होमी भाभा राष्ट्रीय संस्थान

HOMI BHABHA NATIONAL INSTITUTE

ANNUAL REPORT
2009-2010

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

HOMI BHABHA NATIONAL INSTITUTE

ANNUAL REPORT 2009-2010

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

1. Constituent Institutions (CIs) of the Institute

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. TATA MEMORIAL CENTRE (TMC), MUMBAI
10. INSTITUTE OF MATHEMATICAL SCIENCES (IMSC.), CHENNAI

2. From the Director

I am happy to write for the fifth annual report of the Institute and all round progress made by the Institute makes me proud to do it. The year was devoted to consolidation of all ongoing programmes. It is heartening to note that in a short span of time, the Institute has established its status as a multi-disciplinary research university and number of memoranda of understanding signed with prestigious institutes is a testimony of its stature.

In the field of science and engineering, multidisciplinary research by large teams has now become commonplace and is needed to progress further. However, it is a challenge for research managers since they have to assemble large multi-disciplinary teams to find solutions to problems that confront them in today's environment.

DAE Graduate Fellowship Scheme (DGFS) for Ph.D. is a small step to address "this problem". It aims at solving problems which lie at the interface of different, but related disciplines and they do so under supervision of more than one person: one having expertise in basic research and the other having expertise in applied aspects. Wherever possible, we choose experts from across CIs of the Institute. During the year, students, who have already completed a M.Tech., were admitted for Ph.D. programme under this scheme. To give a flavour of what kind of subjects were chosen, I'll give two examples. One student is working on "securing multimedia communication" under the guidance of an electronics engineer from Bhabha Atomic Research Centre and a mathematician from Institute of Mathematical Sciences. For all issues related to cyber security one needs expertise in both electronics and mathematics. Another student is working on "development of organic and organic-inorganic hybrid solar cells" under the guidance of a physicist and a material scientist, both from Bhabha Atomic Research Center. We have to watch the progress made by students over the years and fine tune the scheme to ensure its success in terms of two deliverables: Ph.D. for the student and a true multi-disciplinary research output. It is, of course, already serving one purpose and that is integrating the research community in the Institute.

There is a related issue. Many of the problems being addressed today involve large teams and large research and development laboratories have been set up to address such problems. Research papers addressing such problems invariably have multiple authors. In case of high energy physics, number of authors could be in hundreds. While problems where it is necessary to employ large teams have to addressed, it poses a challenge for human resource managers in laboratories and education administrators in universities. It calls for devising objective systems to judge contribution from an individual to a group activity before considering him or her for awarding a research based degree or any other award such as a promotion. I welcome suggestions in this regard.

(R B Grover)

3. Annual Report 2009-2010

Composition of various bodies

Institute functioned as per the decisions taken by various bodies of the Institute. Composition of various bodies is given in the Annexure-1. It also lists officers of the Institute.

Academic Activities

The academic programmes at the CIs of HBNI were conducted as per schedule. The Annexure-2 lists the Standing Committees whereas the status of admissions during the year in various programmes in each CI is placed at Annexure-3. The list of faculty is placed at Annexure-4.

The abstracts of the theses fulfilling all the formalities for the award of the Degree of the Doctor of Philosophy are placed at Annexure-5.

The titles of M.Tech theses fulfilling all the formalities for the award of the Degree of the Master of Technology are placed at Annexure-6.

A Memorandum of Understanding for academic cooperation and exchange was entered in to with the University of Virginia. It is placed at Annexure-7.

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. Sixth meeting on November 28, 2009, OYC, Mumbai.

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

1. Tenth meeting on October 31, 2009.

Important decisions taken in these meetings are summarized below.

A. Important decisions taken in the meetings of the Council of Management Sixth meeting: November 28, 2009

1. The CoM approved amendment of MoA and Rules to change the address of the registerd office of HBNI from Knowledge Management Group, Central Complex, BARC, Mumbai-400085 to Training School Complex, Anushatinagar, Mumbai-400094.
2. The CoM discussed the issue of mandatory inclusion of course work on Research Methodology specified by the UGC Gazette notification. The Council opined that the generic courses in Research Methodology should be identified and introduced after a careful assessment of course work being pursued at present by the students.
3. The CoM approved the issue of Degree Certificates to the candidates declared as passed to date under various programmes of HBNI.
4. The CoM gave its consent to negotiate terms of the MoU with CEA, France for exchange of Research Scholars.

5. This was the last meeting to be Chaired by Dr. Anil Kakodkar who was to relinquish the office of Chairman, Atomic Energy Commission on November 30, 2009. The members placed on record their appreciation of his efforts in establishing and shaping HBNI.

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

Tenth meeting: October 31, 2009

1. It was decided to recommend to the Council of Management (CoM) to include National Institute for Science Education and Research (NISER) as 11th Constituent Institution of HBNI.
2. It was decided to recommend to CoM to approve constituting the Board of Undergraduate Studies in Science. The number of members and other terms and conditions of the proposed board to be the same as that of the existing Board of Studies.
3. Director, NISER was requested to draft ordinances to govern the academic programmes at NISER. It was decided that, till the time the ordinances are drafted and approved, NISER may conduct academic programmes as per best practices for similar courses in the country.
4. It was decided that the candidates possessing the degree of M.Sc. by research will be eligible for registration in the Ph.D. programme. Such candidates generally will have to undertake one year course work in the Training School even if they are employees in a CI. The guidelines for exemption from part of the course work were outlined.
5. Minimum pass percentages for various courses were decided.
6. It was decided that the M.Sc. part of the integrated M.Sc.-Ph.D. programme be restricted to two years.
7. It was decided to seek the CoM's advice on the question of desirability and practicality of holding Convocation

4. Receipt & Payments for the financial year ending on 31.3.2010 are given in Annexure 8.

Annexure - 1

Composition of the Bodies of the Institute

Council of Management
(CoM)

Dr. Anil Kakodkar Chairman, AEC	Chairman	
Shri V.V.Bhat Member Finance, AEC	Member	
Shri R. P. Agrawal Secretary Higher Education, MHRDD	Member	up to October 2009
Ms Vibha Puri Das Secretary Higher Education, MHRDD	Member	since Nov. 24, 2009
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	
Dr. Baldev Raj Director, IGCAR	Member	
Dr. S. Banerjee Director, BARC	Member	
Dr. R.A. Badwe Director, TMC	Member	
Dr. R.B. Grover Director HBNI	Member	
Prof. P.K.Kaw Director, IPR	Member	
Dr. R.R. Puri Dean HBNI	Member-Secretary	

Academic Council
(AC)

Prof. R.B. Grover	Chairman
Prof. S.K. Apte	Convener Board of Studies in Life Sciences
Dr. R. A. Badwe	Director, TMC
Prof. D. Balasubramanian	Director, Eye Research Foundation, Hyderabad
Prof. R. Balasubramanian	Director, IMSc
Prof. Baldev Raj	Director, IGCAR
Prof. S. Banerjee	Director, BARC
Prof. R.K.Bhandari	Director, VECC (since July, 2009)
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. E.D. Jemmis	IISc, Bangalore
Prof. P.Mohandas	Convener, Board of Health Sciences
Prof. V. Venugopal	Convener Board of Studies in Chemical Sciences
Prof. Gangan Prathap	CSIR Centre for Mathematical Modeling and Computer Simulation, Bangalore.
Prof. K.L. Ramakumar	Convener Board of Strategic Studies
Prof. A. Raychaudhuri	Director, HRI
Prof. M.K. Sanyal	Director, SINP (since July 2009)
Prof. Abhijit Sen	Convener Board of Studies in Physical Sciences
Prof. Sinha Bikash	Director, VECC and SINP (till June 2009)
Prof. V. S. Sunder	Convener Board of Studies in Mathematical Sciences

Prof. Y. P. Viyogi	Director, IoP (till June 2009)
Prof. A. M. Jayannabar	Director, IoP (since Nov. 2009)
Prof. R.R. Puri	Member Secretary

Advisory Committee

Dr. Anil Kakodkar Chairman, AEC	Chairman
Dr. R.A.Badwe Director, TMC	Member
Prof. R. Balasubramanian Director, IMSc	Member
Dr. Baldev Raj Director, IGCAR	Member
Dr. S. Banerjee Director, BARC	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 (since July 2009)
Dr. M.K.Sanyal Director, SINP	Member (since July 2009)

Prof. Sinha Bikash Director, VECC and SINP	Member (till June 2009)
Prof. Y.P. Viyogi Director, IoP	Member (Till June 2009)
Prof. A.M.Jayannabar Director, IoP	Member (Since Nov 2009)
Dr. R.R. Puri Dean, HBNI	Member-Secretary
Dr. P. Mukherjee JS(R&D)	Invitee

Board of Studies of HBNI

Physical Sciences

1. Prof. Abhijit Sen (IPR) Convener
2. Prof. V.M. Datar (BARC)
3. Prof. C.S. Sundar (IGCAR)
4. Prof. Dinesh Srivastava (VECC)
5. Prof. Avinash Khare (IOP)
6. Prof. P.K. Gupta (RRCAT)
7. Prof. Pinaki Majumdar(HRI)
8. Prof. Kamles Kar (SINP)
9. Prof. Ghanashyam Date (IMSc)
10. Prof. Srinivas Ramakrishnan (TIFR)

Chemical Sciences

1. Dr. V. Venugopal (BARC) Convener
2. Dr. J.V. Yakhmi (BARC)
3. Dr. V.K. Manchanda (BARC)
4. Dr. Swapan Ghosh (BARC)
5. Dr. K.S. Viswanathan (IGCAR)
6. Dr. T. Gnanasekaran (IGCAR)
7. Dr. V.K Jain (BARC)
8. Prof. P.N.Bajaj (BARC)

Life Sciences

1. Dr. S.K. Apte (BARC) Convener
2. Dr. (Mrs.) S.M. Zingde (TMC)
3. Dr. S.F. D'Souza (BARC)
4. Prof. Rita Mulherkar (TMC)
5. Prof. M.Seshadri (BARC)
6. Prof. A.K.Sharma (BARC)
7. Prof. B.J.Rao (TIFR)

Engineering Sciences

1. Prof. B.K. Dutta(BARC) Convener
2. Prof. T. Jayakumar (IGCAR)
3. Prof. P.K. Vijayan (BARC)
4. Prof. D. Sathiyamoorthy (BARC)
5. Prof. Kallol Roy (BARC)
6. Prof. A.P. Tiwari (BARC)
7. Prof. A. K. Suri (BARC)
8. Prof. Kamachi Mudali (IGCAR)
9. Prof. P.V. Varde (BARC)
10. Prof. Dr. D.N.Badodkar (BARC)

Mathematical Sciences

1. Prof. V.S. Sunder (IMSc) Convener
2. Prof. S. Kesavan (IMSc)
3. Prof. Prof. B. Ramakrishnan (HRI)
4. Prof. R.R. Puri (BARC)
5. Prof. V. Arvind (IMSc)
6. Prof. N. Raghwendra (HRI)
7. Prof. R.C.Cowsik (MU)
8. Prof. Murali Srinivasan (IIT-B)
9. Prof. Madhav Mukund (CMI)

Strategic Studies

1. Dr. K.L. Ramakumar (BARC) Convener
2. Dr. A.K. Kohli (BRIT)
3. Dr. Subhash Chandra (DAE)
4. Dr. B.B. Singh (ex-BARC and Scientific Advisor, High Court Mumbai)
5. Prof. Rangan Banerjee (IIT-Bombay)

Board of Health Sciences

1. Prof. K.Mohandas (TMC)
2. Prof. K.B.Sainis (BARC)
3. Dr. Rajiv Sarin (TMC)
4. Dr. H.B.Tongaonkar (TMH)
5. Dr. S.B.Banavali (TMH)
6. Dr. S.K.Srivastava (TMC)
7. Dr. N. Jambekar (TMC)
8. Prof. Shobha Bhatia (KEM)
9. Prof. Avinash Supe (KEM)
10. Dr. M.G.R.Rajan (BARC)

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
Shri K. Padmanabhan	Administrative Officer (Till 22.07.2009)
Shri Mahabir Singh	Accounts Officer (Till 31.05.2009)

Deans-Academic at the CIs

BARC

Prof. S.K. Apte - Life Sciences
Prof. B.K. Dutta - Engineering Sciences
Prof. V.M. Datar - Physical Science
Prof. Swapan Ghosh - Chemical Sciences

IGCAR
Prof. K.S. Viswanathan

RRCAT
Prof. S.C.Mehendale (Till September 2009)
Prof. S.B.Roy (Since September 2009)

VECC
Prof. P. Barat
Prof. D. Sarkar

SINP
Prof. Parthasarathi Majumdar

IPR
Prof. Abhijit Sen

IoP
Prof. Avinash Khare

TMC
Dr. K.M. Mohandas

IMSc
Prof. S. Kesavan - Mathematical Sciences
Prof. T.R. Govindarajan - Physical Sciences

HRI
Prof. Biswarup Mukhopadhyaya (Till June 2009)
Prof. Sukumar Das Adhikari (Since June 2009)

Annexure - 2

Standing Committees

BARC Standing Committees

Physical Sciences and Mathematical Sciences

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

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.	Shri S. Kotaiah	Member	Till December 2009
3.	Dr. P.K. Gupta	Member	
4.	Dr. L.M. Kukreja	Member	
5.	Shri C.P. Navathe	Member	
6.	Dr. G.S. Lodha	Member	
7.	Dr. Pitamber Singh	Member	From January 2010
8.	Dr. S.B. Roy	Member	Convener from January 2010
9.	Dr. P.A.Naik	Member	From January 2010
10.	Dr. S.K.Deb	Member	From January 2010
11.	Dr. S.M.Oak	Member	From January 2010
12.	Shri P.R.Hannurkar	Member	From January 2010
13.	Dr. S.C.Bapna	Member	From January 2010
14.	Dr. Arup Banerjee	Member	From January 2010
15.	Dr. A. Chowdhury	Member	From January 2010
16.	Dr. S.C. Mehendale	Convener till December 2009 and Member from January 2010	

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

Admission Statistics

HOMI BHABHA NATIONAL INSTITUTE

Admissions: 2009-10

S. No.	Programme	BARC	IGCAR	RRCAT	VECC	SINP	IPR	IOP	HRI	TMC	IMSc	TOTAL
1	PGD*	289	49	23	0	0	0	0	0	0	0	361
2	PGDRM	4	0	0	0	0	0	0	0	0	0	4
3	PGDMRIT	2	0	0	0	0	0	0	0	0	0	2
4	DipRP	22	0	0	0	0	0	0	0	0	0	22
5	I. M.Sc.	0	0	0	0	0	0	48	0	0	0	48
6	M. Sc. (Engg.)	12	2	0	0	0	0	0	0	0	0	14
7	M. Tech.	13	24	11	0	0	0	0	0	0	0	48
8	M. Phil.	2	0	0	0	0	0	0	0	0	0	2
9	Ph. D. (Engg.)	48	38	2	1	0	0	0	0	0	0	89
10	Ph. D. (Phys.)	22	6	9	16	7	3	6	2	0	12	83
11	Ph. D. (Chem.)	24	3	0	0	0	0	0	0	0	0	27
12	Ph. D. (Life)	9	0	2	0	0	0	0	0	18	0	29
13	Ph. D. (Math.)	0	0	0	0	0	0	0	6	0	4	10
14	Ph. D. (Hlth.)	0	0	0	0	0	0	0	0	3	0	3
15	Ph. D. (Stra.)	0	0	0	0	0	0	0	0	0	0	0
16	I. PhD (Phys.)	0	0	0	0	0	0	0	8	0	3	11
17	I. PhD (Math.)	0	0	0	0	0	0	0	0	0	3	3
18	M. Ch.	0	0	0	0	0	0	0	0	2	0	2
19	M. D.	0	0	0	0	0	0	0	0	18	0	18
20	D. M.	0	0	0	0	0	0	0	0	7	0	7
21	D. A.	0	0	0	0	0	0	0	0	0	0	0
22	Fellowship	0	0	0	0	0	0	0		18	0	18
Total		447	122	47	17	7	3	54	16	66	22	801

Total-PhD No.: 255
Actual Admission No.: 783-(MTech+MPhil) No.= 751
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, 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

Annexure 4

Faculty List (Up to March 2010)

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. Chaurasia S.C.
17. Das D.
18. Das S.K.
19. Dash S.
20. Deo M.N.
21. Dutt G.B.
22. Ganguly R.
23. Ghosh S.K.
24. Ghosh Swapan
25. Goswami A.
26. Jaikumar Sunil
27. Jain V.K.
28. Jha S.K.
29. Kalsi P.C.
30. Kapoor Sudhir
31. Kayasth S.R.
32. Krishnamurthy N.
33. Kshirsagar R.J.
34. Kulshreshtha S.K.
35. Majumder C.
36. Manchanda V.K.
37. Meera Venkatesh (Smt.)
38. Mohapatra P.K.
39. Mukherjee S.K.
40. Mukherjee T.
41. Naik D.B.
42. Naik P.D.
43. Narasimhan S.V.
44. Natrajan V.
45. Nayak S.K.
46. Padmanabhan P.V.A.
47. Pal H.D.
48. Palit D.K.
49. Pathak P.N.
50. Pandey A.K.
51. Pandit Gouri G.
52. Parathasarthy V.
53. Pillai C.G.S.
54. Priyadarshini (Smt.) K.I.
55. Pujari P.K.
56. Ramakumar K.L.
57. Rangarajan S.
58. Reddy A.V.R.
59. Sabharwal Sunil
60. Sali S.K.
61. Samanta S.K.
62. Sarkar S.K.
63. Sinha P.K.
64. Shashikala K.
65. Shivanna K.
66. Srinivasan M.P.
67. Sudarshan V.
68. Sukhendunath
69. Tomar B.S.
70. Tripathi R.M.
71. Tyagi A.K.
72. Varshney Lalit
73. Vatsa R.K.
74. Velmurugan S.
75. Venkataramani B.
76. Venkateswaran G.
77. Venugopal V.
78. Yakhmi J.V.

Engineering Sciences

1. Auluck S.K.H.
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. Chattopadhyay J.
10. Chkaravarthy J.K.
11. Das R.
12. Dey G.K.
13. Dutta B.K.

14. Gantayet L.M.
15. Ghosh A.K.
16. Ghorui Srikumar
17. Gopika Vinod
18. Grover R.B.
19. Hubli R.C.
20. Kain V.
21. Kale G.B.
22. Kapoor Rajiv
23. Kar D.C.
24. Khan K.B.
25. Krishnan J.
26. Kulkarni U.D.
27. Kutty T.R.G.
28. Madan V.K.
29. Maheswari N.K.
30. Nagesh K.V.
31. Nayak A.K.
32. Pande D.P.
33. Patankar V.H.
34. Prasad G.J.
35. Ramanathan S.
36. Rami Reddy G.
37. Ravindranath S.V.G.
38. Roy S.B.
39. Saravana Kumar U.
40. Sathiyamoorthy D.
41. Sengupta A.K.
42. Singh J.B.
43. Singh R.K.
44. Singh R.N.
45. Srivastava D.
46. Suri A.K.
47. Suri V.K.
48. Taliyan S.S.
49. Tewari P.K.
50. Tewari R.
51. Tiwari A.P.
52. Topkar Amita V.
53. Vaidya P.P.
54. Varde P.V.
55. Vijayan P.K.
56. Vinod Kumar A.

Life Sciences

1. Apte S.K.
2. Balakrishnan Sreedevi
3. Bandekar J.R.
4. Bhagwat S.G.
5. Chaubey R.C.
6. Chaudhari Pradip
7. D'Souza S.F.
8. Das Birajlakshmi
9. Devasagayam T.P.A.
10. Dongre T.K.
11. Fulzele D.P.
12. Ganapathi T.R.
13. Gopalakrishna T.
14. Grace Samuel
15. Hosur M.V.
16. Indira Priyadarshini (Smt.)
17. Jambhulkar S.J.
18. Jawali Narendra
19. Kale S.P.
20. Kamat J.P.
21. Lebana J. Joseph (Smt.)
22. Malini (Smt.) Krishna
23. Melo J.S.
24. Meera Venkatesh
25. Minal Mhatre (Smt.)
26. Misra Hari S.
27. Mukherjee P.K.
28. Mukhopadhyaya Rita (Smt.)
29. Narkar Archana
30. Pandey B.N.
31. Poduval T.B.
32. Rao T.S.
33. Rajan M.G.R.
34. Roja Gopalakrishnan (Smt.)
35. Sainis (Smt.) J.K.
36. Sainis K.B.
37. Santosh Kumar S.
38. Satpathy K.
39. Seshadri M.
40. Sharma A.K.
41. Susan (Smt.) Eapen
42. Suprasanna P.
43. Venugopalan V.P.
44. Vinay Kumar
45. 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. Das A.K.
17. Das G.P.
18. Dasgupta K
19. Deb S.K.
20. Debnath A.K.
21. Deo M.N.
22. Degweker S.B.
23. Dhareshwar L.
24. Gadkari S.C.
25. Gaitonde D.M.
26. Ganesan S.
27. Ghorui Srikumar
28. Godbole S.V.
29. Godwal B.K.
30. Goswami B.K.
31. Gupta S.C.
32. Gupta S.K.
33. Gupta N.K.
34. Jagannathan V.
35. Jagtap B.N.
36. Jain S.R.
37. John B.V.
38. Kailas S
39. Kaushik T.C.
40. Kher R.K.
41. Kothiyal G.P.
42. Krishnani P.D.
43. Kshirsagar R.J.
44. Kulkarni U.D.
45. Manohar K.G.
46. Mayya Y.S.
47. Mazumdar S.
48. Mehboob S.A.H.
49. Menon S.V.G.
50. Mishra A.P.
51. Mittal Ranjan
52. Mohanty A.K.
53. Mukherjee G.D.
54. Mukhopadhyay R.
55. Nakhate S.G.
56. Panakkal J.P.
57. Pant L.M.
58. Puri R.R.
59. Raju V.S.
60. Rannot R.C.
61. Rao Mala N.
62. Rao P.M.
63. Rao T.V.C.
64. Ravikumar G.
65. Ray A.K.
66. Sahoo N.K.
67. Sakuntala T
68. Sangeeta
69. Sapra B.K.
70. Sarkar P.K.
71. Sastry U
72. Satyaranjan Santra
73. Saxena Alok
74. Sen Debasis
75. Sharma S.M.
76. Shrivastava Aradhana
77. Shukla P
78. Sinha Amar
79. Sinha S (Smt.)
80. Srivastava G.K.
81. Sundararaman M.
82. Suresh Kumar D.
83. Singh Pitamber
84. Tickoo A.K
85. Thakur K.B.
86. Vijaikumar V
87. Vinay Kumar
88. Wagh A.G.
89. Yusuf S.M.

Strategic Studies

1. Grover R.B.
2. Ramakumar K.L.
3. Vijai Kumar

HRI

Physical Sciences

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

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 T.G.
14. Sundararajan K.
15. Vasudeo Rao P.R.
16. Viswanathan K.S.
17. Viswanathan R.

Engineering Sciences

1. Anand Babu C.
2. Baldev Raj
3. Bhaduri A.K.
4. Chellapandi P.
5. Dasgupta Arup
6. Dayal R.K.
7. Jayakumar T.
8. Kamachi Mudali
9. Mathew M.D.
10. Purna Chandra Rao B.
11. Ramachandran D.
12. Sivaprasad P.V.
13. Valsan M.
14. Velusamy K.
15. Venugopal S.

Physical Sciences

1. Amarendra G.
2. Arora A.K.
3. Baskaran R.
4. Bharathi A.
5. Chandra Shekar N.V.
6. Dasgupta Arup
7. Dash S.
8. Govindaraj R.
9. Indira (Smt.) R.
10. John Philip
11. Keshavamurthy R.S.
12. Kuppusami P
13. Mathi Jaya S.
14. Mohanakrishnan P.
15. Mohankumar N.
16. Murthy K.P.N.
17. Nair Muraleedharan K.G.

18. Panigrahi B.K.
19. Raghavan G.
20. Rajaraman R.
21. Ramachandran Divakar
22. Ramaseshan R.
23. Ravindran T.R.
24. Reddy C.P.
25. Sahu Ch. P.
26. Sahu H.K.
27. Sankar P.
28. Sharat Chandra
29. Sivasubramanian V.
30. Sridharan V.
31. Subramanian N.
32. Sunder C.S.
33. Tata B.V.R.
34. Tyagi Ashok Kumar
35. Venkatesan R.
36. 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. Govindarajan T.R.
9. Indumathi D
10. Kalyana Rama S
11. Kaul R.K.
12. Menon Gautum I
13. Mishra A.K.
14. Murthi M.V.N.
15. Rajesh R
16. Ray P
17. Saratchandra H.S.
18. Sathiapalan B
19. Shankar R
20. Siddharthan R
21. Simon R
22. Sinha N
23. Sinha R
24. Sitabhra Sinha
25. Sudeshna Sinha
26. Vemparala Satyavani

IPR

Engineering Sciences

1. Chaturvedi Shashank
2. Pathak Surya Kumar

Physical Sciences

1. Anurag Shyam
2. Bandopadhyay Mainak
3. Bora Dhiraj
4. Chattopadhyay Prabal
5. Chaturvedi Shashank
6. Das (Smt.) Amita
7. Deshpande Shishir P.
8. Ghosh Joydeep
9. Jha Ratneshwar
10. Joshi H.C.

11. Kaw P.K.
12. Kulkarni S.V.
13. Mukherjee Subroto
14. Rajaraman Ganesh
15. Raole P.M.
16. Reddy Chenna D.
17. Sen Abhijit
18. Sengupta Sudip
19. Srinivasan R.
20. 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

Chemical Sciences

1. Das K.

Life Sciences

1. Dube Alok
2. Sharma (Smt.) Mrinalini

Physical Sciences

1. Banerjee Arup
2. Bartwal Kunwal Singh
3. Chakrabarti (Smt.) Aparna
4. Chattopadhyay M.K.
5. Ganesamoorthy S.
6. Ghosh Harnath
7. Gupta P.K.
8. Gupta, P.D.
9. Gupta S.M.
10. Ingale Alka
11. Joshi Mukesh
12. Krishnagopal S.
13. Kukreja L.M.
14. Lodha G.S.
15. Majmumdar Shovan
16. Mehandale S.C.
17. Naik P.A.
18. Nath Ashish K.
19. Oak S.M.
20. Rai V.N.
21. Rawat H.S.
22. Roy S.B.
23. Sahni V.C.
24. Senecha V.K.
25. Shailendra Kumar
26. Tiwari V.S.

Engineering Sciences

1. Chatterjee Sanjil
2. Nath A.K.

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. Bhattacharya Dhananjay
4. Mukhopadhyay Debashis
5. Sampa Biswas
6. 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. Ghosh Amit
12. Gupta Sankar Kumar
13. Ghoshal Ambar
14. Harindranath A.
15. Iyengar Sekar A.N.
16. Kar Kamles
17. Kundu Anjan
18. Majumdar Debasish
19. Majumdar Harashit
20. Majumdar Nayana
21. Majumdar Parthasarathi
22. Mathews Prakash
23. Menon K.S.R.
24. Mitra Parthasarathi
25. Mustafa M.G.
26. Nambissan P.M.G.
27. Nandy Maitreyee
28. Ranganathan R.
29. Ray Nihar Ranjan
30. Roy Shibaji
31. Samanta Chhanda
32. Sanyal Milan Kumar
33. Sengupta Krishnendu
34. 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.

VECC

Chemical Sciences

1. Das Satyen K.
2. Sen Pintu

Engineering Sciences

1. Mukherjee Paramita
2. Sarkar Debranjan

Physical Sciences

1. Bandyopadhyay S.K.
2. Banerjee S.R.
3. Banerjee G.N.
4. Barat P.
5. Basu D.N.
6. Bhandari R.K.
7. Bhattacharaya (Smt.) Chandana
8. Bhattacharya Sailajananda
9. Chakrabarti Alok
10. Chattopadhyay Subhasis
11. Chaudhuri A.K.
12. De Udayan
13. Jan-e-Alam
14. Md.Haroon Rashid
15. Mohanty Bedangdas
16. Mukhopadhyay Tapan
17. Nayak Tapan Kumar
18. Pal Santanu
19. Pandit V.S.
20. Rashid M.H.
21. Ray Amlan
22. Sarkar Sourav
23. Sarma P.R.
24. Srivastava Dinesh Kumar

Annexure - 5

Abstracts of Ph.D. Theses

HOMI BHABHA NATIONAL INSTITUTE

1. Alok Laddha

Enrolment No.	: PHYS10200604008
Constituent Unit	: Institute of Mathematical Sciences, Chennai
Date of Viva Voce	: 8.4.2009
Date of award of Provisional Degree	: 25.9.2009
Title of Thesis	: PARAMETRIZED FIELD THEORIES AND LOOP QUANTIZATION

Abstract

In this thesis we show how two dimensional Parametrized field theories constitute "perfect" toy models for Loop Quantum Gravity. We quantize two dimensional massless scalar field theories on a Minkowskian cylinder and on a Minkowskian plane, and show how various aspects of Loop quantization e.g. construction of quantum observables, determination of physical Hilbert space and emergence of discrete spacetime can be explicitly illustrated within these models. We also demonstrate how loop quantized parametrized field theories are quantum theories capturing non-perturbative aspects of two dimensional quantum Black-Holes. The thesis is essentially divided into two parts. In the first part we present a polymer quantization of a parametrized scalar field theory on 2 dimensional flat cylinder. Both the matter fields as well as the embedding variables are quantized in LQG type 'polymer' representations. The quantum constraints are solved via group averaging techniques and, analogous to the case of spatial geometry in LQG. the smooth (flat) spacetime geometry is replaced by a discrete quantum structure. An overcomplete set of Dirac observables, consisting of (a) (exponentials of) the standard free scalar field creation- annihilation modes and (b) canonical transformations corresponding to conformal isometries, are represented as operators on the physical Hilbert space. None of these constructions suffer from any of the 'triangulation' dependent choices which arise in treatments of LQG. In contrast to the standard Fock quantization, the non- Fock nature of the representation ensures that the group of conformal isometries as well as that of the gauge transformations generated by the constraints are represented in an anomaly free manner. Semiclassical states can be analysed at the gauge invariant level. It is shown that 'physical weaves' necessarily underly such states and that such states display semiclassicality with respect to, at most, a countable subset of the (uncountably large) set of observables of type (a).

In the second part we present a polymer (loop) quantization of a two dimensional theory of dilatonic gravity known as the CGHS model. We recast the theory as a parametrized free field theory on a flat 2-dimensional spacetime and quantize the resulting phase space using techniques of loop quantization. The resulting (kinematical) Hilbert space admits a unitary representation of the spacetime diffeomorphism group. We obtain the complete spectrum of the theory using a technique known as group averaging and perform quantization of Dirac observables on the resulting Hilbert space. Finally we argue that the algebra of Dirac observables get deformed in the quantum theory. We than tackle the problem of time. Combining the ideas from parametrized field theory with certain relational observables, evolution is defined in the

quantum theory in the Heisenberg picture. Finally the dilaton field is quantized on the physical Hilbert space which carries information about quantum geometry.

Publications

1. Alok Laddha, "Polymer quantization of the CGHS model: I" Class. Quantum Grav. 24 4969-4987.

2. Alok Laddha, "Polymer quantization of the CGHS model: II" Class. Quantum Grav. 24 4989-5009.

3. Alok Laddha and Madhavan Varadarajan, "Polymer Parametrized field theory" Accepted for publication in Physical Review D, Vol. 78, No. 4

2. Chandradew Sharma

Enrolment No.	: PHYS10200605003
Constituent Unit	: Institute of Mathematical Sciences, Chennai
Date of Viva Voce	: 9.3.2009
Date of award of Provisional Degree	: 6.4.2009
Title of Thesis	: Phenomenology of B Meson and CP Violations

Publications

1. Radiative neutralino production in low energy supersymmetric models, Rahul Basu, P.N.Pandita, Chandradew Sharma, arXiv:0711.2121[hep-ph], Submitted to "Physical Review D".

2. Generalised analysis on $B \to K^*\rho$ within and beyond the Standard Model: Can it help understand that $B \to K\pi$ puzzle? C.S.Kim, Sechul Oh, Chandradew Sharma, Rahul Sinha, Yeo Woong Yoon, Phy. Rev. D76, 074019, 2007, arXiv:0706.1150 [hep-ph].

3. Patterns of new physics in B decays, Maxime Imbeault, David London, Chandradew Sharma, Nita Sinha, Rahul Sinha, Phys. Lett. B653, 254-258, 2007, hep-ph/0608169.

4. Angular analysis of B decaying into J/ψ tensor, J/ψ vector and J/ψ scalar modes, Chandradew Sharma, Rahul Sinha, Phys. Rev. D73, 014016, 2006, hep-ph/0504178.

3. Kinjal Banerjee

Enrolment No.	:	PHYS10200605004
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	12.3.2009
Date of award of Provisional Degree	:	6.4.2009
Title of Thesis	:	Studies in Loop Quantization of Cosmological Models

Abstract

One of the central problems in theoretical physics today is combining the principle of quantum mechanics and general relativity into a quantum theory of gravity. It is believed that quantum gravity can address many problems in physics, especially Black Hole (BH) entropy and classical singularities. There is no clear consensus on what a quantum theory of gravity should be, except that it should at least address the two problems mentioned above. At present there are two main candidates - String Theory and Loop Quantum Gravity (LQG).

In String theory, the quantum modifications arise from stringy corrections due to genus expansion as well as the alhoa corrections from sigma model description of first quantized strings. In the cosmological context of LQG, the quantum modifications have a non-perturbative as well as perturbative component in terms of the Immirizi parameter y2. The non-perturbative effects are responsible for singularity avoidance as well as bounded growth of curvature near classical singularity.

In both approaches one is able to reproduce the Bekenstein-Hawking entropy formula from microstate counting, implying a statistical mechanical cause of BH radiation, i.e. the entropy measures the number of microstates and they are quantum mechanical in nature. Another area where the quantum effects of gravity are expected to show up is in the modification in the behaviour of the universe near big bang singularity.

Given the very different premises and frameworks used in String Theory and LQG, a comparison of their implication even in the highly simplified context of homogeneous and isotropic cosmology is quite non trivial. At present a possible comparison between these two theories is conceivable only at perturbative level in the large volume (in Planck units) limit. As a first attempt we look at the simplest context of homogeneous isotropic cosmology models and concentrate only on the perturbative modifications of the gravity sector alone. This is done only in the spirit of comparison between the two theories and not with an effort to relate to observations, because homogeneity and isotropy are themselves approximations to the real world. We look at the second order term in alpha coming from string theory and y2 coming from LQC and compare the two theories in terms of effective classical equations of motion of the underlying theory. Prima facie the equations appear to be very different. However the solutions to both sets of equations predict that at least to the first order in perturbation theory the Minkowski geometry is stable.

Publications

1. Kinjal Banerjee and Ghanashyam Date "Discreteness corrections to the effective Hamiltonian of isotropic loop quantum cosmology." Class. Quant. Grav. 22,2017(2005) [arXiv:gr-qc/0501102]

2. Kinjal Banerjee and Ghanashyam Date "Loop Quantization of the Polarized Gowdy Model on T^3 : Classical Theory." Class. Quant. Grav. 25, 105014 (2008) arXiv:0712.0683 [gr-qc]

3. Kinjal Banerjee and Ghanashyam Date "Loop Quantization of the Polarized Gowdy Model on T^3 : Kinematical States and Constraint Operators" Class. Quant. Grav. 25, 145004 (2008) arXiv:0712.0687 [gr-qc]

4. Mithun Kumar Mitra

Enrolment No.	:	PHYS10200605002
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	24.2.2010
Date of award of Provisional Degree	:	29.3.2010
Title of Thesis	:	Statistical Mechanics of Pressurized Two-Dimensional Polymer Rings

Abstract

This thesis studies the statistical mechanics of pressurized ring polymers. These can be thought of as a simple low-dimensional models for the understanding of vesicle shapes and phase transitions, a classic problem first studied several decades ago in the context of the shapes of red blood cells. The model for the two-dimensional vesicle presents many difficulties for analytic studies, arising principally from the self-avoidance constraint. A related class of models in which the polymer ring is allowed to intersect itself, and the pressure term is conjugate to an algebraic or signed area. The effects of semi-flexibility in the inextensible self-intersecting ring problem is investigated. The flexible chain problem is characterised by a continuous phase transition at a critical value of an appropriately scaled pressure, separating collapsed and inflated regimes of the ring. It is shown that this transition survives for non-zero values of the bending rigidity and an analytic form is obtained for the phase boundary separating the collapsed and inflated phases in the scaled pressure-bending rigidity plane.An analogy with the quantum mechanical problem of an electron moving in a magnetic field applied transverse to the plane of motion, is used to reproduce exact results for the flexible chain. Then incorporated with semi-flexibility in both the continuum and lattice models through scaling arguments, obtains very good agreement with numerics. The numerical data was obtained through the exact enumeration method, which explicitly counts the total number of allowed polygons, and hence the partition function. Also several mean-field approaches to this model are performed. The different mean-field approximations, motivated by physical arguments, model the behaviour of the system in different regimes of parameter space are discussed. The usefulness of these results for more realistic systems lies in the fact that self-intersections are irrelevant in the large pressure limit. The results obtained at large pressures should therefore apply both qualitatively and qualitatively to the more realistic case of a pressurised self-avoiding polymer.

Publications

1. Mithun K.Mitra, Gautam I.Menon, R.Rajesh "Thermodynamic Behaviour of Two-dimensional Self-avoiding Vesicles", (Manuscript in preparation).

2. Mithun K.Mitra, Gautam I.Menon, R.Rajesh "Asymptotic Behaviour of Inflated Lattice Polygons", Journal of Statistical Physics, Vol. 131 (3), 393-404 (2008)
arXiv:0710.1509v1 [cond-mat.stat-mech]

3. Mithun K.Mitra, Gautam I.Menon, R.Rajesh "Phase Transitions in Pressurised Semiflexible Polymer Rings", Physical Review E, Vol. 77, 041802 (2008)
arXiv:0708.3318v1 [cond-mat.stat-mech]

5. N. Narayanan

Enrolment No.	:	MATH10200604017
Constituent Unit	:	Institute of Mathematical Sciences, Chennai
Date of Viva Voce	:	23.6.2009
Date of award of Provisional Degree	:	12.1.2010
Title of Thesis	:	Acyclic, k-intersection Edge Colourings and Oriented Colouring

Abstract

In this thesis, we study three graph colouring problems. The main theme of this thesis is the acyclic edge colouring problem. We also study two other problems, the k-intersection edge colouring and oriented vertex colouring. In the acyclic edge colouring problem, we are required to find the minimum number of colours χ'_a that suffers to colour the edge of a graph properly such that the union of any two colour classes forms a forest. The acyclic edge colouring conjecture (due to Fiamcik and also independently to Alon, Sudakov and Zaks) states that it is possible to colour the edges of any graph G acyclically with at most $\Delta(G) + 2$ colours. It is considered to be a difficult problem as very little is known about exact or tight estimates of this invariant even for highly structured classes of graphs.

In the first part of this thesis, we obtain improved upper bounds on χ'_a for some classes of graphs. We also show that certain classes of graph satisfy the acyclic edge colouring conjecture. Some of these results are obtained making use of probabilistic arguments, while the others are proved making use of structural properties of the underlying graphs.

The second part deals with a related problem that we call the k-intersection edge colouring. Here, one seeks to find the minimum number of colours that are sufficient to colour the edges such that for any pair of adjacent vertices, the number of common colours received on the edges incident on them is at most k. We obtain an upper bound of $O(\Delta^2/k)$ for any graph and also show that this bound is indeed tight for complete graphs.

In the third part, we look at the oriented vertex colouring of graphs. An oriented k-colouring of an oriented graph G is a mapping $C : V(G) \rightarrow [k]$ so that (i) $C(x) \neq C(y)\ \forall_{(x,y)} \in \mathcal{A}(G)$ and (ii) $C(x) = C(w) \Rightarrow C(y) \neq C(z)\ \forall_{(x,y),(Z,W)} \in \mathcal{A}(G)$. The oriented chromatic number χ_o of an oriented graph G is the smallest k such that there is an oriented k-colouring. The oriented chromatic number for an undirected graph G is the maximum $\chi_o(G)$ over all orientations G of G. we obtain improved upper and lower bounds on oriented chromatic number for certain classes of graphs and products of graphs.

Publications

1. Anna Fiedorowicz, Mariusz Haluszczak and N.Narayanan, "Acyclic edge colouring of planar graphs" Information Processing Letters, 2008.

2. Rahul Muthu, N.Narayanan and C.R.Subramanian, "Improved bounds on acyclic edge colouring" Discreet Mathematics, 307(23):3063-3069, 2007.

3. Rahul Muthu, N.Narayanan and C.R.Subramanian, "Improved bounds on acyclic edge colouring" (GRACO-2005, Electronic Notes in Discrete Mathematics, Volume 19, 1 June 2005, Pages 171-177).

4. Rahul Muthu, N.Narayanan and C.R.Subramanian, Acyclic edge colouring of outerplanar graphs Algorithmic Aspects in Information and Management, Third International Conference, AAIM 2007, Portland, OR, USA, June 6-8, 2007, Proceedings volume 4508 of Lecture Notes in Computer Science, pages 144-152, Springer, 2007.

5. N.Narayanan, Aravind Natarajan and C.R.Subramanian, Oriented colouring of some classes of graphs, Manuscript.

6. Raj Kumar Pan

Enrolment No.	:	PHYS10200604006
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	10.8.2009
Date of award of Provisional Degree	:	22.9.2009
Title of Thesis	:	Modularity and Hierarchy in Complex Systems: Relating Network Structure to Dynamics

Abstract

Complex systems, whether integrated circuits, food webs, transportation networks, social systems, or the biochemical interactome of a living cell, all behave in ways that cannot be fully explained by analyzing their constituent parts in isolation. Understanding the emergent behavior of such nonlinear systems, which is more than just an aggregate of the properties of their components, require novel integrative approaches. Many of these systems can be represented as networks, consisting of a large number of nodes connected via directed or undirected links. The recent discovery of the existence of universal principles underlying these complex networks that occur across widely differing domains in the biological, social and technological arenas have spurred the interest of physicists in trying to understand such principles using techniques from statistical physics and nonlinear dynamics. This thesis looks at how the structure of a network, as charaterized by the connection topology, governs its dynamical behavior, and conversely, how the dynamical processes taking place on the network affects its structure (eg. stability considerations constraining the evolution of the network towards specific topologies). In particular the focus is on modularity, the existence of groups whose nodes are more densely connected to each other than to nodes in other groups, and hierarchy ie., the nested arrangement of connection topology into several layers. Both of these mesoscopic organizational structures are observed in many complex networks that occur in reality.

Publications

1. R.K.Pan and S.Sinha, Self-organization of price fluctuation distribution in evolving markets, *Europhys. Lett. 77*, 58004 (2007)

2. R.K.Pan and S.Sinha, Collective behaviour of stock price, movements in an emerging market, *Phys. Rev. E 76*, 046116 (2007)

3. R.K.Pan and S.Sinha, Modular networks emerge from multi-constraint optimization, *Phys. Rev. E 76,* 045106(R) (2007).

4. R.K.Pan and S.Sinha, Inverse cubic law of index fluctuation distribution in Indian markets, *Physica A 387*, 2055-2065 (2008).

5. R.K.Pan and S.Sinha, Modular networks with hierarchical organization: The dynamical implications of complex structure, *Pramana - journal of physics 71*, 331-340 (2008).

6. R.K.Pan and S.Sinha, Small-world of modular networks, arXiv:0802.3671.

7. R.K.Pan and S.Sinha, Effect of information processing constraints on C, elegans neuronal network, *in preparation*.

7. Swagata Sarkar

Enrolment No.	:	MATH10200604002
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	28.1.2010
Date of award of Provisional Degree	:	16.2.2010
Title of Thesis	:	Degrees of maps between complex Grassmann manifolds

Abstract

Let M, N be compact connected oriented d-dimensional manifolds and let $f: N \rightarrow M$ be any continuous map. Then one has the notion of the degree of f defined as $f_*(\mu_N) = (\deg f).\mu_M$ where $\mu_M \in H_d(M;\mathbb{Z})$ denotes the orientation class of M. It is an important and classical problem to determine possible degrees of continuous maps between two given manifolds M and N.

The thesis addresses this and related problems when M and N are complex Grassmann manifolds. Let $N = \mathbb{C}G_{n,k}$ be the complex Grassmann manifold of k dimensional vector subspaces in $\mathbb{C}^n$ and let $M = \mathbb{C}G_{m,l}$. Without loss of generality assume that $1 \leq k \leq n/2, 1 \leq l \leq m/2$. Then $\dim_{\mathbb{C}} \mathbb{C}G_{n,k} = k(n-k) = d$ and so we must have $d = l(m-l) = k(n-k)$. We leave out the case of self maps and also the cases where $l = 1$ or $1 \leq k < l$ which were settled earlier. Our results are also applicable for quaternionic Grassmann manifolds $\mathbb{H}G_{n,k}$. We now state the main results of this paper.

Theorem 1.

Let $\mathbb{F} = \mathbb{C}$ or $\mathbb{H}$ and let $d = \dim_{\mathbb{R}} \mathbb{F}$. Let $f: \mathbb{F}G_{n,k} \rightarrow \mathbb{F}G_{m,l}$ be *any continuous map between two* $\mathbb{F}$*-Grassmann manifolds of the same dimension. Then, there exist algebra generators* $u_i \in H^{di}(\mathbb{F}G_{m,l};\mathbb{Q})$, $1 \leq i \leq l$, *is determined up to a sign ± by the degree of f, provided this degree is non-zero.*

Theorem 2.

Let $\mathbb{F} = \mathbb{C}$ or $\mathbb{H}$. *Fix integers* $2 \leq l < k$. *Let* $m, n \geq 2k$ *be positive integers such that* $k(n-k) = l(m-l)$, *and* $f: \mathbb{F}G_{n,k} \rightarrow \mathbb{F}G_{m,l}$ *any continuous map. Then, degree of f is zero is* $(l^2-1)(k^2-1)((m-l)^2-1)((n-k)^2-1)$ *is not a perfect square. In particular, degree of f is zero for n sufficiently large.*

Theorem 3.

Let $\mathbb{F} = \mathbb{C}$ or $\mathbb{H}$. *Suppose that* $k(n-k) = l(m-l)$, *and* $1 \leq l \leq [m/2]$, $1 \leq k \leq [n/2]$. *If* $f: \mathbb{F}G_{n,k} \rightarrow \mathbb{F}G_{m,l}$ *is a map of degree* ± 1, *then* $(m,l) = (n,k)$ *and f is a homotopy equivalence.*

Publications

1. P. Sankaran and S.Sarkar, Degrees of maps between Grassmann manifolds, Osaka Journal of Mathematics, 46 (2009), no. 4, 1143-1161.

8. Sunil E. Simon

Enrolment No.	:	MATH10200604018
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	17.1.2010
Date of award of Provisional Degree	:	6.2.2010
Title of Thesis	:	A Logical Study of Strategies In Games

Abstract

The main theme of this thesis is reasoning about strategies in games in a logical framework. Logical analyses of games typically consider players' strategies as atomic objects and the reasoning is about existence of strategies, rather than about strategies themselves. This works well with the underlying assumption that players are rational and possess unbounded computational ability. A prescriptive theory which takes into account the limited computational resources of players needs to view strategies as relations constraining players' moves rather than view them as complete functions. The central idea is to formulate the notion of composite strategies which are constructed in a structural manner and to show how explicit reasoning of strategies can be achieved.

The first part of the thesis looks at logical analysis of strategies. We start by defining the notion of structurally specified strategies in the frame-work of unbounded duration games on graphs. Such specifications give rise to partially specified bounded memory strategies which may depend on assump-tions about the opponent's strategies. We consider a simple modal logic to reason about such structured strategies and show that it admits a complete axiomatization.

We then look at how structurally specified strategies can be adapted to the case where the game itself has compositional structure. In this setting we suggest that rather than performing strategic reasoning on the composite game, one needs to compose game-strategy pairs. The advantage of imposing structure not merely on games or on strategies but on game-strategy pairs, is that we can speak of a composite game followed by whereby if the opponent played a strategy ? in , the player responds with ? in G? to ensure a certain outcome. In the presence of iteration, a player has significant ability to strategize by taking into account the explicit structure of games. We consider a propositional dynamic logic whose programs are regular expressions over such game-strategy pairs and present a complete axiomatization of the logic. We also show that the satisfiability problem of the logic is decidable.

In the second part of the thesis, we look at the algorithmic analysis of games. We propose EVALUATION AUTOMATA as a convenient finite state model to present the preference orderings of players in infinite games. We look at the classical solution concept of Nash equilibrium and show that an equilibrium strategy profile (which is monadic second order definable) always exists in infinite duration games on (finite) graphs where the preference orderings of players are specified in terms of evaluation automata.

We finally investigate multi-player games of imperfect information. It follows from the result of Peterson and Reif (1979) that in general the verification question which asks whether a subset of players have a distributed winning strategy is undecidable in these games. The crucial element which yields undecidability is the fact that players are not allowed to communicate with each other. We propose a framework to model games of imperfect information where

communication is explicitly represented. Here a player's information partition is generated in a structural manner rather than being presented as part of the game formalism. We show that for the sub-class of games where communication is restricted to public announcements the verification question is decidable.

Publications

1. R.Ramanujam and S.Simon. Structured strategies in games on graphs. In *Logic and Automata: History and Perspectives,* Volume 2 of *Texts in Logic and Games,* pages 567-587. Amsterdam University Press, 2007.

2. R.Ramanujam and S.Simon. A logical structure for strategies. In *Logic and The Foundations of Game and Decision theory (LOFT 7),* volume 3 of *Texts in Logic and Games,* pages 183-208. Amsterdam University Press, 2008. An initial version appeared in the Proceedings of the 7th Conference on Logic and the Foundations of Game and Decision Theory (LOFT06) under the title *Axioms for Composite Strategies,* pages 189-198.

3. R.Ramanujam and S.Simon. Dynamic logic on games with structured strategies. In *Proceedings of the 11th International Conference on Principles of Knowledge Representation and Reasoning (KR-08),* Pages 49-58. AAAI Press, 2008.

4. R.Ramanujam and S.Simon. Dynamic logic on normal form games. In *Pre-Proc. Workshop on Knowledge Representation for Agents and Multi-Agent Systems (KRAMAS 2008),* pages 140-154, 2008.

5. R.Ramanujam and S.Simon. Reasoning in Games. In *Logic and Navya-Nyaya & Applications,* volume 15 of *Studies in Logic,* pages 261-286. College Publications, 2008.

6. S.Paul and S.Simon. Nash equilibrium in generalized Muller games. In *Proceedings of the Conference on Foundation of Software Technology and Theoretical Computer Science, FSTTCS,* volume 4 of *Leibniz International Proceedings in Informatics (LLIPIcs),* pages 335-346. Schloss Dagstuhl-Leibniz-Zentrum fuer Informatik, 2009.

9. Partha Mukhopadhyay

Enrolment No.	:	MATH10200604025
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	30.9.2009
Date of award of Provisional Degree	:	20.10.2009
Title of Thesis	:	On Polynomial Identity Testing and Related Problems

Abstract

Polynomial Identity Testing is a fundamental problem in the field of computational complexity and randomization. The problem is to determine whether or not the polynomial computed by a given arithmetic circuit over some field is identically zero.

In this thesis, we study various aspects of this problem. We explore the complexity of polynomial identity testing when the coe cients come from a ring rather than a eld. Specifically, we relate the complexity of polynomial identity testing to that of ideal membership testing for monomial ideals. We study the complexity of noncommutative polynomial identity testing and give new deterministic polynomial-time algorithms using automata theory. This approach allows us to connect the derandomization of isolation lemma to proving circuit lower bounds: we show that derandomizing certain natural restrictions of the isolation lemma yields nontrivial arithmetic circuit lower bounds (commutative and noncommutative). Finally, we also study quantum algorithms for testing multilinear identities on nite rings. We show a nontrivial upper bound on the quantum query complexity of this problem, and also show a lower bound result that indicates the tightness of our upper bound.

Publications

1. Vikraman Arvind, Bireswar Das and Partha Mukhopadhyay, "The complexity of black-box ring problems." In COCOON, pages 126-135, 2006.

2. Vikraman Arvind and Partha Mukhopadhyay, "The monomial ideal membership problem and polynomial identity testing." In ISAAC, *(Full Version: ECCC report TR07-095), pages 800-811, 2007.*

3. Vikraman Arvind and Partha Mukhopadhyay, "Derandomizing the isolation lemma and lower bounds for circuit size" In APPROX-RANDOM, pages 276-289, 2008.

4. Vikraman Arvind and Partha Mukhopadhyay, "Quantum query complexity of multilinear identity testing." In STACS'09 (To appear), 2009.

5. Vikraman Arvind , Partha Mukhopadhyay and Srikanth Srinivasan, "New results on noncommutative and commutative polynomial identity testing." In IEEE Conference on Computational Complexity, pages 268-279, 2008.

10. Nutan Pramod Limaye

Enrolment No.	:	MATH10200604021
Constituent Unit	:	Institute of Mathematical Sciences
Date of Viva Voce	:	30.12.2009
Date of award of Provisional Degree	:	12.1.2010
Title of Thesis	:	Exploring LogCFL using language theory

Abstract

We explore the complexity classes contained in LogCFL by drawing connections to language theory. Along the way, we study many depth reduction techniques.

We consider two factor-2 approximation algorithms for block sorting and show that both the algorithms can be implemented in LogCFL. We use depth reduction techniques and specialise them for these problems and give explicit NC algorithms. We also study membership problem for multi-pushdown machines. The stacks in these machines are ordered and pop moves are allowed on the rst non-empty stack. We prove that the membership problem for these machines is complete for LogCFL.

We consider visibly pushdown languages, VPLs, and many generalizations of VPLs and use these languages to draw connections to the complexity classes inside LogCFL. VPA is nondeterministic pushdown machine with a restriction that the height of the stack for a given input is same along every nondeterministic run and is easy to compute. We abstract out this idea to de ne the notion of height-determinism and obtain generalizations of VPLs, namely rhPDA(FST), rhPDA(rDPDA-turn), rhPDA(PDT). We prove that the height of the stack for these machines are functions (height functions) computable in NC, L, and LogDCFL, respectively, and prove that the membership problem for all three of them is in Lh where h is the complexity of the height function.

We also consider multi-stack pushdown machines with visible stacks. A phase in such a machine is the input substring reading which machine pops exactly one stack. We consider membership problem for multi-stack push-down machines with bounded phases and show LogCFL upper bound.

Finally, we consider counting problem for VPLs, and its generalizations, namely: rhPDA(FST), rhPDA(rDPDA-turn), and rhPDA(PDT) and prove LogDCFL upper bound for all. We also consider the counting functions corresponding to VPLs and analyse their closure properties.

Publications

1. Arithmetizing Classes around NC and L.
   Nutan Limaye, Meena Mahajan, and B. V. Raghavendra Rao. To appear in Theory of Computing systems , special issue for STACS 2007.

2. Nutan Limaye, Meena Mahajan, and Antoine Meyer. On the complexity of membership and counting in height-deterministic pushdown automata. In Proceedings of 3rd International Computer Science Symposium in Russia CSR, June 7-12, 2008, Moscow. Springer-Verlag Lecture Notes in Computer Science series Volume 5010 pp.240{251.

3. Nutan Limaye and Meena Mahajan. Membership testing: Removing extra stacks from multi-stack pushdown automata. In Proceedings of 3rd International Conference on Language and Automata Theory and Applications LATA, April 2009, Tarragona, Spain. Springer-Verlag Lecture Notes in Computer Science series Volume 5457 pp.493-504.

11. Anurag Tripathi

Enrolment No.	:	PHYS08200604003
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of Viva Voce	:	2.2.2010
Date of award of Provisional Degree	:	1.4.2010
Title of Thesis	:	Higher order QCD radiative corrections to the processes at the Large Hardon Collider

Abstract

The upcoming LHC will achieve high energies never achieved before in any collider. Signals of new physics could be observed through the deviations they produce in the SM predictions. There are many important channels which can be used as a probe, such as, di-lepton, di-jet productions, or production of photon pairs. Photon pairs serve as an important probe in new physics searches as this is a clean channel with no difficulties associated with reconstruction. We have used this channel as a tool in search studies of new physics at the LHC.

At LHC QCD plays an extremely important role. Not only QCD gives large backgrounds to signals it also gives important contributions through radiative corrections. The other feature of theoretical predictions at the LHC is their sensitivity to factorization scale μF which is largely arbitrary. At leading order μF enters through the parton distribution functions. As the LHC detectors ATLAS and CMS will measure the photon production rates very precisely it is important to have an accurate prediction from theory side. Inclusion of next-to-leading order QCD corrections bring down the sensitivity to μF, these corrections are important. With these aims we have studied production of photon pairs at the LHC in large extra dimension model (ADD) and unparticle scenario.

The final state photons are subject to various kinematical cuts used by ATLAS and CMS detectors. Also many kinematical distributions need to be evaluated to compare against the experimental data. For these requirements Monte Carlo methods prove to be very powerful. To this effect, we used the seminumerical method of two *cutoff phase* space slicing for our next-to-leading order computation.

A next-to-leading order computation involves virtual and real emission processes which are singular. We used dimensional regularization with $n = 4 + \varepsilon$ to separate these singularities as poles in ε. The complicated tensor integrals appearing in virtual diagrams were simplified using Passarino-Veltman reduction. Although the soft singularities cancel between virtual and real emission contributions, the collinear singularities do not cancel completely and are absorbed into bare parton distribution functions. We arranged for the cancellation/ absorption of these singularities analytically in MS scheme using the two cutoff phase space slicing method.

In addition QED singularities appear in final state in real emission contributions. These singularities can be removed by absorbing them into fragmentation functions. However the fragmentation functions are not known to a good accuracy. An alternative to avoid the final state QED singularity and simultaneously suppress the fragmentation photons in an infrared safe manner is to use the smooth cone isolation prescription advocated by Frixione. We used this isolation criterion to completely remove the fragmentation contributions.

We developed a Monte Carlo based code on the two cutoff slicing method to implement the experimental cuts and the smooth cone isolation criterion. This code was subject to various crucial test to check its reliability. Also the SM results were reproduced to check the correctness of the code and our matrix elements. Using our code various important kinematical distributions such as invariant mass, rapidity, pT , etc., distributions were obtained. These distributions are important as these will be measured at the LHC. We found that the QCD corrections give significant enhancement over the leading order predictions in all the kinematical distributions. By our computations we were able to show a significant reduction in the sensitivity to the factorization scale μF, which makes the new theoretical predictions quite precise.

Publications

1. Unparticle physics in di-photon production at the CERN LHC. M.C.Kumar, Prakash Mathews, V.Ravindran and Anurag Tripathi.
   Phys. Rev. D 77 (2008) 055031. arXiv: 0709.2478 [hep-ph]

2. Diphoton signals in theories with large extra dimensions to NLO QCD at hadron colliders.
   M.C.Kumar, Prakash Mathews, V.Ravindran and Anurag Tripathi.
   Phys. Lett. B 672 (2009) 45. arXiv: 0811.1670 [hep-ph]

3. Unparticles in diphoton production to NLO in QCD at the LHC.
   M.C.Kumar, Prakash Mathews, V.Ravindran and Anurag Tripathi.
   arXiv: 0804.4054 [hep-ph], Submitted to Physical Review D.

4. Direct photon pair production at the LHC to O (α_s) in TeV scale gravity models.
   M.C.Kumar, Prakash Mathews, V.Ravindran and Anurag Tripathi.
   arXiv: 0902.4894 [hep-ph].

5. Di-jet production at the LHC in Unparticle scenario.
   Neelima Agarwal, M.C.Kumar, Prakash Mathews, V.Ravindran and Anurag Tripathi.
   arXiv: 0903.0202 [hep-ph]..

12. Arijit Saha

Enrolment No.	:	PHYS08200604005
Constituent Unit	:	Harish-Chandra Research Institute
Date of Viva Voce	:	10.8.2009
Date of award of Provisional Degree	:	19.11.2009
Title of Thesis	:	Electron-electron interaction effects on transport Through mesoscopic hybrid junctions

Abstract

Transport through junctions of mesoscopic quantum dots (QD) and quantum wires (QW) has become an extensive area of research for the last several years both from theoretical as well as experimental point of view. An important aspect of these 1-dimensional (1-D) systems is the effects due to the electron-electron (e-e) interaction inside the QW which is very different from its higher dimensional counterparts where the low energy dynamics is described by the well known Fermi liquid (FL) theory. In contrast in 1-D, due to e-e interactions the FL ground state is destroyed and the electrons form a non-Fermi liquid ground state known as the Tomonaga-Luttinger liquid (LL) where spin and charge move with different velocities and correlation functions show power law behavior. Due to this reason current through such 1-D systems also show power law behavior where the power is determined by the LL interaction parameter.

The thesis asks the following questions - (1) What is the effect of impurity, proximity and e-e interaction on transport through a superconducting junction of multiple 1-D QW? (2) Are there any intermediate fixed points in this case? (3) What are the possible applications of such junctions? There are couple of techniques known in the literature to incorporate the effect of impurity and e-e interaction inside the QW like bosonization, weak interaction renormalisation group (WIRG), boundary conformal field theory (BCFT), functional renormalisation group (FRG) etc. In our work we adopted the WIRG method to analyze the fixed point structure and transport properties around the fixed points of a superconducting junction of multiple LL wires. In WIRG method, a Landauer-Buttiker (LB) S-matrix formulation is used to compute the conductance, and inter-election interactions inside the QW are taken into account by allowing the S-matrix to flow as a function of the length scale or temperature using a renormalization group (RG) procedure.

Our analysis shows that the fixed point structure of this system is far more rich than that of a normal-superconductor (NS) junction. Even a two-LL wire system with a superconducting junction i.e., a NSN structure has non-trivial fixed points with intermediate transmissions and reflections. We also include e-e interaction induced back-scattering in the quantum wires in our study and hence obtain non-Luttinger liquid behavior. We considered quantum charge pumping of electrons across a superconducting double barrier structured in the adiabatic limit. We analyzed the effects of e-e interaction inside the QW on pumped charge through hybrid junctions using the WIRG procedure and found that as we approach the zero temperature limit, due to the RG flow of transmission amplitude, we get destruction of quantized pumped charge. We also studied two-terminal transport through a single channel T-stub where the stub is strongly coupled to a superconducting reservoir. In sharp contrast to the standard stub geometry which has both transmission resonances and anti-resonances in the coherent limit, we found that the superconducting stub geometry shows neither a T=1 (T is the transmission

probability for electrons through the T-stub) resonance nor a T=0 and anti-resonance. Instead, we find that there is only one value at T= 1/4 which is analogous to the resonance or the anti-resonance.

We also performed a comprehensive stability analysis of the Griffiths Fixed Point of a junction of three LL wires and the Symmetric Fixed Point of a superconducting junction of two LL wires.

Publications

1. 1.*A systematic stability analysis of the renormalization group flow for the normal-superconductor-normal junction of Luttinger liquid wires.* Authors: Sourin Das, Sumathi Rao, Arijit Saha. E-print: arXiv:0901.0126 [cond-mat] (Submitted to Phys. Rev. B).

2. *Resonant transmission through a T-stub coupled to a superconductor.* Authors: Sourin Das, Sumathi Rao, Arijit Saha. E-print: arXiv:0811.0660 [cond-mat] (Submitted to New Journal of Physics).

3. *Quantized charge pumping in superconducting double barrier structure : Non-trivial correlations due to proximity effect.* Authors: Arijit Saha and Sourin Das. Journal Ref: Phys. Rev. B 78, 075412 (2008). E-print: arXiv:0711.3216 [cond-mat].

4. *Renormalization group study of transport through a superconducting junction of multiple one-dimensional quantum wires.* Authors: Sourin Das, Sumathi Rao, Arijit Saha. Journal Ref: Phys. Rev. B 77, 155418 (2008). E-print: arXiv:0711.1324 [cond-mat].

5. *Spintronics with NSN Junction of one-dimensional quantum wires : A study of Pure Spin Current and Magnetoresistance.* Authors: Sourin Das, Sumathi Rao, Arijit Saha. Journal Ref: Europhys.Lett.81, 67001 (2008). E-print: arXiv:0710.5240 [cond-mat].

6. *Adiabatic charge pumping through a dot at the junction of N quantum wires.* Authors: Shamik Banerjee, Anamitra Mukherjee, Sumathi Rao, Arijit Saha. Journal Ref: Phys. Rev. B 75, 153407 (2007). E-print: arXiv: cond-mat/0608267.

13. Kalpataru Pradhan

Enrolment No.	:	PHYS08200604004
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of Viva Voce	:	7.9.2009
Date of award of Provisional Degree	:	19.11.2009
Title of Thesis	:	The Impact of B Site Disorder in the Manganites

Abstract

In uncorrelated electron systems one requires substantial disorder, comparable to the Fermi energy, for nontrivial effects to emerge. The manganites provide an exception. In the manganites $A_{1-x}A'_xMnO_3$, `A site' disorder seems to affect the physical properties through several mechanisms, e.g., promoting cluster coexistence, polaron formation, etc. While the effects above are interesting, they all involve suppression of the underlying ordered state. The impact of `B site' (Mn site) dopants, i.e., materials of the form $A_{1-x}A'_xMn1\text{-}_nB_nO_3$, however, present several puzzles. A low density of B dopants (a few percent) can convert an insulator to a metal, or a metal to an insulator, simultaneously affecting the underlying magnetic state.

The thesis starts with an introduction to correlated electron systems and moves on to a detailed discussion of the experimental results on the effect of disorder in the manganites. We discuss both A and B site disorder, but the focus is mainly on B site doping, classifying the wide variety of results in terms of the reference manganite states and the valence and magnetic character of the dopant.

This is followed by a discussion of our results on the impact of weak homogeneous (A site) disorder and strong dilute (B site) scattering on the $x=0.5$ *CE* charge ordered manganites. The modelling of B site disorder in this effort is crude, incorporating only a strong repulsive potential, but leads to results which capture (one family of) key experimental effects, including the percolative metallisation of the CE insulator.

Our detailed results are in two parts, the first focusing on situations where valence change on Mn due to B impurities is the key effect, while the second studies the impact of magnetic dopants. Our principal results are the following: (i) We discover that the following hierarchy of effects arise in all B doping cases: (a) change of the effective valence on the Mn sites, (b) percolation of the metallic phase through impurity free regions, and (c) `reconstruction' of the background magnetism and charge order by magnetic dopants. (ii) By exploring the prominent manganite states, and different B dopants, we are able to explain most of the outstanding experimental results. (iii) We suggest new experiments to test out unexplored insulator-metal transitions driven by B dopants.

Publications

1. Distinct Effects of Homogeneous Weak Disorder and Dilute Strong Scatterers on Phase Competition in the Manganites
K.Pradhan, A.Mukherjee, and P.Majumdar
Phy. Rev. Lett. 99, 147206 (2007).

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

3. Magnetic order Beyond RKKY in the Classical Kondo Lattice
K.Pradhan, and P.Majumdar
Europhys. Lett. 85, 37007 (2009).

4. The Effects of B site Doping on the Maganites
K.Pradhan, and P.Majumdar
Preprint (2009).

5. Conductance Switching and Inhomogeneous Field Melting in the charge Ordered Manganites.
A.Mukherjee , K.Pradhan, and P.Majumdar
Europhys. Lett. In press, arXiv: 0801.2054.

6. First Principles Study of Sc, Ti and V Doped Na_n(n=4,5,6) Clusters: Enhanced Magnetic Moments.
K.Pradhan, P.Sen, J.U.Reveles, S.N.Khanna
Phy. Rev. B77, 045408 (2008).

7. First-Principles Study of $TMNa_n$(TM=Cr, Mn, Fe, Co, Ni; n=4-7) Clusters.
K.Pradhan, P.Sen, J.U.Reveles, S.N.Khanna
J. Phy. Condens. Matter 20, 255243 (2008).

8. Designer Magnetic Superatoms.
J.U.Reveles, P.A.Clayborne, A.C.Reber, S.N.Khanna, K.Pradhan, P.Sen, and M.R.Pederson
Nature Chemistry, in press.

14. Priyotosh Bandyopadhyay

Enrolment No.	:	PHYS08200604013
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of Viva Voce	:	
Date of award of Provisional Degree	:	06.02.10
Title of Thesis	:	Some studies on Higgs searches at the Large Hadron Collider in scenarios beyond the Standard Model

Abstract

Predictions of the Standard Model (SM) of particle physics have now been verified at a remarkable level of precision in recent and ongoing experiments. Central to the SM is the issue of Electro-Weak Symmetry Breaking (EWSB) via the Higgs mechanism which predicts a massive scalar, the Higgs boson. Interestingly enough, this is the only particle of the SM spectrum which is yet to be discovered. Hence, search for the Higgs boson emerges as a priority program at the running (like Tevatron) and the near-future (like the Large Hadron Collider or LHC) collider experiments.

However, the mass of the SM Higgs boson (m_h) is not protected by any symmetry against radiative corrections and this leads to the well-known hierarchy problem. Supersymmetry (SUSY), through a SUSY extension of the SM, offers a technical resolution to the problem. Such an extension necessarily contains corresponding (super)partners for all the SM excitations which differ by spin 1/2 from the latter. The quadratic divergences in context get exactly canceled among diagrams containing the SM particles and the corresponding SUSY excitations.

LEP came out with the most stringent lower bound of $m_h > 114.4$ GeV. For Minimal Supersymmetric extension of Standard Model (MSSM with conserved CP symmetry) the corresponding bound is around $m_h > 93$ GeV. It is now well-known that the bound from LEP on the mass of the lightest Higgs boson of the CP-conserving MSSM can get drastically reduced or even may entirely vanish if non-zero CP-violating phases are allowed for. This can happen through radiative corrections to the Higgs potential resulting in the neutral Higgs states cease to be of definite CP property and they now can mix. We have analysed the benchmark, 'CPX' scenario via the $pp \longrightarrow t_1 t_1^* h_1$. The final state we study is n-jets (with $n <= 5$ of which 3 are tagged *b-jets*) + *dilepton* + p_T. We have carried out a thorough analysis of the above final state taking into account the major backgrounds. We find that with an integrated luminosity of $30\text{-}50\ fb^{-1}$ the 'hole' can be probed fully with a healthy enough significance [1].

In a separate study [2, 3] we concentrate on a different aspect of Higgs-search within a CP-conserving SUSY framework. Higgs bosons are expected to be looked for at the LHC in all probable channels to extract maximum possible information about the underlying framework through various consistency checks. Cascade decays of strongly produced SUSY particles can lead to Higgs bosons in a significant way. The compositions and the masses of the charginos and the neutralinos play a big role in the process. These, in turn, are determined by the values of the $U(1)$ and the $SU(2)$ gaugino masses (M_1 and M_2 respectively, which break SUSY softly) and the value of μ, the SUSY-conserving 'higgsino-mass parameter appearing in the superpotential.

We studied the cascade Higgs production for universal ($M_1 : M_2 = 1 : 2$) and non-universal (departing from that ratio) conditions. At the level of 'production rates' we point out some regions where the variations for the rates of the lightest neutral Higgs boson and that of the charged Higgs bosons are opposite neutral Higgs boson and that of the charged Higgs bosons are opposite while moving from the universal to the non-universal scenario. Later we did a detailed analysis taking into account possible SM and inherent SUSY backgrounds. We find this complementary behaviour for some benchmark points with an integrated luminosity of $10\ fb^{-1}$.

Of recent, in a separate study [4], we look into the prospects of uncovering the Higgs sector of the Universal Extra Dimensions (UED) with one extra spatial dimension. In such a scenario, all the SM particles including the Higgs boson can propagate into the bulk. Compactification of the extra spatial dimension via orbifolding (a S_1/Z_2 orbifold, to ensure chiral fermions in usual 4-dimensions) leads to an expected tower of the Kaluza-Klein (KK)excitations for all the SM particles including the Higgs boson. At the LHC, the strongly interacting level one excitations (g_1g_1, g_1q_1, q_1q_1, etc.) can be copiously produced when R^{-1} is in the ball-park of $1\ TeV$. This opens up the possibility of Higgs production under the cascade decays of UED excitations similar to the case in MSSM discussed earlier. Our initial focus is on the charged Higgs production under such UED cascades. With $\bar{m}_h^2 = 0$, as indicated above, the prospects of detecting the excited Higgs-bosons tend to diminish due to their dominant decays to rather soft ($\sim 10\ GeV$) τ-s. While one starts to have harder ô-s with increasing R^{-1}, this in turn lowers the production cross-sections at the top of the cascade in the first place thus making the early detection of KK-Higgs bosons very difficult for phenomenologically interesting values of R^{-1}

Publications

[1] P. Bandyopadhyay, A. Datta, A. Datta and B. Mukhopadhyaya, *Phys. Rev. D* 78, *015017 (2008) [arXiv:0710.3016 [hep-ph]]*.

[2] P. Bandyopadhyay, A. Datta and B. Mukhopadhyaya, *Phys. Lett. B* 670, *5 (2008) [arXiv:0806.2367 [hep-ph]].*

[3] P. Bandyopadhyay, *arXiv:0811.2537 [hep-ph].*

[4] P. Bandyopadhyay, A. Datta and B. Bhattacherjee, in preparation.

15. Supriya Pisolkar

Enrolment No.	:	MATH08200604002
Constituent Unit	:	Harish-Chandra Research Institute, Allahabad
Date of Viva Voce	:	
Date of award of Provisional Degree	:	19.03.10
Title of Thesis	:	Norm Maps in Entensions of Local Fields and Applications

Abstract

My thesis deals with following two problems. Both these problems have a common theme of understanding behaviour of norm maps in extensions of local fields.

Definition 1. Let K be a field. By a Châtelet surface over K we mean a smooth, projective, geometrically integral surface which is K -birational to the surface given by an affine equation $y^2\text{-}dz^2 = f(x)$ where d $\in K^*$ and $f(x)$ is a monic cubic separable polynomial with coefficients in K.

It is in general a difficult problem to compute the group of zero cycles on a given variety. A conjecture due to Colliot-Thélène and Sansuc says that, for rational surfaces X over a number field K, $A_0(X)_0$ can be understood in terms of $A_0(X_v)_0$ where $X_v = X \times_K K_v$ and K_v is the completion of K at a place v of K. The conjecture has been proved for conic bundle surfaces by P. Salberger. The results are known when $f(x)$ is totally split or irreducible. I have computed the local Chow groups of Châtelet surfaces in the remaining case, where $f(x)$ is of the form $x(x^2\text{-}e)$, $e \in K^*$.

Theorem 2. *Let K be a finite extension of* Q_p, $p \neq 2$. *Assume that the quadratic extensions* $L = K(\sqrt{d})$ *and* $E = K(\sqrt{e})$ *are not isomorphic. Then* $A_0(X)_0$ *is isomorphic to Z/2Z.*

Theorem 3. *Suppose that K =* Q_2. *Assume that* $L = K(\sqrt{d})$ *and* $E = K(\sqrt{e})$ *are non-isomorphic quadratic extensions of* K.

1. *Suppose that L/K is unramified. Then the group* $A_0(X)_0$ *is isomorphic to*
   - *(i)* $\{0\}$ if $\upsilon_K(e) \equiv 0 \pmod 4$.
   - *(ii)* $Z / 2Z$ if $\upsilon_K(e) \neq 0 \pmod 4$.

2. *Suppose that L/K is a ramified extension. Then* $A_0(X)_0$ *is isomorphic to* $Z / 2Z$.

In the remaining cases where *L* and *E* are isomorphic quadratic extensions, or if one of them is the trivial extension, then it can be seen that $A_0(X)_0$ is isomorphic to $\{0\}$.

The main results of [2] are as follows.

Let *K* be a number field and let ∂_K be the discriminant of *K*. A well-known result of Stickelberger says that $\partial_K \equiv 0$ or $1 \pmod 4$. J. Martinet has the following generalization of this result.

Theorem 4. *Let L/K be a quadratic extension of number fields. If* $N_{K/Q}(\partial_{L/K})$ *is odd and if K contains a root of unity of order* 2^m *for some* $m \equiv 1$*, then* $N_{K\backslash Q}(\partial_{L/K}) \equiv (-1)^c(\bmod 2^{m+1})$*, where c is the number of complex places of L lying above a real place of K.*

As this result explains the behaviour of the absolute norm of the relative discriminant at the prime *2*, one may ask if there is a local analogue of Martinet's result.

Recall that if *K* is a *p*-adic field containing a primitive *p*-th root of unity $æ_p$, then a unit $u \in O_K^*$ is called a *p*-primary unit if the extension $K(\sqrt[p]{u})/K$ is unramified. When *L/K* is an unramified extension of *2*-adic fields, the discriminant of any integral basis is a *2*-primary unit. I have proved a local analogue of Martinet's theorem (Corollary as below) which turns out to be a statement about 2-primary units. I have proved the following result which holds for *p*-primary units for all primes *p*.

Theorem 5. *Let K be a finite extension of* Q_p *containing a primitive* p^m*-th root of unity, where* $m \geq 1$*. Let á be a p-primary unit of* O_K^**. Then,*

$$N_{K/Qp}(á) \equiv 1 \ (\bmod\ p^{m+1})$$

Corrollary 6. Let *K* be a finite extension of Q_2 containing a primitive 2^m-th root of unity for some $m \geq 1$. Let *L* be an unramified extension of *K* and let $\{á_1, á_2, \ldots, á_n\}$ be an integral basis of *L/K*. Then,

$$N_{K/Q2}(d_{L/K}(\{á_1, á_2, \ldots, á_n\})\ a"\ 1(\bmod\ 2^{m+1})$$

Moreover an example is given which shows that the absolute norm of a *p-primary* unit may not satisfy a better congruence. I have partially recovered Martinet's global result by using local results.

Corrollary 7. Let *K* be as above with $m \geq 2$. Let *L/K* be a finite extension having an integral basis $\underline{á}$. Assume that the absolute norm $N_{K/Q}$ of the discriminant ideal $\partial_{L/K}$ is odd. Then, $N_{K/Q}(d_{L/K}(\underline{á}))$ is the positive generator of $N_{K/Q}(\partial_{L/K})$. In particular

$$N_{K\backslash Q}(\partial_{L/K}) \equiv 1\ (\bmod\ 2^{m+1})$$

Publications

[1] Pisolkar, S.; Chow group of zero-cycles on certain Châtelet surfaces over local fields. *Indag. Math. (N.S.)* 19 (2008), no. 3, 427 to 439.
[2] Pisolkar, S.; Absolute norms of *p*-primary units. *J. Théorie Nombres Bordeaux* 21 (2009), no. 3, 733 to 740.

16. Narujjaman Md.

Enrolment No.	:	PHYS05200704001
Constituent Unit	:	Saha Institute of Nuclear Physics, Kolkata
Date of Viva Voce	:	
Date of award of Provisional Degree	:	10.06.09
Title of Thesis	:	Nonlinear Dynamics Experiments in Glow Discharge Plasma

Abstract

This thesis presents some results of the nonlinear dynamics experiments in argon dc glow discharge plasma. The study of nonlinear dynamics or chaos theory has emerged in the last three decades or so as an important interdisciplinary area of research encompassing a wide range of fields like: fluids, plasmas, biomedical sciences, finance, turbulence, astronomy, material sciences, etc. Chaos was first observed in the low frequency self-oscillations in the un-driven DC discharge system. Then several other nonlinear phenomena like mode locking, period pulling, etc., had been observed in plasma.

Inverse route, i.e., chaos to ordered state transition has first observed in DC plasma system presented in this thesis. We have also studied noise-induced phenomena in this experimental set up. The experiments were preformed in an argon dc glow discharge plasma produced inside a cylindrical hollow cathode dc glow discharge system, and a Langmuir probe located between the anode and the cathode was used to monitor the floating potential fluctuations, and a black and white CCD camera was used to measure the size of the anode glow. A noise (HP33120A) and a signal generators (Fluke PM5138A) were coupled with the discharge power supply for the noise induced experiments.

Anode glow related observation of chaos to order transition and homoclinic bifurcation in the glow discharge plasma. Depending upon the gas pressure and discharge voltage (DV) plasma showed chaos at the initial stage and then the oscillations became relaxation type oscillations before totally vanishing at the bifurcation point (V_H). The time period of these relaxation oscillations increases with increasing DV. It is observed that $\ln|V-V_H|$ vs Time is a straight line, indicating that the system goes through a homoclinic bifurcation. The floating potential fluctuations exhibit relaxation oscillations on the one side of the V_H (bifurcation point) and a stable fixed point on the other side, called the excitable state and is useful to study noise invoked dynamics.

When the DV is modulated with a stochastic signal, the autonomous dynamics has been recovered, and this phenomenon is termed as coherence resonance. For stochastic resonance, the DV was perturbed by a combination of a subthreshold periodic pulse train and a Gaussian white noise. The time series of the system response in the presence of an identical subthreshold signal for three different amplitudes of imposed noise. It is observed that there is little correspondence between the subthreshold signal and the system response for low noise amplitude. However, there is an excellent correspondence at intermediate noise amplitude. Finally, at higher amplitudes of noise, the subthreshold signal is lost amidst stochastic fluctuations of the system response. Absolute mean difference (AMD) has been used to quantify the information transfer between the subthreshold signal and the system response and the unimodal structure is the signature of the SR phenomena.

Finally, we have presented the observation self organized criticality behavior in plasma. When the system was operated in the pressure region less than the Paschen minimum, for a small range of p ($0.9-1.5\times10^{-2}$ Torr or $1.2-2\times10^{-2}$ mbar), it was observed that the behavior of the floating potential fluctuations was consistent with self organized criticality (SOC). In order to establish the SOC behavior, we had checked the power law behavior of the power spectrum, and the presence of the long-range correlation by estimating Hurst exponent (H) (using R/S technique) and the exponent (α) of autocorrelation function (ACF) decay, and the nongaussian probability distribution function.

In future these works can be extended to study the effect of the noise and suprathreshold on the autonomous dynamics, chaos control and synchronization etc.

Publications

1. Md. Nurujjaman,Ramesh Narayanan, and A. N. Sekar Iyengar, CWT based time-scale and multi-fractal analysis of nonlinear oscillations in a hollow cathode glow discharge plasma, Phys. Plasmas **16**, 102307 (2009).

2. Md. Nurujjaman, Ramesh Narayanan, and A. N. Sekar Iyengar, Comparative study of nonlinear properties of EEG signals of normal persons and epileptic patients, Nonlinear Biomedical Physics, 3:6, (2009).

3. Md. Nurujjaman, P. S. Bhattacharya, A. N. Sekar Iyengar and Sandip Sarkar, Coherence resonance in a unijunction transistor relaxation oscillator, Phys. Rev. E **80**, 015201R (2009).
4. Md. Nurujjaman, A. N. Sekar Iyengar and P. Parmananda, Noise induced resonance dynamics in nonlinear plasmas, Physics Teacher 50, 23 (2008).

5. Md. Nurujjaman, A. N. Sekar Iyengar and Punit Parmananda, Noise-invoked resonances near a homoclinic bifurcation in the glow discharge plasma, Phys. Rev. E **78**, 026406 (2008).

6. Md. Nurujjaman, Ramesh Narayanan and A. N. Sekar Iyengar, Parametric investigation of nonlinear fluctuations in a dc glow discharge plasma, Chaos **17**, 043121 (2007).

7. Md. Nurujjaman and A.N. Sekar Iyengar, Realization of SOC behavior in a dc glow discharge plasma, Physics Letters A **360**, 717 (2007).

8. Md. Nurujjaman, Ramesh Narayanan and A. N. Sekar Iyengar, Fractal Dimension of the El Salvador Earthquake (2001) time Series, Lect. Notes Physics **705**, 499 (2007).

9. Md. Nurujjaman, A.N. Sekar Iyengar, Chaotic-to-ordered state transition of cathode-sheath instabilities in DC glow discharge plasmas, PRAMANA - journal of physics **67**, 299 (2006)

17. Manas Kumar Dalai

Enrolment No.	:	PHYS07200604007
Constituent Unit	:	Institute of Physics, Bhubaneswar
Date of Viva Voce	:	
Date of award of Provisional Degree	:	31.12.09
Title of Thesis	:	Spectroscopic investigations of the electronic structure $Pr_{1-x}Ca_xMnO_3$ system

Abstract

In my thesis work, the electronic structure of $Pr_{1-x}Ca_xMnO_3$ series have been investigated using ultra-violet photoelectron spectroscopy (UPS), X-ray photoelectron spectroscopy (XPS), Inverse photoemission spectroscopy (IPES) and X-ray absorption spectroscopy (XAS). $Pr_{1-x}Ca_xMnO_3$ is one of the interesting among these materials due to their insulating phase at all temperatures and great variety of ordered phases, that are very sensitive to the cation/anion doping. For 0.3 $\leq$ x $\leq$ 0.8, a charge ordering of Mn^{3+} and Mn^{4+} was found and an antiferromagnetic (AF) ordering can be observed with neel temperature ranging from 100 to 170 K. For x $\leq$ 0.25, a ferromagnetic insulating state (FMI) is observed and with no CO, whatever the temperature. In this region the metallic state is never realized even upon the application of magnetic field. But the charge ordered insulating state can be melted into ferromagnetic metallic state (FMM) upon application of a magnetic field. Interestingly the x = 0.33 doping shows the coexistence of FM and AFM phases. Around x = 0.9 a metallic cluster glass domain has been observed.

Using valence band photoemission and O K edge x-ray absorption, we studied the temperature dependent finer changes in the near EF electronic structure of $Pr0._{67}Ca_{0.33}MnO_3$, which is regarded as a prototype for the electronic phase separation models in CMR systems. With decrease in temperature the O 2p contributions to the t_{2g} and e_g spin-up states in the valence band were found to increase until Tc. Below Tc, the density of states with eg spin-up symmetry increased while those with t2g symmetry decreased, possibly due to the change in the orbital degrees of freedom associated with the Mn 3d O 2p hybridization in the pseudo - CE - type charge or orbital ordering. These changes in the density of states could well be connected to the electronic phase separation reported earlier. By combining the UPS and XAS spectra, we derived a quantitative estimate of the charge transfer energy ECT (2.6$\pm$0.1 eV), which is large compared to the earlier reported values in other CMR systems. Such a large charge transfer energy was found to support the phase separation model.

For a complete understanding of the changes in the occupied and unoccupied electronic states we performed a detailed study of the $Pr_{1-x}Ca_xMnO_3$ system across their ferromagnetic - antiferromagnetic phase boundary using UPS and IPES. We used three compositions x = 0.2, 0.33 and 0.4. Our photoemission studies showed that the pseudogap formation in these compositions occur over an energy scale of 0.48$\pm$0.02 eV. Here again, we have estimated the charge transfer energy in these compositions to be of the order of $\sim$ 2.8$\pm$0.2 eV. We have also undertaken a detailed study of the core level electronic structure of $Pr_{1-x}Ca_xMnO_3$ ((x = 0.2, 0.33, 0.4 and 0.84) using X-ray photoelectron spectroscopy. These studies have been performed at the Mn 2p, Ca 2p and Pr 4d levels. We have made systematic measurments of the changes in the binding energy positions of these levels as a function of the charge carrier concentration. We also have analyzed the line shapes of these core levels.

To a large extent the traditional models employing the charge-spin coupling, have been able to explain the CMR in many of the hole doped compositions. But, much less is known about the

electron-doped versions of these materials in which the charge, orbital and spin ordering add more complexity to the ferromagnetic (FM) double exchange and the super exchange interactions. These Mn(IV) rich compositions exhibit marked differences in the electronic and magnetic properties from their Mn(III) rich counterparts. It has been shown that the substitution of Ca by a trivalent cation in the G-type antiferromagnet, CaMnO3 leads to the formation of a FM component with a maximum for optimal electron doping. Depending on the nature of the trivalent cation, the x_{opt} was found to lie between 0.135 and 0.16. This FM component is correlated to the distortion of the MnO6 octahedra and thereby the e_g band width. With low filling of the narrow e_g band, these systems have strong electron-electron interactions and consequent charge localizations. Using high resolution photoelectron spectroscopy and O K edge x-ray absorption spectroscopy we have studied the temperature dependence of the near Fermi level electronic structure in the electron doped CMR, $Ca_{0.86}Pr_{0.14}MnO_3$. We found that the temperature dependent changes in the electronic structure is consistent with the conductivity behavior of the electron doped systems in general. As the temperature is lowered from 293 K a feature due to the e_g states starts appearing near the EF . This increase in the DOS is a signature of the semi-metallic behavior of the sample in the range 110 - 300 K. Surprisingly, though the resistivity measurement on this sample showed an insulating behavior below its transition temperature Tc (110 K), the intensity of this feature further increases below the Tc. Further, we have found an increase in the eg band width (W) also at low temperatures. It was also interesting to note that the increase in the near EF DOS in this compound is apparently different in nature from that associated with the pseudogap formation in the other systems like $Pr_{1-x}Sr_xMnO_3$. We have discussed our results from the point of view of phase sepation models considering the temperature dependent structural changes and consequent localization of the electrons in a narrow e_g band.

Publications

1. M. K. Dalai, P. Pal, R. Kundu, B. R. Sekhar, S. Banik, S. R. Barman, and C. Martin, '*Electronic structure of $Pr_{1-x}Ca_xMnO_3$ from photoemission and inverse photoemission spectroscopies*', Physica B, 405, 186 (2010).
2. P. Pal, M. K. Dalai, R. Kundu, B. R. Sekhar, and C. Martin, '*Pseudo gap behaviour of phase separated $Sm_{1-x}Ca_xMnO_3$: A comparative photoemission study with a double exchange system,* ' Phys. Rev. B 77, 184405 (2008).
3. P. Pal, M. K. Dalai, R. Kundu, M. Chakrabarty, B. R. Sekhar, and C. Martin, ' *Near Fermi level electronic structure of Pr1-xSrxMnO3 : photoemission study*', Phys. Rev. B 76, 195120 (2007).
4. M. K. Dalai, P. Pal, B. R. Sekhar, N. L. Saini, R. K. Singhal, K. B. Garg, B. Doyle, S. Nannarone, C. Martin, and F. Studer, ' *Electronic structure of Pr0.67$Ca_{0.33}MnO_3$ near the Fermi level studied by ultraviolet photoelectron and x-ray absorption spectroscopy* ' Phys. Rev. B 74, 165119 (2006).
5. P. Pal, M. K. Dalai, B. R. Sekhar, S. N. Jha, S. V. N. Bhaskara Rao, N. C. Das, C. Martin, and F. Studer, '*Valence band electronic structure of Pr1-xSrxMnO3 from photoemission studies* ' , J. Phys.: Condens. Matter, 17 2993 - 2999 (2005).
6. M. K. Dalai, P. Pal, R. Kundu, S. K. Garg, B. R. Sekhar, M. Merz, P. Nagel, S. Schuppler, and C. Martin, 'Spectroscopic investigations of electron doped $Ca_{0.86}Pr_{0.14}MnO_3$. (Submitted).
7. M. K. Dalai, R. Kundu, P. Pal, M. Bhanja, B. R. Sekhar, and C. Martin, '*XPS study of $Pr_{1-x}Ca_xMnO_3$*', (Submitted).
8. P. Pal, M. K. Dalai, R. Kundu, B. R. Sekhar, M. Mertz, P. Nagel, S. Schuppler, M. Channabasappa, and A. Sundaresan, ' *Photoemission studies of the magnetic phase transitions in $Pr_{0.5}Sr_{0.5}MnO_3$*', (Submitted).

18. Umananda M. Bhatta

Enrolment No.	:	PHYS07200604018
Constituent Unit	:	Institute of Physics, Bhubaneswar
Date of Viva Voce	:	
Date of award of Provisional Degree	:	19.03.10
Title of Thesis	:	Temperature dependent TEM studies of gold nanostructures on silicon surfaces and in polymer thin films

Abstract

The thesis work involves various aspects related to thermal behavior of gold nanostructures in two different systems: (i) on single crystalline silicon substrates and (ii) in thin polystyrene (PS) films. The emphasis in this thesis work is on the use of transmission electron microscopy (TEM) for carrying out temperature dependent structural variations in gold nanostructures in inorganic (silicon) and organic media (polysterene).

In the first and major part of the thesis work, gold thin films of different thickness were deposited on Si(110) substrates by both UHV-MBE and thermal evaporation methods. In the case of MBE samples (1.0, 2.0, 5.0 and 11.7 nm) *(this represents for the case where no native oxide is present at Au-Si interface)*, upon in-situ annealing in TEM hot-specimen-stage, as deposited irregular nanostructures underwent a shape transformation to form well aligned gold silicide nanorods all aligned along [1-10] direction at higher temperatures ($\approx 700^0$C) (for 1.0 and 2.0 nm case). The selected area diffraction taken at room temperature confirmed the formation of Au5Si2. The alignment of gold silicide structures has been explained on the basis of lattice matching between the substrate silicon and silicide structures [1]. In the case of higher thickness (5.0 and 11.7 nm), formation of much bigger structures aligned in the same directions were found [2]. In presence of a native oxide layer gold coverage was much lesser as compared to MBE sample. Formation of aligned nanostructures were found for all three thickness namely: 2.0, 5.0 and 11.7 nm. Aspect ratios were much higher (as high as 15) in the case of 2.0 nm Au/SiO_2/Si(110) system [3]. Similar formation of aligned nanostructures along [1-10] were found for higher thickness as well. The growth of these gold silicide nanostructures along [1-10] direction has been explained based on selective thermal decomposition of native oxide layer followed by liquid-solid growth mechanism [3]. As a comparative study, similar measurements were done on 2.0 nm Au/Si(111) system in presence of a native oxide layer. Formation of facetted structures were observed following the 3-fold symmetry of the substrate.

In the second part, extent of radiation induced damage (electron/ion) was studied using Si/Cr/PS systems, where in two different thickness (2.5 and 50.0 nm) of Cr were used. Cr thin film acts as a source of primary and secondary electron upon electron irradiation and inducing the damage to the PS overlayer [4, 5]. Low-temperature TEM studies were performed on Polystyrene (PS, Mw = 234 k) - Au nanoparticle composite thin films that were annealed up to 350°C under reduced pressure conditions. A comprehensive TEM analysis was performed specifically at liquid nitrogen temperatures to ensure that the film retained its integrity. The results showed an increase in Au NP diameter (2.3 nm to 3.6 nm) and more importantly, an improved thermal stability of the PS composite film was observed [6].

Publications

1. Umananda M. Bhatta, J. K. Dash, Anupam Roy, A. Rath and P. V. Satyam, *J Phys: Cond. Mat.* 21 (2009) 205403.

2. Umananda M. Bhatta, J. K. Dash, A. Rath, P. V. Satyam, *Appl. Sur. Sci.* 256 (2009) 567.

3. Umananda M Bhatta, Ashutosh Rath, Jatis K Dash, Jay Ghatak, Lai Yi-Feng, Chuan-Pu Liu, P. V. Satyam *Nanotechnology* 20 (2009) 465601.

4. Umananda M. Bhatta, J. Ghatak, M. Mukhopadhyay, Raymond Conley, Chian Liu, and P.V. Satyam, *Nucl. Instrum. Meth.* B 266 (2008) 1548.

5. Umananda M. Bhatta, J.Ghatak, M. Mukhopadhyay, Jin Wang, Suresh Narayanan and P.V. Satyam, *Nucl. Instrum. Meth. B* 267 (2009) 1807.

6. Umananda M. Bhatta, Deepa Khushalani and P.V. Satyam, *Bull. Mater. Sci.* (2010) (accepted, in press).

Annexure 6

Titles of M.Tech. Theses

Titles of M.Tech. Theses Awarded Degree in 2009-2010

S.No.	Name of the Student	Title of thesis
1.	Kumkum Uniyal	Development of advance optically stimulated luminescence reader system and its performance evaluation using phosphor material
2.	Pragya R. Jopat	Studies on the parametric dependencies of effective deposition velocities of Radon/Thoron progeny using passive direct progeny sensing techniques
3.	Istiyak Khan	studies on various damping devices for reduction of Seismic response of structures
4.	Nirmal Singh Negi	Non Linear static pushover analysis of reinforced concrete structure
5.	Rahul Mittal	Prediction of fatigue crack growth life of a notched pipe under viberation loading followed by normal loading
6.	Shri Pankaj Shah	Face Recognition under constrained environment using the hidden Markov Model (HMM) based Probabilistic Statistical learning Paradigm.
7.	Ms. Suja Ramachandran	Information Security Monitoirng system.
8.	Ms. Namita Singh	Optimizing Design Parameters for Automated Material Transfer using Discrete event simulation Methodologies - A case study.
9.	Shri Ashutosh Kabra	Formalization of IEC 61131-3 based PLC Language (SFC) to a Synchronous Framework.
10.	Shri Asheesh Jain	Performance evaluation and development of test Ethernet network for use in NPP.
11.	Shri Kapil Bodkha	Study on Stabilization of Single-Phase natural circulation system using Mechanical gadgets.
12.	Shri Ankur S. Patel	Design and Development of LCL Resonant Rased Repetitive Capacitor Charging Power Supply.
13.	Shri Ramnik Singh	Design, Analysis and Simulation of Double Curvature Neutron Focussing Monochromator.
14.	Shri Ashutos Mohanty	Implementation of Reed Solomon Error Correction Code.
15.	Shri Vineet Sharma	A Study of the effect of Process Migration in Distributed Environments.
16.	Shri Surendra Singh Saini	Friction Compenstation in Advanced Servo Manipulators.
17.	Shri Prashant Joshi	Optimistion of Tuned mass elasto-Plastic Damper Characteristics for various classes of loadings.
18.	Shri K. K. Ahmed Rafiq	Manufacture of Microgripper and evaluation of its performance characteristics.
19.	Shri Amardip Singh	Development of an online impedance measurement unit and evolution of an Algorithm for Maximum Power transer to a Dynamically varying RF Load
20.	Shri Prabal Mehra	Design of FPGA based Neutron Kinetic Simulator.
21.	Shri Koduri Appa Rao	Simulation of Thermal-Hydraulics and Hydrogen behaviour in Multi-Compartment geometries of IPHWRs using Astec code and Validation using Experimental Studies.
22.	Shri Rishi Pamnani	Optimisation of Damper Characteristics for Displacement control of Base isolation system.

23.	Shri Devendra Singh Saini	Design and Development of Wide Range Digitized Nuclear Instrumentation Channel.
24.	Shri Nitin Kumar Rimza	Study , Analysis and Design of CPLD/FPGA based safety logic units for Fuel handling controls of 700MWe
25.	Shri Shiv Kumar	Characterization and Device modeling for CMOS semiconductor devices
26.	Shri Tejas Ramakant Rane	Some studies in liquid helium transfer lines and cryostats
27.	Shri Sumit Goyal	Investigation on Fatigue Ratcheting Behaviour of Piping Components.
28.	Shri Lalit Kumar Patel	Study and Development of a Bandwidth Efficient & Integrated Network Management System for Heterogeneous Networks.
29.	Shri Harsh Ghildiyal	Analysis of Pressure tube and Calandria tube contact Characteristics due to high yemperature creep
30.	Shri Vikas Teotia	Advanced Digital Signature Analysis and Implementation - for TDEM signals.
31.	Shri Jogeshwar Kar	Analysis of Blast Resistant Doors for Hardened Structures
32.	Shri B. Vivek	Optimisation oftuned mass friction damper characteristics with various classes of loadings.
33.	Ms. Sherry Rosily	Development of 75 MHZ.1 KWRF amplifier for heavy ion req accelerator
34.	Shri Amit Agrawal	Development of Remote Control for ROHYTAM (Remotely Operated Hydraulic Trolley Along with Manipulator) using USB Joystick and Steering Wheel.
35.	Shri Sukhdeep Singh	Development of Universal Digital Neutronic Signal Processing Hardware.
36.	Shri Santosh Pandey	Evolution of Methodology for Predicting the Behavior of EPDM O-Ring under High Pressure Environment
37.	Shri J.V.K. Sunil Kumar	Development of Passive and Active Neutron Monitors for Neutron dose Monitoring in and around Medical Accelerators.
38.	Shri Deepak Kumar Akar	Monte Carlo Calculation of uncertainty in the Assessment of lung burden of Actinides using Mathematical phantoms.
39.	Shri Manish Joshi	Size Dependent Radon Progeny Aerosol Removal Characteristics in a Unipolar Ionic Environment.
40.	Shri Sunil Kumar Singh	Development of Techniques for Standardization of low and medium energy ISO Grade X-Ray beams and Synchrotorn Radiation
41.	Shri Ashok Kumar Ranade	Geochemical Interaction of Groundwater Colloids with Transuranics.
42.	Ms. Garima Singh	Development and Characterization of a Passive diffusion sampler for Formaldehyde Estimation in workplaces.
43.	Ms. Vitisha Suman	Development of Decision Support System Software for use in Nuclear or Radiological Emergency
44.	Ms. Richa Pandey	Study and Development of Man Machine Interface and Human Factor Engineering aspects of soft Display Panel(s) for fuelling Machine Integrated Test Facility at Tarapur

45.	Shri Raman Sehgal	Compression of High Energy Physics Experimental Data
46.	Shri Vibhor Sharma	Mathematical and Experimental Study of Temperature Distribution inside MTR Reactor used for Uranium Metal ingot production: Pre-Heating stage.
47.	Shri Soumyajit Koley	Synthesis, Sintering & Electrical Characterization of Samaria Yttria Codoped Zirconia.
48.	Shri Mahesh Acharya	A Study of various Modulator topologies and Development of small scale prototype of Marx Modulator.
49.	Shri Rahul Gaur	Analysis of an RFQ Beam Dynamics with Varying Vane parameters.
50.	Shri Avinash Ojha	Design and Development of Processing Electronics for TL-1 Beam Position Monitor.
51.	Ms. Rinki Upadhyay	High Performance Power supply for CW Klystron Amplifier
52.	Ms. Prachi Chitnis	Epics based Control system for Common Injector of Indus-1 and Indus-2 Synchrotron Radiation sources.
53.	Shri Jitendra Kumar	Design & Development of a flowing dye-cell and its performance evaluation in a dye laser oscillator pumped by a Copper Vapour Laser
54.	Shri Manjeet Ahlawat	Studies of electrical Response of the transmission Line type kicker magnet.
55.	Shri Arup Ratan Jana	A study on the effects of unavoidable geometry errors on the cavity performance through Electromagnetic simulations.
56.	Ms. Sonika Tanwani	Development fo PCI-based card for Laser Control Applications.
57.	Shri Shailesh Khamari	Characterization of MOVPE grown GaAs based p-i-n diodes.
58.	Shri Brijesh Chandra Pant	Design, fabrication and testing of 6-6 SPS, 6-DOF Gough-Stewart Platform.
59.	Shri Mahesh Bajaj	Design and Development of cone flow meters for industrial applications

Annexure 7

Memorandum of Understanding with University of Virginia

CONTR... C-3483

GENERAL AGREEMENT
FOR ACADEMIC COOPERATION AND EXCHANGE
BETWEEN
HOMI BHABHA NATIONAL INSTITUTE
AND
THE RECTOR AND VISITORS OF THE UNIVERSITY OF VIRGINIA

Homi Bhabha National Institute (HBNI) and the Rector and Visitors of the University of Virginia (University of Virginia) hereby enter into this General Agreement for Academic Cooperation and Exchange (General Agreement) to foster international cooperation in education and research.

1. Both parties agree to encourage the following activities to promote international academic cooperation in the fields of science and technology, particularly in the disciplines of physics and engineering:
   (1) Exchange of educational and research materials, publications, and academic information;
   (2) Exchange of faculty and research scholars;
   (3) Exchange of students; and
   (4) Joint research and meetings for education and research.

   Before any of these activities are undertaken, the parties shall discuss the implementation of the activities to their mutual satisfaction, and shall enter into separate written agreements detailing the conduct of such activities.

2. This General Agreement shall be applicable to the educational and research efforts of the University of Virginia Department of Physics and the School of Engineering and Applied Science and HBNI and its Constituent Institutions.

3. For purposes of this General Agreement, the coordinator for HBNI will be Dr. ~~K.C.~~ R R Puri ~~Mittal~~, and the coordinator for the University of Virginia will be Dr. Rao Myneni Ganapati.

4. This General Agreement shall become effective as of the date of signature by representatives of both parties and shall remain in effect for an initial period of five (5) years. The amendment or extension of the Agreement shall require the written agreement of both parties. Either party may terminate the Agreement at will upon written notification to the other party.

5. Both parties agree that this Agreement should be reviewed approximately every five years in order to evaluate progress and improve the quality of the exchange.

6. Both parties subscribe to the policy of equal opportunity and do not discriminate on the basis of race, age, ethnicity, religion or national origin. The University of Virginia and HBNI shall abide by these principles in the administration of this Agreement.

For Homi Bhabha National Institute

Rawinder Puri

Dr. ~~Grover~~ R R Puri — Date
~~Director~~ Dean
Homi Bhabha National Institute

For the Rector and Visitors of the University of Virginia

4/29/09

Stephen A. Kimata — Date
Assistant Vice President for Finance and University Comptroller for the Rector and Visitors of the University of Virginia

Annexure 8

Receipts & Payments for the financial year ending on 31.3.2010

RECEIPTS & PAYMENTS ACCOUNT
FOR THE FINANCIAL YEAR ENDING ON 31.03.2010

Payment	Amt.(Rs.)	Amt.(Rs.)	Receipt	Amt.(Rs.)	Amt.(Rs.)
			Opening balance		4,249,175.00
			Receipt/Admission/ Registration Fees		2,391,530.00
Re-imbursement of tution fees		78,936.00			
Miscellaneous expenditure		51,252.00	Bank Interest on savings as on 30.06.2009	70,557.00	
Bank Charges (charges for o/s cheques)		150.00	as on 31.12.2009	91,156.00	161,713.00
Excess of Income over Expenditure (represented by bank balance in a/c 3012832251-2 as on 31.03.10)		6,672,080.00			
		6,802,418.00			**6,802,418.00**

Published by

Prof. K. Bhanumurthy

Head, Scientific Information Resource Division,

Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, India.