programme converting it to a M.Tech. programme

The Institute continues to make all round progress. Number of students who have completed their doctoral thesis has risen to 32. Many more results, as listed later, have been declared. Second batch of students having M.Tech. qualification has been admitted to the DGFS programme. The Institute continues to make efforts towards increasing collaborations as demonstrated by total number of agreements for cooperation that have been signed.

(R B Grover)

The HBNI has the following as its Constituent Institutions (CIs).

1. Bhabha Atomic Research Centre (BARC), Mumbai
2. Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam
3. Raja Ramanna Centre for Advanced Technology (RRCAT), Indore
4. Variable Energy Cyclotron Centre (VECC), Kolkata
5. Saha Institute of Nuclear Physics (SINP), Kolkata
6. Institute for Plasma Research (IPR), Gandhinagar
7. Institute of Physics (IOP), Bhubaneswar
8. Harish-Chandra Research Institute (HRI), Allahabad
9. Institute of Mathematical Sciences (IMSc), Chennai, and
10. Tata Memorial Centre (TMC), Mumbai.

The role of HBNI is to nurture in-depth capabilities in nuclear science and engineering and to serve as a catalyst to accelerate the pace of basic research and facilitate its translation into technology development and applications through academic programmes, viz., Master's and Ph.D. degrees in Engineering, Physical, Chemical, Mathematical, Life and Health Sciences while encouraging inter-disciplinary research. Additionally, a Strategic Studies programme has also been identified to ensure availability of adequate qualified human resources to address issues pertaining to nuclear law, economics of nuclear power, nuclear security, nuclear proliferation, intellectual property rights etc.

In 2006, the Government of India decided to strengthen science education and set up institutions for science education and research in various parts of the country. One such institution, the National Institute for Science Education and Research (NISER) was set up at Bhubaneswar by the DAE as a project of the Institute of Physics. Academic programmes of this institute were started as a part of IOP and thereby under HBNI. Steps are being taken to make NISER an independent CI of HBNI.

NISER Academic Block (located within IOP campus) at Bhubaneswar.

ACADEMIC PROGRAMMES OF THE INSTITUTE

HBNI offers a range of academic programmes in chemical sciences, engineering sciences, health sciences, life sciences, mathematical sciences and physical sciences. It also has a programme in strategic studies. Except for NISER, all other institutions conduct programmes at post-graduate level. Various programmes offered are the following.

Ph.D.: It is offered at all CIs. in varied disciplines. HRI and IMSc also offer an integrated Ph.D. programme where students study for **M.Sc.** as well as Ph.D.

M.Tech. & M Phil : M Tech. in engineering sciences and **M.Phil.** in physical sciences, chemical sciences and life sciences. These programmes consist of one year of course work and one year of project work. The course work is offered at all campuses of BARC Training School and project work is offered at BARC, IGCAR, RRCAT VECC and some other units of DAE. Those who are not interested in project work get an diploma in lieu of an M.Tech. or a M.Phil.

M.Sc. (Engg.): This Programme has more research content than that in an M.Tech. programme. The duration of the project work under this programme is one-and-a-half year, while the duration of the course work is upto one year. This programme is offered at BARC, IGCAR, VECC and RRCAT and has been tailored for the employees of the Department.

Integrated M.Sc.: It is of five-year duration and presently at NISER only.

Super Specialty Courses at TMC

- **D.M.** (Medical Oncology)
- **M. Ch.** (Surgical Oncology)
- **M. Ch.** (Gynaecological Oncology)

Post Graduate Courses at TMC

- **M.D.** (Pathology)
- **M.D.** (Anaesthesiology)
- **M.D.** (Radio-diagnosis),
- **M.D.** (Radiotherapy),

A partial view of the classroom facility

- **M.D.** (Microbiology), and
- **M.D.** (Immuno Haematology & Blood Transfusion)

DRM: Diploma in Radiation Medicine at BARC.

M.Sc. (Nursing) at TMC

A classroom session in progress

Dip.R.P.: Diploma in Radiological Physics at BARC.

DMRIT: Diploma in Medical Radio Isotope Techniques at BARC.

In addition, the TMC also offers a two-year Certified Fellowship Programme in 23 different disciplines related to Oncology.

The Institute offers a unique Ph.D. programme where students are encouraged to work at the interface of basic research and technology development. Under this programme, they work under the guidance of two supervisors, one having strength in basic research and the other in technology development.

More than 1200 students are pursuing Ph.D. in various disciplines.

All the Constituent Institutions have excellent library facilities having a large collection of books and subscribe to a large number of research journals.

FACULTY

Faculty strength in all CIs put together is about 800 CIs, particularly research & development centres have a large number of scientific officers and they provide valuable inputs to research scholars as Technology Advisers. Amongst faculty and scientific officers, there are many who are fellows of prestigious academies, and winners of national and international awards. List of faculty is placed at Annexure 3.

ADMISSIONS AND RESULTS

The academic programmes at the CIs were conducted as per schedule. The admissions statistics and the results are tabulated in Annexure-4.

The abstracts of the theses fulfilling all the formalities for the award of the Degree of the Doctor of Philosophy (PhD) are placed in Annexure-5.

The titles of M.Tech./M.Phil/M.Sc. (Engg.) theses fulfilling all the formalities for the award of the Degree in Master of Technology / Master of Philosophy/Master of Engineering are placed in Annexure-6.

A Memorandum of Understanding (MOU) for academic cooperation and exchange was entered in to with the University of Virgina. It is placed in Annexure-7.

Receipts and payments for the financial year ending on 31.3.2011 are given in Annexure-8.

Important Meeings and Decisions

Summarized next are the decisions taken in the meetings of Council of Management and the Academic Council during the period of the report.

A. Following meeting of Council of Management (CoM) were held during the period:

1. Seventh meeting on October 2, 2010, HBNI, Training School, Mumbai.

B. Following meeting of Academic Council (AC) were held during the period:

1. Eleventh meeting on August 4, 2010.

Important decisions taken in these meetings are summarized below.

A. Important decisions taken in the meetings of the CoM

Seventh meeting: October 2, 2010

The CoM approved institution of International Travel Scheme for Ph.D. students of HBNI. The scheme provides for support up to Rs.40,000/- to PhD students of HBNI for travel abroad to attend international Conferences.

B. Important decisions taken in the meetings of the Academic Council

Eleventh meeting: August 4, 2010

1. The AC observed that there was a need to put in place a mechanism to address issues related to plagiarism and other unethical practices. It noted that there was an Academy report on this issue. The members agreed to study the said report and come up with proposal to set up a mechanism to deal with those issues in HBNI.
2. The AC approved for the consideration of the Council of Management the institution of International Travel Scheme for Ph.D. students of HBNI. The scheme provides for support up to Rs.40,000/- to PhD students of HBNI for travel abroad to attend international Conferences.

Annexure - 1

Composition of the Bodies of the Institute

Council of Management (CoM)

Dr. Srikumar Banerjee Chairman, AEC	Chairman
Shri V.V.Bhat Member Finance, AEC	Member
Ms Vibha Puri Das Secretary Higher Education, MHRDD	Member
Prof. Arun Nigavekar Raja Ramanna Fellow & Trustee & Senior Advisor, Science & Technology Park, University of Pune	Member
Prof. Vinod K. Gaur India Institute of Astrophysics Bangalore	Member **Till** 30.1.2011
Prof.Sudhir K. Sopory Vice-Chancellor Jawaharlal Nehru Unversity New Delhi	Member **Since 31.1.2011**
Dr. Baldev Raj Director, IGCAR	Member **Till 30.4.2011**
Shri S.C.Chetal Director, IGCAR	Member **Since 30.4.2011**
Dr. R.A. Badwe Director, TMC	Member
Dr. R.B. Grover Director, HBNI	Member
Prof. P.K.Kaw Director, IPR	Member
Dr. R.K.Sinha Director, BARC	Member **Since May 2010**
Dr. R.R. Puri Dean, HBNI	Member-Secretary

Academic Council

Prof. R.B. Grover	Chairman
Prof. S.K. Apte	Convener Board of Studies in Life Sciences
Prof. V. Arvind	Convener, BoS Mathematical Sciences **since** October 2010)
Dr. R. A. Badwe	Director, TMC
Prof. D. Balasubramanian	Director, Eye Research Foundation, Hyderabad (**till August 2010)**
Prof. R. Balasubramanian	Director, IMSc
Prof. Baldev Raj	Director, IGCAR
Prof. R.K.Bhandari	Director, VECC
Prof. B.M.Deb	IISER, Kolkata (**since March 2011**)
Prof. B.K. Dutta	Convener, Board of Studies in Engineering Sciences
Prof. Dipan Ghosh	IIT-Bombay
Prof. P.D.Gupta	Director, RRCAT
Prof. P.K. Kaw	Director, IPR
Prof. A.M. Jayannabar	Director, IoP
Prof. E.D. Jemmis	IISc, Bangalore (**till August 2010)**
Prof. K. Muralidhar	IIT-Kanpur (**since March 2011**)
Prof. P.Mohandas	Convener, Board of Health Sciences (**till October 2010)**
Prof. Srinivasa Ranganathan	ISc, Banglore (**since March 2011**)
Prof. V. Venugopal	Convener, Board of Studies inChemical Sciences **till October 2010)**

Prof. Gangan Prathap	CSIR Centre for Mathematical Modeling and Computer Simulation, Bangalore. (**till August 2010**)
Prof. S.Ramakrishnan	TIFR, Mumbai (**since March 2011**)
Prof. K.L. Ramakumar	Convener, Board of Strategic Studies
Prof. A. Raychaudhuri	Director, HRI
Prof. M.K. Sanyal	Director, SINP
Dr. R.K.Sinha	Director, BARC (**since May 2010**)
Prof. Abhijit Sen	Convener, Board of Studies in Physical Sciences (**till August 2010)**
Dr. R. K. S. Sharma	Convener, BoS, Health Science, TMC (**since October 2010)**
Prof. Dinesh Srivastava	Convener, BoS Physical Sciences (**since October 2010**)
Prof. V.S. Sunder	Convener, Board of Studies in Mathematical Sciences (**Till August 2010)**
Prof. R.R. Puri	Member Secretary

Advisory Committee

Dr. S. Banerjee Chairman, AEC	Chairman
Dr. R.A.Badwe Director, TMC	Member
Prof. R. Balasubramanian Director, IMSc	Member
Dr. Baldev Raj Director, IGCAR	Member
Prof. M. Barman Director, TIFR	Member

Dr. T.K. Chandrashekar Director, NISER	Member
Dr. R.B. Grover Director, HBNI	Member
Prof. P.K. Kaw Director, IPR	Member
Prof. A. Raychaudhury Director, HRI	Member
Dr. P.D.Gupta Director, RRCAT	Member
Dr. R.K.Bhandari Director, VECC	Member
Dr. M.K.Sanyal Director, SINP	Member
Dr. R.K.Sinha Director, BARC	Member (**since May 2010**)
Prof. A.M.Jayannabar Director, IoP	Member
Dr. R.R. Puri Dean, HBNI	Member-Secretary

Board of Studies of HBNI

Physical Sciences

1. Prof. Dinesh Srivastava - **Convener (since October 2010)**
   Variable Energy Cyclotron Centre
   Prof. Abhijit Sen (IPR) - **Convener** (**till October 2010**)
2. Prof. C.S.Sundar
   Indira Gandhi Centre for Atomic Research
3. Prof. R. Ganesh **(since October 2010)**
   Institute of Plasma Research
4. Prof. Ajit Srivastava
   Institute of Physics
5. Prof. P.K.Gupta
   Raja Ramanna Centre for Advanced Technology
6. Prof. V.M. Datar
   Bhabha Atomic Research Centre

7. Prof. Pinaki Majumdar
   Harish-Chandra Research Institute
8. Prof. Kamales Kar
   Saha Institute of Nuclear Physics
9. Prof. Ghanashyam Date
   Institute of Mathematical Sciences
10. Prof. B.N.Jagtap
    Bhabha Atomic Research Centre
11. Prof. Avinash Khare (IOP) (**till** June 30, 2010)
12. Prof. Srinivas Ramakrishnan (TIFR) (**till August 2010**)

Chemical Sciences

1. Prof. K.L. Ramakumar **Convener (since October 2010)**
   Bhabha Atomic Research Centre
   Dr. V. Venugopal (BARC) **Convener (till October 2010)**
2. Prof. A.V.R. Reddy (**since October 2010**)
   Bhabha Atomic Research Centre
3. Prof. V.K. Manchanda (**till** March 2011)
   Bhabha Atomic Research Centre
4. Prof. Swapan K. Ghosh
   Bhabha Atomic Research Centre
5. Prof. K.S. Viswanathan
   Indira Gandhi Centre for Atomic Research
6. Prof. T. Gnanasekaran
   Indira Gandhi Centre for Atomic Research
7. Prof. V.K Jain
   Bhabha Atomic Research Centre
8. Prof. P.N. Bajaj
   Bhabha Atomic Research Centre
9. Dr. J.V. Yakhmi (BARC) (**till** September 2010)

Life Sciences

1. Prof. S.K. Apte **- Convener**
   Bhabha Atomic Research Centre
2. Prof. (Mrs.) S.M. Zingde
   Advanced Centre for Treatment, Research
   & Education in Cancer (ACTREC)
3. Prof. S.F. D'Souza
   Bhabha Atomic Research Centre
4. Dr. Rita Mulherkar
   Advanced Centre for Treatment, Research
   & Education in Cancer (ACTREC)
5. Prof. M. Seshadri
   Bhabha Atomic Research Centre
6. Prof. A.K.Sharma
   Bhabha Atomic Research Centre
7. Prof. B.J.Rao
   Tata Institute of Fundamental Research

8. Dr. S. Chipllaunkar
   ACTREC
9. Dr. Dipak Dasgupta
   SINP
10. Prof. M.Seshadri (BARC) (**till** 30.11.2011)

Engineering Sciences

1. Prof. B.K.Dutta - **Convener**
   Bhabha Atomic Research Centre
2. Prof. T.Jayakumar
   Indira Gandhi Centre for Atomic Research
3. Prof. D. Sathiyamoorthy
   Bhabha Atomic Research Centre
   Prof. A.P.Tiwari
   Bhabha Atomic Research Centre
4. Prof. A. K. Suri
   Bhabha Atomic Research Centre
5. Prof. Kamachi Mudali
   Indira Gandhi Centre for Atomic Research
6. Prof. Kallol Roy
   Bhabha Atomic Research Centre
7. Prof. P.V.Varde
   Bhabha Atomic Research Centre
8. Dr. D.N.Badodkar
   Bhabha Atomic Research Centre
9. Prof. P.K. Vijayan
   Bhabha Atomic Research Centre

Mathematical Sciences

1. Prof. V.Arvind - **Convener (since October 2010**)
   Institute of Mathematical Sciences
   Prof. V.S. Sunder (IMSc) - Convener (**till October 2010**)
2. Prof. D.S. Nagraj
   Institute of Mathematical Sciences
3. Prof. B. Ramakrishnan
   Harish-Chandra Research Institute
4. Prof. R.R.Puri
   Bhabha Atomic Research Centre
5. Prof. V.S.Sunder
   Institute of Mathematical Sciences
6. Dr. N. Raghavendra
   Harish-Chandra Research Institute
7. Prof. R.C.Cowsik
   Mumbai University
8. Prof. Murali Srinivasan
   Indian Institute of Technology-Bombay

9. Prof. Madhavan Mukund
   Chennai Mathematics Institute
10. Prof. S. Kesavan
    (IMSc) (**till October 2010**)

Strategic Studies

1. Prof. K.L. Ramakumar **- Convener**
   Bhabha Atomic Research Centre
2. Dr. A.K. Kohli
   Board of Radiation and Isotope Technology
3. Prof. R.B.Grover
   Knowledge Management Group, BARC
4. Dr. B.B. Singh
   Ex-BARC and Scientific Advisor, High Court Mumbai.
5. Prof. Rangan Banerjee
   Indian Institute of Technology-Bombay

Health Sciences

1. Prof. K. S.Sharma **- Convener (since October 2010)**
   Tata Memorial Centre, Mumbai
   Prof. K.Mohandas (TMC) - Convener (till October 2010)
2. Prof. K. B. Sainis
   Bhabha Atomic Research Centre, Mumbai
3. Dr. Rajiv Sarin
   Advanced Centre for Treatment, Research
   & Education in Cancer (ACTREC), Mumbai
4. Dr. S. K. Srivastava
   Tata Memorial Hospital, Mumbai
5. Dr. H.B.Tongaonkar
   Tata Memorial Hospital, Mumbai
6. Dr S.B.Banavali
   Tata Memorial Hospital
7. N. Jambekar, TMH
   Tata Memorial Hospital, Mumbai
8. Prof. Shobha Bhatia
   KEM Hospital, Mumbai
9. Prof. Avinash Supe
   KEM Hospital, Mumbai
10. Dr. M.G.R. Rajan
    Radiation Medicine Centre, Mumbai

Officers of the Institute

Academic

Prof. R.B. Grover	Director
Prof. R.R. Puri	Dean
Dr. R.P. Patel	Associate Dean

Administrative and Accounts

Shri A. Ramaiah	Finance Officer
Smt B. Lata	Administrative Officer **(Since September 2010)**
Shri Sai Kannan	Accounts Officer

Deans-Academic at the CIs

BARC

Prof. S.K. Apte	Life Sciences
Prof. B.K. Dutta	Engineering Sciences
Prof. V.M. Datar	Physical Sciences (till March 2011)
Prof. B.N. Jagatap	Physics Sciences (from March 2011)
Prof. Swapan Ghosh	Chemical Sciences

IGCAR

Prof. K.S.Viswanathan	Chemical Sciences
Dr. P.Mohanakrishnana	Physical Sciences
Dr. T. Jayakumar	Engineering Sciences

RRCAT

Prof. S.B.Roy

VECC

Prof. P. Barat
Prof. D. Sarkar

SINP

Prof. P. Mitra

IPR

Prof. Abhijit Sen	**(till 31.01.2011)**
Prof. S Mukherjee	**(Since 01.02.2011)**

IoP

Prof. Avinash Khare	(**till** 30.06.2010)
Prof. Ajit Srivastava	**(Since 01.07.2011)**

TMC

Dr. K.M. Mohandas	(**till** 31.03.2010)
Dr. K.S.Sharma	(**since** 01.04.2010)

IMSc

Prof. S. Kesavan	Mathematical Sciences (**till** 22.06.2010)
Prof. Vijay K	Mathematical Science (**since** 23.06.2010)
Prof. T.R. Govindarajan	Physical Sciences

HRI

Prof. Sukumar Das Adhikari

Annexure - 2

Standing Committees

BARC Standing Committees

***Physical Sciences and Mathematical Sciences* (Till March 2011)**

1.	Dr. J.V. Yakhmi	Chairman
2.	Dr. S. Kailas	Member
3.	Dr. R.K. Choudhury	Member
4.	Dr. S.L. Chaplot	Member
5.	Dr. B.N. Jagtap	Member
6.	Dr. S.M. Sharma	Member
7.	Dr. (Smt.) L.J. Dhareshwar	Member
8.	Dr. K.C. Mittal	Member
9.	Dr. S.C. Sabharwal	Member
10.	Dr. R. Srivenkatesan	Member
11.	Dr. D.N. Sharma	Member
12.	Dr. D.P. Chakravarthy	Member
13.	Dr S.V.G. Menon	Member
14.	Dr. V.M. Datar	Convener

Since March 2011 onwards

1.	Dr. S. Kailas	Chairman
2.	Dr. Amber Chatterjee	Member
3.	Dr. S.L. Chaplot	Member
4.	Dr. S.V.G. Menon	Member
5.	Dr. S.M. Sharma	Member
6.	Dr. Amar Sinha	Member
7.	Dr. K.C. Mittal	Member
8.	Dr. N.K. Sahoo	Member
9.	Dr. P.D. Krishnani	Member
10.	Dr. D.N. Sharma	Member
11.	Dr. A.K. Das	Member
12.	Dr. Satish Gupta	Member
13.	Dr. B.N. Jagatap	Convener

Chemical Sciences

1.	Dr. V. Venugopal	Chairman
2.	Dr. T. Mukherjee	Member
3.	Dr. S.K. Kulshreshtha	Member
4.	Dr. B. Venkatramani	Member
5.	Dr. S.K. Sarkar	Member
6.	Dr. S.V. Narsimhan	Member
7.	Dr. J. Arunachalam	Member
8.	Dr. (Smt.) Meera Venkatesh	Member
9.	Dr. V.K. Manchanda	Member
10.	Dr. K.L. Ramkumar	Member
11.	Dr. S.K. Aggarwal	Member
12.	Dr. S. Sabharwal	Member
13.	Dr. S.K. Ghosh	Convener

Life Sciences

1.	Dr. K.B. Sainis	Chairman
2.	Dr. S.F. D'Souza	Member
3.	Dr. M. Seshadri	Member
4.	Dr. A.K. Sharma	Member
5.	Dr. M.G.R. Rajan	Member
6.	Dr. M.V. Hosur	Member
7.	Dr. S.K. Apte	Convener

Engineering Sciences & Strategic Studies

1.	Dr. A.K. Suri	Chairman
2.	Dr. L.M. Gantayet	Member
3.	Dr. R.K. Singh	Member
4.	Dr. P.K. Vijayan	Member
5.	Dr. A.P. Tiwari	Member
6.	Dr. M.S. Bhatia	Member
7.	Dr. P. Varde	Member
8.	Dr. D. Sathiyamoorthy	Member
9.	Dr. V.K. Suri	Member
10.	Dr. B.K. Dutta	Convener

RRCAT Standing Committee

1.	Dr. P.D. Gupta	Chairman
2.	Dr. S.B. Roy	Convener
3.	Dr. P.K. Gupta	Member
2.	Dr. L.M. Kukreja	Member
3.	Shri C.P. Navathe	Member
4.	Dr. G.S. Lodha	Member
5.	Dr. Pitamber Singh	Member
6.	Dr. P.A.Naik	Member
7.	Dr. S.K.Deb	Member
8.	Dr. S.M.Oak	Member
9.	Shri P.R.Hannurkar	Member
10.	Dr. S.C.Bapna	Member
11.	Dr. Arup Banerjee	Member
12.	Dr. A. Chowdhury	Member
13.	Dr. S.C. Mehendale	Member

IGCAR Standing Committees

Physical Sciences

1.	Dr. C.S. Sundar	Chairman
2.	Dr. R. Indira	Member
3.	Dr. P. Mohanakrishnan	Member
4.	Dr. A.K. Arora	Member
5.	Dr. K.G.M. Nair	Member
6.	Dr. A.K. Tyagi	Member
7.	Dr. P.V. Sivaprasad	Member
8.	Dr. N. Subramanian	Member
9.	Dr. H.K. Saha	Member

10.	Dr. M. Sai Baba	Member
11.	Dr. K.S. Viswanathan	Member
12.	Dr. G. Amarendra	Convener

Chemical Sciences

1.	Dr. T. Gnanasekaran	Chairman
2.	Dr. T.G. Srinivasan	Member
3.	Dr. S.B. Koganti	Member
4.	Dr. V. Ganesan	Member
5.	Dr. K. Nagarajan	Member
6.	Dr. U. Kamachi Mudali	Member
7.	Dr. S. Anthonysamy	Member
8.	Dr. K.V.G. Kutty	Member
9.	Dr. A. Bharathi	Member
10.	Dr. M. Sai Baba	Member
11.	Dr. K.S. Viswanathan	Convener

Engineering Sciences

1.	Dr. T. Jayakumar	Chairman
2.	Dr. P. Chellapandi	Member
3.	Dr. S.B. Koganti	Member
4.	Dr. A.K. Bhaduri	Member
5.	Dr. P.V. Sivaprasad	Member
6.	Dr. U. Kamachi Mudali	Member
7.	Dr. C. Anand Babu	Member
8.	Dr. K. Velusami	Member
9.	Dr. B.P.C. Rao	Member
10.	Dr. B.K. Panigrahi	Member
11.	Dr. K.S. Viswanathan	Member
12.	Dr. M. Sai Baba	Convener

VECC Standing Committee

1.	Dr. R. K. Bhandari (Director, VECC)	Chairman
2.	Dr. D. K. Srivastava	
3.	Dr. S. Pal	
4.	Shri Subimal Saha	
5.	Shri Jayanta Chaudhuri	
6.	Dr. D Sarkar	(Convener, Engineering Sciences)
7.	Dr. Alok Chakraborty	
8.	Dr. S. Bhattacharya	
9.	Dr. S. R. Banerjee	
10.	Dr. P. Barat	(Convener, Physical Sciences)
11.	Dr. V. S. Pandit	
12.	Dr. Jane Alam	
13.	Dr. (Smt.) Paramita Mukherjee	

Annexure - 3

Faculty List (Up to March, 2011)

BARC

Chemical Sciences

1. Achary S.N.
2. Acharya R.
3. Achutan P.V.
4. Adhikari S.
5. Agarwal S.K.
6. Arunachalam J.
7. Ashok Kumar Arya
8. Bajaj P.N.
9. Banerjee Aparna
10. Banerjee (Smt.) S.
11. Bharadwaj (Smt.) S.R.
12. Bhardwaj Y.K.
13. Bindal R.C.
14. Chattopadhyay A.
15. Chattopadhyay S.
16. Das D.
17. Das S.K.
18. Dash S.
19. Deo M.N.
20. Dutt G.B.
21. Ganguly R.
22. Ghosh S.K.
23. Ghosh Swapan
24. Goswami A.
25. Jaikumar Sunil
26. Jain V.K.
27. Jha S.K.
28. Kapoor Sudhir
29. Kayasth S.R.
30. Krishnamurthy N.
31. Kshirsagar R.J.
32. Majumder C.
33. Mohapatra P.K.
34. Mukherjee S.K.
35. Mukherjee T.
36. Naik D.B.
37. Naik P.D.
38. Narasimhan S.V.
39. Natrajan V.
40. Nayak S.K.
41. Nayak A.K.
42. Padmanabhan P.V.A.
43. Pal H.D.
44. Palit D.K.
45. Pathak P.N.
46. Pandey A.K.
47. Pandit Gouri G.
48. Pillai C.G.S.
49. Priyadarshini (Smt.) K.I.
50. Pujari P.K.
51. Ramakumar K.L.
52. Rangarajan S.
53. Reddy A.V.R.
54. Sali S.K.
55. Sarkar S.K.
56. Sinha P.K.
57. Shivanna K.
58. Sudarshan V.
59. Sukhendunath
60. Tomar B.S.
61. Tripathi R.M.
62. Tyagi A.K.
63. Varshney Lalit
64. Vatsa R.K.
65. Velmurugan S.
66. Yakhmi J.V.

Engineering Sciences

1. Anup K. Bhattacharjee
2. Awasthi A.
3. Badodkar D.N.
4. Balasubramaniam R.
5. Banerjee S.
6. Bhatia M.S.
7. Bidaye A.C.
8. Chakraborty S.P.
9. Chakravarty A.
10. Chattopadhyay J.
11. Chkaravarthy J.K.
12. Das R.
13. Dey G.K.
14. Dutta B.K.
15. Dwarkanath T.A.
16. Gantayet L.M.
17. Ghosh A.K.
18. Gopika Vinod
19. Grover R.B.
20. Hubli R.C.
21. Kain V.
22. Kallol Roy
23. Kapilesh Bhargava
24. Kapoor Rajiv
25. Kar D.C.
26. Khan K.B.
27. Maheswari N.K.

28. Nayak A.K.
29. Pal P.K.
30. Patankar V.H.
31. Prasad G.J.
32. Ramanathan S.
33. Rami Reddy G.
34. Ravindranath S.V.G.
35. Roy Debanik
36. Roy S.B.
37. Samal M.K.
38. Sandip Saha
39. Saravana Kumar U.
40. Sathiyamoorthy D.
41. Satayasai P.M.
42. Singh J.B.
43. Singh R.K.
44. Singh R.N.
45. Srivastava D.
46. Suri A.K.
47. Suri V.K.
48. Suri B.M.
49. Taliyan S.S.
50. Tewari P.K.
51. Tewari R.
52. Tiwari A.P.
53. Topkar Amita V.
54. Tripathy Prabhatkumar
55. Varde P.V.
56. Vijayan P.K.
57. Vinod Kumar A.

Life Sciences

1. Apte S.K.
2. Balakrishnan Sreedevi
3. Bandekar J.R.
4. Bhagwat S.G.
5. Chaudhari Pradip
6. D'Souza S.F.
7. Das Birajlakshmi
8. Dongre T.K.
9. Fulzele D.P.
10. Ganapathi T.R.
11. Gautam S.
12. Grace Samuel
13. Hosur M.V.
14. Indira Priyadarshini (Smt.)
15. Jambhulkar S.J.
16. Jawali Narendra
17. Kale S.P.
18. Lebana J. Joseph (Smt.)
19. Melo J.S.
20. Meera Venkatesh
21. Minal Mhatre (Smt.)
22. Misra Hari S.
23. Mukhopadhyaya Rita (Smt.)
24. Narkar Archana
25. Pandey B.N.
26. Patro B.S.
27. Poduval T.B.
28. Rao T.S.
29. Rajan M.G.R.
30. Roja Gopalakrishnan (Smt.)
31. Sainis (Smt.) J.K.
32. Sainis K.B.
33. Santosh Kumar S.
34. Satpathy K.
35. Suprasanna P.
36. Venugopalan V.P.
37. Vinay Kumar
38. Warrier Prasad

Physical Sciences

1. Amitabh Das
2. Aswal D.K.
3. Aswal V.K.
4. Auluck S.K.H.
5. Basu S.
6. Bera S.
7. Bhanumurthy K.
8. Bhattacharyya D.
9. Biswas D.
10. Biswas D.C.
11. Biswas D.J.
12. Chaplot S.L.
13. Choudhury N.
14. Choudhury R.K.
15. Chougaonkar M.P.
16. Chourasiya G
17. Dasgupta K
18. Deb S.K.
19. Debnath A.K.
20. Deo M.N.
21. Degweker S.B.
22. Dhareshwar L.
23. Gadkari S.C.
24. Gaitonde D.M.
25. Ghorui Srikumar

26. Godbole S.V.
27. Gursharan Singh
28. Gupta S.C.
29. Gupta S.K.
30. Gupta N.K.
31. Jagtap B.N.
32. Jain S.R.
33. John B.V.
34. Kailas S
35. Kaushik T.C.
36. Kothiyal G.P.
37. Koul D.
38. Krishnani P.D.
39. Kshirsagar R.J.
40. Mahata K.
41. Manohar K.G.
42. Mayya Y.S.
43. Mazumdar S.
44. Mehboob S.A.H.
45. Menon S.V.G.
46. Mishra A.P.
47. Mitra A.K.
48. Mittal Ranjan
49. Mohanty A.K.
50. Mukesh Kumar
51. Mukhopadhyay R.
52. Nakhate S.G.
53. Pant L.M.
54. Palani Selvam T
55. Puri R.R.
56. Rajarajan A.K.
57. Ramaniah L.M. (Ms.)
58. Rannot R.C.
59. Rao Mala N.
60. Rao P.M.
61. Rao T.V.C.
62. Ravikumar G.
63. Ray A.K.
64. Roy B.J.
65. Sahoo N.K.
66. Sakuntala T
67. Sangeeta
68. Sapra B.K.
69. Sarkar P.K.
70. Sastry U
71. Satyaranjan Santra
72. Satyamurthy P.
73. Saxena Alok
74. Sen Debasis
75. Sharma S.D.
76. Sharma S.M.
77. Shrivastava Aradhana
78. Shukla P
79. Sinha Amar
80. Sinha S (Smt.)
81. Suresh Kumar D.
82. Suryanarayan M.V.
83. Singh Pitamber
84. Tickoo A.K
85. Thakur K.B.
86. Vinay Kumar
87. Yusuf S.M.

Strategic Studies

1. Grover R.B.
2. Ramakumar K.L.

HRI

Physical Sciences

1. Bagla J.S.
2. Bera S.
3. Choubey (Smt.) Sandhya
4. Das Tapas Kumar
5. Datta A.
6. Gandhi Raj
7. Gopakumar Rajesh
8. Goswami S.
9. Jatkar Dileep P.
10. Majumdar Pinaki
11. Mangamma G.
12. Mukhopadhyaya B.
13. Naik S.
14. Pai G.V.
15. Panda Sudhakar
16. Pareek T.P.
17. Rao (Smt.) Sumathi
18. Ravindran V.
19. Sai Ram T.N.
20. Sen Ashoke
21. Sen Prasenjit
22. Sriramkumar L.
23. Venkatraman B.

Mathematical Sciences

1. Adhikari Sukumar Das
2. Batra Punita
3. Chakraborty Kalyan

4. Dalawat Chandan Singh
5. Dey Rukmini
6. Manoj Kumar
7. Raghavendra N.
8. Ramakrishnan B.
9. Ratnakumar P.K.
10. Surya Ramana D.
11. Thangadurai R.

IGCAR

Chemical Sciences

1. Anthonysamy S.
2. Antony M.P.
3. Devan K.
4. Dhara Sandip Kumar
5. Gnanasekaran T.
6. Kamachi Mudali (Smt.) U.
7. Mallika(Smt.) C.
8. Nagrajan K.
9. Panigrahi B.S.
10. Ponraju D.
11. Sai Baba M.
12. Satpathy K.K.
13. Srinivasan M.P.
14. Vasudeo Rao P.R.
15. Viswanathan K.S.
16. Viswanathan R.

Engineering Sciences

1. Anand Babu C.
2. Anil K. Sharma
3. Anirudha Moitra
4. Anish Kumar
5. Arup Dasgupta
6. Baldev Raj
7. Bhaduri A.K.
8. Chellapandi P.
9. Dasgupta Arup
10. Jayakumar T.
11. Kamachi Mudali
12. Kinkar Laha
13. Mathew M.D.
14. Mukhopadhyay C.K.
15. Muraleedharan P.
16. Purnachandra Rao B.
17. Ramachandran D.
18. Sasikala G.
19. Shankar P.
20. Sivprasad P.V.
21. Srinivasan V.S.
22. Swaminathan P.
23. Valsan M.
24. Velusamy K.
25. Venugopal S.

Physical Sciences

1. Amarendra G.
2. Arora A.K.
3. Baskaran R.
4. Bera S
5. Bharathi A.
6. Chandra Shekar N.V.
7. Dasgupta Arup
8. Dash S.
9. Govindaraj R.
10. Indira (Smt.) R.
11. John Philip
12. Keshavamurthy R.S.
13. Kuppusami P
14. Mathi Jaya S.
15. Mohanakrishnan P.
16. Nair Muraleedharan K.G.
17. Panigrahi B.K.
18. Raghavan G.
19. Ramachandran Divakar
20. Ravindran T.R.
21. Reddy C.P.
22. Sahu Ch. P.
23. Sahu H.K.
24. Sankar P.
25. Subramanian N.
26. Sunder C.S.
27. Tata B.V.R.
28. Tyagi Ashok Kumar
29. Venkatesan R.
30. Vijayalakshmi M.

IMSc

Mathematical Sciences

1. Arvind V.
2. Balasubramanian R.
3. Chakraborty Parthasarathi
4. Chatterjee Pralay
5. Gun Sanoli

6. Iyer (Smt.) Jaya N.
7. Kesavan S.
8. Kodiyalam Vijay
9. Krishna M.
10. Lodaya Kamal
11. Mahajan Meena
12. Mohari Anilesh
13. Mukhopadhyay Anirban
14. Nagaraj D.S.
15. Paranjape Kapil
16. Prasad Amritanshu
17. Raghavan K.N.
18. Ramanujam R.
19. Sankaran Parameswaran
20. Srivinvas K.
21. Subramanian C.R.
22. Sunder V.S.
23. Venkatesh Raman

Physical Sciences

1. Adhikari Ronojoy
2. Anishetty R
3. Baskaran G
4. Basu R
5. Date G.D.
6. Digal S
7. Ghosh Sibasish
8. Gopalakrishna Shrihari
9. Govindarajan T.R.
10. Hassan Syed Raghib
11. Indumathi D
12. Kalyana Rama S
13. Kaul R.K.
14. Menon Gautum I
15. Mishra A.K.
16. Murthi M.V.N.
17. Nemani Venkata S.
18. Rajesh R
19. Ray P
20. Saratchandra H.S.
21. Sathiapalan B
22. Shankar R
23. Siddharthan R
24. Simon R
25. Sinha N
26. Sinha R
27. Sinha Sitabhra
28. Sinha Sudeshna
29. Sujay Ashok
30. Vemparala Satyavani

IPR

Engineering Sciences

1. Chaturvedi Shashank
2. Pathak Surya Kumar

Physical Sciences

1. Anurag Shyam
2. Bandopadhyay Mainak
3. Chattopadhyay Asim Kumar
4. Chattopadhyay Prabal
5. Chaturvedi Shashank
6. Daniel Raju
7. Das (Smt.) Amita
8. Deshpande Shishir P.
9. Ghosh Joydeep
10. Jha Ratneshwar
11. Joshi H.C.
12. Kaw P.K.
13. Kulkarni S.V.
14. Mukherjee Subroto
15. Rajaraman Ganesh
16. Rao Srinivasa
17. Raole P.M.
18. Reddy Chenna D.
19. Sen Abhijit
20. Sengupta Sudip
21. Singh Raghevendra
22. Sharma Pramod Kumar
23. Srinivasan R.
24. Vinay Kumar

IoP

Physical Sciences

1. Agrawal Pankaj
2. Basu Anirban
   (since Sept 23, 2009)
3. Bhattacharjee Somendra M.
4. Jayannavar A.M.
5. Khare Avinash
6. Kumar Alok (**till Sept 25, 2009**)
7. Kundu Kalyan
8. Mahapatra Durga Prasad

9. Mukherji Sudipta
10. Patra Suresh Kumar
11. Ravi Prasad G.V.
12. Sahu P.K.
13. Sahu S.N.
14. Satyam Parlapalli V.
15. Sekhar Biju R.
16. Som Tapobrata
17. Srivastava Ajit M.
18. Tripathy Gautam
19. Varma Shikha

RRCAT

Life Sciences

1. Dube Alok

Physical Sciences

1. Banerjee Arup
2. Bartwal Kunwal Singh
3. Bindra K.S.
4. Chakera J.A.
5. Chakrabarti (Smt.) Aparna
6. Chattopadhyay M.K.
7. Dixit Sudhir Kumar
8. Ganesamoorthy S.
9. Ghosh Harnath
10. Gupta P.K.
11. Gupta, P.D.
12. Gupta S.M.
13. Ingale Alka
14. Joshi Mukesh
15. Krishnagopal S.
16. Kukreja L.M.
17. Lodha G.S.
18. Mishra Satya Ram
19. Majmumdar Shovan
20. Modi Mohammed Hussain
21. Moorti Anand
22. Mukherjee C.
23. Mukhopadhyay P.K.
24. Naik P.A.
25. Oak S.M.
26. Om Prakash
27. Rai V.N.
28. Rama Chari
29. Rao Divakar K
30. Rawat H.S.
31. Roy S.B.
32. Senecha V.K.
33. Sinha A.K.
34. Shailendra Kumar
35. Sharma T.K.
36. Srivastava Arvind Kumar
37. Tiwari V.S.
38. Vinit Kumar

Engineering Sciences

1. Chatterjee Sanjil

SINP

Chemical Sciences

1. Basu Samita
2. Bhattacharya Dhananjay
3. Chakraborti Abhijit
4. Ganguly Bichitra
5. Lahiri Sushanta

Engineering Sciences

1. Mukhopadhyay Supratik

Life Sciences

1. Chakrabarti Abhijit
2. Chandana Chakrabarti
3. Banerjee Rahul
4. Bhattacharya Dhananjay
5. Dasgupta Dipak
6. Mukhopadhyay Debashis
7. Saha Partha
8. Sampa Biswas
9. Udayaditya Sen

Physical Sciences

1. Agrawal Bijay Kumar
2. Bandyopadhyay Debades
3. Banerjee Sangam
4. Basu Chinmay
5. Bhattacharjee Pijushpani
6. Bhattacharyya Gautam
7. Chakrabarti Nikhil

8. Chattopadhyay Sukalyan
9. De Asit K.
10. Ganguly Bichitra
11. Ghose Debaraata
12. Ghosh Amit
13. Gupta Sankar Kumar
14. Ghoshal Ambar
15. Harindranath A.
16. Iyengar Sekar A.N.
17. Janaki M.S.
18. Kundu Anjan
19. Majumdar Debasish
20. Majumdar Harashit
21. Majumdar Nayana
22. Majumdar Parthasarathi
23. Mathews Prakash
24. Menon K.S.R.
25. Mitra Parthasarathi
26. Mustafa M.G.
27. Nambissan P.M.G.
28. Nandy Maitreyee
29. Ranganathan R.
30. Ray Nihar Ranjan
31. Roy Pradip Kumar
32. Roy Shibaji
33. Saha Satyajit
34. Samanta Chhanda
35. Sanyal Milan Kumar
36. Singh Harvendra

TMC

Chemical Sciences

1. Pakhale S.S.

Life Sciences

1. Bhattacharya Dibyendu
2. Bose Kakoli
3. Chandan Kumar
4. Chiplunkar (Smt.) S.V.
5. Dalal S.N.
6. De Abhijit
7. Desai (Smt.) Sangeeta B.
8. Deshpande DD
9. Dinshaw K.A.
10. Gude Rajiv
11. Gupta Sanjay
12. Jambhekar N.A.
13. Joshi Narendra N.
14. Kadam (Smt.) P.S. Amare
15. Kalraiya Rajiv D.
16. Kelkar Rohini
17. Mahimkar Manoj B.
18. Maru Girish B.
19. Mohandas K. Mallah
20. Mulherkar (Smt.) Rita
21. Mukhopadhyaya Rabindranath
22. Muralikrishna C.
23. Naik(Smt.) Nishigandha R.
24. Prasanna Venkatraman
25. Rai (Smt.) Rekha
26. Ray Pritha
27. Sarin Rajiv
28. Shirsat (Smt.) Neelam V.
29. Teni Tanuja R.
30. Vaidya Milind M.
31. Verma Ashok K.
32. Zingde (Smt.) S.M.

Health Sciences

1. Agarwal J.P.
2. Sarin Rajiv
3. Shastri S.S.
4. Shrivastava S.K.

VECC

Chemical Sciences

1. Sen Pintu

Engineering Sciences

1. Mukherjee Paramita
2. Sarkar Debranjan

Physical Sciences

1. Alam Jan-e
2. Bandyopadhyay S.K.
3. Banerjee S.R.
4. Banerjee (Smt.) Gayatjri N.
5. Bhattacharyya Sarmishta (Smt.)
6. Barat P.
7. Basu D.N.
8. Bhandari R.K.
9. Bhattacharaya (Smt.) Chandana

10. Bhattacharya Sailajananda
11. Bhowmick Debasis
12. Chakrabarti Alok
13. Chattopadhyay Subhasis
14. Chaudhuri A.K.
15. Choudhuri Gargi (Smt.)
16. Das Parnika (Smt.)
17. Ghosh Premomoy
18. Mukhopadhyay Tapan
19. Mukherjee Gopal
20. Naik Vaishali
21. Nayak Tapan Kumar
22. Pal Santanu
23. Pandit V.S.
24. Rashid Md.Haroon
25. Ray Amlan
26. Sanyal Dirtha
27. Sarkar Sourav
28. Srivastava Dinesh Kumar
29. Viyogi Y.P.

NISER

Chemical Sciences

1. Barman Sudip
2. Behera J.N.
3. Chandrashekar T.K.
4. Kar Sanjib
5. Mal Prasenjit
6. Nembenna S.
7. Peruncheralathan Saravanan
8. Purohit C.S.
9. Ritwick Das
10. Srinivasan A
11. Subramanian Arunachalam
12. Upakarasamy Lourderaj

Physical Sciences

1. Anil Kumar A.V.
2. Bhattacherjee J.
3. Basak S.
4. Bedanta S.
5. Gowdigere Chetan N.
6. Moulik Tania
7. Sahoo Pratap Kumar
8. Mohapatra Ashok
9. Samal Prasanjit
10. Srivastava Y.K.
11. Sumedha (Smt.)
12. Swain Sanjay Kumar

Mathematical Sciences

1. Dalai D.K.
2. Muruganandam V.
3. Patra K.I.
4. Parui Sanjay
5. Sahoo B.K.

Life Sciences

1. Chattopadhyay S.
2. Dixit Manjusha (Smt.)
3. Goswami Chandan
4. Mohapatra H.
5. Panigrahi Kishore
6. Konkimalla V.S.B
7. Alone D.P.
8. Alone P.V.
9. Aich Palok
10. Rahaman A.V.

Annexure - 4

Admissions and Results Status (April 1, 2010 - March 31, 2011)

HOMI BHABHA NATIONAL INSTITUTE

Admissions: 2010-11

S. No.	Programme	BARC	IGCAR	RRCAT	VECC	SINP	IPR	IOP#	HRI	TMC	IMSc	TOTAL
1	PGD*	224	37	11								272
2	PGDRM	5										5
3	PGDMRIT	3										3
4	DipRP	26										26
5	I. M.Sc.	0	0	0	0	0	0	58	0	0	0	58
6	M. Sc. (Engg.)	1			2							3
7	M. Tech.	173	48	28	7							256
8	M. Phil.	1										1
9	Ph. D. (Engg.)	28	19	1	3		1					52
10	Ph. D. (Phys.)	20	22	15	9	11	4	13	6		8	108
11	Ph. D. (Chem.)	24	16					15				55
12	Ph. D. (Life)	5		1				17		25		48
13	Ph. D. (Math.)							1	5		10	16
14	Ph. D. (Hlth.)											0
15	Ph. D. (Stra.)	1										1
16	I. PhD (Phys.)								5		7	12
17	I. PhD (Math.)										6	6
18	M. Ch.									16		16
19	M. D.									32		32
20	D. M.									10		10
21	D. A.									0		0
22	Fellowship									17		17
Total		511	142	56	21	11	5	104	16	100	31	997

Total-PhD No.: 289
Actual Admission No.: Total-(MTech+MPhil) No.= 706
 # includes NISER enrolments
PGD: Post Graduate Diploma in Nuclear Science and Engineering
DRM: Diploma in Radiation Medicine
DMRIT: Diploma in Medical Radio Isotope Techniques
Dip. R. P.: Diploma in Radiological Physics
M. Tech: Master of Technology
M. Phil: Master of Philosophy
I. M.Sc.: Integrated M. Sc. at NISER under IoP
M. Sc. (Engg.): Master of Science (Engineering)
Ph. D.: Engineering, Physics, Chemistry, Life, Mathematics, Health and Strategic Studies
IPhD: Integrated Ph. D.
M. Ch.: Surgical Oncology
MD: Pathology, Radiotherapy, Radiodiagnosis, Anaesthesia
DM: Medical Oncology
DA: Diploma in Anaesthesia
*** No. under BARC includes Students fro BARC Training Schools at Hyderabad, Tarapur, Rawatbhata, Kaiga, Kalpakkam and Kudankulam**
 # Refers to Students who have upgraded enrolment from PGD to M. Tech./ M. Phil. subsequent to successfully completing course work for PGD

Results Declared
(April, 2010 – March, 2011)

Sr.No.	Results Summary Degree/Diploma	No.
1.	M.Sc. (Int. Ph.D. programme)	2
2.	M.Phil	4
3.	M.Tech.	86
4.	Ph.D.	32
5.	Dip.RP	22
6.	DMRIT	2
7.	DRM	10
8.	DA	5
	Total	**165**

Annexure - 5

Abstracts of Ph.D. Theses
(April 1, 2010 to March 31, 2011)

HOMI BHABHA NATIONAL INSTITUTE

Ananta Prasad Mishra

Enrolment No.	:	PHYS07200604009
Constituent Unit	:	Institute of Physics, Bhubaneswar Date
of award of Provisional Degree	:	19.04.2010
Title of Thesis		Z(3) Interfaces, Strings and their Consequences in Quark-Gluon Plasma

Abstract

This thesis explores some of the interesting aspects of the formation of topological defects viz. Z(3) interfaces and strings at QCD phase transition and their consequence in early universe as well as in relativistic heavy-ion collisions. We investigate the formation and implications of these solitonic field configurations in the framework of the Polyakov loop model. We discuss special configurations of junctions of Z(N) interfaces, which interpolate between different Z(N) vacua of an SU(N) gauge theory, and show that at the line-like junctions, topological strings exist which have confining phase in the core. Using the Polyakov loop model for QCD, we have estimated the energy per unit length of the core of this QGP string to be about 2.7 GeV/fm at a temperature about 2Tc. We have also determined the profile of the Z(3) interface and have estimated its surface tension to be about 7 GeV/fm^2. We discuss the implications of collapsing Z(3) interfaces in the context of early universe as well as in relativistic heavy-ion collisions. By modelling the dependence of effective mass of the quarks on the Polyakov loop order parameter, we have studied the reflection of quarks from collapsing Z(3) interfaces. We have estimated the large baryon inhomogeneities produced in the context of the early universe. This model gives rise to the concentration of large baryon number as large as 10^{44} in a region of typical size of order one meter which is naturally enriched by strange quarks. These are favourable conditions for the formation of quark-nuggets at the QCD scale which may survive through various dissipative processes until the epoch of nucleosynthesis, thereby providing a potential candidate for the dark matter of the universe. Most importantly, the inhomogeneities produced in this model are separated by large distance scales appropriate for survival until nucleosynthesis and the conclusions are independent of the order, or even the existence of any quark-hadron transition.

We also discuss the formation of a network of the Z(3) walls and strings in the QGP phase in relativistic heavy-ion collision experiments(RHICE). We have studied the collapse of these domain walls in RHICE. The quarks inside the collapsing walls undergo multiple scatterings from the wall, thereby leading to enhancement of multiplicity of quarks at higher transverse momentum. Using recombination model for hadronisation of quarks/anti-quarks with the modified P_T spectra, we expect enhancement of hadrons at higher P_T. We discuss the enrichment of the interior regions of collapsing walls with heavy flavors of quarks, e.g. strange and charm quarks and anti-quarks. Interestingly, it leads to the implication that this may provide additional component for the formation of J/Ψ at RHICE. In essence, the thesis delves into the realm of physical phenomena where such exotic objects as topological defects in relativistic quantum field theories can be studied in great details under controlled laboratory conditions.

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2. Baryon inhomogeneity generation in the quark-gluon plasma phase, B. Layek, A. P. Mishra, A. M. Srivastava and V. K. Tiwari; Phys. Rev. D73, 103514 (2006).

3. Enhancement of high P_T hadrons due to collapsing Z(3) interfaces in heavy-ion collisions, S. Digal, A. P. Mishra, A. M. Srivastava and V. K. Tiwari; (in preparation).

Mamata Sahoo

Enrolment No.	:	PHYS07200604022
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Date of award of Provisional Degree	:	01.05.2010
Title of Thesis	:	Driven Non-Equilibrium Systems: Rachets, Fluctuation Theorems and Related Phenomena

Abstract

The central theme of this thesis is related to fluctuations, transport and noise in nonequilibrium systems. The recently discovered fluctuation theorems have been analyzed in different physical systems. These theorems are valid for systems driven arbitrarily away from equilibrium and are expected to play important role in determining performance characteristics of engines at nanoscales. We have obtained the ways to improve the thermodynamic and Stokes' efficiencies of an adiabatically rocked ratchet (molecular motor) with both spatial and temporal asymmetries. We have calculated the distribution function of the heat dissipated and the work performed on the system, in a periodically driven double well potential exhibiting stochastic resonance (SR). These physical quantities over a large time of observation satisfy the steady state fluctuation theorems and give an additional criterion to describe SR. By analyzing several soluble driven linear models in the presence or absence of magnetic field, the Jarzynski equality for thermodynamic work and the Bochkov-Kuzovlev identity for classical work have been illustrated. The Jarzynski equality complements the Bohr-van Leeuwen theorem on the absence of diamagnetism in classical equilibrium systems. We have found that the systems in nonequilibrium state can support orbital magnetism. Finally, we have demonstrated two differing potentials (one being metastable and the other being bistable) which form supersymmetric partners of each other, exhibit symmetry in transport properties even in the absence of an oscillating drive. The present thesis, thus, delves into various possibilities of physical phenomena in systems driven far away from equilibrium.

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2. Supersymmetry and Fokker Planck dynamics in periodic potentials, M. Sahoo, M. C. Mahato and A. M. Jayannavar, *Physics Letters A 361, 413 (2007).*

3. Charged particle in magnetic field: Jarzynski's Equalit, A. M. Jayannavar and M. Sahoo *Phys. Rev. E 75, 032102 (2007).*

4. Fluctuation theorems and orbital magnetism in nonequilibrium state, A. M. Jayannavar and M. Sahoo, *Pramana J. Phys. 70, 201 (2008).*

5. Stochastic resonance and heat fluctuations in a driven double-well system, M. Sahoo, S. Saikia, M. C. Mahato and A. M. Jayannavar, *Physica A 387, 6284 (2008).*

6. Classical work and Thermodynamic work fluctuations, M. Sahoo and A. M. Jayannavar *Indian J. Phys. 84, 1417 (2010).*

Raghavendra Rao, B.V

Enrolment No.	:	MATH10200604024
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	01.05.2010
Title of Thesis	:	A Study of Width Bounded Arithmetic Circuits and the Complexity of Matroid Isomorphism

Abstract

This thesis is broadly divided into two parts: i) Study of width bounded arithmetic circuits, and ii) Computational complexity of matroid isomorphism problems. Various arithmetizations of boolean complexity class NC1 is studied in the first part. It is shown that constant width syntactic multilinear circuits are equivalent to constant width syntactic multilinear branching programmes at polynomial size formulas. For linear matroids it is shown that the isomorphism testing is in (Sigma_2) ^ p, and is unlikely to be (Sigma_2) ^ p complete. When the rank of the given input matroid is a constant, the problem is polynomial time many-one equivalent to the graph isomorphism problem. For the case of matroids represented by graphs, it is shown that the isomorphism testing problem is polynomial time equivalent to the graph isomorphism problem. Along the way colouring techniques are developed for handling coloured instances of matroid isomorphism problems. It is also proved that polynomial time equivalence of isomorphism testing problem and the problem of computing automorphism groups for the case of linear and graphic matroids.

Publications

1. Arithmetizing Classes around NC1 and L, Nutan Limaye and Meena Mahajan and Raghavendra Rao B.V , Theory of Computing Systems 46(3): 499-522 (2010) (STACS special issue).

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3. Resource Trade-offs in Syntactically Multilinear Arithmetic Circuits, Maurice Jansen and Meena Mahajan and B V Raghavendra Rao. Accepted for Computational Complexity.
4. Small-space analogues of Valiant's classes and the limitations of skew formulas, Meena Mahajan and B. V. Raghavendra Rao. Accepted for Computational Complexity.

Bireswar Das

Enrolment No.	:	MATH10200604019
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	01.05.2010
Title of Thesis	:	Some Complexity Theoretic Aspects of Graph Isomorphism and Related Problems

Abstract

The complexity of graph isomorphism problem for restricted classes of graphs are studied and the complexity of group theoretic problems related graph isomorphism are investigated. Several problems closely related to the graph isomorphism problem are classified in Algorithmic graph theory in the classes PZK and SZK. A constant round perfect zero knowledge proof is given for the group isomorphism problem when the groups are given by their multiplication tables. The prover and the verifier in this proof system use only polylogarithmically many random bits. On this motivation, Honest Verifier Statistical Zero Knowledge(HVSZK) proof is studied where the prover, verifier and the simulator use polylogarithmic randomness but also has polylogarithmic message size and only 2 rounds. A polynomial-time oracle algorithm is given for Tournament Canonization that accesses oracles for Tournament Isomorphism and Rigid-Tournament Canonization. Extending the Babai-Luks Tournament Canonization algorithm, an n^O (k^2 + log n) is given for canonization and isomorphism testing of k-hypertournaments, where n is the number of vertices and k is the size of hyper edges. A FPT algorithm is given for the bounded color class hypergraph isomorphism problem which has run-time (b!2^O(b))(N^O(1)), where b is the size of the largest color class and N is the input size. It is proved that the isomorphism and canonization problem for k-tree is in the class StUL which is contained in UL. It is also proved that the isomorphism problem for k-path is complete for L under disjunctive truth-table reductions computable in uniform AC^0.

Mahender Singh

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Date of award of Provisional Degree	:	05.05.2010
Title of Thesis		Cohomology of Orbit Spaces, Fixed Point Sets of Group Actions, and Parametrized Borsuk-Ulam Problem

Abstract

The major part of this thesis is devoted to determining the cohomology of orbit spaces and fixed point sets of certain compact transformation groups on finitistic spaces. Equivariant maps are also studied and some parametrized Borsuk-Ulam type theorems are proved. The thesis consists of six chapters, whose precise details are as follows:

Chapter 1 consists of basic definitions and results in the cohomology theory of topological transformation groups, finitistic spaces and spectral sequences required for our work.

In Chapter 2, free involutions on finitistic mod 2 cohomology lens spaces are studied. The possible mod 2 cohomology algebra of orbit space of any free involution on a finitistic mod 2 cohomology lens space is completely determined. The technique used is the Leray spectral sequence associated to the Borel fibration. Applications to non-existence of equivariant maps from spheres to such spaces are also given.

In Chapter 3, some parametrized Borsuk-Ulam type theorems are proved for fiber bundles whose fibers are finitistic mod 2 cohomology real or complex projective spaces with free involutions. As an application, the cohomological dimension of the coincidence set of a fiber preserving map is also estimated.

In Chapter 4, involutions on finitistic spaces having mod 2 cohomology algebra of the wedge sum of spheres and projecive spaces are studied and the possible fixed point sets are determined up to mod 2 cohomology, depending on whether or not the fiber in the Borel fibration is totally non-homologous to zero. Examples realizing the possible cases are also given.

Chapter 5, deals with torus actions on finitistic spaces with rational cohomology algebra of the wedge sum of spheres and projecive spaces. The possible fixed point sets are determined up to rational cohomology, depending on whether or not the fiber in the Borel fibration is totally non-homologous to zero. Examples realizing the possible cases are also given.

Chapter 6, contains some miscellaneous results obtained during the course of our study.

The notion of nice actions introduced by Sikora is studied and it is shown that if the cyclic group of prime order acts nicely on two spaces of finite cohomological type, then the diagonal action of on their product is also nice. In the end, the commutativity of

inverse limit and orbit map for free actions of compact groups on compact Hausdorff spaces is proved.

Publications

1. Mahender Singh, *Z_2 actions on Complexes with Three Non-Trivival Cells,* Topology and its Applications 155(2008), 965-971

2. Mahender Singh, *Fixed Points of Circle Actions on Spaces with Rational Cohomology of S^n V S^{2n} V S^{3n} or P^2 (n) V S^{3n} ,* Archiv der Mathematik, 92 (2009), 174-183.

3. Mahender Singh, *A note on the Commutativity of Inverse Limit and Orbit Map,* Mathematica Slovaca, (2010), to appear.

4. Mahender Singh, *Cohomology Algebra of Orbit Spaces of Free Involutions on Lens Spaces,* communicated [available at arXiv:0805.2865).

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Probodh Kumar Kuiri

Enrolment No.	:	PHYS07200604023
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Title of Thesis	:	Energetic Au Irradiation Effects on Nanocrystalline ZnS Films Deposited on Si and Au Nanoparticles Embedded in Silica Glass

Abstract

This thesis deals with two set of studies using energetic Au beams. The first study involves changes in structural, optical, and surface morphological properties of nanocrystalline ZnS films induced by 35 keV, 2 MeV, and 100 MeV Au ions at a fixed fluence of 1×10^{14} ions cm^{-2}. MeV Au irradiation has been found to result in an increase in grain size and a decrease in band gap. Thereis also a change over from compressive stress in the strating film to tensile stress after MeV Au irradiation. The effects of irradiation are seen to be stronger at 100 MeV than that at 2 MeV. However, no changes in grain size and band gap have been observed in following irradiation at the keV energy. The roughnesses produced on the sample surfaces have been studied through an analysis of the power spectral density data of the surface topographies. In the large spatial frequency, q, (at small length scales) the Fourier exponent, γ, has been found to have values 2.80, 3.11, 3.72, and 2.85 for the as-deposited and the samples irradiated with Au at 35 keV, 2 MeV, and 100 MeV, respectively. The values close to 3 could be understood in a model where evaporation and condensation dominate the higher value corresponding to a surface diffusion dominated process.

The second set involves with the studies of effects of 10 and 100 MeV Au irradiations, at different fluences, on isolated Au nanoparticles (NPs) (of average size ~7 nm) embedded in silica glass. The higher energy irradiation was found to result in an elongation of the embedded Au NPs along the beam direction. At higher irradiation fluence there was Au loss from the silica matrix, which is seen to increase with increase in fluence. Up to a fluence of 5×10^{13} ions cm^{-2}, the smaller NPs (size $<$ 9 nm) are found to grow in size while larger ones deformed anisotropically along the ion beam direction. The anisotropy in the larger NPs has been seen to increase with increase in ion fluence. However, in the sample irradiated at a fluence of 1×10^{14} ions cm^{-2}, the Au NPs are seen to be almost spherical in shape, with a large interparticle separation. The results on change of shape (from nearly spherical to elongated ones) from ion irradiation can be understood within the framework of the inelastic thermal spike induced ion track formation. However, no observable change has been seen in the Au NPs in case of 10 MeV irradiation.

In some cases, ejections of NPs have been observed during Au irradiations on the samples mentioned above. For ZnS films, the ejected NPs have been found to have sizes (diameter) lying between 2 to 7 nm in cases of 2 and 100 MeV Au irradiations. However, no such NPs could be found for Au irradiation at 35 keV. For the observed particles with sizes e" 3 nm, the distributions show a power law decay in the form of $Y(n) \sim n^{-\delta}$, n and δ being the number of atoms in a NP and the power law exponent, respectively. The values of δ for 2 and 100 MeV Au irradiations have been found to be close to 2.6 and 3.5, respectively. Corrections for cluster breakup effects yield values close to 2 and 2.6, respectively, for same two cases. It is argued that at 2 MeV, shock waves production is the underlying

mechanism for NPs ejection. On the other hand, at 100 MeV, Coulomb explosion and subsequent inelastic thermal spike induced vaporization and subsequent cooling resulting in the formation of clusters is the main mechanism.

For silica embedded Au NPs, 100 MeV Au irradiation has been found to result in ejection of vaporized Au NPs which follow a rather universal aggregation mechanism occurring in nature. For smaller clusters, the size distribution shows a power law decay, as in the case of ejected ZnS NPs, with a $\ddot{a}$ value of 3/2 as observed in the steady state solution for nonequilibrium aggregation processes with a steady injection of monomers. For sizes greater than 12.5 nm, there seems to be a change over to another steady state aggregation with a higher δ value (of ~7/2) indicating mass dependent effects coming into play. The results do not indicate any liquid-gas type phase transition taking place in the sputtered Au upon cooling.

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   P. K. Kuiri, H. P. Lenka, G. Sahu, D. Kanjilal and D. P. Mahapatra,

Amit Kunwar

Enrolment No.	:	CHEM01200604006
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Date of award of Provisional Degree	:	07.05.2010
Title of Thesis	:	Cellular Localisation, Pro-oxdant/Anti-Oxidant Effects of Natural Products and Organometallics In Normal and Tumor Cells

Abstract

Publications

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2. Kunwar, A.; Mishra, B.; Barik, A.; Kumbhare, L. B.; Pandey, R.; Jain, V. K.; Priyadarsini, K.I. 3,3'-diselenodipropionic acid, an efficient peroxyl radical scavenger and a GPx mimic, protects erythrocytes (RBCs) from AAPH-induced hemolysis. *Chem. Res. Toxicol.* 2007, 20,1482-1487.

3. Kunwar, A.; Narang, H.; Priyadarsini, K. I.; Krishna, M.; Pandey, R.; Sainis, K. B. Delayed activation of PKCdelta and NFkappaB and higher radioprotection in splenic lymphocytes by copper (II)-Curcumin (1:1) complex as compared to curcumin. J*. Cell. Biochem.* 2007, 102,1214-1224.

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Arun Kumar Pathak

Enrolment No.	:	CHEM01200604005
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Date of award of Provisional Degree	:	11.05.2010
Title of Thesis	:	Microsolvation of Charged and Neutral Species : A Theoretical Study

Abstract

To understand the process of microsolvation, a detail study on structure and energetics of finite size cluster of various species in water, ammonia and carbon di oxide have been carried out. Solubility, IR, Photoelctron and UV-Vis spectral properties have also been predicted and compared with experimental findings whenever available. Weighted average properties are also calculated for better predictability. An excellent agreement of weighted average scaled IR spectrum of $Cl_2^{\bullet-}.nH_2O$ (n=3-5) clusters at 100K with experimentally measured spectrum is observed. Bulk properties like solubility, bulk detachment energy of excess electron and aqueous UV-Vis spectra are also measured and compared with reported experimental values. Present study reveals that bromine gas is more soluble than chlorine gas in water. Theoretical UV-Vis spectra of various radical anion species ($Cl_2^{\bullet-}$, Br_2^{-}, $I_2^{\bullet-}$ and $CO_3^{\bullet-}$) is in excellent agreement with the bulk aqueous absorption profile. A general extrapolation model based on microscopic theory has also been developed for prediction of bulk detachment energy of excess electron from the finite size cluster data. This model predicts experimental bulk detachment energies within 7%.

Publications

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2. "A comparative *ab initio* study of Br2•- and Br2 water clusters" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Chem. Phys*. v. 124, p. 024322 (1-7), 2006.

3. "Microhydration shell structure in Cl2 •-.nH2O clusters: A theoretical study" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Chem. Phys.* v. 125, p. 074309 (1-13), 2006.

4. "Structure, energy and IR spectra of I2 •-.nH2O clusters (n=1-8): A theoretical study" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Chem. Phys.* v.126, p. 034301 (1-14), 2007. "Theoretical studies on photoelectron and IR spectral properties of Br2 •-.nH2O clusters" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Chem. Phys.* v.127, p. 044304 (1-8), 2007.

5. " Structure, energy and IR spectra of K-nNH3 cluster: A theoretical study" A. K. Pathak, T. Mukherjee and D. K. Maity *Ind. J. Phys.* v. 81, p. 901-913, 2007. 144

6. "IR Spectra of Small Carbonate-Water Clusters, CO3"2(H2O)n: A Theoretical Study" A. K. Pathak, T. Mukherjee and D. K. Maity *Syn. React. Inorg. MetOrg. Nano Met. Chem.* v. 38, p. 76-83, 2008.

7. "A theoretical study on SCN- + XH reactions (X=O, S): Hemi bonded *vs* H-bondedintermediates" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Mol. Str.THEOCHEM* v. 851, p. 158-166, 2008.

8. "A microhydration study of X2-water clusters (X=Cl, Br and I): A theoretical study onX2. nH2O clusters (n=1-8)" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Phys. Chem. A* v. 112 p. 744-751, 2008.

9. "Microhydration of NO3": A Theoretical Study on Structure, Stability and IR Spectra"\ A. K. Pathak, T. Mukherjee and D. K. Maity *J. Phys. Chem. A* v. 112, p. 3399-3408, 2008.

11. "Photodetacment and UV-Vis spectral properties of Cl2 •-.nH2O clusters: Extrapolation to bulk" A. K. Pathak, T. Mukherjee and D. K. Maity Chem. Phys. Lett. v. 454, p. 17-23, 2008.

12. "Theoretical Study on Spectroscopic Properties of CO3 •-.nH2O Clusters: Extrapolation to Bulk" A. K. Pathak, T. Mukherjee and D. K. Maity *ChemPhysChem* v. 9, p. 2259-2264, 2008.145

13. "Vibrational analysis of I2 •-.nCO2 clusters (n=1-10): A first principle study on microsolvation" A. K. Pathak, T. Mukherjee and D. K. Maity *J. Phys. Chem A* v. 112, p. 12037-12044, 2008.

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15. "Distinctive IR Signature of CO3•- and CO3 2- Hydrated Clusters: A Theoretical Study" A. K. Pathak and D. K. Maity *J. Phys. Chem A* (Lett.) v. 113, p. 13443-13447, 2009.

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18. "Generalized Microscopic Theory for the Detachment Energy of Solvated Negatively Charged Ions in Finite Size Clusters: A Step toward Bulk" A. K. Pathak, A. K. Samanta, D. K. Maity, T. Mukherjee and S. K. Ghosh *J. Phys. Chem. Lett.* v. 1, p. 886-890, 2010. 146

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Date of award of Provisional Degree	:	19.05.2010
Title of Thesis	:	Study of K* production in Relativistic Heavy Ion Collisions at RHIC Au+Au and Cu+Cu collisions at RHIC

Abstract

Ultra-relativistic nucleus-nucleus collisions at RHIC (Relativistic Heavy Ion Collider) provide means to create nuclear matter of high energy density over an extended volume. One of the proposed signatures of a possible phase transition of nuclear matter to de-confined state of quarks and gluons is the modification of vector meson production rates and their in-medium properties. Hadronic resonances, due to their short lifetimes, can be used to investigate the freeze-out mechanisms after hadronization. The production of strange mesonic resonance K* is investigated in Au+Au and Cu+Cu collisions and through comparison with other resonances, the evolution of the fireball is studied.

The data used for the analyses in this thesis were taken with the Solenoidal Tracker at RHIC(STAR) detector. Measurements of K*, through the hadronic decay channel in Au+Au collisions in 62.4 GeV and Cu+Cu collisions in 62.4 GeV and 200 GeV are presented for all centralities. The invariant mass spectra of K* is reconstructed using a combinatorial technique, and a mixed-event technique is applied to estimate the uncorrelated background.Since the lifetime of K* ~ 4 fm is less than the lifetime of the system formed in heavy ion collisions, the K* is expected to decay, rescatter and regenerate all the way throughout the kinetic freeze-out. Various in-medium effects due to the high density and the high temperature of the medium is expected to modify the characteristic properties of resonance.

Measurement of these properties such as mass, width, yield and transverse momentum spectra can provide insight for understanding the dynamics of the medium created in heavy ion collisions. The corrected pt spectra, inverse slope parameters, and yields of K* up to the intermediate pt range in mid-rapidity are measured and compared. The mean pt measurement is compared to other stable particles to investigate particle production mechanism. Particle ratio such as K*/K and K*/phi is used to understand the re-scattering and regeneration effect for K* production in the hadronic medium. The nuclear modification factors, R_{CP} and R_{AA} at intermediate pt range for K* are studied in comparison to other baryons and mesons to differentiate between particle production mechanism in the concerned pt range.

This broad systematic study (Au+Au and Cu+Cu at 62.4 GeV and Cu+Cu at 200 GeV) in comparison to other systems (p+p, d+Au and Au+Au at 200 GeV) is used to infer about the system size and energy dependence of various K* properties in the heavy ion collision scenario.

Publications

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9. Identification and Characterization of Jet Events using Flow method in Heavy Ion Collisions. S.Dash, DAE-BRNS Nuclear Physics Symposium Proceedings, (2005).

K.V.S.N.S. Gopala Krishna Murty

Enrolment No.	:	PHYS1020605006
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	25.06.2010
Title of Thesis	:	BKM Lie Super Algebras in N=4 Supersymmetric String Theory

Abstract

This thesis studies the problem of counting dyons in certain supersymmetric string theory models and the infinite dimensional Lie algebras that underlie the dyonic degeneracies. The counting of 1/4 BPS states in N = 4 supersymmetric four-dimensional string theories can be carried out in a mathematically precise and rigorous fashion due to the fact that the spectrum of these BPS states can be generated by genus-two modular forms[1,2]. The same modular form also occurs in the context of Borcherds-Kac-Mody(BKM) Lie super algebras[3,4] in their dominator identities. The surprising mathematical structure underlying the spectrum of these states is the idea that is developed in this thesis.

Publications

1. S. Govindarajan and K. Gopala Krishna. "Generalized Kac-Moody algebras from CH dyons," JHEP 04 (2009) 032

2. S. Govindarajan and K. Gopala Krishna, "BKM Lie superalgebras from dyon spectra in ZN CHL orbifolds for composite N, "IITM/PH/TH/2009/3; IMSc/2009/04/06;

3. S. Govindarajan, D. Jatkar and K. Gopala Krishna, "BKM Lie superalgebras from counting dyons in N = 4 supersymmetric type II compactifications" IITM/PH/TH/ 2009/4 IMSc/2009/ 04/07

Pooja Singla

Enrolment No.	:	MATH10200604007
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	01.07.2010

Title of Thesis Representations and Conjugacy Classes of General Linear Groups Over Principal Ideal Local Rings of Length Two

Abstract

The irreducible complex representations and conjugacy classes of general linear groups over principal ideal local rings of length two with a fixed finite residue field is studied in this thesis. A canonical correspondence is constructed between the irreducible representations of all such groups which preserves dimensions and a canonical correspondence between the conjugacy classes of all such groups which preserves cardinalities. All the irreducible representations are constructed for general linear groups of order three and four over these rings. It is shown that the problem of constructing all the irreducible representations of the general linear groups over principal ideal local rings of arbitrary length in the function field case.

Publications

On representations of general linear groups over principal ideal local rings of length two <http://arxiv.org/abs/1001.5304>, by Pooja Singla (*Journal of Algebra*, vol 324, 2010).

Somnath Sikdar

Enrolment No.	:	MATH10200604020
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	16.07.2010
Title of Thesis	:	Parameterizing from the Extremes : Feasible Parameterizations of some NP-Optimization Problems

Abstract

Parameterized complexity is a newly developed sub-area of computational complexity that allows for a more refined analysis of problems that are considered hard in the classical sense. In contrast to the classical theory where the complexity of a problem is measured in terms of the input size only, parameterized complexity seeks to exploit the internal structure of a problem. The complexity of a problem in this case is measured not just in terms of the input size but in terms of the input size and, what is called, the parameter. A parameterized problem is a decision problem whose instances consist of tuples (I, k), where n = |I| is the size of the input instance and k is the parameter. The goal here is to design algorithms that decide whether (I, k) is a yes-instance in time f(k) . nO(1), where f is a computable function of k alone, as against a trivial algorithm with running time nk+O(1). Problems that admit such algorithms are said to be fixed-parameter tractable and FPT denotes the class of all fixed-parameter tractable problems. The parameter, however, is not unique and often there are several ways in which a problem can be parameterized. This is, in fact, one of the strengths of parameterized complexity as it allows the same problem to be analyzed in different ways depending on the parameter. In this thesis, different parameterizations of NP-optimization problems are studied with the intent of identifying those parameterizations that are feasible and most likely to be useful in practice. A commonly studied parameterization of NP-optimization problems is the standard parameterized version, where the parameter is the solution size. To start with, it is shown that a number of NP-optimization problems, and in particular problems in MAX SNP, have the property that their optimum solution size is bounded below by an unbounded function of the input size. It is also shown that the standard parameterized version of these problems is trivially in FPT and it is argued that the natural parameter in such cases is the deficit between the optimum and the lower bound. That is, one ought to parameterize above the guaranteed lower bound and such a parameterization could be called as an "above-guarantee" parameterization. One can similarly define parameterizations below a guaranteed upper bound. Then the notion of "tight" lower and upper bounds are introduced and problems for which the above-guarantee and below-guarantee parameterization with respect to a tight bound is fixed-parameter tractable or W-hard. It is shown that if one 'parameterize "sufficiently" above or below tight bounds', then these parameterized versions are not in FPT, unless P = NP, for a class of NP-optimization problems. Then related questions in the approximation algorithms setting are considered. It investigates the possibility of obtaining an approximation algorithm for an NP-optimization problem that is an E-fraction better than the best known approximation ratio for the problem. Since the best-known ratio could also be the approximation lower-bound for the problem, the algorithm in question could possibly have a worst-case exponential-time complexity. But the challenge is to obtain moderately exponential-time algorithms, whose run-time is possibly a function of E and the input-size, that deliver (alpha + Epsilon)-approximate

solutions. It is discussed that a technique that allows to author to obtain such algorithms for a class of NP-optimization problems. It is studied that the parameterized complexity (and occasionally the approximability) of a number of concrete problems: Konig Subgraph problems, Unique Coverage and its weighted variant, a version of the Induced Subgraph problem in directed graphs, and the Directed Full-Degree Spanning Tree problem. The Konig Subgraph problem is actually a set of problems where the goal is to decide whether a given graph has a Konig subgraph of a certain size. A graph is Konig if the size of a maximum matching equals that of a minimum vertex cover in the graph. Such graphs have been studied extensively from a structural point-of-view. In this thesis, the study of the parameterized complexity and approximability of finding Konig subgraphs of a given graph is initiated. It is seen that one of the Konig Subgraph problems, namely Konig Vertex Deletion, is closely related to a well-known problem in parameterized complexity called Above Guarantee Vertex Cover. While studying the parameterized complexity of Konig Vertex Deletion, it is also observed some interesting structural relations between matchings and vertex covers of a graph. Unique Coverage is a natural maximization version of the well-known Set Cover problem and has applications in wireless networking and radio broadcasting. It is also a natural generalization of the well-known Max Cut problem. In this problem given a family of subsets of a finite universe and a non-negative integer k as parameter, and the goal is to decide whether there exists a subfamily that covers at least k elements exactly once. It shows that this problem is fixed-parameter tractable by exhibiting a problem kernel with 4k sets. A weighted variant of it called Budgeted Unique Coverage is also considered and, by an application of the color-coding technique, shows it to be fixed-parameter tractable. Application of color-coding uses an interesting variation of k-perfect hash families where for every s-element subset S of the universe, and for every k-element subset X of S, there exists a function that maps X injectively and maps the remaining elements of S into a different range. Such families are called (k, s)-hash families and were studied before in the context of coding theory. The existence of such hash families of size smaller than that of the best-known S-perfect hash families, is proved using the Probabilistic method. Explicit constructions of such hash families of size promised by the probabilistic method is open. A version of the Induced Subgraph problem in directed graphs defined as follows: given a hereditary property P on digraphs, an input digraph D and a non-negative integer k, decide whether D has an induced sub digraph on k vertices with property P. Hereditary properties are completely characterized for which this induced sub graph problem is W[1]-complete for two classes of directed graphs: general directed graphs and oriented graphs. Also those properties for which the induced subgraph problem is W[1]-complete are characterized for general directed graphs but fixed-parameter tractable for oriented graphs. A directed analog of a problem called Full Degree Spanning Tree is studied which has applications in water distribution networks. This problem is defined as follows: given a digraph D and a non-negative integer k, decide whether there exists a spanning out-tree of D with at least k vertices of full out-degree. It is shown that this problem is W[1]-hard on two important digraph classes: directed acyclic digraphs and strongly connected digraphs. In the dual version, called Reduced Degree Spanning Tree, one has to decide whether there exists a spanning out-tree with at most k vertices of reduced out-degree. It is shown that this problem is fixed-parameter tractable and admits a problem kernel with at most 8k vertices on strongly connected digraphs and O(k2) vertices on general digraphs. An algorithm is given for this problem on general digraphs with run-time O(5.942k).

Publications

1. M. Mahajan, V. Raman and S. Sikdar.
Parameterizing NP-Optimization Problems Above or Below Guaranteed Values.
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2. V. Raman and S. Sikdar.
Approximating Beyond the Limit of Approximation. Manuscript.

3. S. Mishra, V. Raman, S. Saurabh, S. Sikdar and C.R. Subramanian.
The Complexity of Konig Subgraph Problems and Above-Guarantee Vertex Cover. To appear in Algorithmica.

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The Complexity of the Unique Coverage Problem. In Proceedings of the 18th International Symposium on Algorithms and Computation (ISAAC 2007), Springer LNCS Volume 4835, Pages 621-631, 2007.

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Budgeted Unique Coverage and Color-Coding. In Proceedings of the 4th Computer Science Symposium in Russia, CSR 2009, Springer LNCS, Volume 5675, Pages 310-321, 2009.

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Parameterized Complexity of the Induced Subgraph Problem in Directed Graphs. Information Processing Letters, Volume 104, Pages 79-85, 2007.

7. D. Lokshtanov, V. Raman, S. Saurabh and S. Sikdar.
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To appear in Discrete Optimization. A preliminary version appeared in the proceedings of the 4th International Workshop on Parameterized and Exact Computation (IWPEC 2009), Springer LNCS, Volume 5917, Pages 276-287, 2009.

Gayatri Sahu

Enrolment No.	:	PHYS07200604016
Constituent Unit	:	Institute of Physics, Bhubaneswar
Date of award of Provisional Degree	:	29.08.2010
Title of Thesis	:	Synthesis and Characterization of Silicon Nanoclusters in Silicon using Ion implantation

Abstract

Silicon is an excellent material for electronic industry with well established processing techniques. But because of its indirect band-gap nature it is an inefficient light emitter, which hinder it to be used in optoelectronic device applications. However, by reducing its size into nanometer scale one can overcome this limitation. There are numerous methods for synthesizing Si nanoclusters (NCs). Among many processing techniques, ion implantation followed by thermal annealing is one of the most appropriate methods for synthesis of Si NCs. This technique provides control over depth and concentration of the implanted impurity in the host matrix. In this regards, there are reports where Si NCs have been synthesized through excess Si implantation in SiO_2 or Si_3N_4 matrix. The formed NCs produce luminescence over an energy range of 1.4 eV to 1.9 eV. And the emission lifetimes have been found in the range of few *ms* to *ìs* with a stretched exponential nature. For our study, we have been able to synthesize Si NCs in a bulk Si matrix (which has better electrical properties) using a two-stage Au implantation. The idea has been to use a low energy (keV range) Au ion implantation first to amorphise the top surface layer of the Si substrate. A second MeV Au ion irradiation (to a fluence $\sim 10^{15}$ cm^{-2}) has been used to induce localized recrystallization by depositing its energy around the ion track through electronic excitations in the medium. This resulted in a production of Si NCs in the top amorphous layer. The NCs formed have been characterized using electron microscopy, photoluminescence and Raman scattering techniques. Unlike the earlier cases these implanted samples show luminescence in the ultraviolet regime with lifetimes in *ns* at room temperature. The presence of Au nanoparticles in the system further enhances the emission intensity through surface plasmon excitations. At low temperatures, the emission show structures very similar to direct and phonon assisted transitions. A detail analysis has been done for the low temperature PL measurements.

Publications

1. "Observation of direct bandgap emission and phonon mediated effects in ion beam synthesized Si nanoclusters." G. Sahu, H.P. Lenka, D.P. Mahapatra, M.P. Das, B. Rout and F.D. McDaniel, *Phys. Rev. Letts.* (2011, Under Review)

2. "Study of annealing induced redistribution of implanted Au in Si: Fluence dependence."G. Sahu, B. Joseph and H.P. Lenka *Nucl. Instr. and Meth. Phys. B 268*, 3471 (2010)

3. "Tuning size and shape of Au nanoparticles embedded in Silica glass by Swift Heavy ion irradiation." P.K. Kuiri, B. Joseph, J. Ghatak, H.P. Lenka and G. Sahu *Advanced Science Letter* 3, 404 (2010)

4. "Narrow band UV emission from direct band gap Si nanoclusters embedded in bulk Si." G. Sahu, H.P. Lenka, D.P. Mahapatra, B. Rout and F.D. McDaniel, *Journ. of Physics: Condensed Matter (Fast Track Communication)* 22 (2010) 0752203.

5. "Saturation effects observed in high fluence heavy ion implantation at few tens of keV" G. Sahu, S.K. Rath, B. Joseph, G.S. Roy and D.P. Mahapatra *Vacuum* 83 (2009) 836.

6. "Observation of a Universal Aggregation Mechanism and a Possible Phase Transition in Sputtered Au induced by Swift heavy ion irradiation" P.K. Kuiri, B. Joseph, H.P. Lenka, G. Sahu, J. Ghatak, D. Kanjilal and D.P. Mahapatra *Phys. Rev. Letts.* 100 (2008) 245501.

7. "Study of low energy Si^{+5} and Cs^{+} implantation induced amorphization effects in Si(100)" H.P. Lenka, B. Joseph, P.K. Kuiri, G. Sahu, P. Mishra, D. Ghose and D.P. Mahapatra *J. Phys. D: Appl. Phys.* 41 (2008) 215305.

8. "MeV Au irradiation induced nanoparticle formation and recrystallization in a low energy Au implanted Si layer" G. Sahu, B. Joseph, H.P. Lenka and P.K. Kuiri, A. Pradhan and D.P. Mahapatra *Nanotechnology* 18 (2007) 495702 .

9. "Formation and growth of SnO2 nanoparticles in silica glass by Sn implantation and annealing" P.K. Kuiri, H.P. Lenka, J. Ghatak, G. Sahu, B. Joseph and D.P. Mahapatra *Journal of Applied Physics* 102 (2007) 024315.

10. "Effect of Au irradiation-energy on ejection of ZnS nanoparticles from ZnS films" P.K. Kuiri, J. Ghatak, B. Joseph, H.P. Lenka, G. Sahu, D.P. Mahapata, A. Tripathi, D. Kanjilal and N.C. Mishra *Journal of Applied Physics* 101(2007) 014313.

11. "Observation of ZnS nanoparticles sputtered from ZnS films under 2 MeV Au irradiation" P.K. Kuiri, B. Joseph, J. Ghatak, H.P. Lenka, G. Sahu, B. Acharaya and D.P. Mahapatra *Nucl. Instr. and Meth. Phys.* B 248 (2006) 25-30.

12. "Low energy Cn cluster ion induced damage effects in Si(100) substrates" H.P. Lenka, B. Joseph, P.K. Kuiri, G. Sahu and D.P. Mahapatra *Nucl. Instr. and Meth. Phys.* B 256 (2007) 665.

13. "Effect of 100 MeV Au irradiation on embedded Au nanoclusters in silica glass" B. Joseph, J. Ghatak, H.P. Lenka, P.K. Kuiri, G. Sahu, N.C. Mishra and D.P. Mahapatra *Nucl. Instr. and Meth. Phys.* B 256 (2007) 659.

14. "Raman scattering study of Si nanoclusters formed in Si through a double Au implantation." G. Sahu and D.P. Mahapatra Proceedings of MRS Spring Meeting 2011, San Francisco, USA.

Pratyusha Chattopadhyay

Enrolment No.	:	MATH10200604004
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Date of award of Provisional Degree	:	01.09.2010
Title of Thesis	:	Equality of Elementary Orbits and Elementary Symplectic Orbits

Abstract

The aim of this thesis is to show a bijection between the orbit spaces of unimodular rows under the action of the elementary linear group and the orbit spaces of unimodular rows under the action of the elementary symplectic group. Also established a relative version of it with respect to an ideal. Then generalized this result and shown that the orbit space of unimodular rows of a projective module under the action of the group of elementary transvections, is in bijection with the orbit space of unimodular rows of a projective module under the action of the group of elementary symplectic transvections with respect to an alrternating form. Specific equalities are used to improve the injective stability bound for K1Sp(R) and Sp(Q, (,)) / E TransSp(Q, (,)).

Publications

1. P. Chattopadhyay, R.A. Rao, Elementary symplectic orbit and improved k1-stability, Journal of K-Theory 7 (2011), 389-403.

2. R. Basu, P. Chattopadhyay, R.A. Rao, Some remarks on symplectic injective stability, Proc. Amer. Math. Soc. 139 (7) (2011), 2317-2325.

3. H. Apte, P. Chattopadhyay, R.A. Rao, A symplectic excision theorem, Journal of Ramanujan Mathematical Society (to appear).

4. P. Chattopadhyay and R.A. Rao, Equality of linear and symplectic orbits, (Preprint). Can be found at http://arxiv.org/abs/1108.1288

Subhaditya Bhattacharya

Enrolment No.	:	PHYS08200604011
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Date of award of Provisional Degree	:	02.10.2010
Title of Thesis	:	Supersymmetry with Non-Universal High-Scale Parameters and the Large Hadron Collider

Abstract

Within the ambit of gravity mediated supersymmetry (SUSY) breaking schemes (SUGRA), themost simple-minded phenomenological framework is the so called minimal supergravity (mSUGRA)where one has a high-scale universal gaugino mass (M1=2), and a high-scale universal scalar mass (m0) parameter, in addition to the universal trilinear coupling (A0), tan _ and sign of the Higgsinomass parameter _.

However, within SUGRA-inspired Grand-Uni_ed Theories (GUT) itself, one might _nd some deviations from the simpli_ed situations mentioned above. For instance, the uni_ed gaugino massparameter (M1=2) or the common scalar mass parameter (m0) can become non-universal at theGUT scale which has strikingly di_erent collider implications. With this motivation, the followingstudies have been undertaken in this thesis:

We discuss the signals at the Large Hadron Collider (LHC) for scenarios with non-universalgaugino masses in supersymmetric SU(5) and SO(10) GUT theories. The possible non-singlet Higgses that can lead to non-universal gaugino masses can belong to representations 24, 75 or 200in case of SU(5) and 54, 210 and 770 in case of SO(10) or any linear combinations of the abovewith themselves or with the singlet one. We perform a multichannel analysis, and consider the ratios of event rates in di_erent channels such as jets + E=T , same - and opposite-sign dileptons +jets + E=T , as well as single-lepton and trilepton _nal states together with jets + E=T. It has been observed that the scenarios with non-universal ratios where M2;M1 > M3 (for eg, 75 or 200 in case of SU(5), and 770 of SO(10) breaking though SU(4)C _ SU(2)L _ SU(2)R (G422) at the GUT scale) is well distinguished from the mSUGRA by a overall suppression in the leptonic final states for these non-universal gaugino mass scenarios [1, 2]. This is because, such cases yield low-lying charginos and neutralinos heavier and more often with a larger Higgsino component thus reducing the decay branching fraction of the gluino through the second neutralino _~20 or _rst chargino _~1_, while their subsequent decays to leptons also get suppressed additionally due to the their larger higgsino component. Some other features also emerge which serves to distinguish these non-universal models from mSUGRA in context of the LHC.

We investigate the parameter space of the minimal supersymmetric Standard Model (MSSM) where the gluino and squark masses are much above 1 TeV but the remaining part of the sparticle spectrum is accessible to the Large Hadron Collider at CERN [3].

After pointing out that such a scenario may constitute an important benchmark of gaugino/scalar non-universality, we find that hadronically quiet trileptons are rather useful signals for it. Regions of the parameter space, where the signal is likely to be appreciable, are identi_ed through a detailed scan. The advantage of hadronically quiet trileptons over other types of signals is demonstrated.

We also study the possible signatures of di_erent non-universal scalar mass scenarios in supersymmetry at the Large Hadron Collider (LHC) [4]. Speci_cally, we have studied (a) squark-slepton non-universality, (b) non-universality in sfermion masses of the third family, (c) the e_ects of SO(10) D-terms in supersymmetric Grand Uni_ed Theories. After presenting an elaborate numerical analysis in multilepton channels, we point out that the cases of third family scalar mass non-universality with _rst two generation scalar masses much heavier than the third generation ones, yield a signi_cant enhancement in the leptonic _nal states when compared to mSUGRA. On the other hand, distinction between the non-universal scenarios coming from SO(10) D-terms with mSUGRA is rather di_cult. It is also found that, with some exceptions, the trilepton channels are likely to be especially useful for this purpose.

We perform a multilepton channel analysis in the context of the Large Hadron Collider (LHC) for WMAP compatible points in a model with non-universal scalar masses that admits a large Higgs funnel region for SUSY dark matter [5]. In addition to two and three- lepton _nal states, four- lepton events, too, are shown to be useful for this purpose. We also compare the collider signatures in similar channels for WMAP compatible points in the minimal supergravity (mSUGRA) framework with similar gluino masses and point out that a clear distinction is possible in context of the LHC.

Publications

1. S. Bhattacharya, A.Datta and B.Mukhopadhyaya, "Non-universal gaugino masses: A Signal-based analysis for the Large Hadron Collider," JHEP 0710, 080 (2007) [arXiv:0708.2427 [hep-ph]].

2. S. Bhattacharya, A.Datta and B.Mukhopadhyaya, "Non-universal scalar masses: A Signal-based analysis for the Large Hadron Collider," Phys. Rev. D 78, 035011 (2008) [arXiv:0804.4051 [hep-ph]].

3. S. Bhattacharya, A.Datta and B.Mukhopadhyaya, "Non-universal gaugino and scalar masses, hadronically quiet trileptons and the Large Hadron Collider," Phys. Rev. D 78, 115018 (2008) [arXiv:0809.2012 [hep-ph]].

4. S. Bhattacharya and J. Chakrabortty, "Gaugino mass non-universality in an SO(10) supersymmetric Grand Unified Theory: low-energy spectra and collider signals," Phys. Rev. D 81, 015007 (2010) [arXiv:0903.4196 [hep-ph]].

5. S. Bhattacharya, P. Dey and B. Mukhopadhyaya, "Unitarity violation in sequential neutrino mixing in a model of extra dimensions," Phys. Rev. D 80, 075013 (2009) [arXiv:0907.0099 [hep-ph]].

6. S. Bhattacharya, U. Chattopadhyay,D. Choudhury,D.Das and B.Mukhopadhyaya, "Non-universal scalar mass scenario with Higgs funnel region of SUSY dark matter: a signal-based analysis for the Large Hadron Collider," Phys. Rev. D 81, 075009 (2010) [arXiv:0907.3428 [hep-ph]].

Ayan Chatterjee

Enrolment No.	:	PHYS05200704002
Constituent Unit	:	Saha Institute of Nuclear Physics, Kolkata
Date of award of Provisional Degree	:	01.10.2010
Title of Thesis	:	Aspects of Black Hole Physics

Abstract

It is now well known that black holes behave like thermal objects. Indeed, black holes have their own laws of mechanics which look very similar to those of thermodynamics. Moreover, if one makes some identifications- of the surface gravity
of the black hole as temperature and the area of the black hole to entropy, the relation to laws of thermodynamics becomes exact. During 1974-76, through the works of Bekenstein, Bardeen, Carter, Penrose , Hawking and others, it was apparant that these identifications are natural from the point of view of quantum theory. Thus, black holes radiate like a black body with temperature proprtional to their surface gravity and have entropy which is proportional to their area.

The thesis "Aspects of Black Hole Physics" deals with two major aspects. First is the derivation of the laws of black hole mechanics and the second is their use to understand the entropy of black holes in supergravity. We discuss these issues in the following.

The original derivation of black hole mechanics was based on the assumption that the entire evolution of the spacetime, in which the black hole exists, is known. This assumption, though holds for a class of black hole spacetimes, is certainly not true for most cases as well as astrophysically relevant ones. In the last few years, the formalism of *Isolated Horizons* (IH) have been developed by Ashtekar and coworkers to understand classical and quantum properties of black holes from their local geometrical properties. In this thesis, we extend their methods to understand extremal and non- extremal black holes. In the first part of the thesis, we discuss the local geometrical properties of black hole horizons and expalin our reasons for modifications of the IH formalism. We use the Holst action to study dynamics since this action is the starting point for loop quantisation of gravity. We derive the laws of black hole mechanics and discuss their significance.

In the second part of the thesis, we extend this formalism to understand quantum properties of black holes in supergravity theories. In recent years, the entropy of black holes in extended supergravity and string theories have been of great interest.

In these theories, the interesting black hole solutions are necessarily extremal and the *macroscopic calculation* of entropy is based on the Wald entropy formula which however, has not been established for extremal black holes. We show that method of quantisation used in loop quantum gravity can be readily used to understand the entropy of black holes in these theories. Since our method also works for extremal black holes, these questions can be handled satisfactorily.

Publications

Papers marked with a star (*) are included in this thesis.

1. **Entropy of black holes in* N = 2 *supergravity*, Ayan Chatterjee, *Preprint* arXiv: 0907.1556 [gr-qc], (submitted to journal)

2. *Non-minimally Coupled Holst Action and Black Hole Mechanics*, Ayan Chatterjee *Preprint* arXiv: 0906.2102 [gr-qc], (submitted to journal).

3. **Laws of Black Hole Mechanics from Holst Action*, Ayan Chatterjee and Amit Ghosh, *Phys.Rev.* D80, 064036, 2009.

4. *Weak isolated horizons*, Ayan Chatterjee, *AIP Conf. Proc.*, 939, 96-100, 2007.

5. **Generic weak isolated horizons*, Ayan Chatterjee and Amit Ghosh, *Class. Quant. Grav.* 23, 7521-7530, 2006.

6. *Kalb-Ramond field interactions in a braneworld scenario*, Ayan Chatterjee and Parthasarathi Majumdar, *Phys. Rev.* D72, 066013, 2005.

Tanusree Pal

Enrolment No.	:	PHYS08200604001
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of award of Provisional Degree	:	01.10.2010
Title of Thesis	:	Integrable Representations of Lie Tori & an Invariant of Real Forms of Twisted Affine Kac-Moody Lie Algebras

Abstract

Publications

1. Pal, Tanusree, Vogan diagrams of twisted a_ne Kac-Moody Lie algebras. Paci_c J. Math. 239 (2009), no. 1, 65{88.

2. Pal, Tanusree, Batra Punita, Representation of Graded Multi-loop Lie Algebra. Accepted for publication in Communications in Algebra.

3. Chari, Vyjayanthi, Fourier, Ghislain, Khandai, Tanusree, A categorical approach to Weyl modules. arXiv:0906.2014v1 [math.RT] Submitted.

4. Khandai, Tanusree, Batra, Punita, Representations of Lie algebras of type Al coordinated by cyclotomic quantum tori. Preprint.

Shankar Prasad Koiry

Enrolment No.	:	PHYS01200704015
Constituent Unit	:	Bhabha Atomic Research Centre, Mumbai
Date of award of Provisional Degree	:	28.10.2010
Title of Thesis	:	Studies for the Development of Molecular Electronics Devices

Abstract

Silicon-based microelectronics has undergone relentless miniaturization during the last three decades or so, leading to dramatic improvements in computational capacity and speed. Now it is being anticipated that the Si technology will face the scaling limits when the projected size of the transistors goes down to 20 nm or below. This is mainly because the physics of the transistors leads to unacceptable power dissipation.. Therefore, scientists and engineers have proposed a medium term solution—say for next 10–15 years, to make molecules compatible to silicon, so that the nanoscale electronic functionality of molecules can be utilized in silicon based microelectronics. In this thesis work, we have designed and synthesized new functional molecules and grafted them onto Si substrates. We have demonstrated several electronic functionalities which are needed for the development of hybrid nanoelectronics. The major outcomes of this thesis are summarized below.

(i) Alkane (C3-C18) monolayers on the Si substrate have been shown as promsing candidate for 1-3nm ultrathin dielectrics. These alkane monolayers have the low leakage current through the monolayer, e.g. $\sim 10^{-8}$ A/cm^2 at 1V, high capacitance $\sim 7.12 \times 10^{-7}$ F/cm^2, and breakdown voltage i.e. 10-20 MV/cm, indicating their utility as dielectric in hybrid nanoelectronics.

(ii) The fabrication of diodes based on donor-acceptor (D-A) has been demonstrated using meso- tetraphenylporphyrin (TPP), 5,10,15,20 tetra(3-fluorophenyl)-porphyrin (TFPP) and 5,10,15,20 tetra(4-hydroxyphenyl)-porphyrin (TPPH) as donor and C_{60} as acceptor. The current voltage characteristics of the bilayer reveal highly current rectifying behavior having the highest rectification ratio of 3500.

(iii) Resistive memory effect utilizing the electrical bistability have been shown in the following two systems: (1) memory effect in a newly designed and synthesized **σ-** π molecule, namely 5-(4-undecenyloxyphenyl)-10, 15, 20-triphenylporphyrin(TPP-C11); (2) A pronounced resistive memory effect with an on/off ratio of ~ 2.

(iv) Negative differential resistance (NDR) have been shown in newly designed and synthesized a **σ-π-σ** molecule, that is, N-(2-(4-diazoniophenyl)ethyl)-N-hexylnaphthalene-1,8:4,5-tetracarboxydiimide tetrafluoroborate (DHTT). The NDR effect has been explained using calculations based on *ab-initio* molecular-orbital theory.

Future Scope of the work:

In this thesis we have shown the realization of some of the concepts pertaining to the hybrid nanoelectronics. This field is still at infancy and new molecules need to be synthesized. There are several challenges that need to be addressed for the development of this field such as demonstration of molecular transistor, development of robust methods of making counterelectrodes like soft lithography.

Publications

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2. D.K. Aswal, S. P. Koiry, V.Saxena, et.al., Electrografting of organic monolayer on silicon for molecular electronics, in : Physics, Chemistryand Application of nanostructure: Reviews and Short Notes, eds V.EBorisenko, S.V.Gaponenko, V.S.Gurin, World Scientific, Singapore.2007, pp. 541-548

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16. Interfacial and bulk polymerization of indole, S.P. Koiry, Vibha Saxena,D. Sutar, D.K. Aswal, S.K. Gupta and J.V. Yakhmi, SaRNAM 2006,BARC.

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Enrolment No.	:	PHYS07200604004
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Title of Thesis	:	Synthesis of II-VI Semiconductor Nanomaterials by Chemical Precipitation and Low energy Cluster Beam Deposition Techniques and their Characterization

Abstract

Shape and size of a nanomaterial affect its properties. Hence, to control shape and size by suitable synthesis technique and understand their properties is one of the thrust areas of research for last few decades. Since in most synthesis techniques nanomaterials form through process of phase transition, good understanding on the subject is necessary to have efficient control over shape and size of nanomaterials. For this purpose, two different methods (viz. chemical precipitation method and low energy cluster beam deposition (LECBD) method) are adopted to synthesize nanomaterial and three II-VI semiconducting materials (viz. HgS, CdS, and ZnO) are chosen to study for the thesis work. HgS and CdS nanomaterials were synthesized by chemical precipitation method and ZnO nanomaterials were synthesized by LECBD method. Synthesis of ZnO nanoclusters by LECBD method is achieved by two ways: (1) by depositing Zn nanoclusters first and then allowing them to oxidize in ambient atmosphere, (2) by passing oxygen along with argon as the carrier gas during process of deposition. Techniques like transmission electron microscopy, atomic force microscopy, X - ray Diffraction, optical absorption spectroscopy, photoluminescence spectroscopy, Rutherford backscattering spectrometry and particle Induced X - ray emission technique were utilized to study different properties of the synthesized nanomaterials.

The chemical precipitation method used for synthesis of CdS nanostructures is a single step process and carried out in ambient temperature. The viscosity and surface tension of solution, which are related to the concentration of polymer (Polyvinyl Alcohol) used, significantly affect the structure of nanomaterials. By varying the polymer concentration, different structures like nanotubes, nanowires, and nanocrystals are synthesized. The wall thickness of nanotubes is comparable to the excitonic diameter of the bulk material (6 nm) and as a result the system shows quantum confinement effect. The excitonic peak position is blue shifted by 48 nm in optical absorption spectrum and by 20 nm in photoluminescence spectrum from its bulk band gap value (512 nm). Nucleation of CdS nanocrystallites and dissolved gas (i. e. ammonia) bubbles, and their kinetics and interactions, lead them for formation of nanotubes [1]. Following a similar chemical synthesis procedure, HgS nanocrystals were synthesized. HgS nanocrystals also show high energy shifting of excitonic peak position in the optical absorption spectra compared to its bulk band gap value. The standard deviation in size distribution of nanocrystals at the mean position is calculated by fitting optical absorption line shape with a theoretical model by considering the distribution as Gaussian [2].

The morphology of ZnO nanomaterials, synthesized by first depositing Zn nanoclusters through LECBD technique and then allowing to oxidize in the ambient, shows dependence on the initial shape and size of deposited Zn nanoclusters. After ten days of exposure to ambient, it is observed that nanoclusters bigger than 15 nm are Zn - ZnO core- shell type, between 15 to 5 nm form Zn - void - ZnO type and smaller than 5 nm are ZnO

hollow sphere type. Significant change in morphology is not observed even after three months of exposure to the ambient [3]. However, when the samples are checked after exposing to ambient for three years, it is observed that all type of nanoclusters are transformed to ZnO hollow nanoclusters, which are broken.

Nanoclusters produced by passing oxygen along with argon as carrier gas in the LECBD method, during process of deposition, are geometrical shaped, mainly triangular, hexagonal, and rectangular. In this case, Zn clusters are randomly distributed within ZnO nanoclusters. When these nanoclusters are checked after three years of exposure to ambient, it is noticed that nanoclusters are cracked, unlike formation of hollow structures as in the earlier case, and each nanocluster is an agglomeration of large number of small ZnO nanocrystallites. It gives an indirect evidence that, during process of nucleation monomers first aggregates and then rearrange themselves into a stable configuration.

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2. A. K. Mahapatra, A. K. Dash; *"α- HgS nanocrystals: Synthesis, structure and optical properties"* , Physica E 35, 9-15 (2006) .

3. A. K. Mahapatra, T. Som; *"Oxidation behavior of Zn nanoclusters"* (Communicated) (arXiv:1106.3752, 2011).

Nishikanta Khandai

Enrolment No.	:	PHYS08200604008
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Date of award of Provisional Degree	:	19.12.2010
Title of Thesis	:	Non-Linear Gravitational Clustering in the Universe

Abstract

Large scale structures traced by galaxies are believed to have formed by ampli_cation of small perturbations. Galaxies are highly over-dense systems, matter density ρ in galaxies is thousands of times larger than the average density ρ in the universe. Typical density contrast ($\delta \equiv \rho/\rho - 1$)) in matter at these scales in the early universe was much smaller than unity in the early universe. Thus the problem of galaxy formation and the large scale distribution of galaxies requires an understanding of the evolution of density perturbations from small initial values to the large values we encounter today. Initial density perturbations were present at all scales that have been observed. The equations that describe the evolution of density perturbations in an expanding universe have been known for several decades and these are easy to solve when the amplitude of perturbations is small. Once density contrast at relevant scales becomes comparable to unity, perturbations becomes non-linear and coupling with perturbations at other scales cannot be ignored. The equation for evolution of density perturbations cannot be solved for generic initial conditions in this regime. N-Body simulations are often used to study the evolution in this regime. In this thesis we _rst develop the numerical tools, and use it to study aspects of gravitational clustering in an expanding universe.

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3. Mass function of haloes: scale invariant models Authors: Bagla J. S. and Khandai Nishikanta, Girish Kulkarni 2009, arXiv:0908.2702

4. H I as a probe of the large scale structure in the post-reionization universe: Power Spectrum and its evolution. Authors: Bagla J. S. and Khandai Nishikanta 2009, arXiv:0908.3796

5. H I as a probe of the large scale structure in the post-reionization universe: Visibility correlations and prospects for detection. Authors: Khandai Nishikanta, Datta Kanan K. and Bagla J. S. 2009, arXiv:0908.3857

Other Publications

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Title of Thesis	:	Classical and Quantum Corrections to Entropy of Extremal Black Hole

Abstract

We have studied the correction to the entropy of extremal black hole in string theory. In the first part we discussed the higher derivative correction to the entropy of the *BTZ* black hole. In string theory, one finds that the low energy effective action contains higher curvature terms. In fact at tree level it contains an Einstein-Hilbert term together with an infinite series of higher curvature terms that are suppressed by powers of α, so that they are subleading at low energy. We described field redefinition and consistent truncation in three dimensional general higher derivative theory of (super-) gravity coupled to arbitrary set of matter fields. After field redefinition and consistent truncation the action reduces to standard (super-) gravity action which is sum of three terms, Einstein–Hilbert term, a cosmological constant term and the Chern-Simons term. The effect of higher derivative corrections are encoded in the correction of the central charges. These will give classical correction to the entropy of extremal black hole in string theory whose near horizon geometry corresponds to that of extremal *BTZ* black hole.

In the second part we described the quantum entropy of the extremal black hole. The quantum degeneracy associated with horizon degrees of freedom of the extremal black hole is given as the finite part of the partition function of string theory on AdS_2 According to this proposal the macroscopic entropy in full quantum theory is equal to logarithm of degeneracy of the ground states of the *CQM* living on the boundary of AdS_2. We first check this proposal in case of extremal BTZ black hole where there exist an independent definition of entropy via AdS_3/CFT_2 correspondence. We found that both the definitions of entropy agree. We also simplify this path integral using the supersymmetry of the near horizon geometry. The isometry supergroup of the near horizon geometry has a factor *SU (1, 1|2)*. Using supersymmetry and localization techniques we showed that the path integral could receives non-vanishing contribution only from a special class of field configurations which preserve a particular subgroup of *SU (1, 1|2).*

Publcations

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Date of award of Provisional Degree	:	19.12.2010
Title of Thesis	:	Complexity Analysis of Some Problems in Planar Graphs, Bounded Tree-Width Graphs, and Planar Point Sets

Abstract

The focus of this thesis is on the complexity analysis of some computational problems in restricted graph-classes. The problems considered include graph isomorphism, various path problems like reachability, shortest path, and longest path computations. We investigate the space complexity of the graph isomorphism problem for planar graphs. The space complexity of path problems is considered for planar graphs, and k-trees. Another problem studied in the thesis is the clustering problem. One of the main results on graph isomorphism included in the thesis is a log-space algorithm for isomorphism of planar graphs. This settles the complexity of planar graph isomorphism, since hardness for log-space is already known. A log-space algorithm is first described for isomorphism of 3-connected planar graphs, which is then used in the algorithm for planar graph isomorphism. The results on path problems include an improved upper bound for computing the length of a longest path between two designated nodes in a planar DAG. We also present new upper bounds for counting the number of paths between two designated nodes in a planar DAG and in a single-sink DAG, under the promise that these numbers are bounded by a polynomial in the size of the graph. Reachability problem is also studied for directed k-trees and a log-space algorithm is given. Complexity of the shortest and longest path problems for directed acyclic k-trees has been analysed and log-space algorithms are described for these problems. We also give matching log-space hardness results, thereby settling the complexity of these problems for directed k-trees and directed acyclic k-trees respectively. These algorithms are applicable for partial k-trees, which are also known as graphs of tree-width at most k, provided a tree-decomposition for partial k-trees is given as input. The tree-decomposition for k-trees is known to be computable in log-space, but is not known for partial k-trees. Another problem studied in this thesis is the k-means problem. It is a variant of the clustering problem. We prove that the k-means problem is NP-hard when the input is a set of points in two dimensions, and k is part of input. Earlier the hardness was known only for those instances where the number of dimensions is a part of input.

Publications

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2. Samir Datta, Nutan Limaye, and Prajakta Nimbhorkar. 3-connected planar graph isomorphism is in log-space. In Proceedings of the 28th annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS), pages 153–162, 2008.

3. Samir Datta, Nutan Limaye, Prajakta Nimbhorkar, Thomas Thierauf, and Fabian Wagner. Planar graph isomorphism is in log-space. In CCC '09: Proceedings of the 24th Annual IEEE Conference on Computational Complexity, pages 203–214, 2009.

4. Nutan Limaye, Meena Mahajan, and Prajakta Nimbhorkar. Longest paths in planar dags in unambiguous logspace. Chicago Journal of Theoretical Computer Science, CATS 2009 special issue, 2010(8), 2010.

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Title of Thesis	:	The Field Induced Melting of Charge Order in the Manganites

Abstract

Correlated materials such as the transition metal oxides involve strong coupling between spin, charge, orbital and lattice degrees of freedom. This leads to complex phases, with cooperative ordering in all these variables. One such is the charge and orbital ordered phase (CO-OO) in the half doped manganites. The CO-OO is often formed in the background of antiferromagnetic (AF) order and can be weakened by a magnetic field as the AF phase is destabilised. Since the field induced transition is first order the response near the transition is hysteretic.

The thesis is based on a detailed exploration of the process of field induced melting of charge order in the manganites, probing for the first time the non equilibrium aspects of this phenomenon. We have explored the parameter space of the electronic model in detail, compared our results to a large body of experimental data, and made predictions about the spatial character of the melted state. Recent measurements confirm our view of this melting process.

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2. Exploiting B Site Disorder for Phase Control in the Manganites. K. Pradhan, A. Mukherjee and P. Majumdarm Europhys. Lett. 84, 37007 (2008).

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3. A Real Space Description of Field Induced Melting in the Charge Ordered Manganites: I. The Clean Limit. A. Mukherjee and P. Majumdar arXiv:0811.3563

5. A Real Space Description of Field Induced Melting in the Charge Ordered Manganites: II. The Disordered case. A. Mukherjee and P. Majumdar arXiv:0811.3746 Adiabatic charge pumping through a dot at the junction of N quantum wires. S. Banerjee, A. Mukherjee, S. Rao, and A. Saha Phys. Rev. B 75, 153407 (2007).

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Enrolment No.	:	MATH08200605001
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Title of Thesis	:	Some Problems on Jacobi Forms

Abstract

It is well known that a certain class of modular forms, namely the Poincaré series, span the space of cusp forms for several types of modular forms. However it is general an open question when such a Poincaré series does not vanish identically. In this present thesis, we prove that under suitable conditions (both depending and independent of the weight), a Jacobi Poincaré series of exponential type of integer weight and matrix index does not vanish identically. For Jacobi forms of degree *1*, a basis consisting of the 'first' few Poincaré series is given. We establish the equality of certain Kloosterman-type sums which occur the the Fourier expansions of Poincaré series for Jacobi forms of degree *1* and those for half-integral weight modular forms. Also, we prove a result on the non-vanishing of Jacobi Poincaré series when an odd prime divides the index.

Hermitian Jacobi forms arise naturally from the Fourier-Jacobi expansion of Hermitian modular forms. In this thesis, we introduce a certain differential operator on the space of Hermitian Jacobi forms of degree *1*. This is the analogue of the heat operator studied by Eichler and Zagier in the case of classical Jacobi forms. We use this operator to construct Hermitian Jacobi cusp forms from elliptic modular cusp forms. We prove that the space of Hermitian Jacobi forms of weight *1* and index *m* is zero for any *m e" 1*. We construct Hermitian Jacobi forms from the tensor product of two copies of classical Jacobi forms and also from the differentiation of the variables. We determine the number of Fourier coefficients that determine a Hermitian Jacobi form and use the differential operator introduced above to embed a certain subspace of Hermitian Jacobi forms into the direct sum of finitely many spaces of elliptic modular forms.

We also consider the structural properties of Hermitian Jacobi forms of index *1* and *2*. We compare the spaces of Hermitian Jacobi forms of weight *k* and indices *1, 2* with classical Jacobi forms of weight *k* and indices *1, 2, 4* by connecting them via several exact sequences and differential operators. It turns out that the Hermitian Jacobi forms of index *1* and *2* can be embedded into finitely many spaces of classical Jacobi forms. Using this, upper bounds for the order of vanishing of a Hermitian Jacobi form at the origin is obtained. We compute the rank of the space of the Hermitian Jacobi forms of index *m* and of weight a multiple of *2* and *4* as a module over the algebra of the elliptic modular forms. It is known that the space of Hermitian Jacobi forms of index *1* and

weight a multiple of *4* is generated as a module over the algebra of the elliptic modular forms by *3* explicit generators. We prove that the explicit generators are algebraically independent over the algebra of the elliptic modular forms. Some related questions are also discussed.

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Date of award of Provisional Degree	:	25.01.2011
Title of Thesis	:	Counting Microscopic Degeneracy of N = 4 Black Holes

Abstract

Black Holes are classical solutions of the equations of General Theory of Relativity. They have the characteristic features that the space-time curvature blows up at a point which is called the singularity. It is believed that a black hole produced as a result of gravitational collapse will always be surrounded by a horizon of finite area which allows inflow of matter and radiation but nothing can come out of it. It turns out that a black hole has entropy proportional to the horizon area and it also has temperature. According to the statistical mechanics the entropy of a system is equal to the logarithm of number of microstates accessible to the system. In this thesis we have tried to account for the microstates of a special class of supersymmetric black holes in four dimensions which can be obtained as a solution of low energy effective field theory of *N=4* superstring theory. This theory is invariant under T and S duality symmetries and the black holes carry both electric and magnetic charges under *28U(1)* gauge fields. We shall refer to these black holes as Quarter *BPS* Dyons.

In our first work, we derive the complete set of T-duality invariants which characterize a pair of charge vectors *(Q, P)*. Using this we could identify the complete set of dyonic black holes to which the previously derived microstate degeneracy formula can be extended.

In our next work, we studied the action of *S*-duality group on the discrete *T*-duality invariants and studied its consequences for the dyon degeneracy formula.

In the third work, we proposed a general set of constraints on the partition function of quarter BPS dyons in any *N=4* supersymmetric string theory by drawing insight from known examples, and studied the consequences of this proposal.

The original proposal of Dijkgraaf, Verlinde and Verlinde for the quarter *BPS* dyon partition function in heterotic string theory in T^6 is known to correctly produce the degeneracy of dyons of torsion *1*, i.e. dyons for which $gcd(Q^p) = 1$. In our last work we proposed a generalization of this formula to dyons of arbitrary torsion. Our proposal satisfies the constraints coming from *S*-duality invariance, wall crossing formula, black hole entropy and the gauge theory limit.

Ayan Mukhopadhyay

Enrolment No.	:	PHYS08200604012
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of award of Provisional Degree	:	01.10.2010
Title of Thesis	:	Aspects of Black Hole Physics

Abstract

Publications

1. R. K. Gupta and A. Mukhopadhyay, \On the universal hydrodynamics of strongly coupled CFTs with gravity duals," JHEP 0903, 067 (2009) [arXiv:0810.4851 [hepth]].

2. R. Iyer and A. Mukhopadhyay, \AdS/CFT Connection between Boltzmann and Einstein equations : Kinetic Theory and pure gravity in AdS space," Phys. Rev. D 81, 086005 (2010) [arXiv:0907.1156 [hep-th]].

3. A. Mukhopadhyay, \A Covariant Form of the Navier-Stokes Equation for the Galilean Conformal Algebra," JHEP 1001, 100 (2010) [arXiv:0908.0797 [hep-th]].

4. A. Mukhopadhyay and T. Padmanabhan, \Holography of gravitational action functionals," Phys. Rev. D 74, 124023 (2006) [arXiv:hep-th/0608120].

5. J. R. David, R. Gopakumar and A. Mukhopadhyay, \Worldsheet Properties of Extremal Correlators in AdS/CFT," JHEP 0810, 029 (2008) [arXiv:0807.5027 [hepth]].

Sovan Chakraborty

Enrolment No.	:	PHYS05200704010
Constituent Unit	:	Saha Institute of Nuclear Physics, Kolkata
Date of award of Provisional Degree	:	26.01.2011
Title of Thesis	:	Neutrino oscillations in Supernovae

Abstract

The resolutions of the solar neutrino problem and the atmospheric neutrino anomaly established non-zero neutrino mass and neutrino oscillations in a three-flavor framework. It is also known that the neutrino oscillation phenomenon gets enhanced in the presence of matter, particularly for matter with a density gradient and this effect is known as the Mikheyev-Smirnov-Wolfenstein (MSW) mechanism. The parameters involved in this three-flavor oscillation are the two mass squared differences for the three mass eigenstates and the three mixing angles. A number of accelerators and reactor experiments also gave independent support to the oscillation hypothesis.

On the other hand neutrinos emitted during the explosion of a core-collapse supernova (SN) turn out to be important in probing both neutrino properties and SN mechanism. Though only neutrinos from the SN 1987A explosions have been detected so far, one hopes to observe neutrinos in terrestrial detectors in future SN explosions at galactic distances. The neutrinos emitted during the explosions of core-collapse SN pass through a very large density gradient and undergo the MSW resonant flavor conversion. The flavor conversion can give information on neutrino mass hierarchy and the third mixing angle (Theta13) . In the last few years it was realized that a crucial feature in the study of SN neutrinos comes from the collective neutrino-neutrino interaction at very high densities of the core and this may change the emitted flux of different flavors substantially.

We mainly study three aspects of SN neutrinos. The first aspect is regarding the effect of neutrino-neutrino interaction on the neutrino spectra. It has been seen that the number of split in the spectra and the split energy depend on the variation of initial relative luminosity or relative flux of different neutrino species. This dependence is extensively studied in the thesis. We analyzed the variation of split patterns with initial relative flux for different possible models of SN neutrino spectra.

Another aspect we discussed in this thesis is the prospect of SN as a r-process nucleosynthesis site in light of this variation of split patterns due to neutrino-neutrino interaction. Though the site for the mechanism of rapid capture of neutrons leading to synthesis of heavier element or r-process nucleosynthesis is not definitely known, supernovae are considered to be excellent candidates for it. One of the criteria for the rapid nucleosynthesis to take place is that it has to be in a neutron-rich region. With the two competing beta processes $n + \boldsymbol{\nu}_e \rightarrow p + e''$ and $p + \bar{\boldsymbol{\nu}}_e \rightarrow n + e^+$ occurring in the hot bubble and neutrino driven wind region, the minimal condition is that the electron fraction (defined as the number of electrons divided by the total number of baryons), $Ye < 0.5$. The r-process in SN is expected to take place in the neutrino driven wind deep inside the supernova (within a few hundred kilometers from the center). Since the collective flavor oscillations also happen very close to the neutrinosphere, they are sure to impact on the r-process nucleosynthesis. Hence we studied the effect of spectral splits on the electron fraction (Y_e), which is a diagnostic of successful r-process

nucleosynthesis in supernova. We also considered the inverse problem i.e. to study the possibility of putting constraints on the initial relative fluxes by demanding the neutron rich condition of Y_e.

The other aspect studied in the thesis is the Diffuse Supernova Neutrino Background (DSNB) or the relic background of neutrinos emitted from all past SN. Our study included the fact that collective as well as MSW oscillation can affect the DSNB. Since the two oscillation effects happen at two widely separated region, typically collective effect around a few 100 km and MSW around $10^4 – 10^5$ km, they are considered to be independent. In our analysis we considered the effect of these oscillations on the SN relic neutrinos. We also studied the variation of split patterns coming from the variation of initial relative flux and discussed how these split pattern variations can affect the DSNB flux. The important problem of mass hierarchy in neutrino physics is examined using the DSNB event rate and favorable situations where the inverted hierarchy can be distinguished from the normal one identified. The realistic situation of a distribution of supernovae as a function of the relative neutrino and antineutrino fluxes are also considered while investigating this issue.

Publications

Papers marked with a star (*) are included in this thesis.

1. *On the Observability of Collective Flavor Oscillations in Diffuse Super- nova Neutrino Background, Sovan Chakraborty, Sandhya Choubey and Kamales Kar. Preprint arXiv:1006.3756 [hep-ph].(submitted to journal).

2. Constraining Scalar Singlet DarkMatter with CDMS, XENON and DAMA and Prediction for Direct Detection Rates .Abhijit Bandyopadhyay, Sovan Chakraborty, Ambar Ghosal, Debasish Majumdar. Preprint arXiv:1003.0809 [hep-ph]. (To appear in JHEP)

3. Interpreting the bounds on DarkMatter induced muons at Super-Kamiokande in the light of CDMS data . Abhijit Bandyopadhyay, Sovan Chakraborty, Debasish Majumdar. Preprint arXiv:1002.0753 [hep-ph]. Int. J. Mod. Phys. A.25 :3741-3747, 2010.

4. *Collective Flavor Oscillations Of Supernova Neutrinos and r-Process Nucleosynthesis. Sovan Chakraborty, Sandhya Choubey, Srubabati Goswami, Kamales Kar Preprint arXiv:0911.1218 [hep-ph]. Journal of Cosmology and Astroparticle Physics (JCAP) 1006:007, 2010. 113

5. *Effect of Collective Flavor Oscillations on the Diffuse Supernova Neu- trino Background. Sovan Chakraborty, Sandhya Choubey, Basudeb Dasgupta, Kamales Kar. Preprint arXiv:0805.3131 [hep-ph]. Journal of Cosmology and Astroparticle Physics (JCAP) 0809:013, 2008.

6. Upper Limit on the Cosmic Gamma-Ray Burst Rate from High Energy Diffuse Neutrino Background . Pijushpani Bhattacharjee, Sovan Chakraborty, Srirupa Das Gupta, Kamales Kar. Preprint arXiv:0710.5922 [astro-ph]. Phys. Rev. D77 :043008, 2008.

Preena Samuel

Enrolment No.	:	MATH10200604005
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	15.02.2011
Title of Thesis	:	RSK Bases in Invarient Theory and Representation Theory

Abstract

From the combinatorial characterizations of right, left, and two sided Kazhdan-Lusztig cells of the symmetric groups, RSK bases are constructed for certain quotients by two sided ideals of the group ring and the Hecke Algebra. Applications to Invariant Theory, over various base rings, of the general linear group, and representation theory both ordinary and modular, of the symmetric group are discussed in this Thesis.

Publications

1. "RSK bases and Kazhdan-Lusztig cells", to appear in Annales del'Institut Fourier, Institut Fourier, Grenoble (France).

Vallan Bruno Cruz

Enrolment No.	:	PHYS10200605005
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	15.02.2011
Title of Thesis	:	Electron Transfer In Electrochemical Environment

Abstract

Though the traditional views of electron transport theories in electrochemical environment is to consider a transfer between two reservoirs or between DBA complexes wherein the donor and acceptor states are in discrete energies, the author presents his results in this thesis for the electron transfer rate from a redox to a reservoir. This problem demands attention since while the reservoir normally has a continum of states while the redox which has single energy level but is dependent on the fluctuation of the solvent that is the polorisation mode of the solvent. Hence the total electron transfer rate is determined by the competition between the resonance tunneling of the electron and the solvation of the redox. Electron transfer through a chemically modified electrode is studied in the present thesis. The adsorbate is randomly distributed on the electrode surface and its coverage factor is allowed to vary from zero to one, this covering all regimes from lone adsorbate to monolayers. A modified Newns-Anderson Hamiltonian is employed to model the system, and the current is calculated with the linear response regime. The randomness in the adsorbate distribution is handled using CPA. The DOS is analysed for different regimes of strong and week coupling as well as lone and monolayer coverage regimes. The current-potential profiles are similarly plotted for various limiting regimes. The Marcus inverted regime is recovered in the low coverage case and also a direct heterogeneous electron transfer in the high coverage regime, when the coupling is strong. A saddle point behaviour is observed in the low coverage regime with weak coupling.

Publications

1. A Vallan Bruno Cruz, A.K. Mishra and W. Schmickler. " Electron tunneling between two electrodes mediated by a molecular wire containing a redox center, " [arXiv:cond-mes-hall/0912.1165]

2. A. Vallan Bruno Cruz, A.K. Mishra and W.Schmickler, "Electron Transfer rate between a electrode and a bridged redox, "[arXiv:cond-mat.mes-hall/0912.3083]

3. A. Vallan Bruno Cruz, A.K. Mishra and W.Schmickler, "Electron Transfer Reaction Through an Adsorbed Layer," [arXiv:cond-mat.mes-hall/0912.2856]

Biswaranjan Dikshit

Enrolment No.	:	ENGG01200704030
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Date of award of Provisional Degree	:	28.02.2011
Title of Thesis	:	Studies on Electron Beam Vapor Generation in PVD Processes

Abstract

Generation of metal vapor by e-beam heating is a complex phenomenon that involves many linear, as well as non-linear physical and dynamical processes in response to the incidence of concentrated flux of energetic electrons on the target. These processes occurring at different stages need to be understood in details for optimization of the process and also for suitable tailoring for specific end uses. Working in this direction, detailed investigations were carried out on important aspects of the e-beam evaporation process. The electron optics as affected by bending of e-beam and geometrical errors of the magnetic lens, stability and controllability of electron emission current, process monitoring, convective heat transfer in melt pool on the target and physical processes occurring in the metal vapor and accompanying plasma emerging from the hot zone have been examined in detail.

For a realistic assessment of electron optics in e-gun used for evaporation, numerical simulation of the electron trajectories was carried out starting from the anode exit hole up-to the metal target placed in a water cooled crucible. As e-beam used for evaporation is generally bent by 450 to 2700 to avoid transgress of vapor/ions into the cathode/ anode region, the shape and size of the e-beam spot on the target deteriorate. In addition to this, presence of possible angular/positional misalignment of the e-beam axis with the axis of the focusing magnetic lens affects the characteristics of the e-beam power distribution. The dependence of the compactness, circular symmetry and shift of the e-beam spot from the expected position on the target are quantified in terms of above parameters and dominant factors are identified. Finally, a novel scheme for ideal distortion-less focusing of a bent non-paraxial e-beam is analytically derived. It was proved that the effect of bending on the size and shape of e-beam spot on the target can be completely eliminated (*theoretically made zero*) by choosing a radially decreasing magnetic field and also a *circularly asymmetric* radial velocity distribution for the beam electrons. In the paraxial case, elimination of the distortion due to bending is possible by using a radially decreasing magnetic field and circularly symmetric radial velocity distribution, which is easily achieved by a coaxial thin magnetic lens. These conclusions are shown to be valid for any angle of bending of e-beam and are relativistically correct. Extension of this principle for ideal focusing of circulating charged particles in betatron type accelerators where kinetic energy gradually increases during the motion is also derived. Investigations on the stability of the electron emission current was taken up next, which is a desirable feature in e-guns used for evaporation of metals. However, a region of instability (hysteresis in electron emission current) was observed. It was noted that in the forward direction of power change, the required filament-heating current for a specified ebeam current was significantly higher than the filament current required in the backward direction. By use of theoretical calculations and experimental validations, it was established that this hysteresis arises due to energetic metal ion bombardment on the electron-emitting area of filament in e-gun. A practical way to check this

uncontrollability arising due to bombardment of ions is presented. In addition to this, ways for minimizing repeated electrical discharges occurring in e-guns and precautions to be taken for protection of the HVPS from transient over voltages/currents are also discussed.

One of the important process monitoring parameters in the e-beam evaporation is the temperature of hot zone created by impact of high power e-beam. Direct line of sight viewing of the hot zone for temperature measurement using an optical pyrometer on a continuous basis]\ is ruled out in e-beam evaporators due to opacity introduced by coating of the vacuum windows within a short time span. Continuous visual monitoring conventionally relies on a periscopic arrangement that makes use of a process generated thin film mirror formed by deposition of evaporating metal atoms. However, it was found that this method introduces significant error in temperature as measured by optical pyrometer. The dominant factors viz. temperature and reactivity of evaporant metal which affect the measurement were experimentally examined. A solution that bypasses this problem was proposed and it was shown through calculations that this novel method avoids errors associated with the periscopic method and yet extends the continuous monitoring time by a factor of ~1000 from few seconds to few hours. Finally our results on the measurement of other important parameters viz.. atomic vapor flux and (atomic) state resolved atom densities by use of piezoelectric sensor and spectroscopic absorption method respectively are presented.

During vacuum evaporation of metals by use of a concentrated energy flux such as ebeam, a liquid metal pool with a steep temperature gradient is formed around the hot zone. Due to temperature dependence of surface tension as well as density and depression of the evaporating surface caused by back-pressure of the emitted vapor in this molten pool, strong convective flow sets in the molten pool. It was proposed for the first time that this convection passes through three different stages as e-beam power is increased. This was experimentally confirmed by quantifying convective heat transfer in terms of dimensionless Nusselt number and by studying its evolution with power in experiments using aluminum, copper and zirconium as targets. Experimental values of Nusselt number were compared with the theoretically predicted values by earlier researchers to test the validity of assumptions made and to know the type of flow in the melt pool. Thus, conclusions about the evolution of convective heat transfer and physical characteristics of flow in the molten pool could be drawn by considering the roles of surface tension and depression on the evaporating surface.

In a few applications such as atomic vapor laser isotope separation, excitation temperature of the e-beam generated metal vapor needs to be known. As the excitation temperature may depart significantly from the equilibrium value, we have experimentally measured it in uranium vapor generated by e-beam heating. To understand the various processes affecting it, quantitative expressions were derived to estimate the effect of atomatom and electron-atom collisions on the excitation temperature at different source temperatures. This was compared with the experimental data recorded by spectroscopic absorption technique using a HCDL. It was concluded from analysis of experimental data that relaxation of the metastable atoms by collisions with low-energy plasma electrons was so large that it lowers the excitation temperature below the translational temperature of the vapor. So, with increase in atom density, frequent atom-atom collisions were expected to establish equilibrium between the excitation and translational

temperatures resulting in increase of the excitation temperature (i.e. heating of vapor). From the observed excitation temperature at low e-beam power, total de-excitation cross section for relaxation of uranium atoms in 620 cm-1 state by interaction with low energy electrons was estimated to be ~10-14 cm2. Finally using this value of cross section, extent of excitational cooling/heating by electron-atom and atom-atom collisions were estimated at higher e-beam powers. During e-beam evaporation of metals, the generated atomic vapor is partially ionized due to Saha ionization and electron impact ionization that occurs by impact of the primary, backscattered and secondary electrons with the atomic vapor near the hot zone. Total ionization content of the vapor is generally in the range of ~0.2-0.5%. Thus, generation of plasma during e-beam evaporation of metals is an inherent phenomenon of the vapor generation process. The above-mentioned plasma is however a non-equilibrium one consisting of two different groups of electrons depending upon their origin (atom-atom or electron-atom collisions) and these groups are characterized by different energy spread o temperature. While this plasma expands with the metal vapor, thermodynamic equilibrium between these two groups of electrons is gradually established by electron-electron coulomb collisions and electron-atom inelastic collisions. Evolution of this two-temperature plasma was experimentally investigated by a disc type Langmuir probe during e-beam evaporation of zirconium. The method of interpretation of the V-I characteristics of the Langmuir probe for diagnostics of a *two-temperature plasma* is given in detail along with justification.

Mathematical expressions for the effect of different interactions on the evolution of electron temperatures of the plasma were derived and applied to our experimental situation. Taking the initial temperature of the plasma at the source of vapor, total cross section for electron-atom inelastic collisions was calculated, the order of which agreed well with the reported values. Thus, contribution of each type of interaction (electron-electron and electron-atom) on the cooling of high temperature group of electrons in plasma were quantified. To summarize, important stages in the e-beam vapor generation process have been studied in this work starting from e-beam generation to the thermo-physical processes occurring in the atomic vapor. In many cases, novel propositions along with experimental or theoretical proof have been made for better understanding of the phenomena with an eye to solve the difficulties encountered in the process.

Publications

INTERNATIONAL JOURNALS

1. "Ideal distortion-less bending of a focused non-paraxial electron beam", Biswaranjan Dikshit and M. S. Bhatia, Nuclear Instruments and Methods in Physics Research A 596, (2008) 300–304

2. "Hysteresis in electron-emission current of an axial electron gun used for evaporation of metals", Biswaranjan Dikshit and M. S. Bhatia IEEE transactions on Plasma Science, 35 (2), (2007) 396-401

3. "Effect of periscope reflecting mirror on uncertainty of measured temperature of an electron beam heated metal vapor source", B. Dikshit, G. R. Zende, M. S. Bhatia and B. M. Suri, Measurement Science & Technology, 19 (2008) 511 – 516

4. "Convection in molten pool created by a concentrated energy flux on a solid metal target" B. Dikshit, G. R. Zende, M. S. Bhatia and B. M. Suri Physics of Fluids, 21, 084105 (2009)

5. "Collisional effects on metastable atom population in vapour generated by electron beam heating", B. Dikshit, A. Mazumder, M. S. Bhatia and V. K .Mago Journal of Physics D: Applied Physics, 41 (2008) 521 – 526

6. "Evolution of a two-temperature plasma expanding with metal vapor generated by electron beam heating", B. Dikshit, G. R. Zende, M. S. Bhatia and B. M. Suri IEEE transactions on Plasma Science, 37 (7), (2009) 1196-1202

7. "A Novel 270-degree Bent-Axial-Type Electron Gun and Positioning of Its Electron Beam Spot on the Target" Biswaranjan Dikshit and M. S. Bhatia IEEE Transactions on Electron Devices, 57 (4), (2010) 939-945

SYMPOSIUM

1. "Use of Langmuir probe for analysis of charged particles in metal vapour generated by electron beam heating", B Dikshit and M. S. Bhatia, International symposium on Vacuum Science and Technology, Nov 28-30, 2007, TIFR, Mumbai (also published in Journal of Physics: Conference series. 114, 012030, 2008)

Prabhat Kumar Singh

Enrolment No.	:	CHEM0120080402
Constituent Unit	:	Bhabha Atomic Research Centre, Mumbai
Date of award of Provisional Degree	:	28.03.2011
Title of Thesis	:	Studies on the Dynamics of Ultrafast Photoinduced Processes in Condensed Phase Using Thioflavin-T And Coumarin as the Probes

Abstract

The work reported in this PhD thesis deals with the dynamics of ultrafast photoinduced processes in condensed phase using Thioflavin-T(ThT) and Coumarin as the probes. Despite the widespread use of Thioflavin-T (ThT), a benzothiazole based cationic dye, in the detection of amyloid fibril, understanding the basic molecular aspect of the process that is involved in the observed fluorescence enhancement of ThT in the amyloid fibril has mostly remained speculative. This thesis reveals the actual molecular process involved in the fluorescence sensing activity of the widely used amyloid fibril sensing dye, Thioflavin-T (ThT), through a detailed study on the ultrafast fluorescence decay dynamics of Thioflavin-T in water and in different solvents of varying viscosity. These results convincingly demonstrate that the basic molecular mechanism for its fluorescence sensor activity is the torsional relaxation around the central C-C single bond of the ThT molecule. Further, the ultrafast dynamics of the photoexcited ThT molecule under different confined microenvironments like reverse micelles and ?-cyclodextrin cavity has also been explored. Finally, through the investigation of ThT in amyloid fibril, it has been clearly demonstrated that the bond twisting process in the excited state of ThT molecule gets substantially retarded in amyloid fibril.

Dynamic Stokes' shift measurements using a solvatochromic probe for solvent relaxation study have been applied very extensively to understand the structure and dynamics of different chemical and biological systems. In order to understand the actual dynamics of the solvent relaxation process, it is very essential to separate out the contribution of the interfering intramolecular processes in the larger probes from the solvent relaxation process. In this thesis a methodology has been developed to quantitatively separate the interfering ultrafast intramolecular relaxation component from the observed dynamic Stokes' shift results and thus to extract the solvent polarization relaxation dynamics accurately. The methodology has been successfully demonstrated for selected coumarin derivatives that are extensively used as the fluorescence probes in understanding the solvation/hydration processes for different micro-heterogeneous and biological environments.

This thesis also reports an interesting work on the supramolecular assemblies formed via the cooperative interactions of block-copolymers and ionic surfactants. Because of the availability of wide range of microenvironments in these supramolecular assemblies, the solutes may also have quite different physical and chemical properties depending on their locations in the micelle. Thus, by changing the position of a solute in these micelles, it is possible to modulate the physical as well as the chemical properties of the solute in these microheterogeneous systems. It has been interestingly demonstrated that the location as well as reactivity (*e.g*. redox property) of a solute in these assemblies can be suitably controlled just by changing the compositions of the constituent partners,

a result that can have immense implications in controlling the reactivity of a substance without changing it chemical identity.

Publications

1. Quantitative Distinction between Competing Intramolecular Bond Twisting & Solvent Relaxation Dynamics: An Ultrafast Study Prabhat K. Singh, Sukhendu Nath, Manoj Kumbhakar, A. C. Bhasikuttan, and Haridas Pal *J. Phys. Chem. A, 112*, 5598–5603, 2008.

2. Effect of electrostatic interaction on the location of molecular probe in polymersurfactant supramolecular assembly: A solvent relaxation study Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 112*, 7771-7777, 2008.

3. A Nanoreactor for Tuning the Chemical Reactivity of a Solute Prabhat K. Singh, A. K. Satpati, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B (Letter), 112*, 11447–11450, 2008. (Art work appeared as the cover page)

4. Ultrafast Torsional Dynamics of Protein binding dye, Thioflavin T, in Nanoconfined Water Pool Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 113, 8532–8538,* 2009.

5. Modulation in the solute location in block copolymer-surfactant supramolecular assembly: A time resolved fluorescence study Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 113*, 1353-1359, 2009. 207

6. Change in the location of a solute in Pluronic- surfactant supramolecular assembly: A fluorescence and neutron scattering study Prabhat K. Singh, Manoj Kumbhakar, Rajib Ganguly, V. K. Aswal, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 114, 3818-3826,* 2010.

7. Ultrafast Bond Twisting Dynamics in Amyloid Fibril Sensor Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 114,* 2541-2546, 2010.

8. Viscosity effect on the ultrafast bond twisting dynamics in an amyloid fibril sensor : Thioflavin- T Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *J. Phys. Chem. B, 114,* 5920-5927, 2010.

9. Identifying the bond responsible for the fluorescence modulation in amyloid fibril sensor Anvita Srivastava, Prabhat K. Singh, Manoj Kumbhakar, Tulsi Mukherjee, Subrata chattopadhyay, Haridas Pal and Sukhendu Nath *Chem Euro J., 16, 9257-9263,* 2010

10. Confined Ultrafast Torsional Dynamics of Thioflavin-T in a Nanocavity Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath *Phys. Chem. Chem. Phys., 2011 (Accepted)*

11. Nano-confined Charged Layer Defy the Rule of Electrostatic Interaction Prabhat K. Singh, Manoj Kumbhakar, Haridas Pal, and Sukhendu Nath (Communicated)

Srikanth Srinivasan

Enrolment No.	:	MATH10200605005
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of award of Provisional Degree	:	28.03.2011
Title of Thesis	:	New Directions in Arthmetic and Boolean Circuit Complexity

Abstract

Proving lower bounds has been a notoriously hard problem for Theoretical Computer Scientists. The purpose of this thesis is to supplement the efforts in many theorems regarding lower bounds in restricted models of computation: namely, to point out some interesting new directions for lower bounds, and take some steps towards resolving these questions. *This thesis studies the question of proving lower bounds for constant-depth Boolean circuits with help functions and noncommutative Algebraic Branching Programs with help polynomials; of proving lower bounds for monotone arithmetic circuits of bounded width; and of proving lower bounds on the size of noncommutative arithmetic circuits computing the noncommutative determinant. These problems are introduced in greater detail and the corresponding results are stated.

Publications

1. On the hardness of the noncommutative determinant. In Leonerd J. Shulman (Ed.): Proceedings of the 42nd ACM Symposium on Theory of Computing, STOC 2010, Cambridge, Massachesetts, USA, 5-8 June 2010, pp. 677-686.

Annexure - 6

Titles of M.Tech M.Phil & M.Sc. (Engg.) Theses

Titles of M.Tech. Theses Awarded Degree During April 1, 2010 to March 31, 2012

S. No	Name of the Student	Date of Award of Degree	Thesis Title
1	Shri Shiv Raj Saran	07.04.10	Investigation On The Heat Dissipation Characteristics Of Electromagnetic Coil For High Temperature Applications
2	Shri Dhruvdeep Narwat	01.05.10	Design And Development Of Digital Control And PC Interface For A Pulsed Power Supply
3	Ms. Subhaprada Pavani	02.06.10	Non Destructive Evaluation Of Empty (Fuel) Tube Appendage Welds
4	Shri Pradeep Nair	09.06.10	Design Of Ultrasonic Instrumentation And Signal Analysis For Non-Contact Ultrasonic Technique
5	Shri Vakil Nafees Ahmed	13.06.10	Performance Evaluation of Oscillatory Baffle Column Reactor for Bunsen Reaction of I-S Process
6	Shri Lokendra Kumar	17.06.10	Experimental Investigations On Melting Of N-Octadecane And P-Xylene In A Cylindrical Enclosure
7	Ms. Diptimayee Samantaray	25.06.10	Thermo-Viscoplastic Constitutive Modeling Of High Temperature Flow Behavior Of An Austenitic Stainless Steel And A Ferritic Steel
8	Shri Sandeep Gupta	28.06.10	Study The Behavior Of Fuelling Machine Assembly Coupled With The CoolantChannel Assembly For Soft Soil And Hard Rock Spectrum
9	Shri Nitesh Joshi	13.07.10	Design, Development And Experimental Study Of Static Compensator
10	Shri Manish Kumar Sijaria	13.08.10	Hydrogen Generation & Its Distribution In Containment During Postulated Accident For 700 MWe PHWRs.
11	Shri Anchal Sohaney	13.08.10	Analysis And Experimental Validation of Complex 3d Piping Network System Connected to Multiple-Rotating Machines
12	Shri Deochakke Kamlesh Suryakant	13.08.10	
13	Shri Venugopal Gude	28.08.10	Reactor Control Based On State And Fast Output Sampling Feedback
14	Shri Arvind Kumar Bind	28.08.10	Effect of Heat-Treatment and Hydrogen on Microstructural Evolution, Flow Behavior and Fracture Toughness Of Zr-2.5Nb Pressure Tube Material

15	Shri Shubhro Das	29.08.10	Development Of A New Numerical Methodology For Analyzing Tuned Mass Friction Damper
16	Shri Randhir Singh Rana	29.08.10	Development of Risk Based Maintenance Strategy for Pool Type Research Reactors
17	Shri Bhise Santanu Dnyaneshwar	29.08.10	Development of Methodology Based on Potential Measurement for Predicting Corrosion Behaviour of Ss 304l in Boiling Nitric Acid Containing Oxidizing ions
18	Shri Vivek A. Inamdar	20.09.10	Specification and Modeling of Time Triggered Architecture in an Orchestration Language
19	Shri Ajay Kumar	20.09.10	Feasibility Studies on Design of Steel Containment Subjected to Normal and Seismic Loading for AHWR
20	Shri S. Prakash	20.09.10	Development of Decoupling Criteria for Multi-Support Systems Under Seismic Loading
21	Shri Giridhar Chary	23.09.10	Development Of Integral Detector Cum Radiation Monitor
22	Shri Saurav Chauhan	23.09.10	Development of an Online Impedance Matching Unit For Plasma Load
23	Shri Shishir Kumar Singh	09.10.10	Mobile Robot Localization with Laser Range Data using Extended Kalman Filter
24	Shri Biswajit Swain	09.10.10	Studies on Hydrodynamics of Formation of Extracting Emulsions
25	Shri Mukesh Kumar Chauhan	20.10.10	Ultra High Stability Smps Based Magnet Current Regulator
26	Shri Pramod Kumar Pandey	26.10.10	Conceptual Design for Automation of Control and Instrumentation of Submarine Battery and Reliability Assessment
27	Shri T. Rajkumar	09.11.10	Thermal Hydraulic Investigations of Temperature Senstive Electromagnet of Safety Rod Drive Mechanism For Passive Safety of Fast Breeder Reactors
28	Shri T. Suresh Kumar	09.11.10	Seismic Design Of Glove Box
29	Shri Sanjeev Kumar	09.11.10	Assessment Of Pullout Forces, Conceptualisation of Pantograph Machine and Assessment & Modelling of the Link System of Pantograph Machine

30	Shri Sukant Kothari	09.11.10	Clustered Architecture In Wireless Sensor Network: Network Simulation and Implementation
31	Shri P. Balamurali	09.11.10	Evolution of a Maintenace Programme for Air Conditioning and Ventilation System Fans of Fast Breeder Test Reactor Using Condition Monitoring Tools
32	Shri Hemant Prakash Agnihotri	09.11.10	Rotor Dynamic Analysis Of Vertical Sodium Pump
33	Shri Ranga Ramakrishna	09.11.10	Development of Signal Processing Technique for Online Steam Generator Leak Detection System of Fast Breeder Reactors
34	Shri Lalit Dagre	09.11.10	Design and Development of Web Based Tool "HPCUP" (High Performance Computing Utilization Portal) for Utilization of Grid Computing and Cluster Computing
35	Shri Rajarshi Dasgupta	09.11.10	Quest for High Temperature Sensors
36	Shri P. Visweswaran	09.11.10	Numerical Simulation Of Shear Punch Test
37	Shri Venkata Satyamu Sanapala	09.11.10	Numerical Modeling and Analysis of Chopping
38	Shri Bhagwanaram	09.11.10	Hysraulic Designs of Double Suction Primary Sodium Pump for Future Fast Breeder Reactors
39	Shri Y. V. Nagaraja Bhat	09.11.10	Investigation of Siphon Time and Dripping Time of Sodium from Transfer Pot of Fast Breeder Reactor
40	Shri R. Dheenadhayalan	09.11.10	Reliability Comparison of Computer Based Core Temperature Monitoring System with Two and Three Thermocouples Per Sub-Assembly forFast Breeder Reactors
41	Shri Mente Vaijunath Mallinath	09.11.10	Experimental Investigation of Inter Wrapper Flow Under Natural Convection Decay Heat Removal in a FBR
42	Shri Anuj Kumar Deo	09.11.10	T Hermal Design of Metallic Fuel Pin & Core for Furture FBRs
43	Shri Shripal	09.11.10	Material Chaterization In Tensile Testing Using Digital Image Correlations
44	Shri M. Balamurugan	09.11.10	Mass Transfer and Hydrodynamic Studies with CFD Simulation In a Single Stage Inline Static Mixer
45	Shri Ravi Prakash Pandey	09.11.10	Dynamic Analysis Dsrdm During SSE

46	Shri Rashmi Nawlakha	09.11.10	Modeling & Simulation of Backup Control Room
47	Shri Dinesh Kumar Maurya	09.11.10	Study of Bump Mapping Techniques for Texture Mapping and its Implementation UsingGLSL
48	Ms. Urvashi N. Karnani	09.11.10	A Novel Distributed Memory File System
49	Shri Nirbhay Chandorkar	09.11.10	A Study and Implementation of Network Swap for Performance Improvement
50	Shri Sumit K. Gaur	09.11.10	Study and Design of Translation Scheme For LEC 61131-3 Complaint Function
51	Shri Abhishek Bajpai	21.11.10	Design and Development of an Optimized Hardware Encryption Module of Gigabit throughput Based on Galois Field Arithmetic for Secure Communication
52	Shri Parikshit Arunrao Dagdu	21.11.10	Software Reliability Prediction using Software Complexity Attributes
53	Shri Ansul Kumar	23.11.10	Performance Evaluation of Encryption Algorithms for Access Control System
54	Shri Rajeev Kumar Verma	23.11.10	Iterative Response Spectrum Method For Complex Piping Systems
55	Shri Harpal Singh	19.12.10	Modeling of a Large PHWR Plant for Analysis and Control Design
56	Shri Sudip Kumar Nath	19.12.10	The Deposition and Characterization Of Nb/Cu Bilayers
57	Shri Mohammad Tayyab	19.12.10	Neutron Generation from Interaction of Ultrashort Intense Laser Pulses with Matter
58	Shri Mayank Agarwal	13.01.11	Development of Risk Based Operation and Maintenance Management System for Nuclear Plants
59	Shri Chiragbhai Patidar	25.01.11	Design of Low Energy Beam Transport(LEBT) with Chopper for ISNS LINAC Front End
60	Shri Kaushik Dutta	25.01.11	Design and Fabrication of Beam Position Monitoring System using Photo-electric Effect
61	Shri Hemant Krishna	07.02.11	Spectral Imaging for Cancer Diagnosis
62	Shri Gurupreet Singh	07.02.11	Design and Development of Digital Control and PC interface for a Pulsed Power Supply using ARM controller

63	Shri Akhilesh Tripathi	10.02.11	Design and Development of 1 Mw Cw Klystron Amplifier Subsystem – a Floating Filament Power Supply
64	Shri Kuldeep Kumar Singh	10.02.11	Remotely Operated Control Unit for a Five Axes Cam Based Motorized Precision Alignment Mechanism
65	Shri Alok Singh	10.02.11	Design And Development of 25 KW Buck Converter
66	Shri Sachin Kumar Agarwal	10.02.11	Design and Development of High Performance High Power DC Power Supply
67	Shri Abhishek Borana	15.02.11	Determination Fault Tolerant Protocol for Real Distributed Systems
68	Shri Debasish Das	15.02.11	Partitioning of Metal ions from simulated high level liquid waste: and Ion-Chromatographic Study
69	Ms. Shikha Srivastava	23.02.11	ECG Analysis for Mobile based Tele-ECG
70	Shri Amit Mangal	23.02.11	Capability of the Relapfive Code to Simulate Natural Circulation behaviour in Test Facilities
71	Shri Manoranjan Dash	23.02.11	Characterising the exchange rates of (222Rn) Radon-222/Thoron(Rn-220) into Pin Holes Dosimeter for application in Inhalation Dosimetry
72	Ms. Nallgachu Sujatha Kumari	23.02.11	Design of a Tailored Multi-spectral Neutron Assembly using a 241-Am-Be Neutron source
73	Shri Sabyasachi Paul	23.02.11	Identification of Gamma Radionuclide of interest present in a Gamma spectrum using Wavelet Transformation
74	Shri Manish Chopra	23.02.11	Sensitivity and Uncertainty Analysis for Transport of Uranium and its progeny in Ground Water at Tailings Pond Site
75	Shri Sandeep Dattatraya Kanse	23.02.11	Study and Formation of distribution of Thoron gas and its progenies from Ammonium Diuranate(ADU) during PHWR spent fuel reprocessing
76	Shri Sukanta Maity	23.02.11	Studies in Distribution Coefficients(Kd) of naturally occuring Radionuclides in Geological Matrices
77	Shri Gitender Singh	23.02.11	Dissolution Studies on ThO2 and (Th-U)O2 MOX Pellets

78	Shri Nishant Chaudhary	23.02.11	Design, Development and Operation of BREMSSTRAHLUNG Converter for High Energy Electron Accelerator
79	Shri Jis Romal Jose	23.02.11	Optimization Techniques for Route Allocation in a GIS based Detection Support System(DSS) for response to Nuclear Disaster/Radiological Emergencies
80	Shri Soumyajyoti Kar	23.02.11	Response study on the Dose characteristics of extrapolation chamber for 85-Kr beta field- Experimental and Monte Carlo Methods
81	Shri Manjunath B. S.	03.03.11	Determination Of Master Curve for 20MnNi55 Ferritic Steel Using Micro-Mechanical Modeling
82	Shri Lokpati Mishra	15.03.11	Assessment of Internal Contamination factor of Uranium in case of exposure to a mixture of Radionuclides using an array of HPGe Detectors
83	Shri Sandeep Bhowmick	15.03.11	Thermal Denitration of Ammonium Nitrate Solution in a Fluidized Bed Reactor
84	Shri Sourav Mukhopadhyay	18.03.11	Design of Integrated Photodiode and Readout Electronics Asic In 0.35 ì CMOS Process
85	Shri Anuj Soni	28.03.11	Development of Oxide based Crystalline and Polycrystalline OSL Phosphorus Al2O3:C and Al2O3:B for applications in Personal and Environmental Dosimetry
86	Shri Babalu M Lingade	28.03.11	Heat Transfer and Stability Studies in a Supercritical Natural Circulation Loop

Titles of M.Phil Theses Awarded Degree During the period April 1, 2010 to March 31, 2012

Sr. No	Name of the Student	Date of Award of Degree	Thesis Title
1.	Ms. Kshama Kundu	23.07.10	Camphone-10 Sulphonic Acid Catalyzed Mannich Type Reactions; Synthesis of -Amino Carbonyl Compounds
2.	Shri Kartikey Kumar Yadav	13.08.10	Kinetic Studies of Uranium Recovery from Phosphoric Acid by solvent Extraction
3.	ShriVineet Sharma	15.02.11	A Variational Study of Self Stable Dipolar Bose Einstein Condensates

Titles of M.Sc. (Engg.) Theses Awarded Degree During April 1, 2010 to March 31, 2012

Sr. No	Name of the Student	Date of Award of Degree	Thesis Title
1.	Shri Pusker D. Bhatt	06.05.10	Design, Optimization and Performance Evaluatiojn of R.F. Grounding System
2.	Shri Kanchan Gaain	23.07.10	Study of Active Magnetic Bearing System
3.	Shri Parag Balaram Walinjkar	30.12.10	Condition Monitoring of Distillation Columns using Gamma Monitoring
4.	Shri K.C.Sandeep	02.02.11	Mathematical Modeling, Simulation and Validation of the Code for Steam-Methane Reformer for Fuel Cell Applications

Annexure - 7

Memoranda of Understanding with CFA and with IIT Kanpur

Implementing Agreement

between

The Commissariat à l'énergie atomique et aux énergies alternatives

and

Homi Bhabha National Institute

of The Department of Atomic Energy, Government of the Republic of India

in the field of PhD education within common scientific programs

The ***Commissariat à l'énergie atomique et aux énergies alternatives***, a French state-owned research entity with a scientific, technical or industrial activity duly organised under the laws of France and having its registered office located at Bâtiment Le Ponant D-25, rue Leblanc- Paris 15ème (France) - and declared at the Paris Register of Commerce and Trade ("*Registre du Commerce et des Sociétés de Paris*") under the following registration number: R.C.S. PAR S B 775 685 019,

Represented by Mr Bernard BIGOT, acting as "Administrateur général",
Hereafter referred to as "**CEA** ",

On the one hand

Homi Bhabha National Institute of the Department of Atomic Energy (DAE) of the Government of the Republic of India, headquartered at Training School Complex, Anushaktinagar, Mumbai 400 094, India,

Represented by Dr. R.B. Grover, acting as 'Director"

Hereafter referred to as "**HBNI**",

On the other hand

Hereunder referred to collectively as "Parties" or individually as "Party",

WHEREAS CEA and DAE have signed on December 6, 2010 a Cooperation Agreement in the field of nuclear science and technology for peaceful uses of nuclear energy (hereinafter referred to as "the CEA-DAE Cooperation Agreement");

WHEREAS the Government of the French Republic and the Government of the Republic of India have signed on December 6, 2010 an agreement concerning intellectual property rights on the development of the peaceful uses of nuclear energy (hereinafter referred to as "IP Agreement");

WHEREAS the Homi Bhabha National Institute (hereinafter referred to as "HBNI") is established under DAE's authority with a deemed to be university status with the following units of DAE as the Constituent Institutions (CIs) of HBNI:

1. Bhabha Atomic Research Centre (BARC), Mumbai
2. Indira Gandhi Centre for Atomic Research (IGCAR) , Kalpakkam
3. Raja Ramanna Centre for Advanced Technology (RRCAT), Indore
4. Variable Energy Cyclotron Centre (VECC) Kolkata
5. Saha Institute of Nuclear Physics (SINP), Kolkata
6. Institute of Plasma Research (IPR), Gandhinagar
7. Institute of Physics (IOP), Bhubaneswar
8. Harish-Chandra Research Institute (HRI) , Allahabad
9. Tata Memorial Centre (TMC), Mumbai
10. Institute of Mathematical Science (IMSc), Chennai

WHEREAS CEA on one hand, DAE and HBNI on the other hand, plan to intensify the long-standing cooperation between various laboratories and/or institutes of CEA and various CIs of HBNI on selected topics of the fundamental scientific research in the field of nuclear science and technology for peaceful uses of nuclear energy and the education of young scientists and/or students of either Party (hereinafter referred to as the "Scientists");

WHEREAS this cooperation between the laboratories and/or institutes should be organized in order to have a long lasting joint PhD program for Indian and French students (hereinafter referred to as "PhD Students");

WHEREAS the setting up of a procedure of a PhD program on common scientific programs (hereinafter referred to as the "PhD Collaboration Program"), as a first step, will

strengthen ties between the laboratories and/or institutes in India and France and help to create a long lasting scientific and personal friendship between the Scientists in the two countries. The broad spectrum of common scientific research interests is the basis on which the PhD Collaboration Program will be founded.

THEREFORE the Parties have agreed to conclude this implementing agreement (hereinafter referred to as the "Implementing Agreement"), as follows, in accordance with article 5 of the CEA-DAE Cooperation Agreement:

ARTICLE 1. NEED FOR THE PhD COLLABORATION PROGRAM

Successful scientific collaborative works with joint publications will not only help in enhancing the scientific and technical knowledge and the standard of research but would also motivate close contacts over a long period of time. It is expected that open minded interaction between these young Scientists, who will undoubtedly be the future leaders, will be of utmost importance to seed further scientific collaborations between both countries.

The proposed concept is of interest to the Parties as it allows:

i) the scientific education in the institutes of excellence outside of the country, for a period of one to two years, with a return to the home institute;
ii) access to specific experimental and computing facilities;
iii) contact with the international scientific community connected with Parties' research interests;
iv) access to the dynamic Indian and French science evolution for many years.

ARTICLE 2. AIMS, SCOPE AND FORMS OF THE PhD COLLABORATION PROGRAM

The objective of PhD Collaboration Program established under this Implementing Agreement is to increase close co-operation in research and education of Scientists in the laboratories and/or institutes under the aegis of the Parties and to exchange scientific results on an organized basis.

This Implementing Agreement shall cover the topics related to nuclear science and technology for peaceful uses of nuclear energy.

The Parties will agree on the time schedule of each visit. The visiting Party would inform the other party about the identity of each visitor sufficiently in advance to enable the welcoming party to make timely arrangements for hosting the visitor and for processing the administrative formalities.

Scientists of one Party who stay at the research institutes of the other Party during the duration of this Implementing Agreement are subjected to the operating instructions of the other Party. Each Party commits to comply with all the regulations concerning operational safety in the installation of the other Party.

ARTICLE 3. JOINT SCIENTIFIC COMMITTEE

3.1 The Parties hereby agree to establish a joint scientific committee ("the Joint Scientific Committee") responsible for the implementation of the PhD Collaboration Program. Each Party shall nominate three members to the Joint Scientific Committee and among them, a co-chairman. The Joint Scientific Committee will meet regularly, at least once a year, alternatively in France and India.

3.2 The Joint Scientific Committee will be responsible for the following:

i) review and approval of proposed common scientific sub-programs within the scope of the PhD Collaboration Program proposed by one of the members of the Joint Scientific Committee (hereinafter referred to as 'Common scientific sub-programs"),

ii) for each of the selected Common scientific sub-programs, selection of PhD Students, one from each Party. The French and Indian PhD Students may work on Common scientific sub-programs, but on different aspects; and

iii) for each selected Common scientific sub-program, designation of two co-supervisors, one from each Party.

The co-supervisors may attend a Joint Scientific Committee meeting, on the request of the co-chairmen.

3.3. The Joint Scientific Committee shall provide an annual report on the implementation of this Implementing Agreement to the Franco-Indian Joint Committee for Atomic Energy.

ARTICLE 4. COMMON SCIENTIFIC SUB-PROGRAM

The details of a Common scientific sub-program agreed within the PhD Collaboration Program are specified in Annex A which forms an integral part of this Implementing Agreement.

ARTICLE 5. REVIEW OF THE PhD COLLABORATION PROGRAM- DEFENSE

The co-supervisors shall jointly review the work performed by the PhD Student and meet at least once between two meetings of the Joint Scientific Committee. They shall jointly attend the defense by the PhD Student, conducted at the end of his/her PhD.

The appointment of examiners and conduct of defense shall be as per the rules governing the PhD program of the institute in which the PhD Student is enrolled. Thus a PhD Student enrolled in the French institute shall be governed by the French rules and the one enrolled in the Indian institute shall be governed by the Indian rules.

ARTICLE 6. FINANCE

In accordance with article 8 of the CEA-DAE Cooperation Agreement, the Party assigning its PhD Student shall be responsible for the salaries and expenses related to international travel incurred on that PhD Student. Living expenses, accommodation and internal travel if any, undertaken in connection with the work related with the problem of the PhD Student whilst on attachment shall be borne by the receiving Party in accordance with the rules in the hosting country applicable, as the case may be, to doctoral students/ post-docs/scientific visitors of the category in which the scientist is visiting.

ARTICLE 7. INTELLECTUAL PROPERTY / PATENTS

The general provisions provided for in the IP Agreement are applicable also to this Implementing Agreement.

Parties shall exchange technical information and knowledge obtained by the Parties under this Implementing Agreement or have been obtained prior to it or independently of it to the extent that they are necessary for the performance of the Implementing Agreement.

except for the technical information and knowledge that the Parties are prohibited from disclosing under an agreement with a third party.

Any information and technology which is held by one Party prior to the conclusion of the agreement or, acquired in parallel with it, or acquired solely by one Party, shall remain the sole property of that Party and shall be treated as confidential information pursuant to Article 8 of this Implementing Agreement.

The exploitation rights of own information and technology and/or Joint Results, as defined in the IP Agreement, generated under the PhD Collaboration Programs as well as the details of the preparation, filing, prosecution and maintenance of patent applications within these programs shall be governed by the provisions of the IP Agreement or otherwise agreed in a separate agreement on a case to case basis. Parties grant each other a non-exclusive, non-transferable, royalty-free license without the right to sublicense, for the duration of this Implementing Agreement, on its own information and technology and/or Joint Results generated under the PhD Collaboration Programs for their own internal research activities.

No Party shall assign or otherwise transfer to any third party in whole or in part any of its right or obligation under this Implementing Agreement, without the prior consent of the other Party.

ARTICLE 8. CONFIDENTIALITY

Confidentiality shall be governed by the provisions of the CEA-DAE Cooperation Agreement.

ARTICLE 9. PUBLICATION

9.1 Each Party may freely publish its own information and technology generated by its PhD Students.

9.2 Each Party may publish the own information and technology generated by the PhD Students assigned by the other Party and/or Joint Results only after giving a copy of the publication to the other Party, through its co-chairman of the Joint Scientific Committee, at

least thirty (30) days prior to the intended submission for publication to allow the other Party to review the materials for any inadvertent disclosure of patentable materials and/or for any inadvertent disclosure of the other Party's Confidential Information as defined in the CEA-DAE Cooperation Agreement. The Party that intends to publish will refrain from publication of the other Party's Confidential Information, provided the Party has raised an objection within the above thirty (30) days period.

ARTICLE 10. MISCELLANEOUS

10.1 Liability issues shall be governed by the provisions of the CEA-DAE Cooperation Agreement.

10.2 This Implementing Agreement and each action related thereto shall be ruled by the terms and conditions of the CEA-DAE Cooperation Agreement, unless otherwise specified therein.

ARTICLE 11. DURATION, TERMINATION

11.1 This Implementing Agreement shall enter into force at the same date as the CEA-DAE Cooperation Agreement and shall continue for 5 (five) years.

11.2 Ancillary agreements, amendments and additions hereto must be made in writing.

11.3 Settlement of disputes shall be governed by the provisions of the CEA-DAE Cooperation Agreement.

In witness whereof, the Parties have caused this Implementing Agreement to be executed and signed in duplicate in English by their respective duly authorised representatives.

For HBNI

Date : 6/12/2010
Place : New Delhi

for the CEA

New Delhi

ANNEX A

Details of a Common scientific sub-program

1. Involved institutes:

In India: Bhabha Atomic Research Centre (BARC), Indira Gandhi Centre for Atomic Research (IGCAR) , Kalpakkam Raja Ramanna Centre for Advanced Technology (RRCAT), Indore and other constituent institutions of HBNI

In France : Divisions of CEA (DEN, DSM, DRT, DSV)

2. Details

As first step a PhD thesis work assigned to an Indian or French student is formulated within a Common scientific sub-program. This will be organized in the following way:

• The Indian or French institute nominates a PhD Student for the Common scientific sub-program after verifying that the PhD Student fulfills the conditions for a PhD education in their respective countries i.e in connection with the Homi Bhabha National Institute (HBNI) and the French university involved.

• The experimental and theoretical background of the work has to be determined. An early personal contact is desired by way of short exchange visits of a maximum duration of one week to the institutes in India and the CEA centre in France.

• A time schedule has to be fixed:

1. For Indian PhD Students: As the standard PhD time in India is between 4 to 5 years which are financially covered by a contract at the Indian institute, the following time table is possible:

- First Year (India): Introduction by the Indian supervisor into the PhD topic: This must cover theory and experimental techniques which are planned to use in the laboratories in France. The scientist, either a student or a DAE employee, gets financial support by the Indian institute.

- Second to third Year (France): Experimental work of the PhD thesis is conducted under the guidance of the French supervisor with continuing contacts with the home institute. The scientist is incorporated into a centre of CEA.

- Fourth to Fifth Year (India): Return to the Indian home institute, evaluation of the experimental information and technology and writing up the PhD thesis. This time is financially covered by the Indian side.

2. **For French PhD Students:** The French PhD Student concludes with the CEA a three year PhD contract which guarantees a salary during the whole contract period.

- First Year (France): Introduction by the French supervisor into the PhD topic. This must cover theory and experimental techniques which are planned to be used in the laboratories in India.
- -Second Year (India): Theoretical or Experimental work of the PhD thesis is conducted under the co-guidance of the Indian supervisor with continuing contacts with CEA. The French PhD Student is incorporated into an institute of DAE.
- Third Year (France): Return to CEA, to continue research and write up the PhD thesis.

MEMORANDUM OF UNDERSTANDING
BETWEEN
HOMI BHABHA NATIONAL INSTITUTE
AND
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

1. Preamble

Indian Institute of Technology Kanpur (hereafter referred to as IITK) is a premier educational institution in science and technology and the Homi Bhabha National Institute (hereafter referred to as HBNI), a Deemed to be University, is a newly established institute under the aegis of the Department of Atomic Energy (hereafter referred to as DAE), Government of India. For the purpose of academic programmes, the following units of DAE are the Constituent Institutions (CIs) of HBNI:

1. Bhabha Atomic Research Centre (BARC), Mumbai
2. Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam
3. Raja Ramanna Centre for Advanced Technology (RRCAT), Indore
4. Variable Energy Cyclotron Centre (VECC), Kolkata
5. Saha Institute of Nuclear Physics (SINP), Kolkata
6. Institute of Plasma Research (IPR), Gandhinagar
7. Institute of Physics (IOP), Bhubaneswar
8. Harish Chandra Research Institute (HRI), Allahabad
9. Tata Memorial Centre (TMC), Mumbai.
10. Institute of Mathematical Science (IMSc), Chennai

RECOGNISING the long standing collaboration and cooperation between IITK and some of the CIs of HBNI through programmes such as collaborative research supported by extra-mural funding through the Board of Research in Nuclear Sciences (BRNS), a body under DAE, or directly through allocation under five year plans; pursuit of M.Tech. provided they fulfil eligibility criteria set by IITK under the DAE Graduate Fellowship

Scheme (DGFS) wherein the candidates assigned for employment in some of the CIs of HBNI study in an IIT, including IITK, and carry the projects under the joint supervision of the faculty from the IITs and the scientists from the CIs of HBNI, lectures by IITK faculty at BARC and by BARC scientists at IITK, and

RECOGNISING that certain collaborative programmes are ongoing because of individual initiative such as pursuit of research leading to Ph.D. by employees of CIs under the external registration programme of IITK and co supervision of Ph.D students at IITK by the scientists of C.I and the faculty of IITK, and

RECOGNISING that, in view of the establishment of HBNI, while continuing the existing programmes as of present, there is scope of further expansion of the existing collaboration and cooperation, the IITK and HBNI, collectively referred to as "Partner Institutes".

HEREBY agree to create a long-term institutional partnership in education and research, including the possibility of enhanced funding from BRNS for research in the areas of mutual interest, according to the broad framework set forth in this Memorandum of Understanding (MoU).

2. Objective

To enhance collaborative research in the areas of mutual interest, both in extent and scope, by using the medium of research students enrolled in the Partner Institutes.

3. Modalities of cooperation

A student registered under a supervisor for M.Tech./Ph.D. in one Partner Institute (hereafter referred to as Parent Institute) can have a co-supervisor from the other Partner Institute. To that end, the supervisor from the Parent Institute of the student will identify and seek concurrence of a faculty member from the Partner Institute to take up the responsibility of being a co-supervisor. The arrangement will come into effect after the

supervisor and the co-supervisor obtain approval for the same from their respective institute.

The Ph.D student in one Partner Institute may carry a part of the course work in the other Partner Institute with credit transfer. In Particular.

1) The credits to be awarded to the student for attending a course in the Partner Institute will be determined by the Parent Institute of the student. The award of credits will go through the procedures laid out by the Parent Institute.

2) To facilitate the process of a student attending a course in the Partner Institute, the supervisor of the student will put up the proposal (in consultation with appropriate academic bodies of the Department) to the Dean, Academic Affairs (IITK)/Dean (HBNI) – as the case may be.

The Parent Institute shall be responsible for paying to the Partner Institute the tuition fee, if any, for participation of its students in the course work conducted at the Partner Institute.

The ongoing exchange of faculty for lectures and research for short periods shall be further strengthened.

A mechanism shall be formulated to identify the research areas of mutual interest and for possible funding for the same from BRNS.

The issues related with the Intellectual Property Right (IPR) with regard to the outcomes of the collaborative research and the outcomes of projects/thesis work carried under the joint supervision of the faculty from the Partner Institute shall be governed by the IPR regulations of the Government of India.

4. Implementation

This MoU becomes effective from the date it is signed by the Partner Institutes and will be valid for an initial period of five years. The agreement may be extended by mutual consent. In case one Partner Institute wishes to cancel the MoU, written intent to that effect will have to be communicated by June of that year. The MoU in that event will cease to be operative from the end of the year i.e. from December 31 of the year in question. However, the commitments already made under this MoU before its lapse or termination will be fulfilled.

For implementation of this MoU, the following will be the contact persons:

.. From HBNI - Dean HBNI

.. From IITK - Dean (Academic Affairs)

Signed on (date) 24th day of Dec 2010

For and on behalf of
Homi Bhabha National Institute

(R.B. Grover)
Director, HBNI

(Seal) डॉ आर. बी. ग्रोवर/DR. R. B. GROVER
निदेशक, होमी भाभा राष्ट्रीय संस्थान
Director, Homi Bhabha National Institute
सेंट्रल कॉम्प्लेक्स, बी.ए.आर.सी.
Central Complex, B.A.R.C.
मुंबई-400085./Trombay, Mumbai-400085.

Witness by:
(Dr R.R. Puri)
Head, HRDD and Dean, HBNI

For and on behalf of
Indian Institute of Technology Kanpur

(Sanjay G. Dhande)
Director, IIT Kanpur

(Seal) निदेशक Director
भारतीय प्रौद्योगिकी संस्थान कानपुर
Indian Institute of Technology Kanpur

Witness by:
(Prof. Sanjay Mittal)
Dean (Academic Affairs) IIT Kanpur

Annexure - 8

Receipts & Payments for the financial year ending on 31.3.2011

RECEIPTS & PAYMENTS ACCOUNT
FOR THE FINANCIAL YEAR ENDING ON 31.03.2011

Payment	Amt.(Rs.)	Amt.(Rs.)	Receipt	Amt.(Rs.)	Amt.(Rs.)
Honararium paid to			Opening balance	2,069,646.00	2,069,646.00
Prof. J C Mondel		1,200.00			
			Receipt/Admission/Registration Fees	2,121,000.00	
Re-imbursement of tution fees		14,104.00	Less: - Refund of fees	5,000.00	2,116,000.00
Miscellaneous expenditure		5,470.00	Bank Interest on savings as on 30.06.2008	34,446.00	
Bank Charges (charges for o/s cheques)		120.00	as on 31.12.2008	49,977.00	84,423.00
Excess of Income over Expenditure (represented by bank balance in		4,249,175.00			
a/c 3012832251-2 as on 31.03.09)					
		4,270,069.00			4,270,069.00

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