होमी भाभा राष्ट्रीय संस्थान

Homi Bhabha National Institute

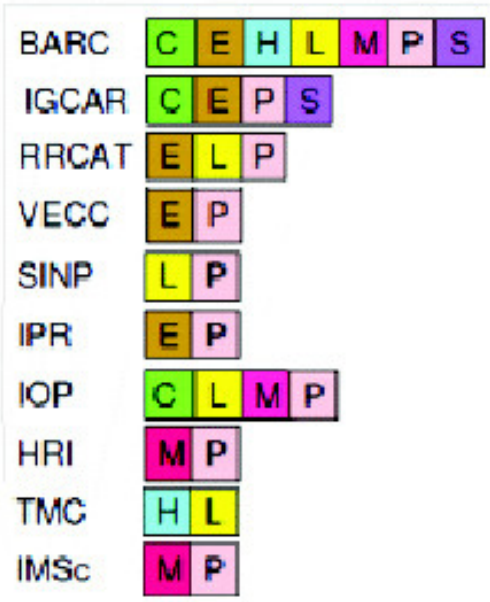
ANNUAL REPORT
2011-2012
(Volume - 2)

Training School
Bhabha Atomic Research Centre

MANAGEMENT OF THE INSTITUTE

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

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



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

Composition of Bodies of the Institute is given in Annexure 1. Composition of Standing Committees is given in Annexure 2. List of faculty is placed at Annexure 3.

Front cover page : Main entrance of Training School Complex Anushaktinagar, Mumbai 400 094

ADMISSIONS AND RESULTS

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

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

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

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

Receipts and payments for the financial year ending on 31.3.2012 are given in Annex-8.

Important Meetings and Decisions

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

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

1. **Eighth meeting on September 12, 2011, HBNI, Training School, Mumbai.**

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

1. **Twelfth meeting on April 11, 2011.**

Important decisions taken in these meetings are summarized below.

12th Academic Council Meeting held at Council Hall, HBNI on April 11, 2011.

A. Important decisions taken in the meetings of the CoM

Eighth meeting: September 12, 2011

The CoM approved revised MoA and Rules of HBNI to comply with theUGC (Institutions Deemed to be Universities) Regulations 2010.

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

Twelfth meeting: April 11, 2011

1. **The AC decided that the PGDiploma and MTech programme in Geology and Geophysics disciplines in the Training School at AMD Hyderabad would be named Exploration Geosciences.**
2. **The AC approved that a handout be designed highlighting the objective and programmes of HBNI.**

Annex 1

Composition of the Bodies of the Institute

Council of Management (CoM)

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

Academic Council

Prof. R.B. Grover	**Chairman**
Prof. S.K. Apte	**Convener Board of Studies in Life Sciences**

Prof. V. Arvind	**Convener, BoS Mathematical Sciences**
Dr. R. A. Badwe	**Director, TMC**
Prof. R. Balasubramanian	**Director, IMSc**
Shri S.C.Chetal	**Director, IGCAR**
Prof. R.K.Bhandari	**Director, VECC**
Prof. B.M.Deb	**IISER, Kolkata**
Prof. B.K. Dutta	**Convener Board of Studies in Engineering Sciences**
Prof. Dipan Ghosh	**IIT-Bombay**
Prof. P.D.Gupta	**Director, RRCAT**
Prof. P.K. Kaw	**Director, IPR**
Prof. A.M. Jayannabar	**Director, IoP**
Prof. K. Muralidhar	**IIT-Kanpur**
Prof. Srinivasa Ranganathan	**IISc, Banglore**
Prof. S.Ramakrishnan	**TIFR, Mumbai**
Prof. K.L. Ramakumar	**Convener Board of Strategic Studies**
Prof. M.K. Sanyal	**Director, SINP**
Dr. R.K.Sinha	**Director, BARC**
Dr. R. K. S. Sharma	**Convener, BoS, Health Science, TMC**
Prof. Dinesh Srivastava	**Convener, BoS Physical Sciences**
Prof. R.R. Puri	**Member Secretary**

Advisory Committee

Dr. S. Banerjee **Chairman, AEC**	**Chairman**
Dr. R.A.Badwe **Director, TMC**	**Member**
Prof. R. Balasubramanian **Director, IMSc**	**Member**
Shri S.C.Chetal **Director, IGCAR**	**Member**
Prof. M. Barman **Director, TIFR**	**Member**
Dr. T.K. Chandrashekar **Director, NISER**	**Member**
Dr. R.B. Grover **Director, HBNI**	**Member**
Prof. P.K. Kaw **Director, IPR**	**Member**
Dr. P.D.Gupta **Director, RRCAT**	**Member**
Dr. R.K.Bhandari **Director, VECC**	**Member**
Dr. M.K.Sanyal **Director, SINP**	**Member**
Dr. R.K.Sinha **Director, BARC**	**Member**
Prof. A.M.Jayannabar **Director, IoP**	**Member**
Dr. R.R. Puri **Dean, HBNI**	**Member-Secretary**

Board of Studies of HBNI

Physical Sciences

1. **Prof. Dinesh Srivastava** - **Convener**
   Variable Energy Cyclotron Centre
2. **Prof. C.S.Sundar**
   Indira Gandhi Centre for Atomic Research
3. **Prof. R. Ganesh**
   Institute of Plasma Research
4. **Prof. Ajit Srivastava**
   Institute of Physics
5. **Prof. P.K.Gupta**
   Raja Ramanna Centre for Advanced Technology
6. **Prof. V.M. Datar**
   Bhabha Atomic Research Centre
7. **Prof. Pinaki Majumdar**
   Harish-Chandra Research Institute
8. **Prof. Kamales Kar**
   Saha Institute of Nuclear Physics
9. **Prof. Ghanashyam Date**
   Institute of Mathematical Sciences
10. **Prof. B.N.Jagtap**
    Bhabha Atomic Research Centre

Chemical Sciences

1. **Prof. K.L. Ramakumar** - **Convener**
2. **Prof.A.V.R. Reddy**
   Bhabha Atomic Research Centre
4. **Prof. Swapan Ghosh**
   Bhabha Atomic Research Centre
5. **Prof. K.S. Viswanathan**
   Indira Gandhi Centre for Atomic Research
6. **Prof. T. Gnanasekaran**
   Indira Gandhi Centre for Atomic Research
7. **Prof. V.K Jain**
   Bhabha Atomic Research Centre
8. **Prof. P.N. Bajaj**
   Bhabha Atomic Research Centre

Life Sciences

1. **Prof. S.K. Apte** - **Convener**
   Bhabha Atomic Research Centre
2. **Prof. (Mrs.) S.M. Zingde**
   Advanced Centre for Treatment, Research & Education in Cancer (ACTREC)
3. **Prof. S.F. D'Souza**
   Bhabha Atomic Research Centre

4. **Dr. Rita Mulherkar**
   Advanced Centre for Treatment, Research & Education in Cancer (ACTREC)
5. **Prof. M. Seshadri**
   Bhabha Atomic Research Centre
6. **Prof. A.K.Sharma**
   Bhabha Atomic Research Centre
7. **Prof. B.J.Rao**
   Tata Institute of Fundamental Research
8. **Dr. S. Chipllaunkar**
   ACTREC
9. **Dr. Dipak Dasgupta**
   SINP

Engineering Sciences

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

Mathematical Sciences

1. **Prof. V.Arvind** - **Convener**
   Institute of Mathematical Sciences
2. **Prof. D.S. Nagraj**
   Institute of Mathematical Sciences
3. **Prof. B. Ramakrishnan**
   Harish-Chandra Research Institute
4. **Prof. R.R.Puri**
   Bhabha Atomic Research Centre
5. **Prof. V.S.Sunder**
   Institute of Mathematical Sciences

6. **Dr. N. Raghavendra**
   Harish-Chandra Research Institute
7. **Prof. R.C.Cowsik**
   Mumbai University
8. **Prof. Murali Srinivasan**
   Indian Institute of Technology-Bombay
9. **Prof. Madhavan Mukund**
   Chennai Mathematics Institute

Strategic Studies

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

Board of Health Sciences

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

Officers of the Institute

Academic

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

Administrative and Accounts

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

Deans-Academic at the CIs

BARC

Prof. S.K. Apte	**– Life Sciences**
Prof. B.K. Dutta	**– Engineering Sciences**
Prof. B.N. Jagatap	**–Physics Sciences**
Prof. Swapan Ghosh	**– Chemical Sciences**

IGCAR

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

RRCAT

Prof. S.B.Roy

VECC

Prof. P. Barat
Prof. D. Sarkar

SINP

Prof. P. Mitra

IPR

Prof. S Mukherjee

IoP

Prof. Ajit Srivastava

TMC

Dr. K.S.Sharma

IMSc

Prof. Vijay K - Mathematical Science

Prof. T.R. Govindarajan - Physical Sciences

HRI

Prof. Sukumar Das Adhikari

Annex 2

Composition of Standing Committees

BARC Standing Committees

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

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

Since March 2011 onwards

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

Chemical Sciences

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

Life Sciences

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

Engineering Sciences & Strategic Studies

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

RRCAT Standing Committee

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

IGCAR Standing Committees

Physical Sciences

1.	Dr. C.S. Sundar	Chairman
2.	Dr. P. Mohanakrishnan	Member

3.	Dr. A.K. Arora	Member
4.	Dr. K.G.M. Nair	Member
5.	Dr. A.K. Tyagi	Member
6.	Dr. N. Subramanian	Member
7.	Dr. M. Sai Baba	Member
8.	Dr. K.S. Viswanathan	Member
9.	Dr. G. Amarendra	Convener

Chemical Sciences

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

Engineering Sciences

1.	Dr. T. Jayakumar	Chairman
2.	Dr. P. Chellapandi	Member
3.	Dr. A.K. Bhaduri	Member
4.	Dr. U. Kamachi Mudali	Member
5.	Dr. C. Anand Babu	Member
6.	Dr. K. Velusami	Member
7.	Dr. B.P.C. Rao	Member
8.	Dr. B.K. Panigrahi	Member
9.	Dr. K.S. Viswanathan	Member
10.	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	

Annex 3

Faculty List (Updated upto March 2012)

BARC

Chemical Sciences

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

Engineering Sciences

1. Anup K. Bhattacharjee
2. Awasthi A.
3. Badodkar D.N.
4. Balasubramaniam R.
5. Banerjee S.
6. Bhatia M.S.
7. Bidaye A.C.
8. Chakraborty S.P.
9. Chakravarty A.
10. Chattopadhyay J.
11. Chkaravarthy J.K.
12. Das R.
13. Dey G.K.
14. Dutta B.K.
15. Dwarkanath T.A.
16. Gantayet L.M.
17. Ghosh A.K.
18. Gopika Vinod

19. Grover R.B.
20. Hubli R.C.
21. Kain V.
22. Kallol Roy
23. Kapilesh Bhargava
24. Kapoor Rajiv
25. Kar D.C.
26. Khan K.B.
27. Maheswari N.K.
28. Nayak A.K.
29. Pal P.K.
30. Patankar V.H.
31. Prasad G.J.
32. Ramanathan S.
33. Rami Reddy G.
34. Ravindranath S.V.G.
35. Roy Debanik
36. Roy S.B.
37. Samal M.K.
38. Sandip Saha
39. Saravana Kumar U.
40. Sathiyamoorthy D.
41. Satayasai P.M.
42. Singh J.B.
43. Singh R.K.
44. Singh R.N.
45. Srivastava D.
46. Suri A.K.
47. Suri V.K.
48. Suri B.M.
49. Taliyan S.S.
50. Tewari P.K.
51. Tewari R.
52. Tiwari A.P.
53. Topkar Amita V.
54. Tripathy Prabhatkumar
55. Varde P.V.
56. Vijayan P.K.
57. Vinod Kumar A.

Life Sciences

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

Physical Sciences

1. Amitabh Das
2. Aswal D.K.
3. Aswal V.K.
4. Auluck S.K.H.
5. Basu S.
6. Bera S.
7. Bhanumurthy K.
8. Bhattacharyya D.
9. Biswas D.
10. Biswas D.C.
11. Biswas D.J.

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

Strategic Studies

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

HRI

Physical Sciences

1. Basu Anirban
2. Bhattacharjee Jayanta Kumar
3. Choubey (Smt.) Sandhya
4. Choudhury Tirthankar Roy
5. Das Tapas Kumar

6. Datta A.
7. De Aditi Sen
8. Gandhi Raj
9. Gopakumar Rajesh
10. Jatkar Dileep P.
11. Majumdar Pinaki
12. Mukhopadhyaya B.
13. Naik S.
14. Pai G.V.
15. Panda Sudhakar
16. Pati Arun Kumar
17. Pareek T.P.
18. Rao (Smt.) Sumathi
19. Ravindran V.
20. Sen Ashoke
21. Sen Prasenjit
22. Sen Ujjwal
23. Sriramkumar D.L.

Mathematical Sciences

1. Adhikari Sukumar Das
2. Batra Punita
3. Chakraborty Kalyan
4. Dalawat Chandan Singh
5. Dey Rukmini
6. Gyan Prakash
7. Manoj Kumar
8. Raghavendra N.
9. Ramakrishnan B.
10. Ratnakumar P.K.
11. Surya Ramana D.
12. Thangadurai R.

IGCAR

Chemical Sciences

1. Anthonysamy S.
2. Ananthasivan K.
3. Antony M.P.
4. Gnanasekaran T.
5. Ganesan V.
6. Govindan Kutty K.V.
7. Kamachi Mudali U.
8. Jayaraman V.
9. Joseph M.
10. Mallika(Smt.) C.
11. Nagarajan K.
12. Panigrahi B.S.
13. Ponraju D.
14. Sai Baba M.
15. Satpathy K.K.
16. Srinivasan T.G.
17. Sunndararajan K.
18. Vasudeva Rao P.R.
19. Viswanathan R.

Engineering Sciences

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

Physical Sciences

1. Amarendra G.
2. Arora A.K.
3. Baskaran R.
4. Bera S
5. Bharathi A.
6. Chandra Shekar N.V.
7. Dasgupta Arup
8. Dash S.

9. Devan K.
10. Dhara Sandip Kumar
11. Govindaraj R.
12. John Philip
13. Keshavamurthy R.S.
14. Kuppusami P
15. Mathi Jaya S.
16. Mohanakrishnan P.
17. Nair Muraleedharan K.G.
18. Panigrahi B.K.
19. Raghavan G.
20. Ramachandran Divakar
21. Ravindran T.R.
22. Reddy C.P.
23. Sahu Ch. P.
24. Subramanian N.
25. Sunder C.S.
26. Tata B.V.R.
27. Tyagi Ashok Kumar
28. Venkatesan R.
29. Vijayalakshmi M.

IMSc

Mathematical Sciences

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

Physical Sciences

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

IPR

Engineering Sciences

1. Chaturvedi Shashank
2. Pathak Surya Kumar

Physical Sciences

1. Anurag Shyam
2. Bandopadhyay Mainak
3. Chattopadhyay Asim Kumar
4. Chattopadhyay Prabal
5. Chaturvedi Shashank

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

IoP

Physical Sciences

1. Agrawal Pankaj
2. Bhattacharjee Somendra M.
3. Jayannavar A.M.
4. Kumar Alok (till Sept 25, 2009)
5. Kundu Kalyan
6. Mahapatra Durga Prasad
7. Mukherji Sudipta
8. Patra Suresh Kumar
9. Ravi Prasad G.V.
10. Sahu P.K.
11. Satyam Parlapalli V.
12. Sekhar Biju R.
13. Som Tapobrata
14. Srivastava Ajit M.
15. Tripathy Gautam
16. Varma Shikha

RRCAT

Life Sciences

1. Dube Alok

Physical Sciences

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

Engineering Sciences

1. Chatterjee Sanjil

SINP

Chemical Sciences

1. Basu Samita

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

Engineering Sciences

1. Mukhopadhyay Supratik

Life Sciences

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

Physical Sciences

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

TMC

Chemical Sciences

1. Pakhale S.S.

Life Sciences

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

31. Verma Ashok K.
32. Zingde (Smt.) S.M.

Health Sciences

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

VECC

Chemical Sciences

1. Sen Pintu

Engineering Sciences

1. Mukherjee Paramita
2. Sarkar Debranjan

Physical Sciences

1. Alam Jan-e
2. Bandyopadhyay S.K.
3. Banerjee S.R.
4. Banerjee (Smt.) Gayatjri N.
5. Bhattacharyya Sarmishta (Smt.)
6. Barat P.
7. Basu D.N.
8. Bhandari R.K.
9. Bhattacharaya (Smt.) Chandana
10. Bhattacharya Sailajananda
11. Bhowmick Debasis
12. Chakrabarti Alok
13. Chattopadhyay Subhasis
14. Chaudhuri A.K.
15. Choudhuri Gargi (Smt.)
16. Das Parnika (Smt.)
17. Ghosh Premomoy
18. Mukhopadhyay Tapan
19. Mukherjee Gopal
20. Naik Vaishali
21. Nayak Tapan Kumar
22. Pal Santanu
23. Pandit V.S.
24. Rashid Md.Haroon
25. Ray Amlan
26. Sanyal Dirtha
27. Sarkar Sourav
28. Srivastava Dinesh Kumar
29. Viyogi Y.P.

NISER

Chemical Sciences

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

Physical Sciences

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

Mathematical Sciences

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

Life Sciences

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

Annex 4

Admission and Results Status

HOMI BHABHA NATIONAL INSTITUTE
Admissions : 2011

S.No.	Programme	BARC	IGCAR	RRCAT	VECC	SINP	IPR	IOP#	HRI	TMC	IMSc	TOTAL
1	PGD*	185	35	12								232
2	PGDRM	4										4
3	PGDMRIT	6										6
4	DipRP	30										30
5	I. M.Sc.$							59				59
6	M. Sc. Engg.)		5									5
7	M. Tech.#	94	22	8	4							128
8	M. Phil.#											0
9	Ph. D. Engg.)	20	42	1	3		3					69
10	Ph. D. (Phys.)	20	16	15	6	3	14	6	10		6	96
11	Ph. D.Chem.)	33	13	1				14				61
12	Ph. D. (Life)	6		1		1		7		17		32
13	Ph. D. Math.)							2	6		8	16
14	Ph. D. (Hlth.)									4		4
15	Ph. D. (Stra.)											0
16	I. PhD (Phys.)								8		2	10
17	I. PhD Math.)										4	4
18	M. Ch.									17		17
19	M. D.									36		36
20	D. M.									10		10
21	D. A.											0
22	C. Fellowship									16		16
23	Nursing									7		7
Total		398	133	38	13	4	17	88	24	107	20	842

Total-PhD No.: 292

Actual Admission No.: Total-(MTech+MPhil) No.= 714

 # includes NISER enrolments

PGD: Post Graduate Diploma in Nuclear Science and Engineering

DRM: Diploma in Radiation Medicine

DMRIT: Diploma in Medical Radio Isotope Techniques

Dip. R. P.: Diploma in Radiological Physics

M. Tech: Master of Technology

M. Phil: Master of Philosophy

I. M.Sc.: Integrated M. Sc. at NISER under IoP

M. Sc. (Engg.): Master of Science (Engineering)

Ph. D.: Engineering, Physics, Chemistry, Life, Mathematics, Health and Strategic Studies

IPhD: Integrated Ph. D.

M. Ch.: Surgical & Gynaecological Oncology

MD: Pathology, Radiotherapy, Radiodiagnosis, Anaesthesia

DM: Medical Oncology

DA: Diploma in Anaesthesia

*** No. under BARC includes Students fro BARC Training Schools at Hyderabad, Tarapur, Rawatbhata, Kaiga, Kalpakkam and Kudankulam, and AMD, Hyderabad- 1st batch from 2010 onwards**

 # Refers to Students who have upgraded enrolment from PGD to M. Tech./ M. Phil. subsequent to successfully completing course work for PGD

C. Fellowship: Certified Fellowship programme of 2 Years duration under Health Sciences

Results notified during April 1, 2011 – March 31, 2012

Sr.No.	Degree/Diploma	No.
1.	PGD in Nuclear Engineering/Science	317
2.	DMRIT	2
3.	DRM	4
4.	Dip.RP	23
5.	M.Sc.(Part of Integrated Ph.D)	10
6.	M.Sc. (Engg.)	9
7.	M.Phil	2
8.	M.Tech.	176
9.	M.D.	16
10.	D.M.	02
11.	M.Ch.	02
12.	Ph.D.	54
	Total	617

Results declared during April 1, 2011 – March 31, 2012

Sr.No.	Degree/Diploma	No.
1.	PGD in Nuclear Engineering/Science	317
2.	DMRIT	2
3.	DRM	2
4.	Dip.RP	22
6.	M.Sc. (Engg.)	4
7.	M.Phil	3
8.	M.Sc. (Integrated Ph.D.)	1
8.	M.Tech.	103
9.	M.D.	15
10.	D.M.	02
11.	M.Ch.	02
12.	Ph.D.	34
	Total	507

Note : As and when a student completes all academic requirements of a programme, his/her result is notified. Results are declared after approval by CoM.

Annex 5

Abstracts of Ph.D. theses for which results were notified during April 1, 2011 to March 31, 2012

Name	:	Mohit Tyagi
Enrolment No.	:	PHYS01200704008
Constituent Institute	:	Bhabha Atomic Research Centre, Mumbai
Title	:	Growth And Characterization of Scheelite Crystals

Abstract

ABO_4 type of compounds, where 'A' stands for a divalent cation (Pb, Ca, and Ba) and B is for W or Mo crystallize in Scheelite structure with tetragonal symmetry. Some of the double tungstates having formula $MT(WO_4)_2$ [where M: monovalent and T: trivalent cation] also crystallize in Scheelite structure. While some particular crystals exhibit high figure of merit for specific applications, several characteristics like photoluminescence (PL), broad transmission range and high radiation hardness are their common characteristics.This study explains some unresolved issues in oxide crystals having scheelite structure. Single crystals of different molybdates and tungstates were grown by Czochralski method and characterized for their optical properties. These crystals having same crystalline structure have been investigated for rather different aspects in order to understand their markedly different characteristics in spite of having several features in common.The role of non-stoichiometry in crystal cracking, coloration, radiation hardness, optical and emission properties has been demonstrated in details. First principles studies havebeen successfully applied to explain the optical properties and scintillation mechanism in these crystals. Electronic band structure calculations have been used to predict BaWO4 and $NaBi(WO_4)_2$ as better Cherenkov radiator.

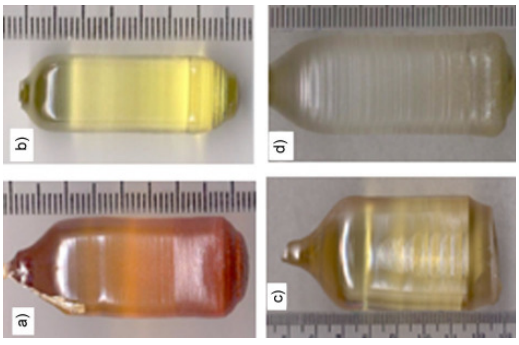


FIGURE 1. PbMO4 crystals grown using different source materials

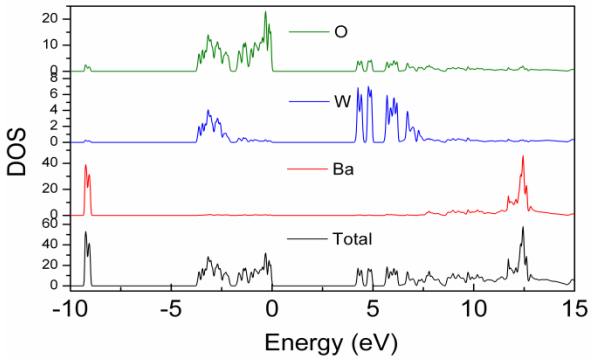


FIGURE 2. Calculated GGA density of states of BaWO4 crystal and PDOS of constituent atoms.

Publications :

1. "Non-Stoichiometry induced cracking in PbMoO4 crystals" Sangeeta, D.G.Desai, A.K.Singh, M.Tyagi, S.C. Sabharwal J. Crystal Growth 296 (2006) 81-85.
2. " New observations on the luminescence of lead molybdate crystals" Mohit Tyagi, Sangeeta, D G Desai, S.C.Sabharwal, J. Luminescence 128 (2008) 22-26
3. " Luminescence properties of BaWO4 single crystal" Mohit Tyagi, Sangeeta, S.C.Sabharwal, J.Luminescence 128 (2008) 1528-1532
4. "An overview of scintillator crystals" M.Tyagi, S.G.Singh, A.K.Singh, D.G.Desai, K.Chennakesavulu, Shashwati Sen, A.K.Chauhan, S.C.Gadkari Asian Journal of physics Vol. 18, No. 4 (2009) 53-75
5. "Investigations on the Origin of Coloration in Lead Molybdate Crystals" Mohit Tyagi, S. Govind Singh, Awadh K. Singh, Padma Patil, Omana Narayanan, Sangeeta Asian Journal of Physics Vol. 18, No. 4 (2009) 19-22.
6. "Understanding colorations in PbMoO4 crystals through stoichiometric variations and annealing studies" M. Tyagi, S.G.Singh, A.K.Singh, and S.C.Gadkari Phys. Status Solidi A, 207, No. 8, (2010), 1802-1806
7. "Exciton transition and electronic structure of PbMoO4 crystals studied by polarized light" Masami Fujita, Minoru Itoh, Hiroyuki Mitani, Sangeeta and Mohit Tyagi Phys. Status Solidi B 247, No. 2, (2010), 405-410
8. "First principles calculation of optical properties of BaWO4: A study by full potential method" Mohit Tyagi, S.G.Singh, A.K.Chauhan, S.C.Gadkari Physica B 405, (2010), 4530-4535
9. "Effect of foreign phases on the growth of NaBi(WO4)2 crystals" S.G.Singh, M. Tyagi, A.K.Singh, and Sangeeta Cryst. Res. Technol. 45, No. 1, (2010), 18-24
10. "Radiation damage studies on NaBi(WO4)2 single crystals through oxygen related defects" S.G.Singh, M.Tyagi, D.G.Desai, A.K.Singh, S.C.Gadkari Nuclear Instr. Methods A621, (2010), 111-115
11. "A study of electronic and optical properties of NaBi(WO4)2: A disordered double tungstate crystal Mohit Tyagi, S.G.Singh, Sangeeta, R.Prasad, S. Auluck, D.J.Singh Physica B 40, (2010), 3267-3271.

Name : **Shanavas K.V.**
Enrolment No. : **PHYS01200704004**
Constituent Institute : **Bhabha Atomic Research Centre, Mumbai**
Title : **Classical & Quantum Simulations of noval functional material**

Abstract

Materials have played a key role in the progress of human civilization. The quest for new materials has continued in an attempt to meet the never-ending demand for smaller, cheaper and faster devices. Novel functional materials have attracted a lot attention as consequence of their useful properties (electrical, magnetic or mechanical), that can be tuned as a function of external parameters such as temperature, stress, electromagnetic fields etc. Many materials fall into this category; including ferroelectrics, ferromagnets, piezoelectrics and superconductors, but to be technologically useful, they need to exhibit strong responses to the external parameters. In addition to the fundamental physics interest in the microscopic interactions that lead to the observed behavior, study of factors that affect the phase transitions in functional materials is important in efficient utilization of these materials in technological applications.

Computational materials science (CMS) has come into prominence in recent years due to the development of fast computers (thanks to semiconductors) and efficient algorithms. Ab-initio electronic structure and atomistic simulation techniques can now do "virtual experiments" and link experimental observations directly to the microscopic scale. They can also work as a testing ground for theoretical models helping us to better understand the fundamental laws that prevail at these scales.

The materials that were investigated as part of the doctoral research work are as follows: (a) Multiferroics : They are multi-functional materials that exhibit coexistence and coupling of magnetism and ferroelectricity (and optionally ferro-elasticity) in the same phase and have potential applications in magneto-electric sensors. (b) Nanomaterials: As size is reduced from bulk, several unexpected properties emerge in materials, for example, the color of gold nanoparticles turning red below 100 nm. Nanomaterials find applications in a wide range of fields, including chemical and biological sensors, energy and material storage devices etc. (c) Molecular solids: Under suitable temperature and pressure, molecules can condense to form soft solids and careful organization of functional molecules in to 2D (thin films) and 3D (crystals) structures can effectively enhance their properties. In some cases, higher functionalities emerge as a consequence of this organization. (d) Transition metal oxides: Out of all the functional responses observed in condensed matter systems, structural changes in crystals under pressure are probably the most dramatic. The stable config uration of a material corresponds to the lowest energy structure, however, the energy landscape changes when subjected to compression and it can transform from one structure to another. (e) Amorphous solids: Amorphous silicon (a-Si) is used widely in electronic circuits because it can be deposited over large areas at relatively lower temperatures and is used to make thin film transistors for large LCD screens and solar cells.

Publications

1. K. V. Shanavas, A. Nag, A. Hazarika, I. Dasgupta, D. D. Sarma, and S. M. Sharma. First principles study of the effect of organic ligands in the crystal structure of CdS nanoparticles. J. Phys. Chem. C, 116, 6507 (2012).
2. K. V. Shanavas, K. K. Pandey, N. Garg, and S. M. Sharma. Computer simulations of the crystallization kinetics in amorphous silicon under pressure. J. Appl. Phys. 111, 063509 (2012)
3. K. V. Shanavas, H. K. Poswal, and S. M. Sharma. First principles studies on the high pressure behavior of SiH4(H2)2. Solid. State. Commun. 152, 877 (2012)
4. N. Garg, K. K. Pandey, K. V. Shanavas, C. A. Betty, and S. M. ,Sharma. Memory effect in low-density amorphous silicon under pressure. Phys. Rev. B 83, 115202 (2011).
5. A. Nag, A. Hazarika, K. V. Shanavas, S. M. Sharma, I. Dasgupta, and D. D. Sarma. Crystal Structure Engineering by Fine-Tuning the Surface Energy: The Case of CdE (E = S/Se) Nanocrystals. J. Chem. Phys. Lett., 2, 706 (2011)
6. K. V. Shanavas, D. Chaudhury, I. Dasgupta, S. M. Sharma, and D. D.Sarma. Origin of ferroelectric polarization in spiral magnetic structure of MnWO4. Phys. Rev. B, 81, 212406 (2010)
7. A. K. Mishra, N. Garg, K. K. Pandey, K. V. Shanavas, A. K. Tyagi, and S. M. Sharma. Zircon-monoclinic-scheelite transformation in nanocrystalline chromates. Phys. Rev. B, 81, 104109 (2010).
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Name : **Ajay Kumar Dash**
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Title : **Practicle Production and Forward-backward Correlation at LHC Energies**

Abstract

In the present thesis attempts have been made to study the pseudo rapidity distributions of photons, dNγ/dη, and charged particles, dNch/dη, at the starting LHC energy. We have looked at data taken by the PMD(Photon Multiplicity Detector) and the FMD(Forward Multiplicity Detector) sub detectors of ALICE corresponding to collisions at p+p √s=900GeV during end of2009. The results have been compared with the results of the string fragmentation model PYTHIA. The other important results presented in the thesis correspond to predictions on Nch and d Nch/dη for p+p collisions at the LHC top energy using some extrapolation schemes that use the existing experimental data as obtained from p+¯p collisions available at √s=900GeV and below. We have also looked at the expected forward-backward correlation of charged particles at top LHC energy.

The work presented in the thesis can be grouped under two parts. The first part corresponds to experimental determination of photon and charged particle multiplicity using the PMD and the FMD. Since the pre shower PMD has been one of our main detectors, some details regarding its fabrication and functioning are presented with special emphasis on detect or performance using test beam data at CERN PS. The detector prototypes have been tested at CERN using 2-5 GeV electron and 4-5 GeV pion beams employing converters of different thicknesses (2 -4 radiation lengths). Operating conditions like the cathode voltage has been optimized by the above mentioned beam tests carried out at CERN PS. A relationship between the energy deposited, in keV, as obtained from simulation and the same in ADC units as obtained from the pre shower data is obtained. Extensive simulation work has been carried out for determination of various correction factors such as the photon counting efficiency and the purity of the photon sample which are required for counting photon hits (photon multiplicity) in the detector. With the presence of a converter electrons and photons are expected to result in shower formation resulting in signal from groups of cells, called clusters. On the other hand charged particles produce mostly single cell clusters with only 14% resulting in clusters of larger size. We have shown with suitable cuts viz ADC > 3MIPs and number of cells affected more than 1, it possible to get reasonable numbers regarding gamma-like clusters produced on the detector. Using the efficiency (45 -62 % for 2.3 <η< 3.9) and purity values (close to 42 %)together with the detectors acceptance as obtained from simulations, preliminary data on dNγ/dη has been estimated.

It must be mentioned that the CPV plane of PMD can be used to measure the charge particle multiplicity. But due to the up-stream material a lot of background particles are expected on CPV. To reduce the secondary particles which are coming from interaction of produced particles with material, we have used a tracking procedure based on the hits in one of the rings of FMD(FMD2i) and the CPV plane of the PMD over the same acceptance. To apply this technique one has to know the vertex position before hand.

Such an analysis has to be carried out only in magnetic field off condition. As the effect of magnetic field is less in the

forward direction this method can be used to estimate dNch/dη in the forward rapidity region even in the magnetic field on condition. This has been used to obtain the dNch/dη in a common η range from 2.3 -3.5 for p+ p collisions at 900 GeV.

In the second part of the thesis h (Nch) and Nch distribution have been estimated for the top LHC energies viz √s=10 and 14 TeV. This has been done using two different extrapolations of the existing data. One of this is based on a quadratic dependence of (Nch) on ln √s. In the other (Nch) is fitted to a power law in √s. Both these fittings, valid for the low energy data up to √s=900 GeV, lead to drastically different results at top LHC energies. The extrapolated results have been compared with estimations from PYTHIA and PHOJET. As for results, the Nch distribution at midrapidity |η|< 0.5 as obtained from the power law based extrapolation has been found to be way above the PYTHIA and PHOJET results. In this η window PYTHIA results are seen to be closer to the extrapolated values obtained with the ln s dependence. However, for |η|< 5 both extapolations are seen to result in data closer to PHOJET values. PYTHIA is seen to result in a higher tail most likely due to higher multiparton interactions. Measurements at LHC, particularly at midrapidity, where there is are large differences between the two extrapolations, will help to distinguish whether (Nch) has a power law or a logarithmic dependence on √ s.

Another extrapolation has been used for the prediction of dNch/dη using the exsiting data on η distributions from p+¯p collisions obtained at lower energies, up to 900 GeV. The shape of dNch/dηversus η is found to be reasonably well described by a function with three parameters which accounts for the basic features of the distribution viz the height at midrapidity, the central rapidity plateau and the higher rapidity fall off. The full distributions as would be expected at 10 and 14 TeV are obtained extrapolating the above parameters to those energies. This extrapolation has been found to result in data in close agreement with very recent data taken at 2.36 and 7 TeV by the ALICE and ATLAS experiments at LHC.

The existing data on forward-backward (FB) correlations in p+ ¯p(p) collisions have been reviewed. The experimentally obtained FB data are compared with those obtained from PYTHIA and PHOJET. The correlation strength, b, as obtained from PYTHIA is found to be in agreement with the existing data. On the other hand the PHOJET calculation gives higher correlations. However for top LHC energies of = 10 and 14 TeV, the correlation strength, b, from PHOJET is lower compared to PYTHIA, suggesting a transition at an intermediate energy accessible at LHC. The measured correlation strengths are found to increase linearly with ln s an extrapolation of which suggests that b will reach unity(maximum value) around TeV, well beyond the LHC top energy. However model calculations suggest that *b*,tends to saturate beyond 2 TeV. We have also reviewed the existing results on a common interpretation of FB correlations in terms of cluster production. The expected cluster sizes are found to increase with increase in beam energy. Similar to the correlation strength, the cluster size from PYTHIA compares well with the existing experimental data. For higher energies(> 1 TeV)

PHOJET gives a higher cluster size compared to PYTHIA. The study of cluster size from FB correlations can be a very good discriminator for the particle production models in p+ p collisions

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6. **"Charged-particle multiplicity measurement in proton-proton collisions at √s = 0.9 and 2.36 TeV with ALICE at LHC". K. Aamodt et al. (ALICE Collaboration), Eur. Phys. J. C68 (2010) 89.**
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10. **"Transverse momentum spectra of charged particles in proton-proton collisions at √s = 900 GeV with ALICE at the LHC". K. Aamodt et al. (ALICE Collaboration), arXiv:1007.0719.**

Name : **Ankita Rao**
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Title : **Supercritical Fluid Extraction of Metal Ions From Various Matrices**

Abstract

Separation and purification of metal ions from various matrices forms the backbone of innumerable analytical and industrial operations. Though conventional separation techniques like solvent extraction, ion exchange, distillation and precipitation are extensively employed; there is strong impetus to search for alternative techniques. Supercritical fluid extraction (SFE) is an area of active research being pursued fervently owing to its simplicity, ease of operation and most importantly minimization of the generation of analytical waste. This aspect of waste minimization assumes considerable significance for metal ion separations relevant to the nuclear industry as this results in reduction of radioactive waste. CO_2 is a popular choice for the Supercritical Fluid (SCF) due to its attractive properties.

Present studies were focused on metal ions and matrices especially relevant to the nuclear industry and are expected to contribute towards application of this alternative separation technique for efficient extraction of metal ions. Efficiency of extraction is a function of multiple parameters (e.g. temperature, pressure, SCF flow rate, choice of complexing agent, amount of complexing agent etc.). Maximization of extraction efficiency by tuning parameters requires in depth understanding of effect of various parameters on extraction efficiency. Studies regarding the formation, solubility and stability of metal complex during extraction and dynamics of extraction will contribute to the basic understanding of SCF in general and the development of feasible technology for metal ion extraction in particular. The thesis centers around these objectives. It involves studies on the SFE of uranium and thorium employing different complexing agents from various matrices.

The thesis comprises of six chapters. Chapter 1 provides a brief introduction to separation science, its significance and the conventional techniques of separation. The importance of metal ion separation for nuclear industry, the emergence of SFE as alternative separation technique and its associated advantages are described. This is followed by the theoretical aspects of supercritical fluids in general, advantages of employing carbon dioxide in particular and the principles of SFE. The scope of the subsequent chapters is also described here. Chapter 2 provides a brief overview of the experimental set-up, general procedure of SFE and the method employed for uranium and thorium determination in the present work. This chapter also provides the experimental details of the work, which enable a better understanding of the investigations and implications of studies enumerated in subsequent chapters. Chapter 3 and 4 describe the SFE of metal ion from aqueous solution viz. uranium from nitric acid medium. Chapter 3 deals with SFE employing the organophosphorus reagent TBP. It provides an overview of the effect that various parameters have on the extraction efficiency and attempts to understand the reason for the observed behavior. Chapter 4

deals with crown ethers as complexing agent. In addition to examining the effect of various parameters, the study attempts to correlate the effect of substituents and ring size of the crown ethers on the efficiency of extraction. Chapter 5 deals with SFE of metal species loaded on solid matrix viz. thorium from tissue paper matrix employing organophosphorus reagents as well as β-diketones. The parametric effects are analyzed for the solid tissue paper matrix. Effect of the structure of organophosphorus reagents and extent of fluorination of β-diketones on the extraction efficiency is revealed. Chapter 6 describes the SFE of metal directly from solid matrices e.g. uranium oxides and oxides loaded on tissue paper matrix. Uranium oxides have been chosen from the various stages of nuclear fuel fabrication. The TBP-HNO_3 adduct has been used in the study in an attempt to avoid free acid usage.

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6. **"Separation of uranium from different uranium oxide matrices employing supercritical carbon dioxide", Ankita Rao, Pradeep Kumar and K.L. Ramakumar, Journal of Radioanalytical and Nuclear Chemistry, 285 (2010) 245-257.**

Name : **Dibakar Goswami**
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Title : **Asymmetric Strategies for the synthesis of biologically relevant molecules**

Abstract

The importance of asymmetric synthesis as a tool for obtaining enantiomerically pure compounds has grown dramatically in the last two decades not only in synthetic organic chemistry, but also in medicinal and agricultural fields. However, even at the height of maturity, synthetic organic chemistry is facing the challenge to design and develop efficient protocols for asymmetric synthesis. In view of this modern requirement, the present investigations were directed to i) the development of new asymmetric synthetic methodologies for the synthesis of chiral carbinols, and ii) application of these carbinols for the synthesis of biologically relevant organic molecules. Towards the development of new synthetic methodologies, we have disclosed efficiency of the RTIL, [bmim][Br], as a solvent for the different (In, Ga, Bi, Zn, Sb etc.) metal mediated allylation reactions (both with allyl bromide and different gamma-substituted allyl bromides) with chiral and achiral aldehydes. The plausible mechanistic pathways for In- and Ga-metal mediated allylations have also been elaborately discussed. Apart from this, the diastereoselective construction of homoallylic and homobenzylic alcohols from (*R*)-cyclohexylideneglyceraldehyde (as a chiral template) using the bi-metal redox strategy utilizing the combination of a metal/metal salt has also been described. Finally, these strategies were used for the asymmetric syntheses of a diverse array of biologically active compounds viz. (i) (*R*)-Arundic acid, an anti-Alzheimer compound, (ii) the octadienoic acid segment of Cryptophycins, an anti-tumor compound, (iii) 3'C-branched 2',3'-dideoxynucleosides, (iv) 2(*S*)-[1(*S*)-Azido-2phenylethyl]oxirane, an advanced synthon for HIV protease inhibitors, and (v) *trans*-Oak lactone, a substituted δ-lactone.

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Name	**:**	**Arjun Bagchi**
Enrolment No.	**:**	**PHYS08200604010**
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Title	**:**	**The Non-Relativistic Limit of the ADS/CFT Conjecture**

Publications

1. **GCA in 2d, Arjun Bagchi, Rajesh Gopakumar Ipsita Mandal and Akitsugu Miwa. E-Print:arXiv:0912.1090(hep-th)**
2. **Supersymmetric Extensions of Gaillean Conformal Algebra. Arjun Bagchi, and Ispita Mandal. Publish in Phys.Rev.D80:086011, 2009**
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Name : **Sunita Negi**
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Title : **Molecular Dynamics Simulations of Nanometer Sized Devices Based on Carbon Nanotubes**

Abstract

Carbon nanotubes have become very important in molecular research because of the potential applications of nanomachines in the field of computing, electronics, robotics and drug delivery. Nanometer-sized devices, especially nanomotors, based on carbon nanotubes, are of interest for their novel applications in drug delivery techniques. Earlier workers have reported the results of Molecular Dynamics (MD) simulations of electrically-driven nanomotors based on double-walled carbon nanotubes (DWNT). The inner and outer CNTs are called the "shaft" and "sleeve' respectively. Those studies broke new ground and yielded interesting insights into the atomistic level behavior of such nanomotors. However, those studies either did not consider certain aspects of nanomotor operation, or did not investigate them in sufficient detail. Some of those limitations have been addressed in the present thesis.

Firstly, during MD simulations of a DWNT-based motor with the sleeve held fixed, we found that distortion of the shaft at high electric fields leads to highly non ideal behavior of the motor, such as 'locked states' in the rotation of the shaft inside the fixed sleeve. The frequencies of shifts between the observed locked states correspond to the frequency of the applied electric field. An explanation has been given for these locked states in terms of the radial shape variations of the shaft and shifts in the centroid of the shaft inside the fixed sleeve. In the other set of simulations, where both the shaft and sleeve are free to move, the usual pendulum and motor-like behavior is observed. A simple theoretical model is also given in this case and we see that the motion of the shaft and the sleeve obtained from this model matches reasonably well with the MD results.

Secondly, we have obtained, for the first time, the complete set of the characteristic modes of a single-walled carbon nanotube (SWNT) and a DWNT, using the novel technique of singular value decomposition (SVD) analysis on our MD data. Good agreement is observed between the calculated frequency of radial breathing modes (RBM) and published experimental measurements, as also the inverse scaling of this frequency with tube diameter. A few other important modes are obtained which are classified into two different classes, one having $m_z = 0$, i.e., axial uniformity, and the other class having $m_\theta = 0$, i.e., azimuthal uniformity.

Thirdly, we determined the useful region in frequency-amplitude space for producing pure motor-like motion in the nanomotor. We first obtain a nominal operating point in amplitude-frequency space and then study the full parameter space around this operating point using MD simulations. For a given frequency, electric field amplitudes below a threshold are not able to overcome the potential energy barriers due to

interaction of the rotating shaft with the frozen sleeve. This is then followed by a range of amplitudes where unidirectional motion is observed. At still higher amplitudes, distortion of

the shaft increases the potential energy barriers to levels higher than those that can be overcome by the electric field. For a given amplitude, as the frequency is varied, more complex behavior is obtained, which can be broken up into four regions. At low frequencies (Region-1), large distortion of the shaft leads to an increase in potential energy barriers, hindering rotation. Over an intermediate range (Region-2), unidirectional motion is observed, since shaft distortions are smaller than in Region-1. This is followed by an anomalous region (Region-3), where resonant excitation of a characteristic mode of the shaft leads to very large distortions, which greatly enhance the barrier. Finally, in Region-4, the distortion again starts falling off with rise in frequency. A detailed physical explanation has been provided for the anomalous behavior in Region-3, in terms of resonant excitation of a characteristic mode.

Depending on the application, some part of the nanomotor must be attached to a surface, e.g. electrical contact for an electrically-driven motor. We must understand the behaviour of such "joints". Fourthly, therefore, we have made a start in this area by examining the interaction of an SWNT with a graphite surface. At a fixed temperature of 100 K, nanotubes of larger diameters are observed to acquire a large contact area on the top of the graphite surface. The tubes are seen to deform to have a larger contact area with the graphite surface and thus have larger binding energy with the surface. The variation of the binding energy per unit length along the axis of the CNT, obtained from our MD calculations, matches well with the Molecular Mechanics (MM) results of other workers.

Publications

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3. **"Normal Mode analysis of a single walled carbon nanotube based on molecular dynamic: A Singular Value Decomposition study", S.Negi and S. Chaturvedi, Intenational Journal of Nanoscience (9) No.-5 (2010) 1-16**
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Title : **Role of passivity and surface modification on the corrosion behavior of AISI 304L Stainless steel in Nitric Acid Medium**

Abstract

The thesis on "*Role of Passivity and Surface Modification on Corrosion Behaviour of AISI 304L Stainless Steel in Nitric Acid Medium*" is based upon the investigation of passive film property of AISI 304L SS in both ex-situ, and in-situ conditions and various surface modification ways for improving the corrosion resistance of AISI 304L stainless steel in nitric acid medium. Nitrogen ion implantation and anti-corrosive Ti, TiO_2 and duplex Ti-TiO_2 coatings were used as sub-surface and top-surface modification process to study the extent of improvement in corrosion resistance.

Passivity of AISI 304L SS at low concentration of nitric acid (0.1M-0.5 M) starts initially with the formation of adsorbed chromium hydroxide species which appears in the form of platelet like structures on the surface. The hydroxide layer at lower concentration is electro-inactive and provides protective film from aggressive environment of nitric acid. With increase in concentration (0.6 M), the hydroxide layer changes over to oxide layer, and during this platelet like structures forms homogenous oxide layer on the surface. With still rise in concentration of nitric acid (1M) the protective oxide film depletes from structural heterogeneous areas leading to opening up of oxide boundaries. The depletion of oxide layer at structural heterogeneous areas initiates selective dissolution as well as localized corrosion in 304L SS.

Sub-surface modification using nitrogen ion implantation on 304L SS brings structural and compositional changes on the surface which significantly increases the localized corrosion resistance in the oxidizing environment of nitric acid. The factors responsible for the improvement in corrosion resistance are homogenization of the surface, enrichment of nitrogen and formation of selective chromium nitride (Cr_2N) phase. Thus the beneficial aspect nitrogen on the corrosion resistance is well reflected from the study on corrosion behaviour of nitrogen ion implanted 304L SS in nitric acid medium.
Top surface modification using Titanium (Ti) layer gives good corrosion performance in 1 M nitric acid and low protection at higher concentration of 8 M nitric acid. Titanium dioxide (TiO_2) gives improved corrosion performance as compared to titanium coating in both low (1 M) and high (8 M) concentration of nitric acid despite presence structural heterogeneities on the surface. Duplex Ti-TiO_2 coating is extremely effective for corrosion protection in both low (1M) and high concentration (8M) of nitric acid as compared to Ti and TiO_2 coatings due to combination of good passivation property of titanium dioxide and minimization of structural heterogeneities by Ti interlayer.

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(A) International journals

1. **N. Padhy, Ranita Paul, U. Kamachi Mudali, Baldev Raj, Morphological and compositional analysis of passive film on AISI type 304L stainless steel in nitric acid medium, Applied Surface Science, 257 (2011) 5088-5097.**

2. **N. Padhy, S. Ningshen, U. Kamachi Mudali, Baldev Raj, In situ surface investigation of austenitic stainless steel in nitric acid medium using electrochemical atomic force microscope, Scripta Materialia, 62 (2010) 45-48**

3. **N. Padhy, S. Ningshen, B. K. Panigrahi, U. Kamachi Mudali, Corrosion behaviour of nitrogen ion implanted AISI type 304L stainless steel in nitric acid medium, Corrosion Science, 52 (2010) 104-112.**

4. **N. Padhy, Subhash Kamal, Ramesh Chandra, U. Kamachi Mudali, Baldev Raj, Corrosion performance of TiO_2 coated type 304L stainless steel in nitric acid medium, Surface & Coatings Technology, 204 (2010) 2782-2788.**

5. **N. Padhy, U. Kamachi Mudali, Vipin Chawla, Ramesh Chandra, Baldev Raj, Electrochemical and surface morphological aspect of Ti and duplex Ti-TiO_2 coating on austenitic stainless steel, Materials Chemistry and Physics, Under Review.**

6. **U. Kamachi Mudali, N. Padhy, In-situ corrosion study of materials using electrochemical scanning probe microscope, Corrosion Review, Under Review.**

(B) Conference Proceedings

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2. **N. Padhy, S. Ningshen, R. V. Subbao Rao, U. Kamachi Mudali, Morphological and compositional analysis of passive film on AISI type 304L stainless steel in nitric acid medium, International Conference on Surface Modification Technologies (SMT-23), 2-5 November 2009, Mamalapuram, India.**

3. **N. Padhy, Subhash Kamal, Ramesh Chandra, U. Kamachi Mudali,Corrosion performance of TiO_2 coated type 304L stainless steel in nitric acid medium, International Conference on Surface Modification Technologies (SMT-23), 2-5 November 2009, Mamalapuram, India**

4. **N. Padhy, S. Ningshen, B.K. Panigrahi and U. Kamachi Mudali, Corrosion behaviour of nitrogen ion implanted AISI Type 304L stainless steel in nitric acid medium, Proceedings of International Conference on Corrosion (CORCON 2007), NACE International (India Section) 26-28th September 2007, Mumbai, India.**

5. **N.Padhy, U. Kamachi Mudali, Study of passivation and corrosion behavior of AISI 304L SS in nitric acid medium using scanning probe microscope, National Convention of Electrochemists (NCE-14), 6-7 December 2007, IGCAR, Kalpakkam, India.**

(C) <u>Chapter in Book</u>

1. **U. Kamchi Mudali, N. Padhy, A. Ravi shankar Application of Electrochemical STM/AFM for corrosion investigation, Corrosion Prevention and Control, Eds: Baldev Raj, U. Kamachi Mudali, S. Rangarajan, Page 179-184, Narosa Publication, New Delhi, 2009.**

Name : **Aditi Chakrabarty Patra**
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Title : **Disequilibrium of Naturally occurring radionuclides and distribution of trace elements in a highly mineralised zone.**

Abstract

The highly mineralized Singhbhum Shear Zone in Jharkhand state of Eastern India is known for hosting vein/disseminated type of uranium deposits. Mining and processing of low-grade uranium ore commenced in the mid-sixties and is being carried out at different locations in this region. The mining and milling operations at the uranium deposits in this region have the potential to redistribute environmentally noxious elements in the surrounding environment if adequate safety measures are not taken during operation and waste disposal. Distribution and transport of elements in this mineralized region and their leaching characteristics is therefore an important subject area of research.

Radiological and chemical investigations coupled with laboratory based experiments have been employed in this thesis to gain knowledge on the transport and behaviour of elements in this highly mineralised zone. Radionuclides were observed to be distributed in a disseminated fashion in different matrices, implying crustal nature. Radioactive daughter-parent activity ratios indicated deviation from secular equilibrium in surface soils but host rocks indicated radioactive equilibrium. Uranium accumulation and complex processes of uranium redistribution was observed in the uranium deposits, but there was an overall slight shift from secular equilibrium condition, indicating less elemental mobility.

Rare earth anomaly reflected reducing conditions and uranium mineralisation in rocks from this region. Rare earth element fractionation and fractional condensation at the time of solidification of magma was also observed. Trace elements were observed to concentrate in smaller particle sizes due to their association with minerals in soils and uranium tailings.

The leaching of uranium from soils, ores and wastes was very slow, being faster in the initial stage and then attaining a near steady state condition under semi-dynamic conditions of lab-based leaching experiments. Apparent diffusion coefficient (cm^2/s) ranged from 10^{-10} to 10^{-11}. Under dynamic conditions of leaching, U leached from soils was highest at basic pH. Leaching rate was observed to be higher in the smaller particle sizes, due to higher reactive surface area. Low leach rates under experimental conditions also indicated less mobility of uranium.

Publications

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Name : **Arnab Sarkar**
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Title : **Laser induced breakdown spectroscopic studies for material characterization**

Publications

1. **Determination of thorium and uranium in solution by laser-induced breakdown Spectrometry Arnab Sarkar, D. Alamelu & S.K. Aggarwal Applied Optics 47 (2008) G58-G64.**
2. **Laser induced breakdown spectroscopy for determination of uranium in Thorium – uranium mixed oxide fuel materials Arnab Sarkar, D. Alamelu & S.K. Aggarwal Talanta 78 (2009) 800-804.**
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Name : **Neetika Rawat**
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Title : **Thermodynamics of complexatin of actinides and lanthanides with ligands relevant to environmental and separation science**

Abstract

The central theme of the present thesis was the determination of thermodynamic parameters of lanthanides and actinides complexation by microcalorimetry in conjunction with various techniques used for stability constant determination viz., potentiometry, spectrophotometry and fluorescence spectroscopy. The studies carried out as a part of this thesis can be summarized as follows.

1. **An isothermal titration calorimeter was installed and calibrated electrically and chemically using complexation of Ba^{2+} and 18 Crown 6.**
2. **Complexation of Eu(III) by mono-carboxylates, di-carboxylates (aliphatic and aromatic) and hydroxyl carboxylates by potentiometry and calorimetry revealed that the reactions are mainly driven by entropy with the enthalpy being small and positive, except for hydroxy carboxylate where ΔH_C was slightly negative.**
3. **Complexation of Th(IV) by di-carboxylates of varying alkyl chain length showed that the log β decreases with the chain length with the maximum stability associated with 6 member chelate ring. In the case of Th(IV), ΔS_C, which is measure of extent of dehydration of metal ion, remains constant, while ΔH_C increases with increase in chain length. Though, the reactions are driven by ΔS_C for all the Th(VI)-di-carboxylate complexes, the decrease in ΔG_C with increase in chain length is due to increase in ΔH_C. Comparison of the thermodynamic data for Th(IV) di-carboxylates with that for U(VI) and Ln(III) revealed the important role of the coordination space available for the ligand around the metal ion.**
4. **In the case of complexation of U(VI) and Eu(III) by unsaturated di-carboxylates, viz., maleate and fumarate, higher stability constants were observed for maleate than that for fumarate, due to the chelate effect in the former. Fumarate complexes were found to have higher log β than mono-carboxylates of same basicity, indicating the occurrence of charge polarization during complexation of the metal ion by fumarate, which was also corroborated by theoretical calculations.**
5. **The stability constant of U(VI)-succinate was found to increase with temperature (25 - 65^{0}C) which was well explained by Born equation indicating the complexation being governed by electrostatic factors. The ΔH_C increased linearly with temperature, but the reaction became more feasible owing to higher increase in ΔS_C. The ΔC_p for U(VI)-succinate was found to be higher than oxalate and malonate suggesting role of hydrophobicity of the ligand in determining the heat capacity.**
6. **Thermodynamic studies on the complexation of Ln(III) with ethyl-BTP revealed the role of ionic potential and changing coordination number of metal ion along the Ln(III) series. The stability constant of Eu(III)-alkyl-BTP complexes was found to increase with the increase in alkyl chain length of substituent group to the triazinyl ring. The complexation was found to be driven mainly by the ΔH_C.**

The thermodynamic parameters determined in this thesis are not only helpful in improving basic understanding of lanthanide and actinide complexation with hard and soft donor ligands, but also help in closing the gap in available data base which are required for predicting actinide migration in aquatic environment.

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4. **Thermodynamics of U(VI) complexation by succinate at variable temperatures Neetika Rawat, B.S.Tomar and V.K.Manchanda J. Chem. Thermodynamics 43, 1023-1027 (2011).**
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Title	**:**	**Development, Implementation and Performance Report of Dimuon High Level Trigger of ALICE**

Publications:

1. **"ALICE: Physic Performance report, Volume II", The ALICE Collaboration et. al., J. Phys. G 32 (2006) 1295-2040 [http://iopscience.iop.org/0954-3899/32/10/001/pdf/0954-3899_32_10_001.pdf]**
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Title : **Study of Early Universe in an M Theoretic Model**

Abstract

In this thesis we study early universe in the frame work of M theory. We assume that the early universe is homogeneous, anisotropic, and is dominated by the mutually BPS intersecting branes of M theory. Certain class of black holes can be described by string/M theory have similar structure of intersecting BPS branes configurations. We are motivated by such black holes to make a similar model for early universe.

But due to the lack of knowledge of the exact brane dynamics, we use U duality symmetry of the M theory to get an equation of states. We also verify the equations of states obtained by duality also hold for known case like black holes. Then we solve Einstein equations to get evolution of early universe.

But due to the lack of knowledge of the exact brane dynamics, we use U duality symmetry of the M theory to get an equation of states. We also verify the equations of states obtained by duality also hold for known case like black holes. Then we solve Einstein equations to get evolution of early universe.

In particular We assume that the early universe is homogeneous, anisotropic, and is dominated by the mutually BPS $22'55'$ intersecting branes of M theory. The spatial directions are all taken to be toroidal. Using analytical and numerical methods, we study the evolution of such an universe. We find that, asymptotically, three spatial directions expand to infinity and the remaining spatial directions reach stabilised values. From string theory perspective, the dilaton is hence stabilised also. We give a physical description of the stabilisation mechanism.

Any stabilised values can be obtained by a fine tuning of initial brane densities. The constant sizes depend on certain imbalance among initial values. One naturally obtains $M_{11} \simeq M_s \simeq M_4$ and $g_s \simeq 1$ within a few orders of magnitude. Smaller numbers, for example $M_s \simeq 10^{-16} M_4$, are also possible but require fine tuning.

In some sense our $22'55'$ configuration is special. We give some example of other configurations for which stabilisation can not be achieved. We give their asymptotic time evolution. We find only $22'55'$ and its U dual configuration can achieved stabilisation of 7 spacelike dimensions.

Also, from the perspective of four dimensional spacetime, the effective four dimensional Newton's constant G_4 is now time varying. Its time dependence will follow from explicit solutions. We find in the present case that, asymptotically, G_4 exhibits characteristic log periodic oscillations.

Publications

1. **S. Bhowmick and S. Kalyana Rama " A Description of Rotating Multi Charged Black Holes in terms of Branes and Antibranes", arXiv:0709.3891 [hep-th]**
2. **S. Bhowmick, S. Digal and S. Kalyana Rama, " Stablisation of Seven (Toroidal) Directions and Expansion of the remaining three in an M. theoretic Early Universe Model", Phys. Rev. D79, 101901 (2009), arXiv:0810.4049 [hep-th]**
3. **S. Bhowmick and s. Kalayana Rama, "10 +1 to 3 + 1 in an Ealy Universe with mutually BPS Intersecting Branes", arXiv:1007.0205 [hep-th] to be published in Phys. Rev.**

Name : **Arvind N. R**
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Title : **Forbidden Subgraph Colorings Oriebted Colorings and Intersection Dimensions Of Graphs**

Abstract

This thesis deals mainly with two related coloring problems - forbidden subgraph colorings and oriented colorings. The former deals with proper colorings of vertices or edges of a graph with constraints on the union of color classes. A well-known example is the acyclic vertex coloring in which we require a proper coloring such that the union of any two color classes is acyclic. Other well-studied examples include the acyclic edge coloring and star coloring. Our focus in this thesis is a generalization of these special types of colorings.

Oriented coloring deals with colorings of oriented graphs (directed graphs obtained by orienting each edge of a simple undirected graph). Specifically, an oriented coloring is a homomorphism to an oriented graph, the vertices of the target graph being considered as the colors assigned to the vertices of the source graph.

For both of these problems, we want to find good upper bounds for the number of colors required for such colorings.

Oriented coloring deals with colorings of oriented graphs (directed graphs obtained by orienting each edge of a simple undirected graph). Specifically, an oriented coloring is a homomorphism to an oriented graph, the vertices of the target graph being considered as the colors assigned to the vertices of the source graph.

For both of these problems, we want to find good upper bounds for the number of colors required for such colorings.

In this thesis, we find upper bounds for forbidden subgraph chromatic numbers in terms of the maximum degree. For the union of two color classes, we show the asymptotic tightness of our bounds by a probabilistic contstruction. We then show that the oriented chromatic number of a graph can be bounded in terms of the forbidden subgraph chromatic numbers. In conjunction with our afore-mentioned results, this allowed us to prove improved bounds on oriented chromatic numbers of graphs on surfaces.

Specifically, we obtained the following results:

- Given a family $\mathcal{F}$ of connected graphs each having at least m edges, the vertices of any graph of maximum degree Δ can be properly colored using $O(\Delta^{1+\frac{1}{m-1}})$ colors so that in the union of any 2 color classes, there is no copy of H for any $H \in \mathcal{F}$.

- Any graph of genus g has oriented chromatic number at most $2^{g^{1/2+o(1)}}$.

We also consider edge colorings of graphs with restrictions on the union of color classes. While edge colorings can simply be considered as vertex colorings of the line graph, it is usually the case that they are often quite different in nature. Indeed, we found a general upper bound which shows that the bounds for edge colorings with similar restrictions as those on vertex colorings often require substantially fewer colors in terms of the maximum degree.

In particular, we showed that using just $O(\Delta)$ colors, (where Δ is the maximum degree), we can properly color the edges of a graph with any (or even all) of the following constraints:

(i) the union of any 2 color classes is a forest (this is a known result due to Alon, McDiarmid and Reed);

(ii) the union of any 3 color classes is outerplanar;

(iii) the union of any 4 color classes has treewidth at most 2;

(iv) the union of any 5 color classes is planar;

(v) the union of any 6 color classes is 5-degenerate.

We obtain the above bounds as an application of a special case of the Lovász Local Lemma which we derive and show that these bounds can be constructivized by the algorithm obtained by Moser and Tardos in [MT10].

Finally, we also study the intersection dimension of graphs. In contrast to coloring problems where we partition the graph into smaller pieces, the problem here is the following: Given a graph class $\mathcal{A}$ and a graph G, express G as the intersection of some supergraphs on the vertex set of G, subject to the condition that each of these supergraphs belongs to the class $\mathcal{A}$. The least number of supergraphs needed is the intersection dimension of G with respect to the class $\mathcal{A}$. A well-known example of such a parameter is the boxicity of a graph, which is the least number of interval graphs whose intersection is the given graph.

We show that the intersection dimension of graphs with respect to several hereditary classes can be bounded as a function of the maximum degree. As an interesting special case, we show that the circular dimension of a graph with maximum degree Δ is at most $O(\Delta\frac{\log\Delta}{\log\log\Delta})$. We also obtained bounds in terms of treewidth.

Publications

1. **Bounds on Vertex colourings with restrictions on the union of color classes N. R. Aravind and C. R, Subramanian (2011). Journal of Graph Theory, vol 66, No. 3, pages 213-234.**

2. **Bounds on edge colourings with restrictions on the union of color classes. N. R. Arvind and C.R. Subramanian (2010). SIAM Jounals of Discrete Mathematics, vol 24, No 3, pages 841-852.**
3. **Forbidden subgraph coloring and the oriented chromatic number. N. R. Aravind and C. R. Subramanian. Proceeding of 4th International Workshop on Combinatorial Algorithms (IWOCA) 2009. Springer-Verlag LNCS Colume 4393, pages 477-488.**
4. **Intersection dimensions and maximum degree. N. R. Aravind and C. R. Subrmanian. Proceedings of Latin-American Algorithms, Graph and Optimization Symposium (LAGOS) 2009. ENDM volume 35, pages 353-358.**

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Publications

1. **International Journal of Geometric Methods in Modern Physics, Volume 7 (2),March 2010, pp.311-322.**

Name : **Rachna Agarwal**
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Title: : **Physico-chemical characterization and Biogenesis of photosynthesome and thylakoid membranes from synechocystis 6803**

Abstract

Objective

The current research interests in biological sciences are aimed at studying multimolecular interactions or interactomes in various metabolic pathways instead of isolated macromolecules. Various tools are being developed over the past few years for *in silico* analyses although actual biochemical existence of such interactomes has been rarely documented. We have been studying interactomes in photosynthesis. A thylakoid fraction associated with five sequential enzymes was isolated earlier from *Synechococcus* which showed photophosphorylation dependent CO_2 assimilation suggesting existence of supramolecular complex of the components of light and dark reaction that has been termed as Photosynthesome: A Photosynthetic Module.

The present investigations involved the studies to understand the presence of photosynthetic module in another unicellular cyanobacterium *Synechocystis* 6803 and study its biochemical, biophysical and proteomic characterization. The process of biogenesis of protein components of thylakoids was studied by providing ionizing radiation stress.

Experimental

The studies involved HPF fixation of cyanobacteria and immunolocalisation of ribose -5-phosphate isomerase, ribulose-5-phosphate kinase, ribulose-1,6-bisphosphare carboxylase /oxygenase, phosphoglycerate kinase and glyceraldehyde-3-phosphate dehydrogenase along with CF1 that served as a positive control for membranes. Thylakoid membrane fractions were isolated by sequential ultracentrifugation at 40,000, 90,000 and 150, 000xg to obtain the fraction called40k, 90k and 150k fractions respectively. The above mentioned enzymes were also immunolocalised in isolated thylakoids. The isolated thylakoids were biochemically analysed for photosystem activities and co-ordinated activities of light and dark reactions. Biophysical analysis involved absorbance, fluorescence spectra, and chlorophyll life time measurements. Proteomic study involved LC-ESI-MS and BN PAGE and MS. Thylakoid protein biogenesis was studied through ^{35}S methionine labeling of proteins and D1 protein translation on exposure to ionizing radiation stress. These studies were done after carrying out various assays to understand the effect of ionizing radiation on thylakoid membrane structure and function like C-14 incorporation, ROS and TBARS estimation, effect on PSI and PSII activity and TEM of exposed cells.

Results

Results on immunolocalisation suggested preferential location of soluble Calvin cycle enzymes in the vicinity of the thylakoids *in vivo* as well as in the isolated thylakoids. Biochemical assays showed that the 150k fraction has highest co-ordinated activity of

light and dark reactions as well as highest activity of the aforesaid five enzymes. Photosytem assays showed a heterogenous distribution of PSI and PSII activity with highest total PSI activity in 40k fraction and PSII activity in 150k fraction. These observations were further substantiated with low temperature fluorescence data. Life time measurements further corroborated the higher efficiency as well as the functional heterogeneity between the three fractions. The proteome analysis through LC-MS confirmed the presence of soluble Calvin cycle enzymes along the thylakoids and further reiterated the concept of heterogeneity in terms of differential distribution of proteins among the three thylakoid fractions. BN-PAGE analysis showed the differences in the supercomplex distribution among the three fractions and occurrence of RuBiSCO and GAPDH with PSI.

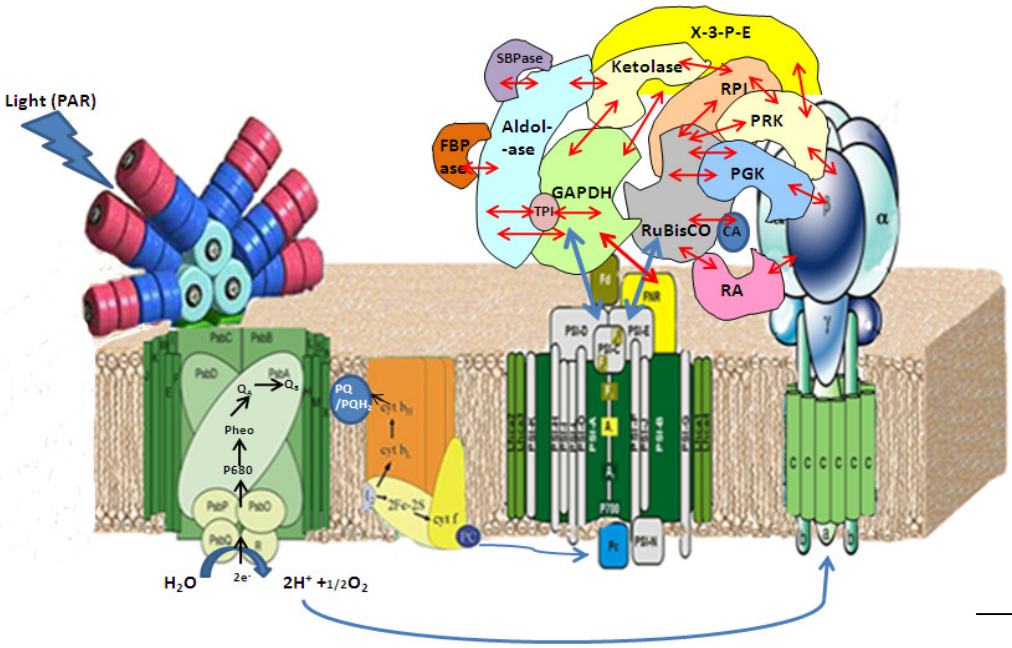
Studies on membrane biogenesis on *Synechococcus* and *Synechocystis* suggested that the membrane dependent functions like photosystem activities are highly resistant to very high dose of ^{60}Coγ radiation immediately after exposure. These processes decline only upon incubation of exposed cells. The protein synthesis declines immediately after exposure and remain so after incubation. Dose dependent effect on amount of translation on D1 protein in *Synechocystis* shows that this protein declines after incubation of exposed cells thus suggesting that the decline in protein biogenesis affect the thylakoid membrane functions post incubation

CONCLUSIONS

It has been concluded from the data obtained that the Calvin cycle enzymes are associated with thylakoids of *Synechocytis* as well, possibly next to PSI. The functional heterogeneity is probably due to compositional differences in the proteome of the three thylakoid fractions. Further the membrane protein biogenesis is susceptible to oxidative stress that leads to decline in membrane associated functions post incubation.

MODEL

Based upon our current findings and the previous data on nearest neighbor analysis the following model for the Photosynthesome is proposed:



Publications

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Name : **Sundar S**
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Title : **The Geometry Of Some Quantum Homogeneous Spaces And The Weak Heat Kernel Expansion**

Abstract

We study the noncommutative geometry of some quantum homogeneous spaces associated with the quantum group SUq(n). First we consider the quantum space SUq(n)/SUq(n − 1) called the odd dimensional quantum spheres and denoted S_q^{2n-1}. We consider two spectral triples associated to the odd dimensional quantum spheres S_q^{2n-1}. We show that the spectral triples satisfy the hypothesis of the local index formula. A conceptual explanation is given by considering a property which we call the weak heat kernel asymptotic expansion property of spectral triples. We show that a spectral triple having the weak heat kernel asymptotic expansion property satisfies the hypothesis of the local index formula. We also show that this property is stable under quantum double suspension. Finally we compute the K-groups of the quantum homogeneous space SUq(n)/SUq(n −2).

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2. **Partha Sarathi chakraborty and S.Sundar. Quantum double Suspension and spectral triples, Journal of functional analysis, 2011, doi:10.1016/j.jfa.2011.01.009**
3. **Partha Sarathi Chakraborty and S.Sundar. K-groups of the quantum homogeneous space *SUq*(n) / *SUq* (n-2). arXiv:1006.1742/math.KT.**

Name : **Sharad Kumar Yadav**
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Title : **Evolution of Galaxies and the Intergalactic Medium at High Redshift**

Abstract

The main theme of this thesis is to understand the propagation behavior of electron current pulses in an inhomogeneous plasma medium. For this purpose the framework of Electron Magnetohydrodynamic (EMHD) fluid description is adopted. Therefore, the EMHD model is generalized by incorporating any arbitrary plasma density inhomogeneity. The new model is termed as the Generalized Electron Magnetohydrodynamic (G-EMHD). The G-EMHD evolution equations being nonlinear, a numerical code has been developed to solve the evolution equations in two dimension. For the study purpose we chose exact nonlinear solutions for a homogeneous plasma in the form of EMHD monopoles and dipoles. Our numerical studies show that (i) these current pulse structures acquire an additional drift velocity. The drift is transverse to the magnetic field and the density gradient. (ii) The dipole can readily penetrate inside a high density plasma region and often gets trapped there. (iii) The dipole acquires the size of the skin depth associated with the local plasma density. (iv) The phenomena of trapping has been investigated in detail to formulate a threshold criteria (the ratio of the density inhomogeneity scale length and the distance traversed by the structure) for trapping vs. transmission of the structures.

Moreover we observe that as the dipolar current pulse structure passes through the density inhomogeneity to penetrate the high density region, it forms magnetic shocks and/or sharp current layers. A strong energy dissipation at the location of magnetic shock region occurs when the dipole structure enters the high density region. Our numerical studies show that the total energy dissipation is independent of the magnitude and the character of the dissipative processes present in the system. A semi – analytic approximate estimate for the total energy dissipation has also been made which confirms the numerical observation of the independence of the total dissipated energy to the magnitude and character (resistivity and/or viscosity) of the dissipative processes at work.

In addition a number of fundamental observations, e.g. Illustration of the (Kelvin Helmholtz) KH destabilization of the sharp current pulses in the presence of plasma density inhomogeneity and the formation of a novel coherent nonlinear state in the form of vortex beads aligned along the density inhomogeneity have also been made.

We also propose a new simpler scheme to collimate and guide the path of energetic electrons using a tailored plasma density inhomogeneity profile.

Publications

1. **"Propagation of Electron Magnetohydrodynamic Structures in a Two- Dimensional Inhomogeneous Plasma", Sharad Kumar Yadav, Amita Das, and Predhiman Kaw*Phys. Plasmas* 15, 062308 (2008)**

2. **"Near-Complete Absorption of Intense, Ultrashort Laser Light by Sub- Lambda Gratings" S. Kahaly, S. K. Yadav, W. M. Wang, S. Sengupta, Z. M. Sheng, A. Das, P. K. Kaw, and G. Ravindra Kumar *Phys. Rev. Lett.* 101, 145001 (2008)**

3. **"Hot Electron Generation by Highly Efficient Absorption of High Intensity Femtosecond Laser Light in Plasma Generated on Sub- Lambda Gratings", S. Kahaly, G. R. Kumar, S. K. Yadav, S. Sengupta, A. Das, and P. K. Kaw *Journal of Physics: Conference Series* 112, 022102 (2008)**

4. **"Anomalous Energy Dissipation of Electron Current Pulses Propagating through an Inhomogeneous Collisionless Plasma Medium", Sharad Kumar Yadav, Amita Das, Predhiman Kaw, and Sudip Sengupta *Phys. Plasmas* 16, 040701 (2009)**

5. **"Role of Natural Length and Time Scales on Shear Driven Two Dimensional Electron Magnetohydrodynamic Instability", G. Gaur, S. Sundar, S. K. Yadav, A. Das, P. Kaw, and S. Sharma *Phys. Plasmas* 16, 072310 (2009)**

6. **"Nonlinear Studies of Fast Electron Current Pulse Propagation in a Two Dimensional Inhomogeneous Plasma", Sharad Kumar Yadav, and Amita Das *Phys. Plasmas* 17, 052306 (2010)**

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Constituent Institute : **The Institute of Mathematical Sciences, Chennai**
Title : **On Weighted Eigenvalue problems And Applications**

Abstract

The main objective of this thesis is to find a large class of weight functions that admits a positive principal eigenvalue for the weighted eigenvalue problems for the Laplacian and the p-Laplacian. More specifically, for a connected domain Ω in $\mathbb{R}^N$ with $N \geq 2$, we study sufficient conditions for a function $g \in L^1_{loc}(\Omega)$ to admit a pair (λ, u), with $\lambda \in \mathbb{R}^+$ and $u > 0$ a.e. such that u is a weak solution of the following problem:

$$-\Delta_p u = \lambda g|u|^{p-2}u, \quad \text{in } \Omega, \tag{1}$$

where $1 < p < N$ and $\Delta_p u := \operatorname{div}(|\nabla u|^{p-2}\nabla u)$ is the p-Laplace operator. Such a λ, if exists, is called a principal eigenvalue of (1). In the literature, most of the sufficient conditions for the existence of a positive principal eigenvalue demand that the weight function g or its positive part g^+ to be in $L^{\frac{N}{p}}(\Omega)$. However, in the field of applications one may need to consider weights that are not belonging to any of the Lebesgue spaces.

We look for a weak solution of (1) in $\mathcal{D}_0^{1,p}(\Omega)$, where

$$\mathcal{D}_0^{1,p}(\Omega) := \text{completion of } \mathcal{C}_c^\infty(\Omega) \text{with respect to } \|\nabla \cdot\|_p \text{ norm }.$$

Now the existence of a positive principal eigenvalue for (1) is closely related with the existence of a minimizer for the functional $J(u) = \int_\Omega |\nabla u|^p$ on the level set $\mathcal{M}_p = \left\{u \in \mathcal{D}_0^{1,2}(\Omega) : \int_\Omega g|u|^p = 1\right\}$. If the map G, $G(u) = \int_\Omega g^+|u|^p$, is compact, then a direct variational method ensures the existence of a minimizer for J on $\mathcal{M}_p$. If g^+ is in $L^{\frac{N}{p}}(\Omega)$, the dual of $L^{\frac{p^*}{p}}(\Omega)$, then the map G is compact. This is mainly a consequence of three facts (i) the continuous embedding of $\mathcal{D}_0^{1,p}(\Omega)$ into $L^{p^*}(\Omega)$ (ii) the compactness of the embedding of $\mathcal{D}_0^{1,p}(\Omega)$ into $L^p_{loc}(\Omega)$ (iii) the density of $\mathcal{C}_c^\infty(\Omega)$ in $L^{\frac{N}{p}}(\Omega)$.

The main novelty of our results is that we allow weights that are not in any of the Lebesgue spaces, but only in certain weak Lebesgue spaces. For this we make use of the finest embedding of $\mathcal{D}_0^{1,p}(\Omega)$ into the Lorentz space

$$L(p^*, p) = \left\{u \text{ measurable } : \int_0^{|\Omega|} [t^{\frac{1}{p^*}} u^*(t)]^p \frac{dt}{t} < \infty\right\},$$

where u^* denotes the one dimensional decreasing rearrangement of u. The Lorentz space $L(p^*, p)$ is a Banach space with a suitable norm and it is a proper subspace of the Lebesgue space $L^{p^*}(\Omega)$. However, when g^+ is in the Lorentz space $L(\frac{N}{p}, \infty)$ (the dual space of $L(\frac{p^*}{p}, 1)$), the map G is not necessarily compact. For example, when $g(x) = \frac{1}{|x|^p}$ and Ω contains the origin, the map G is not compact, indeed $\frac{1}{|x|^p}$ is in $L(\frac{N}{p}, \infty)$. In this thesis, we find a large class of admissible weights in $L(\frac{N}{p}, \infty)$ that admits a

minimizer for J on $\mathcal{M}_p$. Namely, the closure of $C_c^\infty(\Omega)$ in $L(\frac{N}{p}, \infty)$ that will henceforth be denoted by $\mathcal{F}_{\frac{N}{p}}$:

$$\mathcal{F}_{\frac{N}{p}} := \overline{C_c^\infty(\Omega)}^{\|\cdot\|_{(\frac{N}{p},\infty)}} \subset L\left(\frac{N}{p}, \infty\right).$$

We prove that J admits a minimizer on $\mathcal{M}_p$, when g^+ is in $\mathcal{F}_{\frac{N}{p}}$.

We consider the case $p = 2$ separately, because of the simple and rich theory available for the Laplacian. Moreover, certain results that hold for the p-Laplacian hold good for the Laplacian under weaker assumptions. For $g^+ \in \mathcal{F}_{\frac{N}{p}}$, using a variant of the strong maximum principle, we show that λ_1, the minimum of J on $\mathcal{M}_p$, is indeed a principal eigenvalue of (1). A necessary condition, namely a Pohozev type identity for the existence of a principal eigenvalue is obtained for certain class of weight functions. The radial symmetry of the eigenfunctions corresponding to λ_1 are also discussed when Ω is $\mathbb{R}^N$ or a ball centred at the origin. The existence of a nontrivial

solution branch for certain types of nonlinear equations is studied as an application of the weighted eigenvalue problem using the bifurcation theory. The existence of an infinite sequence of eigenvalues is obtained using the Ljusternik-Schirelmann theory. The weighted eigenvalue problem for the Laplacian on bounded domains in $\mathbb{R}^2$ is also studied. We obtain various sufficient conditions for the existence of a positive principal eigenvalue by making use of the optimal embeddings of $H_0^1(\Omega)$ in the classes of Orlicz and Lorentz-Zygmund spaces.

Publlications

1. **Eigenvalue problems with weights in Lorentz spaces, with Mythily Ramswamy, Marcello Lucia, Calculus of Variations and PDE, Volume 36, No, 2009, 355-376**
2. **Positive solutions branch for nonlinear eigenvalue problems in $\mathbb{R}^N$. with Jagmohan Tyagi, Nonlinear Analysis, Theory, Methods and Application, Volume 74, No. 6, 2011.**
3. **The weighted eigenvalue problems for p-Laplacian with weight in weak**
4. **Lebesgue spaces, Electronic Journal of Differential Equations, Volume 2011, No. 64, 2011, pp. 1-22.**

Name : **J. Solomon Ivan**
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Title : **Nonclassicality and Entanglement in Continuous Variable Systems**

Abstract

Nonclassicality and entanglement are two important features exhibited by continuous variable quantum states. This thesis is centered on the connection between nonclassicality and entanglement in the context of continuous variable quantum systems. Evidently, nonclassicality is a prerequisite for entanglement. The connection between the two has been well explored in the context of Gaussian states, namely in the context of squeezing nonclassicality. We study the connection in the context of other well known nonclassicalities, namely nonclassical photon number statistics and antibunching. By definition, every classical state is a convex sum of coherent states, and hence is separable. Nonclassicality does not imply entanglement, but every entangled state is nonclassical. Negativity under Partial Transpose (NPT) implies nonclassicality, but Positivity under Partial Transpose (PPT) by itself does not indicate that the state is classical or separable. A PPT state can be separable or entangled, can be classical or nonclassical.

Chapter 1 is primarily introductory in nature, bringing forth the various concepts involved in the theory of entanglement, both in the finite dimensional situation as well as in the infinite dimensional case of continuous variable systems. It is expository in nature and collects some of the techniques useful later in the thesis.

In Chapter 2 we bring forth a relationship between nonclassicality and entanglement. The problem of studying the interrelationship between nonclassicality and entanglement is tied to the fact that there is no simple test which can conclude in a definite manner if a given generic mixed state is classical or not, and there is no single test which can answer with certainty if a mixed state is entangled or separable. However, in very special or specific cases one can make definitive statements. For states of a single mode of radiation which are diagonal in the Fock basis, the issue of classicality/nonclassicality has been settled. This is possible thanks to the result of the classical Stieltjes moment problem [170]. We bring out the possibility of using such nonclassical (non-Gaussian) resources to generate useful entanglement. With a product state of the form $\hat{\rho}_{\rm in}^{(ab)} = \hat{\rho}^{(a)} \otimes |0\rangle_{bb}\langle 0|$ as input, the output two-mode state $\hat{\rho}_{\rm out}^{(ab)}$ of a beamsplitter is shown to be NPT whenever the photon number distribution (PND) statistics $\{p(n_a)\}$ associated with the mixed state $\hat{\rho}^{(a)}$ of the input a-mode is antibunched or otherwise nonclassical, i.e., if $\{p(n_a)\}$ fails to respect any one of an infinite sequence of necessary and sufficient classicality conditions. We establish the equivalence of classicality and PPT of $\hat{\rho}_{\rm out}^{(ab)}$ in this kind of situations. Thus NPT is a necessary and sufficient test of entanglement of $\hat{\rho}_{\rm out}^{(ab)}$. Furthermore $\hat{\rho}_{\rm out}^{(ab)}$ is shown to be distillable if $\hat{\rho}^{(a)}$ is antibunched or violates any one of an infinite sequence of three term classicality conditions. We also discuss the issue of distillability arising from an intrinsically higher order violation of classicality. This is the only second instance in

continuous variable entanglement theory where NPT has turned out to be a necessary and sufficient criterion for entanglement, the earlier instance being that of two-mode Gaussian states. A preliminary version of these results is found in [194]. We attempt to estimate the entanglement of formation (EOF) of entangled states generated in the above manner. We evaluate both upper and lower bounds on EOF for very special examples. Our principal tool in this scheme is the fact that average entanglement does not increase under local operations and classical communications (LOCC). The general idea used has been to project out the state into 2×2 subspaces, and then use Wootter's formula for the entanglement of formation of a two-qubit system to estimate the entanglement; such a process is clearly an LOCC. However, a drawback with such a scheme is the fact that one cannot estimate more than one ebit of entanglement even from a highly entangled state. For the simple example of an entangled state generated by passing through a 50:50 beamsplitter an arbitrary mixture of the ground state and n^{th} Fock state on Alice's side, with Bob's side in the ground state, we give a distillation procedure whereby we distill more entanglement than given by lower bound for EOF in [76]. We extend these ideas to entangled states generated from PND's which correspond to a very special superposition of coherent states, and we demonstrate distillation procedures which distill well above one ebit of entanglement. We also indicate the possibility of using the Terhal-Vollbrect formula [69,76] in estimating entanglement, in a more general context, using a truncation scheme.

The study undertaken in Chapter 2 is continued in Chapter 3 from a more general perspective. We describe a single test which, if successful, is able to simultaneously establish both the nonclassicality and NPT entanglement of a given two-mode state. We extend the notion of antibunching to two-mode systems through the Mandel matrix construct, and show that nonclassicality at this level naturally separates into two distinct kinds, Type I and Type II, depending on whether the sub Poissonian statistics is visible or not at a single-mode level. The "Type" of a nonclassical state is invariant under the action of every $U(2)$ beamsplitter. A state could go from separable to entangled under beamsplitter action, but its Type is invariant. Type II states are special in the sense that one may pass such states through any $U(2)$ beamsplitter, even then can never detect antibunching locally i.e., in a single-mode. We construct examples of both types. We introduce a beamsplitter invariant definition for the Mandel parameter, extended to the case of two-mode systems through the nonpositivity of the Mandel matrix. That we are able to do so is because the Mandel matrix transforms covariantly under beamsplitter action. However, we find that the two-mode Mandel parameter can take values less than -1, as compared to the Mandel parameter in the single-mode case. This feature seems to expose the limitation of the beamsplitter as an entangling device, as there are entangled states that the beamsplitter cannot produce. The two-mode Mandel parameter is relevant only within the Type under consideration. We explore the production of bipartite entanglement from separable nonclassical states by beamsplitters, we trace back the entanglement to the nonclassicality involved, and we illustrate this aspect through several examples. We demonstrate distillable entanglement in this context. We extend these ideas to the case of generating tripartite entanglement through generalised beamsplitters, and examine their detection through simple moment-based tests which trace back the entanglement to a particular type of nonclassicality. We also demonstrate the possibility of generating genuine tripartite entanglement from two-mode Mandel type nonclassicality.

In Chapter 4 the EOF of an arbitrary two-mode Gaussian state is computed. In this context, we bring out the intimate connection between the two-mode squeeze parameter as a measure of the strength of nonclassicality and alternatively as a measure of entanglement. Apart from a conjecture, our analysis rests on two main ingredients. One of them is a four-parameter canonical form we develop for the covariance matrix, one of these parameters, the squeeze parameter, acting as a measure of EOF. The other is the generalisation of the EPR correlation used in the work of Giedke *et al* [70] to noncommuting variables. The conjecture is in respect of an extremal property of this correlation [327].

In Chapter 5 we study the compatibility conditions between the (global) spectrum and the spectra of the individual modes of a general n-mode Gaussian state. We present an elementary proof for the compatibility conditions, making optimal use of beamsplitter and two-mode squeezing transformations. An unexpected bye-product of our elementary approach is the result that every two-mode Gaussian state is uniquely determined, modulo local transformations, by its global spectrum and local spectra, a property shared not even by a pair of qubits [18].

In Chapter 6 we obtain the operator-sum representation of all the quantum limited single-mode Bosonic Gaussian channels. The analysis lends insight into how certain unphysical processes such as the transposition map, or scaling of the Weyl-ordered characteristic function, or a combination of both can be rendered physical through a threshold Gaussian noise. The motive here is to bring out this aspect in a transparent manner through the operator-sum representation. We have that the scaling of the diagonal weight function and scaling of the Husimi Q function correspond to physical processes. As will be seen in the following Chapter, the fact that scaling of the Q function is physical is of critical relevance when one defines a measure of non-Gaussianity for quantum states. This Chapter further explores the notion of nonclassicality breaking and the notion of entanglement breaking in light of the operator-sum representation.

Having brought out the connection between nonclassicality and entanglement, and having exposed nonclassicality as a resource, it is useful to understand this resource as being Gaussian and non-Gaussian. Chapters 2 and 3 primarily dealt with non-Gaussian states and the nonclassicality associated with them, but Chapters 4, 5, and 6, dealt with Gaussian states and issues regarding them. In Chapter 7 we bring out the essential difference between these two very different resources through the consideration of cumulants. Since the higher order cumulants defined through an s-ordered quasi-probability is independant of the ordering parameter s and hence is intrinsic to the state, every non vanishing cumulant of order greater than two serves as an indicator of non-Gaussianity. We introduce a new measure for non-Gaussianity based on the negentropy of the Q function. We show that our measure satisfies some of the requirements that a good non-Gaussianity measure should satisfy, especially the invariance of the measure under uniform scaling of the Q function. The scale invariance of the measure is demanded by the fact that scaling of the Q function is a valid physical transformation as shown in Chapter 6. The measure is well supported by the fact that the Marcinkiewicz theorem holds for phase space distributions too [358]. We analytically evaluate this non-Gaussianity measure for

mixed entangled states generated by passing the photon-added thermal state through a $U(2)$ beamsplitter, the ancilla being in the ground state. We find for these examples that the non-Gaussianity as evaluated by our measure, is independent of temperature, which is a direct manifestation of scale invariance. That we are able to evaluate the non-Gaussianity for these mixed entangled states is because of the invariance of the measure under passive transformations. We also evaluate the measure for the phase averaged coherent state. In a recent work [361, 362], Genoni *et al* introduced distance based measures of non-Gaussianity of a state through the Hilbert-Schmidt distance and relative entropy defined at the density operator level. We compare their measure with ours for the simple example of the photon-added thermal state [216].

Finally we conclude with some remarks and discuss possible future directions of research, particularly in the context of the use of non-Gaussian resources in quantum information processing.

Publlications

1. **Generation of Distillable Entanglement From Nonclassical Photon Statistics (In preparation), the preliminary version is found in : J. Solomon Ivan, N. Mukunda, and R. Simon, Generation of NPT Entanglement from Nonclassical Photon Statistics, quant-ph/0603255.**
2. **J. Solomon Ivan, S. Chaturvedi, E. Ercolessi, G. Marmo, G. Morandi, N. Mukunda, R. Simon Entanglement and nonclassicality for multi-mode radiation Field states, arXiv:1009.6104 (Accepted in PRA)**
3. **J. Solomon Ivan and R. Simon, Entanglement of Formation for Gaussian states, Quant-ph/0808.1658 (Submitted to PRL).**
4. **J. Solomon Ivan and R. Simon, Compatability conditions on local and global Spectra for n-mode Gaussian states, quant-ph/0812.2805.**
5. **J. Solomon Ivan, Krishnakumar Sabapathy, and R. Simon, Operator-sum Representation for Bosonic Gaussian channels, arXiv:1012.4266.**
6. **J. Solomon Ivan, M. Sanjay Kumar, and R. Simon, A measure of non- Gaussianity of quantum states, quant-ph/0812.2800 (Submitted to PRA**

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Title	**:**	**Unveiling some supersymmetric scenarios using tau-leptons at the Large Hadron Collider**

Publlications

1. **S. Biswas and B. Mukhopadhyaya,"Neutralino reconstruction in supersymmetry with long-lived staus", Phys. Rev. D79:115009, (2009), arXiv:0902.4349 [hep-ph]**
2. **S. Biswas and B. Mukhopadhyaya," Chargino reconstruction in supersymmetry with long-lived staus", Phys. Rev. D81:015003, (2010), arXiv:0910.3446 [hep-ph].**
3. **S. Biswas, "Reconstruction of the left-chiral tau-sneutrino in supersymmetry with a right-sneutrino as the lighest supersymmetric particle", Phys. Rev. D82:075020, (2010), arXiv:1002.4395 [hep-ph]**
4. **S. Biswas, J. Chakrabortty and S. Roy, "Multi-photon signal in supersymmetry comprising non-pointing photon (s) at the LHC", Phys.Rev. D83:075009, (2011), arXiv:1010.0949 [hep-ph]**
5. **S. Bhattachrya, S. Biswas, B. Mukhopadhyaya and M.M. Nojiri, "Signatures of supersymmetry with non-universal Higgs mass at the Large Hadron Collider", arXiv:1105.3097 [hep-ph]**

Name : **S. M. Kamil**
Enrolment No. : **PHYS10200604004**
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Title : **Problems in the Statics and Dynamics of Nematic Liquid Crystals**

Abstract

Liquid crystalline states of matter provide a useful testing ground for statistical mechanical theories of ordered states, since a variety of ordered phases can be accessed in experiments and computer simulations. They also constitute simple model systems for studying the interplay between internal structure and an externally imposed flow, thus illuminating rheological studies of a large class of complex fluids.

In this thesis, we study some problems in the statics and dynamics of nematic liquid crystals. Nematics, typically formed in solution by rod-like molecules with an aspect ratio which deviates sufficiently from unity, exhibit orientational order in the absence of translational order. Such orientational order is quantified through a traceless, symmetric tensor $Q_{\alpha\beta}$. The free energy which quantifies the cost of deformations is the Ginzburg-Landau-de Gennes (GLdG) free energy functional, obtained *via* a gradient expansion in $\mathbf{Q}$.

This thesis studies two broad classes of problems using the GLdG approach. The first class deals with the static properties of the isotropic-nematic interface. The problem of interface structure for the nematic is particularly interesting since it provides a simple illustration of how the structure of an interface can differ substantially from structure in the bulk.

The second class of problems involves the study of the dynamics of $Q_{\alpha\beta}$ for a nematic fluid in an external shear flow. Our study of the dynamics of $Q_{\alpha\beta}$ impacts experiments on the flow behaviour of fluids with orientational order, a prototypical model for the understanding of complex fluid rheology, in particular of chaos associated with unsteady rheological response or "rheochaos". Such rheochaos is a consequence of constitutive and not convective non-linearities, originating in the coupling of the flow to structural or orientational variables describing the local state of the fluid

A powerful approach to understanding complex spatio-temporal dynamics is based on the study of coupled map lattices, a numerical scheme in which maps placed on the sites of a lattice evolve both via local dynamics as well as through couplings to neighbouring sites. However, the utility of this methodology in a specific context is often severely limited by the availability of local maps able to comprehensively describe the spatially uniform case. In this thesis, we discuss this

requirement in the context of a model for rheochaos, proposing a local map as well as a coupled map description of the regular and chaotic states obtained in sheared nematics.

The thesis is organized as follows. In the first chapter, the Introduction, we briefly review the GLdG order parameter theory of the isotropic-nematic transition. We survey the literature which deals with the isotropic-nematic interface and briefly describe methodologies for studying the rheology of complex fluids, in particular nematogenic fluids. The results presented in the chapters which follow are summarized in more detail below, chapterwise. Finally, we end this thesis with a conclusion and point to further work.

Isotropic-Nematic interface with Planar Anchoring

In the second chapter of this thesis we revisit the classic problem of the structure of the isotropic-nematic interface within Ginzburg-Landau-de Gennes theory, refining previous analytic treatments of biaxiality at the interface. We present results for the uniaxial and biaxial profiles, specialized to the case of planar anchoring, showing how a term in the Euler-Lagrange equations neglected in previous work contributes substantially to determining the structure of the interface. We use results from a fast and highly accurate spectral collocation scheme for the solution of the Landau-Ginzburg-de Gennes equations to test these analytic results. In comparison to earlier work, we obtain improved agreement with numerics for both the uniaxial and biaxial profiles, with our results being increasingly accurate as κ is reduced. We also provide accurate asymptotic results for the decay of the S and T order parameters deep into the nematic and isotropic phases.

Isotropic-Nematic interface with Planar Anchoring

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Isotropic-Nematic Interface with an Oblique Anchoring Condition

In the third chapter of this thesis, we study the case where a general anchoring condition is imposed on the nematic side of the interface, reproducing results of previous work in the limit in which this anchoring condition reduces to the planar or homoeotropic case. Our approach uses variational methods, based on physically motivated and computationally flexible variational profiles for uniaxial and biaxial order, as well as for the variation of the angle between the nematic axis

and the coordinate normal to the interface. Results from our analysis are compared to numerical results obtained from a direct numerical minimization of the Ginzburg-Landau-de Gennes free energy. While spatial variations of the uniaxial and biaxial order parameters are approximately confined to the neighbourhood of the interface, nematic elasticity requires that the director orientation interpolate smoothly between planar anchoring at the location of the interface and the imposed boundary condition at infinity. Our variational results are in close agreement with numerical results as well as results from molecular simulations. Our methods access the nontrivial structure of the biaxiality at the interface including the large tail towards the isotropic side and the change in the sign of the biaxial order parameter across the interface. This approach also captures the inversion of the profile of biaxiality as the elastic coefficient L_2 crosses zero.

Local Map Description of Nematic Liquid Crystals

In chapter four of this thesis, we propose and study a local map capable of describing the full variety of dynamical states, ranging from regular to chaotic, obtained when a nematic liquid crystal is subjected to a steady shear flow. The map is formulated in terms of a quaternion parametrization of rotations of the local frame described by the axes of the nematic director, subdirector and the joint normal to these, with two additional scalars describing the strength of ordering. Our model yields kayaking, wagging, tumbling, aligned and coexistence states, in agreement with previous formulations based on coupled ordinary differential equations. The phase diagram we obtain using our methods contains all non-trivial dynamical states obtained in previous work. Moreover, it closely resembles, even at the quantitative level, phase diagrams obtained in previous work which used ordinary differential equations formulated in continuous time. Our approach makes an extension to the case in which the shear rate is periodically modulated, possible. Our work thus supplies a crucial ingredient required for the construction of cou-

Our work thus supplies a crucial ingredient required for the construction of coupled map lattice approaches to the spatio-temporal aspects of rheological chaos, a problem currently at the boundaries of our understanding of the dynamics of complex fluids.

A Coupled Map Lattice Model of Rheological Chaos.

In chapter five of this thesis we devise and study a coupled map lattice model for a nematogenic fluid in a passive shear flow. We begin with a local map which contains all the states predicted using a ODE-based methodology. We then couple these maps together spatially, using standard techniques, in one and two dimensions. Our results provide evidence for spatially and temporally uniform states, as well as states which are spatially uniform but temporally periodic. In a restricted regime of parameter space, we find evidence for spatio-temporally chaotic behaviour, which we characterize in detail. We obtain a phase diagram in the space of the coupling constant for the spatial coupling of sites as well as a paramter which enters our map, illustrating how the different spatio-temporal phases are connected to each

other. Previous work on rheochaos has been based on methodologies which use partial differential equations, which are then solved (typically in one dimension) in the passive advection approximation. Our results here obtain the same states found in approaches which use PDE's, but allow a numerically tractable extension to two and higher dimensions. Our results for this model indicate that behaviour in the one dimensional and two dimensional cases are qualitatively similar, although the larger number of neighbours in two dimensions suppresses spatial irregularity. We have checked that our results are qualitatively similar for different choices of spatial coupling schemes. Our results include the complete characterization of phases and the phase diagram as well as the demonstration of spatio-temporal intermittency in this system. More centrally, our work shows that coupled map lattice models of rheological chaos can provide accurate yet computationally tractable descriptions of the steady state behaviour of driven complex fluids.

Publlications

1. **Regular and Chaotic States in a Local Map description of Nematic Liquid Crystals,**
2. **S.M. Kamil, Sudeshna Sinha and Gautam I.Menon, Physical Review E 78, 011706(2008).(arXiv:0801.3876v2)**
3. **Biaxiality at the Isotropic-Nematic Interface with Planar Anchoring.**
4. **S.M.Kamil,A.K. Bhattacharjee, r Adhikari and Gautam I.Menon Phys. Rev. E 80, 041705(2009) (http://arxiv.org/abs/0906.2899)**
5. **The isotropic-nematic interface with an oblique anchoring condition.**
6. **S.M.Kamil, A.K. Bhattacharjee, R.Adhikari and Gautam I.Menon The journal of Chemical Physics, 131, 174701(2009) (http://arxiv.org/abs/0908.2517)**
7. **A Coupled Map Lattice Model for Rheological Chaos in Sheared Nematic Liquid Crystals.S.M.Kamil,Gautam I.Menon and Sudeshna Sinha Chaos 20 043123 (2010) (http://arxiv.org/abs/1005.2041)**

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Title : **Nondestructive Assay Of Nuclear Materials By Gamma Ray Spectrometry**

Abstract

The thesis presents the work on Nondestructive assay based on gamma ray spectrometry. In this work, procedures for obtaining the attenuation and true coincidence summing correction factors which are required for the gamma based nondestructive assay of nuclear materials have been developed. Attenuation correction procedures have been developed for samples with both standard and nonstandard geometries. For homogenous samples with standard geometry, a Hybrid Monte Carlo method has been developed to compute attenuation correction factors for some common sample geometries such as cylinder, disc, sphere and box. The attenuation correction factors have been obtained for a wide range of transmittances and sample-to-detector distances. The approach has been validated theoretically as well as experimentally. For nonstandard samples, an apparent mass method has been standardized for the assay of uranium and plutonium. This method has been applied to real samples eg. stainless steel samples, sludge and enriched uranium.

Full Energy Peak (FEP) efficiency calibration has been carried out using Monte Carlo Neutral Particle (MCNP) code. The effect of different detector geometry parameters on the FEP efficiency has been studied and detector geometry has been optimized to match experimental and MCNP efficiencies. The results have been verified for extended sources also. True coincidence summing occurs when the nuclide monitored emits two or more gamma rays in cascade. An analytical approach has been used to obtain coincidence summing correction factors for both point and extended source geometry. The total and FEP efficiencies required for this method has been obtained by MCNP. These correction factors have been validated by comparing these correction factors with the experimentally obtained correction factors.

The work reported in this thesis has led to the development of methodologies for obtaining correction factors that are very important for gamma based Non-destructive assay of nuclear materials. The work described in the thesis has led to 7 (seven) publications in peer reviewed International Journals.

Publlications

1. **Determination of uranium in aqueous attenuation samples using ray spectrometry." Chhavi Agarwal, p.c.kalsi, A. Mhatre, and A. Goswami, Applied Radiation and Isotopes, 65(2007) 1386.**
2. **" A simple numerical method for gamma ray self-attenuation correction for samples of common geometries." Chhavi Agarwal, Sanhita Poi, A. Goswami, Manohar Gathibandhe, R. A. Agarwal, Nuclear Instruments & Methods in physics Research A, 597 (2008) 198.**

3. **"Attenuation Correction factors for cylindrical disc and box geometry." Chhavi Agarwal, Sanchita Poi, Amol Mhatre, A. Goswami and Manohar Gathi bandhe, Nuclear Instruments & Methods in Physics Research A, 607(2009) 439.**
4. **"Nondestructive determination of plutonium by gamma spectrometry and neutron well coincidence counting." Chhavi Agarwal, Sanhita Poi, T.N.Nathaniel, Amol Mhatre, P.C.Kalsi, Sarbjit Singh and A. Goswami, Journal of Nuclear Materials, 385 (2009) 131.**
5. **"Full energy peak efficiency calibration of HPGe detector for point and extended sources using Monte Carlo code." Chhavi Agarwal, Sanhita Chaudhury, A. Goswami and Manohar Gathibandhe, Journal of Radioanalytical and Nuclear chemistry 287 (2011) 701.**
6. **"Coincidence summing corrections for point and extended geometries" Chhavi Agarwal, Sanhita chaudhury, A. Goswami and Manohar Gathibandhe, Applied Radiation and Isotopes 289 (2011) 773.**
7. **"Nondestructive assay of plutonium in empty stainless steel boxes by apparent mass method." Chhavi Agarwal, Sanhita Chaudhury, A. Goswami and M. Gathibandhe, Journal of Radioanalytical and Nuclear Chemistry**

Name : **Ajay Singh Ramdin Thakur**
Enrolment No. : **MATH10200604009**
Constituent Institute : **The Institute of Mathematical Sciences, Chennai**
Title: : **Complex Structures On Product of Circle Bundles Over Compact Complex Manifolds**

Abstract

Let Li →Xi be a holomorphic line bundle over a compact complex manifold for I = 1; 2. Let S_i denote the associated principal circle-bundle with respect to some hermitian inner product on L_i. We construct complex structures on S = S1 x S2 which we refer to as scalar, diagonal, and linear types. While scalar type structures always exist, diagonal type structures are constructed assuming that _Li are equivariant $(C^o)^{ni}$-bundles satisfying some additional conditions. The linear type complex structures are constructed assuming Xi are (generalized) ag varieties and Li negative ample line bundles over X_i. When $H^1(Xx:;R) = 0$ and $c_1(L_1)$ € $H^2(X_1;:R)$ is non-zero, the compact manifold S does not admit any symplectic structure and hence it is non- K□ahler with respect to any complex structure.

In the case of diagonal type complex structures on S, we determine their Picard groups and the field of meromorphic function when $X_i = G_i = P_i$ where G_i are simple and P_i maximal parabolic subgroups.

Publlications

1. **Parameswaran Sankaran and Ajay Singh Thakur. Complex structures on Products of circle bundles over complex manifolds, C.R. Math. Acad. Sci. Paris, Volume 349, Issues 7-8, April 2011, Pages 437-439.**

Name : **Nilanjan Sircar**
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Constituent Institute : **Institute For Plasma Research, Gandhinagar**
Title : **Plasma Response to Transient High Voltage Pulses**

Abstract

This thesis is devoted to study of two aspects or use of AdS/CFT conjecture: Oneis the use of AdS/CFT in understanding the IR-cut-o_ appearing in the resolution of Hagedorn limiting temperature in String Theory via BFSS matrix model. And other is the use of AdS/CFT in understanding of low energy condensed matter system. A brief abstract of these studies are written separately below.

Hagedorn Phase Transition and Matrix Model for String Theory:

Hagedorn Temperature is the temperature at which the partition function diverges due to the exponential growth in the density of states, which overtakes the Boltzmann suppression factor. BFSS matrix model which describes M-theory in some limit, has membrane degrees of freedom. String like configurations can be constructed from basic degrees of freedom of the matrix model. Hagedorn temperature can be reinterpreted in terms of new degrees of freedom as a phase transition. In the first part of this thesis, we will construct two phases of matrix model ("string" phase and "clustered phase"), and compare their free energies to _nd signature of phase transition. It will be shown that, there exist phase transitions between these two configurations -but only in presence of an IR cut-o_. The low temperature phase corresponds to a string (wrapped membrane) phase and so we call this the Hagedorn phase transition. While the presence of an IR cut-o_ seemingly is only required for perturbative analysis to be valid, the physical necessity of such a cut-o_ can be seen in the dual super-gravity side using AdS/CFT conjecture. Interestingly the perturbative analysis also shows a second phase transition back to a string phase. This is reminiscent of the Gregory-La_amme instability.

Duality between Charged BTZ black hole and Luttinger liquids:

In the second part of thesis, we study properties of strongly coupled CFT's with non-zero background electric charge in 1+1 dimensions by studying the dual gravity theory - which is a charged BTZ black hole. We will calculate correlators of operators dual to scalars, gauge _elds and fermions are studied at both $T = 0$ and $T \neq 0$. In the $T = 0$ case we will also able to compare with analytical results based on AdS_2 and find reasonable agreement. In particular the correlation between log periodicity and the presence of finite spectral density of gapless modes will be seen. The real part of the conductivity (given by the current-current correlator) also vanishes as $\omega \to 0$ as expected. The fermion Green's function shows quasi particle peaks with approximately linear dispersion but the detailed structure is neither Fermi liquid nor Luttinger liquid and bears some similarity to a "Fermi-Luttinger" liquid. This is expected since there is a background charge and the theory is not Lorentz or scale invariant. A boundary action

that produces the observed non-Luttinger-liquid like behavior (*k*-independent non-analyticity at $\omega = 0$) in the Green's function is discussed.

Publlications

1. **B. Sathiapalan and Nilanjan Sircar, "Can the Hagedorn Phase Transition be explained from Matrix Model for Strings?" JHEP 0808:019 (2008), arXiv:0805.0076 [hep-th]**
2. **Debaprasad Maity, Swarnendu Sarkar, B. Sathiapalan, R. Shankar and Nilanjan Sircar, "Properties of CFTs dual to Charged BTZ black-hole" Nucl.Phys.B 839-526-551 (2010), arXiv:0909.4051 [hep-th].**

Name : **Pushkar S. Joglekar**
Enrolment No. : **MATH10200604027**
Constituent Institute : **The Institute of Mathematical Science, Chennai**
Title : **Randomized Algorithms in Some Commutative And Noncommutative Domains**

Abstract

In this thesis we explore the computation complexity of some algebraic problems in the commutative and the noncommutative setting. Our motivation is to better understand the algorithmic questions in both the settings and to see the interplay between them. We also investigate the possibility of applying the techniques and tools developed in the one model to the other. Specifically, we focus on the computational complexity of the problems over integer lattices, permutation groups and arithmetic circuits.

Algorithmic problems over integer lattices and permutation groups Shortest vector problem(SVP) and the closest vector problem(CVP) are two important problems over integer lattices and their algorithmic complexity is a subject of extensive research in the recent time due to advent of lattice based cryptosystems. Both of these problems are known to be NP-hard. Ajtai, Kumar and Sivakumar in a breakthrough work gave a singly exponetial time randomized algorithm for SVP and a singly exponential algorithm for solving CVP within factor of $1 + \varepsilon$ for any constant $\varepsilon > 0$. Recently a new problem was introduced by Blömer and Naewe called Subspace avoiding problem SAP to better understand the computational complexity of CVP and SVP. Both of these problems are special cases of SAP. Given an integer lattice *L* of rank *n* and a subspace M *C* R of dimension k, the Subspace avoiding problem is to compute the length of a shortest vector in *L* | *M* with respect to the concerned norm. In this thesis we give a new algorithm for SAP based on the Ajtai-Kumar-Sivakumar sieving technique which performs better compared to Blömer and Naewe algorithm parameterized on the dimension k of the subspace concerned. Our algorithm works for metrics given by gauge functions which includes usual *lp* norms. Later we give some applications of our algorithm to the CVP and the SVP problem.

Next we investigate the computational complexity of two natural problems for metrics on permutation groups (which are nonabelian in general) given by generating sets. These problems are exact analogue of closest vector problem and the shortest vector problem. These problems are also known to be NP-hard for various metrics. Interestingly we can adapt Ajtai-Kumar-Sivakumar like sieving technique to give a singly exponential algorithm to compute a shortest nonidentity permutation in a given permutation group with respect to `1 metric. We also extend some of the results known for CVP and SVP to the permutation group setting, some of our results need a restriction on the group to be solvable(which are also nonabelian in general).

Monomial algebras and finite automata In this part of the thesis we study arithmetic circuit and algebraic branching program size lower bound questions as well as

polynomial identity testing problem over monomial algebras both in the noncommutative and the commutative setting. Main tool we use is basic automata theory. Our first result is extension of Nisan's lower bound for the Permanent and Determinant polynomials over free noncommutative algebra to the similar lower bound result over noncommutative monomial algebras. Furthermore, the Raz-Shpilka deterministic identity test for noncommutative ABPs also carry over to monomial algebras.

In the commutative setting, we extend Jerrum and Snir's 2(n) size lower bound for monotone arithmetic circuits computing the n_n Permanent in the commutative polynomial ring to similar lower bound result over commutative monomial algebras. Next we investigate randomize parallel complexity of Monomial Search Problem which is a natural search version on the identity testing problem. We give randomized-NC2 upperbound on the complexity both in the commutative and noncommutative setting.

Hadamard product of polynomials We introduce and study the Hadamard product of the multivariate polynomials in the free noncommutative polynomial ring F{x_1….x_2… x_n} We explore arithmetic circuit and branching program complexity of the Hadamard product of polynomials when they are individually given by arithmetic circuits and/or algebraic branching programs. We show that the noncommutative branching program complexity of the Hadamard product of polynomials given by ABPs is upper bounded by the product of the given branching program sizes. We then apply this result to tightly classify the complexity of identity testing problem for noncommutative ABPs over field of rationals. We show that the problem is complete for logspace counting class C=L. We also explore same problem over finite fields and show nonuniform-ModpL upperbound on the complexity.

Publlications

1. **Algorithmic Problems for Metrics on Permutation Groups. In Proceedings of SOFSEM 2008, Lecture Notes in Computer Science, Vol. 4910 springer 2008, pp 136-147. (Joint with V. Arvind.)**
2. **Some sieving algorithms for lattice problems. In Proceedings of FSTTCS 2008 Conference in series LIPICS 2 Schloss Dagstuhl – Leibniz-Zentrum Fuer Informatik 2008, pp 25-36. (Joint with V. Arvind)**
3. **Arithmetic circuits, monomial algebras and finite automata. In Proceedings of the MFCS conference, Lecture Notes in Computer Science <http: /www.informatik.uni-trier.de/%7Eley/db/journals/incs.html> 5734 Springer 2009, pp 78-89. (Joint with V. Arvind).**
4. **Arithmetic circuits and the hadamard product of polynomials. In Proceedings FSTTCS 2009 conference in series LIPICS 4 Schloss Dagstuhl – Leibniz-Zentrum Fuer Informatik 2009, pp. 25-36. (Joint with V. Arvind and Srikanth Srinivasan).**
5. **On Lower Bounds for Constant Width Arithmetic Circuits. In Proceedings of the 20th ISAAC conference. Lecture Notes in Computer Science <http:/ /www.springerlink.com/content/0302-9743/>, 2009, Volume 5878/2009, 637-646. (Also, submitted to the Journal of Computer and System Sciences.)**

Name : **Chintamani M. Namdev**
Enrolment No. : **MATH08200604008**
Constituent Institute : **Harish-Chandra Research Institute, Allahabad**
Title : **Weighted Subsequence Sums in Finite Abelian Groups**

Abstract

A well-known result of Erdős-Ginzburg-Ziv [32] says that, given a sequence S of $2n-1$ integers, there is a subsequence S' of S with length n such that the sum of the terms of S' is zero modulo n.

Let G be an abelian group of order n, written additively. In [8] we have proved the following result :

Theorem 1.1 *Let G be a finite abelian group of order n, k a positive integer and 0 denote the identity element of G. Let $(w_1, w_2, \cdots, w_k)$ be a sequence of integers where each w_i is co-prime to n. Then, given a sequence $S : (x_1, x_2, \cdots, x_{k+r})$ of elements of G, where $1 \leq r \leq n-1$, if 0 is the most repeated element in S and*

$$\sum_{i=1}^{k} w_i x_{\sigma(i)} \neq 0,$$

for all permutations σ of $[k+r]$, we have

$$\left| \left\{ \sum_{i=1}^{k} w_i x_{\sigma(i)} : \sigma \text{ is a permutation of } [k+r] \right\} \right| \geq r+1.$$

Here, for a positive integer m, the notation $[m]$ is used for the set $\{1, 2, \cdots, m\}$. Given a finite non-empty subset A of integers, a sequence $(x_1, x_2, \cdots, x_l)$ of elements of G is said to be an A-weighted zero-sum sequence if $\sum_{i=1}^{l} a_i x_i = 0$, for some $a_i \in A$.

We have proved some weighted generalization of the result of Bollobás and Leader.

Let $G \cong \mathbb{Z}/n\mathbb{Z}$, where n is a prime power or an odd integer greater than one and $A = (\mathbb{Z}/n\mathbb{Z})^*$ (the group of units modulo n). We derived a lower bound on the number of A-weighted n-sums of a sequence of elements of G which does not have an A-weighted zero-sum subsequence of length n. In what follows, $\varphi(m)$ is the number of integers t, $1 \leq t \leq m$ which are co-prime to m. Further, by $\Omega(m)$ (resp. $\omega(m)$) we denote the number of prime factors of m counted with multiplicity (resp. without multiplicity). We have proved the following results in [26].

Theorem 2.1 *Let p be any prime, $\alpha \geq r \geq 1$ and $A = (\mathbb{Z}/p^\alpha\mathbb{Z})^*$, the set of all units modulo p^α. Given a sequence $X = \{x_i\}_{i=1}^{p^\alpha+r}$ of integers, let*

$$S = \left\{ \sum w_i x_i \pmod{p^\alpha} : I \subseteq [p^\alpha + r] \text{ with } |I| = p^\alpha,\ w_i \in A \right\}.$$

If $0 \notin S$, then $|S| \geq p^{r+1} - p^r$.

Theorem 2.2 *Let n be an odd integer, $r \geq 1$ and $A = (\mathbb{Z}/n\mathbb{Z})^*$. Given a sequence $X = \{x_i\}_{i=1}^{n+r}$ of integers, let*

$$S = \left\{ \sum_{i \in I} w_i x_i \pmod{n} : I \subseteq [n + r] \text{ with } |I| = n,\ w_i \in A \right\}$$

and $0 \notin S$. Then there exist primes $p_1, p_2, \ldots, p_{r+1}$ such that

$$|S| \geq \varphi(p_1)\varphi(p_2)\cdots\varphi(p_{r+1}) \text{ with } p_1 p_2 \cdots p_{r+1} | n.$$

These are related to the results of F. Luca [53] and S. Griffiths [42], who independently confirmed a conjecture from [6].

A similar result is obtained, for general finite abelian group G and the weight set $A = \{1, -1\}$, in [7]. This is a weighted version of the result of Bollobás and Leader [20].

More precisely, we have proved the following result [7] :

Theorem 3.1 *Let G be a finite abelian group of order n and let it be of the form $G \cong \mathbb{Z}/n_1\mathbb{Z} \oplus \mathbb{Z}/n_2\mathbb{Z} \oplus \cdots \oplus \mathbb{Z}/n_r\mathbb{Z}$, where $1 < n_1 | n_2 | \cdots | n_r$. Let $A = \{1, -1\}$ and k be a natural number satisfying $k \geq 2^{r'-1} - 1 + \frac{r'}{2}$, where $r' = |\{i \in [r] : n_i \text{ is even}\}|$. Then, given a sequence $S = (x_1, x_2, \cdots, x_{n+k})$, with $x_i \in G$, if S has no A-weighted zero-sum subsequence of length n, then there are at least $2^{k+1} - \delta$ distinct A-weighted n-sums, where*

$$\delta = \begin{cases} 1 & \text{if } 2 \mid n \\ 0 & \text{otherwise.} \end{cases}$$

As a corollary, one obtains a result of Adhikari et. al. [6], giving the exact value of $E_A(G)$ for the cyclic case and unconditional bounds in many cases.

A result of Yuan and Zeng [71] on the existence of zero-smooth subsequence and the DeVos-Goddyn-Mohar Theorem [29] are some of the main ingredients of the proof of Theorem 3.1.

Publlications

1. **S.D. Adhikari, M.N. Chintamani, B.K. Moriya and P. Paul, Weighted sums In finite abelian groups, Unif. Distrib. Theory 3 (2008), 105-110.**
2. **M.N. Chintamani, B.K.Moriya and P. Paul, The Number of Weighted n-sums, Int. J. Mod. Math., Vol 5 (2) 215-222 (2010)**

S.D. Adhikari, M.N. Chintamani, Number of weighted subsequence sums with Weights in {1, -1}, Integers, 11 (2011), Paper A36

Name : **Ashwin Joy**
Enrolment No. : **PHYS06200704007**
Constituent Institute : **Institute for Plasma Research, Ghandhinagar, India**
Title : **Molecular Dynamics Simulations of Coherent Structures in Strongly Coupled Yukawa Liquids**

Abstract

This thesis presents a computational study of large scale hydrodynamic flows in strongly coupled liquids using "first principles" classical molecular dynamics (MD) simulations. The prototype model used in the study is a Yukawa liquid. As is well known, Yukawa liquids are ubiquitous in nature and well known examples include complex or "dusty" plasmas, colloids and certain astrophysical systems such as giant planetary interiors and cometary tails, to mention a few. The components of a typical Yukawa liquid such as a complex plasma are electrons, positive ions, neutrals and negatively charged dust grains. Such a complex plasma can exist in a state of strong coupling where the ratio of average interparticle potential energy per dust grain can significantly exceed the average kinetic energy. It is important to note that the mutual influence of the components determines the physical state of the system, for eg. the grain-plasma interaction can lead to the charge on a given dust grain to be a function of time i.e Q = Q(t). Hence, a complex plasma cannot, in general, be described by thermodynamic potentials and are as such *thermodynamically open* systems. As can be expected, an ideal description of complex plasma amounts to modeling grain-grain interactions including the dynamics of electrons, ions and neutrals. Such a description is clearly a formidable challenge even with the availability of modern day computers. One can, however, construct a near ideal "exact" description of complex plasma by considering only one charged species, namely the dust grains and assuming that both the grain charge and the background plasma do not evolve in time. This allows the grain dynamics to be modeled by a screened Coulomb or a Yukawa potential $U(r) = (1/r)\exp(-r/\lambda D)$, where λD is the Debye length of the background plasma. The resulting N body problem is numerically solved using a classical MD simulation.

Using "first principles" classical MD simulations, the present thesis reports the onset, growth and nonlinear saturation of large scale hydrodynamic instabilities in strongly coupled Yukawa liquids. To this end, a massively parallel Multi Potential Molecular Dynamics (MPMD) code has been developed as part of this thesis. The code is extensively benchmarked against known results. The thesis begins with a study of Kelvin Helmholtz instability (KH) in parallel shear flows of a strongly coupled Yukawa liquid. At a given coupling strength, a subsonic shear profile is superposed on an equilibrated Yukawa liquid and an instability is observed. Linear growth rates directly computed from MD simulations are seen to increase with strong coupling and vortex roll formation in the non-linear regime is observed. The most interesting feature noticed here is the increase of instability growth rate with strong coupling. Interestingly, it is also observed that KH destabilized modes undergo inverse cascade leading to formation of giant coherent vortices. The emergence of such coherent vortices in the nonlinear regime of KH destabilized flows motivates one to investigate the stability of an isolated coherent vortex. The thesis also reports a comparison between growth rates directly

obtained from MD simulations and a phenomenological generalized hydrodynamics (GH) model.

Following the study on parallel shears flows, we undertake a study on the evolution of axisymmetric flows in a 2D strongly coupled Yukawa liquid using MD simulations and report the emergence of coherent tripolar vortices in the nonlinear regime. Our MD simulations reveal that the tripolar vortices persist over several turn over times and hence may be observed in strongly coupled liquids such as complex plasma, liquid metals and astrophysical systems like white dwarfs and giant planetary interiors, thereby making the phenomenon universal. It is also seen that under certain conditions a tripolar vortex can spontaneously decay into a pair of dipolar vortices propagating in mutually opposite directions. Linear growth rates directly obtained from MD simulations are compared with a generalized hydrodynamic model. It is indeed very tempting to study if it is possible to excite such dipolar vortices from generic initial conditions and study their interactions in a laboratory produced complex plasma. For this we undertake a study on evolution of jets in a strongly coupled Yukawa liquid using MD simulations. The initial state for this study is a sub-sonic jet profile superposed on a thermally equilibrated Yukawa liquid. A dipolar vortex is then seen to emerge from the self-organization of this jet profile. This dipole is seen to be very robust and, in general, shows a nonlinear relationship between vorticity and stream function. Starting from two jets injecting linear momentum in mutually opposite directions, we report on the centered head-on collisions between two dipolar vortices. It is seen that the inertial effects needed for the sustenance of dipolar vortices are rapidly quenched by gas friction. Hence, such dipolar vortices may be observed in a laboratory complex plasma at low gas friction. In each of the foregoing flow studies, we noticed a significant heat generation close to the shear layers. This motivated us to perform a detailed study of molecular heat generation in shear flows of Yukawa liquids. To this end, we superposed a subsonic shear profile on an equilibrated Yukawa liquid and observed a KH instability. Inverse cascade leads to formation of giant coherent vortices. It is seen that while this inverse cascade leads to a continuous transfer of flow energy towards the largest scales, at the smallest scale there is also a simultaneous transfer of flow energy into the thermal velocities of grains. The latter is an effect of velocity shear and thus leads to the generation of a nonlinear heat front. We notice that the heat front is seen to propagate at speed much lesser than the adiabatic sound speed of the liquid in the linear regime. Hence, the spatio-temporal growth of this heat front occurs concurrently with the inverse cascade of KH modes.

The MD studies reported in the present thesis results are exact numerical solutions to the N body problem and hence "first principles" in nature. The results are "*to scale*", for eg. in a typical laboratory dusty plasma, the dust plasma frequency ωpd 100 Hz. A typical growth rate (normalized to ω−1 pd) in the studies presented so far, falls in the range 10−3 − 10−2 and corresponds to [0.1−1] Hz's in physical units. Typical system size used in our studies, for eg. L = 640 (in units of Wigner Seitz radius a) corresponds to 26 cm approximately for a = 0.4mm. Hence the hydrodynamic phenomena addressed in the thesis should be observable in laboratory experiments on complex "dusty" plasma.

Publlications

1. **Ashwin J. And R. Ganesh, "Formation and Interaction of dipolar vortices in strongly coupled Yukawa Liquids" (Under Review)**
2. **Ashwin. J, and R. Ganesh, "Coevolution of inverse cascade and nonlinear heat front in shear flows of strongly coupled Yukawa liquids" Phys. Plasmas (18), 083704 (2011)**
3. **Ashwin J. And R. Ganesh, "Coherent Vortices in Strongly couples liquids. Phys. Rev. Lett.(106), 135001 (2011)**
4. **Ashwin J. And R. Ganesh, " Parallel shear flow instabilities in strongly coupled Yukawa liquids- A comparison of generalized hydrodynamic model and molecular dynamics results". Phys. Plasmas (17), 103706 (2010)**
5. **Ashwin J. And R. Ganesh, "Kelvin-Hemholtz instability in strongly coupled Yukawa liquids", Phys. Rev. Lett. (104), 215003 (2010)**
6. **Ashwin J. And R. Ganesh, "Effect of external drive on strongly coupled Yukawa systems: A nonequilibrium molecular dynamics study", Phys. Rev. E. (80), 056408 (2009)**

Name : **Nabyendu Das**
Enrolment No. : **PHYS07200604020**
Constituent Institute : **Institute of Physics, Bhubaneswar**
Title : **Some Aspects of Quantum Phase Transition in Incipient Ferroelectrics**

Abstract

The thesis contains some theoretical studies on the low temperature dielectric properties of incipient ferroelectrics such as SrTiO3, KTaO3, EuTiO3 etc. in the vicinity of a quantum phase transition. Studies are motivated by experimental findings on the low temperature dielectric behavior of these materials under various external perturbations.

In the first chapter the basic ideas related to the quantum phase transition relevant for these materials are presented. In the second chapter we explore the possible consequences of a quantum fluctuations in the low temperature dielectric behavior of these materials using a semi-phenomenological Landau-Ginzburg theory. Within a minimal model we are able to describe the effects of quantum fluctuations in the low temperature behavior of pure SrTiO3, which is a well-known quantum paraelectric material. A $\frac{1}{T^2}$ behavior of susceptibility, in contrast to the usual Curie-Weiss behavior near a quantum critical point, is predicted.

A recent Raman scattering experiment reports that SrTiO3 shows phase separation near a quantum critical point in O^{18} doped $SrTiO_3^{16}$ which provides strong evidence for a first order phase transition. Motivated by this experiment, we make an attempt to discuss the effects of the strain fluctuations in a quantum critical paraelectric in the third chapter. In our theory strain fluctuations are integrated out resulting to a long range interaction among paraelectric fluctuations. We predict a weak first order transition, where the effective quartic coupling of the paraelectric action is negative and close to zero. We emphasis that in such a case one should consider fluctuation effects in the quartic coupling, namely four point vertices. We then show that the fluctuation effects can stabilize the system without invoking higher order terms. The crucial role played by strain mediated long range interaction is also explained. The experimental observation, that a non-zero temperature restores the second-order nature of the transition near a quantum phase transition, is captured in this theory.

In the fourth chapter we focus on an incipient ferroelectric $EuTiO_3$. In this case the ferroelectric fluctuations are coupled to anti-ferromagnetic fluctuations. We consider a case where this material is tuned to ferroelectric or anti-ferroelectric quantum critical points by a non-thermal parameter. Using a self-consistent mean field approach and scaling arguments a new power law behavior of the static dielectric constant, namely a $T^{-\frac{3}{2}}$ variation, in presence of small non-zero magnetic field is predicted. It is in contrast of the $\frac{1}{T^2}$ behavior of the quantum critical paraelectric. This result has already got some attention of the experimental community.

Finally, we look for the effects of quenched disorder in quantum critical paraelectrics using a replica formalism in the fifth chapter. Here the coupling between a random Tc type disorder with energy density is considered. A broad power law distribution of the quantum critical points is predicted. Its consequences of the static dielectric behavior at finite temperature is also emphasized.

Publlications

1. **On the Possibility of mixed phases in disordered quantum paraeletrics: N Das, arXiv:1104.1692**
2. **Quantum critical behavior of magnetic quantum paraelectrics: N Das, arXiv:0910.4374**
3. **Weak first order phase transaction in quantum ferroelctrics: N Das and S G Mishra, arXiv:0906.0944**
4. **Fluctuations and criticality in quantum paraelectrics: N Das and S G Mishra, arxiv:0707.2634, J. Phys: Cond. Mat 21 (2009) 095901**

Name	**:**	**Anupam Mathur**
Enrolment No.	**:**	**CHEM01200604037**
Constituent Institute	**:**	**Bhabha Atomic Research Centre**
Title	**:**	**Design And Evaluation Of Novel Diagnostic**
	:	**Radiopharmaceuticals Based On ^{99m}Tc-Nitrido ($[^{99m}Tc{=}N]^{2+}$) Core**

Publlications

1. **Synthesis, radiolabeling and evaluation of a new positively charged^{99m}Tc-labeled fatty acid derivative for myocardial imaging Anupam Mathur, Madhava B. Mallia, Haladhar D. Sarma, Sharmila Banerjee and Meera Venkatesh J labeled Comp. & Radiopharmaceuticals; Vol 54, Issue 3, March 2011, Pages: 150-156,**
2. **Evaluation of new positively charged 11 – and 12- carbon ^{99m} Tc-labeled fatty acid derivatives for myocardial imaging Anupam Mathur, Madhava B. Mallia, Haladhar D. Sarma, Sharmila Banerjee, and Meera Venkatesh J labeled Comp, & Radiopharmaceuticals, Volume 53, Issue 9, July 2010, Pages: 580-585.**
3. **Synthesis and evaluation of 2-, 4-, 5-substituted nitroimidazole-iminodiacetic acid- ^{99m}Tc(CO)3 complexes to target hypoxic tumors Madhava B. Mallia, Suresh Subramanian, Anupam Mathur, H. D. Sarma, Meera Venkatesh and Sharmila Banerjee J labeled Comp. & Radiopharmaceuticals Vol 53, Issue 8, 30 June 2010, Pages: 535-542,**
4. **Synthesis and bio-evaluation of a new fatty acid derivative for myocardial imaging Anupam Mathur, Suresh Subramanian, Madhava B. Mallia, Sharmila Banrjee, Grace Samuel, H.D. Sarma, Meera Venkatesh Bioorganic & Medicinal Chemistry, 16 (2008) 7927-7931.**
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Name : **Manimala Mitra**
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Title : **Design And Evaluation Of Novel Diagnostic Neutrinos and Some Aspects of Physics Beyond the Standard Model**

Publlications

1. **Two Higgs doublet type III seesaw with μ-τ symmetry at LHC,P. Bandyopadhyay, S. Choubey and M. Mitra, JHEP 0910, 012 (2009) [arXiv:0906.5330 [hep-ph]**
2. **Spontaneous R-parity Violating type III seesaw, S. Choubey and M. Mitra JHEP 1005, 021 (2010) [arXiv:0911.2030 [hep-ph]].**
3. **A4 flavor symmetry and neutrino phenomenology, B. Brahmachari, S. Choubey and M. Mitra Phys. Rev.D 77, 073008 (2008) [arXiv:0801.3554 [hep-ph]].**
4. **Lepton masses in a minimal model with triplet Higgs bosons and S3 flaor Symmetry, M. Mitra and S. Choubey Phys.Rev. D 78, 115014 (2008) [arXiv:0806.3254 [hep-ph]].**
5. **Spontaneous R-Parity Violation, A4 Flavor Symmetry and Tribimaximal Mixing [1], M. Mitra, arXiv:0912.5291 [hep-ph].**

Name : **Bhavin K. Moriya**
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Title : **Some Zero Sum Problems in Combinatorial Number Theory**

Abstract

This thesis comprises of three results each of which dealt in separate chapters. First chapter is of introductory nature, as the title suggest. And the other three chapters are devoted to three different problems. Following is a brief introduction to our results.

1. Let G be any finite abelian group of rank r with invariants $n_1, n_2, \cdots, n_r$. In other words, $G = \mathbb{Z}_{n_1} \oplus \mathbb{Z}_{n_2} \oplus \cdots \oplus \mathbb{Z}_{n_r}$ where n_i's are integers satisfying $1 < n_1 | n_2 | \cdots | n_r$. The *Davenport constant* of a group G is defined as the smallest positive integer t such that every sequence of length t of elements of G has a non-empty zero-sum subsequence. It has been conjectured by Śliwa that, $D(G) \leq \sum_{i=1}^{r} n_i$. Thinking in the direction of this conjecture we have obtained the following upper bound on Davenport constant $D(G)$, of G,

$$D(G) \leq n_r + n_{r-1} + (c(3)-1)n_{r-2} + (c(4)-1)n_{r-3} + \cdots + (c(r)-1)n_1 + 1,$$

where $c(i)$'s are Alon-Dubiner constants [10] for respective i's. Also we shall give an application of Davenport's constant to Quadratic sieve.

2. Let G be a finite abelian group with $\exp(G) = e$. Let $s(G)$ (respectively, $\eta(G)$) be the minimal positive integer t with the property that any sequence S of length t of elements of G contains an e-term subsequence (respectively, a non-empty subsequence of length at most e) of S with sum zero. For the group of rank at most two this constant has been determined completely (see [45]). Looking at the problem for groups of rank greater that 2 gave rise to this result. Our problem is to determine value of $s(C_{nm}^r)$ under some constraints on $n, m,$ and r.

Let n, m and r be positive integers and $m \geq 3$. Furthermore, $\eta(C_m^r) = a_r(m-1)+1$, for some constant a_r depending on r and n is a fixed integer greater than or equal to,

$$\frac{m^r(c(r)m - a_r(m-r) + m - 3)(m-1) - (m+1) + (m+1)(a_r+1)}{m(m+1)(a_r+1)}$$

and $s(C_n^r) = (a_r+1)(n-1)+1$. In the above lower bound on $n, c(r)$ is the Alon-Dubiner constant. Then $s(C_{nm}^r) = (a_r+1)(nm-1)+1$.

3. Given an abelian group G of order n, and a finite non-empty subset A of integers, the *Davenport constant of G with weight A*, denoted by $D_A(G)$, is defined to be the least positive integer t such that every sequence $(x_1, \cdots, x_l)$ with $x_i \in G$ has a non-empty subsequence $(x_{j_1}, \cdots, x_{j_l})$ and $a_i \in A$ such that $\sum_{i=1}^{l} a_i x_{j_i} = 0$. Similarly, $E_A(G)$ is defined to be the least positive integer t such that every sequence $(x_1, \cdots, x_t)$ of length t of elements of G has a subsequence $(x_{j_1}, \cdots, x_{j_n})$ such that $\sum_{i=1}^{n} a_i x_{j_i} = 0$, for some $a_i \in A$. When G is of order n, one considers A to be a non-empty subset of $\{1, \cdots, n-1\}$. If G is the cyclic group $\mathbb{Z}/n\mathbb{Z}$ we denote $E_A(G)$ and $D_A(G)$ by $E_A(n)$ and $D_A(n)$ respectively.

Here we extend some results in an article of Adhikari et al. [5] and determine bounds for $D_{R_n}(n)$ and $E_{R_n}(n)$, where $R_n = \{x^2 : x \in (\mathbb{Z}/n\mathbb{Z})^*\}$ and $(\mathbb{Z}/n\mathbb{Z})^*$ is a group of units modulo n. We follow some line of arguments in [5] and use a recent result of Yuan and Zeng [79], a theorem due to I. Chowla [24] and Kneser's theorem [52].

Publlications

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2. **On Zero Sum subsequences of restricted size, Proc. Indian Acad. Sci.(Math. Sci.) Vol. 120, No. 4, September 2010, pp. 395-402.**
   (with M.N.Chintamani) Generalizations of some Zero Sum Theorems, Preprint.

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Title: : **Development of Carbon Based Materials With Sic Coating for High Temperature Nuclear Applications**

Abstract

Carbon and carbon-based materials have been extensively used in nuclear reactors as moderator, and reflectors. Also there has been a growing interest to develop graphite and carbon-based materials for high temperature thermal nuclear and fusion reactors. Efforts are underway to develop carbon materials with high density as well as amorphous isotropic carbon for use in thermal reactors. The carbon–carbon composites exhibit excellent properties such as light weight, high strength at high temperature (3000°C) in non-oxidizing atmospheres, low coefficient of thermal expansion, high thermal conductivity, high thermal shock resistance and low recession in high pressure ablation environments. The mechanical strength of C/C composites increases with temperature, in contrast to the strength of metal and ceramics. The main application areas of these are in military, space and aircraft industries. Some of the emerging applications include their use as critical parts in advanced reactors.

The main objective of this study was to fabricate carbon-carbon composites by liquid impregnation method and characterize these composites. Thermo-physical properties of the carbon composite like density, co-efficient of thermal expansion and compressive strength have been evaluated. The microstructure was investigated using Scanning Electron Microscope imaging for the carbon composites to study the effect of different processing parameters like impregnation time duration, pressure, number of cycles of impregnation on the final product.

In the present studies carbon-carbon (C/C) composites were developed using non-graphitizing precursors such as polyacrylonitrile (PAN) carbon fiber and phenolic resin matrix. The desired non-graphitic composite material, having stability under irradiation, was obtained after a judicious control on the processing parameters.

These C/C composites are typically having 40 vol% of PAN fibre which was found to be amorphous. The effect of the processing parameters, pressure and time duration on the density was studied by varying the pressure and time duration of impregnation. The composites were thoroughly characterized by X-ray Diffraction (XRD), Small Angle X-ray Scattering (SAXS), Small Angle Neutron Scattering (SANS), X-ray tomography and Raman Spectroscopy. The carbon-carbon (C/C) composite samples have been irradiated with thermal neutrons at APSARA Reactor, Bhabha Atomic Research Center, Trombay. These composites have been irradiated by neutrons and were characterized before and after irradiation for various structural parameters like extent of local ordering along c-axis, the average spacing of the $d_{(002)}$ i.e. the (002) crystallographic planes using X-ray diffraction (XRD) technique. The salient observations were further validated using Raman spectroscopy. The fluence used were 2.52 x 10^{16} n/cm^2, 5.04 x 10^{16} n/cm^{2}and 7.2 x 10^{16} n/cm^2 at temperature of 313 K during the irradiation. The stored energy in the composite due to irradiation was measured using DSC.

Although the C/C composites possess excellent properties, they are prone to oxidation at high temperatures when exposed to oxidizing atmospheres. Therefore, these composites were

given protective coating. SiC is a material with high temperature oxidation resistance along with good thermal shock properties and stability against hot corrosion. Among the different techniques to grow SiC on different substrates, the chemical vapor deposition (CVD) is the most frequently used technique, as it can deposit materials with near theoretical density and good adherence to the substrate. SiC coating can be formed by using various Si and C compounds. In the present work, the coating was carried out with methyl trichlorosilane (MTS) as the SiC precursor. Extensive studies on coating with SiC by CVD technique using a hot wall reactor with methyl trichlorosilane was carried out at 1673K. The effect of the operating parameters such as MTS, hydrogen flow rate and feed rate of MTS were studied. The SiC coatings have been characterized by X-Ray Diffraction (XRD) and Raman spectroscopy for phase identification. Scanning electron microscopy (SEM) analysis with EDS was also carried out for microstructure and elemental analysis. These efforts resulted in dense isotropic β-SiC phase coatings on carbon composites, which are desirable for the point of view of nuclear applications. The major outcome of the above investigations was establishing the fact that the C/C composites are potential candidate material in terms of structural material for low temperature reactor applications.

Publlications

1. **Noval isotropic high density amorphous carbon composite for moderator Application in low temperature thermal reactors. K. Dasgupta, M. Roy, A.K. Tyagi, S.K. Kulshrestha, Ramani Venugopalan and D. Sathiyamoorthy Composite Science and Technology 67 (2007) 1794-1801.\]**
2. **Neutron irradiation studies on low density pan fiber based carbon / carbon Composites. Ramani Venugopalan, D. Sathiyamoorthy, R. Acharya and A.K. Tyagi, J. Nucl. Mater. 404 (2010) 19-24.**
3. **Preparation and microstructural characterization of carbon/carbon composite, Ramani Venugopalan, D. Sathiyamoorthy, and A.K. Tyagi World Journal of Engineering (Accepted).**
4. **Morphological study of SiC coating developed on 2D Carbon Composites using MTS precursor in a hot wall vertical reactor. Ramani Venugopalan, Jyoti Prakash, J. Nuwad, C.G.S. Pillai, A.K. Tyag And D. Sathiyamoorthy Int J. Mater. Res. (Communicated)**
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Title: : **On the Serre-Swan Theorem, and On Vector Bundles over Real Abelian Varieties**

Abstract

This thesis is divided into two parts.

In Chapter 1 we prove a generalization of two classical results of Serre and Swan on the relation between locally free sheaves and projective modules, by emphasizing the axiomatic aspect of the problem. We determine a class of ringed spaces (X,OX) for which the category of locally free sheaves of bounded rank over X is equivalent to the category of finitely generated projective Γ(X,OX)- modules. The well-known Serre-Swan theorems for affine schemes, differentiable manifolds, Stein spaces, etc., are then derived.

In Chapter 2 we study real algebraic vector bundles over a real abelian variety. The main theorem in this part gives various equivalent criteria for a real algebraic vector bundle over a real abelian variety to admit a flat holomorphic connection. In the course of the proof of the main theorem we also derive a version of a result of Simpson for real abelian varieties.

Publlications

1. **A.S. Morye, Note on the Serre-swan Theorem, accepted for publication in Math. Nachr.**
2. **A.S. Morye, Real vector bundles over a real abelian variety, Preprint**

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Title: : **Parameterized Complexity Of Some Problems In Concurrency and Verification**

Abstract

Formal methods for the analysis of concurrent systems is an active area of research. Many mathematical models like Petri nets, communicating automata, automata with auxiliary storage like counters and stacks, rewrite systems and process algebras have been proposed for modelling concurrent infinite state systems. Efficient algorithms for analysis and the power to express interesting properties of concurrent systems are conflicting goals in these models. Having too much expressiveness results in undecidability, so it is important to get an insight into what kind of restrictions will lead to good analysis algorithms while retaining some expressive power. Restrictions like reversal boundedness in counter automata, disallowing cycles in network of push-down systems etc. lead to decidability in the respective models.

In this thesis, we propose to use the framework of parameterized complexity to study the effect of various restrictions on the complexity of problems related to some models and logics of concurrent systems. Parameterized complexity works by trying to find efficient algorithms for instances of hard problems where one can identify structure that helps in analysis. A numerical parameter is associated with problem instances and algorithms are designed whose time and/or memory requirement is a fast growing function of the parameter, but growing slowly in terms of the size of the instance. On instances where the parameter is small, such algorithms run efficiently. Apart from providing efficient algorithms, parameterized complexity provides a mathematically rigorous way of studying finer structure of the models under analysis.

In the first part of this thesis, we look at the e_ect of well known graph parameters treewidth and pathwidth on the parameterized complexity of satisfiability of some logics used to specify properties of finite state concurrent systems. This is followed by parameterized complexity of some problems associated with synchronized transition systems and 1-safe Petri nets, which are compactly represented finite state systems. In the second part of the thesis, we look at general Petri nets (which are infinite state) and study the parameterized complexity of coverability, boundedness and extensions of theseproblems with respect to two parameters.

Publlications

1. **Foundations of Software Technology and Theoretical Computer Science, volume 4 of Leibniz International Proceedings in Informatics 347—358, 2009**
2. **In Mathematical Foundations of Computer Science, Springer Lecture Notes in Computer Science, volume 6281, Pages 580—591, 2010.**
3. **In International symposium on parameterized and Exact Computation, Springer Lecture Notes in Computer Science, volume 6478, pages 216—227, 2010.**

Name : **Joydeep Chakraborty**
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Title : **Some aspects of Grand Unified Theory: Gauge coupling unification with dimensions-5 operators and neutrino massesin an SO (10)model**

Abstract

This thesis deals mainly with two related coloring problems - forbidden subgraph colorings and oriented colorings. The former deals with proper colorings of vertices or edges of a graph with constraints on the union of color classes. A well-known example is the acyclic vertex coloring in which we require a proper coloring such that the union of any two color classes is acyclic. Other well-studied examples include the acyclic edge coloring and star coloring. Our focus in this thesis is a generalization of these special types of colorings.

Oriented coloring deals with colorings of oriented graphs (directed graphs obtained by orienting each edge of a simple undirected graph). Specifically, an oriented coloring is a homomorphism to an oriented graph, the vertices of the target graph being considered as the colors assigned to the vertices of the source graph.

For both of these problems, we want to find good upper bounds for the number of colors required for such colorings.

In this thesis, we find upper bounds for forbidden subgraph chromatic numbers in terms of the maximum degree. For the union of two color classes, we show the asymptotic tightness of our bounds by a probabilistic contstruction. We then show that the oriented chromatic number of a graph can be bounded in terms of the forbidden subgraph chromatic numbers. In conjunction with our afore-mentioned results, this allowed us to prove improved bounds on oriented chromatic numbers of graphs on surfaces.

Specifically, we obtained the following results:

- Given a family $\mathcal{F}$ of connected graphs each having at least m edges, the vertices of any graph of maximum degree Δ can be properly colored using $O(\Delta^{1+\frac{1}{m-1}})$ colors so that in the union of any 2 color classes, there is no copy of H for any $H \in \mathcal{F}$.

- Any graph of genus g has oriented chromatic number at most $2^{g^{1/2+o(1)}}$.

We also consider edge colorings of graphs with restrictions on the union of color classes. While edge colorings can simply be considered as vertex colorings of the line graph, it is usually the case that they are often quite different in

nature. Indeed, we found a general upper bound which shows that the bounds for edge colorings with similar restrictions as those on vertex colorings often require substantially fewer colors in terms of the maximum degree.

In particular, we showed that using just $O(\Delta)$ colors, (where Δ is the maximum degree), we can properly color the edges of a graph with any (or even all) of the following constraints:

(i) the union of any 2 color classes is a forest (this is a known result due to Alon, McDiarmid and Reed);

(ii) the union of any 3 color classes is outerplanar;

(iii) the union of any 4 color classes has treewidth at most 2;

(iv) the union of any 5 color classes is planar;

(v) the union of any 6 color classes is 5-degenerate.

We obtain the above bounds as an application of a special case of the Lovász Local Lemma which we derive and show that these bounds can be constructivized by the algorithm obtained by Moser and Tardos in [MT10].

Finally, we also study the intersection dimension of graphs. In contrast to coloring problems where we partition the graph into smaller pieces, the problem here is the following: Given a graph class $\mathcal{A}$ and a graph G, express G as the intersection of some supergraphs on the vertex set of G, subject to the condition that each of these supergraphs belongs to the class $\mathcal{A}$. The least number of supergraphs needed is the intersection dimension of G with respect to the class $\mathcal{A}$. A well-known example of such a parameter is the boxicity of a graph, which is the least number of interval graphs whose intersection is the given graph.

We show that the intersection dimension of graphs with respect to several hereditary classes can be bounded as a function of the maximum degree. As an interesting special case, we show that the circular dimension of a graph with maximum degree Δ is at most $O(\Delta\frac{\log\Delta}{\log\log\Delta})$. We also obtained bounds in terms of treewidth.

Publlications

List paper and preprints that form the thesis of the candidate

1. **A Note on dimension-5 operators in GUTs and their impact. Joydeep Chakarbortty, Amitava Raychaudhuri. Published in Phys Lett.B 673:57-62, 2009.**

2. **Gaugino mass non-universality in an SO(10) supersymmetric Grand Unified Theory: Low- energy spectra and collider singals. Subhaditya Bhattacharya, Joydeep Chakarbortty. Published in Phys. Rev. D 81:055004, 2010.**
3. **GUTs with dim-5 interactions: Gauge Unification and Intermediate Scales Joydeep Chakarbortty, Amitava Raychaudhuri. Published in Phys. R ev D 81:055004, 2010.**
4. **Dimension-5 operators and the unification condition in SO(10) and E(6). Joydeep Chakraborty, Amitava Raychaudhuri. e-print:arXiv:1006.1252 [hep-ph].**
5. **An SO (10) model with adjoint fermions for double seesaw neutrino masses. Joydeep Chakrabortty, Srubabati Goswami, Amitava Raychaudhuri. Publuished in Phys. Lett. B 698:265-270, 2011.**

List of papers and preprints of the candidate that are not included in the thesis

1. **Renormalisation group evolution of neutrino masses and mixing in the Type-III seesaw mechanism. Joydeep Chakarbortty, Amol Dighe, Srubabati Goswami, Shamayita Ray. Published in Nucl. Phys. B 820:116-147, 2009**
2. **Maximal mixing as a 'sum' of small mixings. Joydeep Chakrabortty, Anjan S. Joshipura, Poonam Mehta, Sudhir K. Vempati. E-print :ArXiv:0909.3116 [hep-ph]**
3. **TeV scale double seesaw in left-right symmetric theories. Joydeep Chakrabortty. E-print:arXiv:1003.2154 [hep-ph]**

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Title : **Development of Radionuclide Generators For Biomedical Applications**

Abstract

A radionuclide generator system comprising of the parent-daughter pair is used to separate the daughter product in a ready to use form. The success of a radionuclide generator system depends on the efficiency of the radiochemical separation of the daughter radionuclide from the parent radionuclide which in turn depends on the extent of difference in chemical properties of the two. Post separation, the daughter product should have high radionuclidic, radiochemical and chemical purities together with adequate radioactive concentration to ensure its subsequent intended use. The daughter product isolated is in 'no-carrier-added' (NCA) form with specific activity approaching to the theoretically calculated values.

The development of radionuclide generators for biomedical applications presents many challenges owing to the stringent requirements for such applications. These requirements can only be met with advances in separation chemistry. In this thesis, development of radionuclide generators based on two novel separation approaches has been described. The first approach involves the use of electrochemical method for separation and the second involves the use of nanomaterials based sorbents as column chromatography matrices for the preparation of radionuclide generators. Electrochemical method provides a simple and convenient approach of performing a wide variety of metal ion separations. A mixture of metal ions having adequate difference in their formal potential values in an electrolytic medium can be mutually separated by selective electrodeposition of one metal on an electrode surface under the influence of controlled applied potential. In-situ electrochemical deposition of a daughter radionuclide is an attractive route to develop radionuclide generators. The major advantage of this approach is that the daughter radioisotope can be obtained with very high radionuclidic purity and radioactive concentration, irrespective of the specific activity of the parent radioisotope. The second approach based on the use of nanomaterials based sorbents as column matrices for the preparation of generators relies on the unique morphological features, pore structure, high surface areas and high surface charge of nanomaterials. Such sorbents demonstrate much higher sorption capacity and selectivity for sorption of the parent radioisotope compared to their bulk counterparts. The daughter activity can be availed with appreciably high radioactive concentration and purity suitable for biomedical applications.

Adopting these novel approaches, radionuclide generators have been developed both for diagnostic applications (^{99}Mo/^{99m}Tc and ^{68}Ge/^{68}Ga) as well as therapeutic applications (^{90}Sr/^{90}Y and ^{188}W/^{188}Re). The performances of these generators were studied over their respective shelf-lives and found to be satisfactory for clinical applications.

Publications

International Journals (Full papers)

[1]. Development of an electrochemical ^{90}Sr-^{90}Y generator for the separation of ^{90}Y suitable for targeted therapy Rubel Chakravarty, Usha Pandey, Remani B. Manolkar, Ashutosh Dash, Meera Venkatesh and M.R. Ambikalmajan Pillai *Nucl. Med. Biol.* 2008; 35: 245-252.

[2] Polymer embedded nanocrystalline titania sorbent for ^{99}Mo-^{99m}Tc generator
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J. Nanosci. Nanotechnol. 2008; 8: 4447-4452.

[3] A novel ^{188}W/^{188}Re electrochemical generator with potential for medical applications
Rubel Chakravarty, Ashutosh Dash, Kanchan Kothari, M.R. Ambikalmajan Pillai and Meera Venkatesh
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Rubel Chakravarty, Ashutosh Dash and Meera Venkatesh
Chromatographia 2009; 69: 1363-1371.

[5] A novel electrochemical technique for the production of clinical grade ^{99m}Tc using (n, γ)^{99}Mo
Rubel Chakravarty, Ashutosh Dash and Meera Venkatesh
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[6] Nanocrystalline zirconia: A novel sorbent for the preparation of ^{188}W/^{188}Re generator
Rubel Chakravarty, Rakesh Shukla, Ramu Ram, A.K. Tyagi, Ashutosh Dash and Meera Venkatesh.
Appl. Radiat. Isot. 2010; 68: 229-238.

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Rubel Chakravarty, Meera Venkatesh and Ashutosh Dash
J. Radioanal. Nucl. Chem. **2011; 72: 875-884.**

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[1] Development of $^{90}Sr/^{90}Y$ generators for radiotherapeutic applications
R. Chakravarty, P. Dhami, U. Pandey, P. Naik, A. Dash, M.R.A. Pillai and M. Venkatesh
J. Nucl. Med. **2008; 49(S1): 45.**

[2] An electrochemical ^{90}Sr-^{90}Y generator and estimation of the radionuclidic purity using extraction paper chromatography
U. Pandey, R. Chakravarty, P. S. Dhami, A. Dash, M. Venkatesh and M.R.A. Pillai
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[3] Validation of 'BARC Technique' for estimation of the radionuclidic purity of ^{90}Y and measurement of ^{90}Sr in ^{90}Y prepared by different $^{90}Sr/^{90}Y$ generators
U. Pandey, R. Chakravarty, P. Dhami, M. Venkatesh and M.R.A. Pillai
J. Nucl. Med. **2008; 49(S1): 93.**

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Constituent Institute : **Raja Ramanna Centre for Advanced Technology, Indore**
Title : **High Order Harmonic Generation From Preformed Laser Plasma Plumes**

Abstract

The interaction of ultra-short laser pulses with matter generates coherent radiation at multiples of the laser frequency known as the high order harmonic generation (HHG). The high order harmonics are a very good source of ultra-short, coherent, extreme ultraviolet (XUV) radiation. The usual route for HHG is through the interaction of ultra-short laser pulses with low density gas or with solid surfaces. In the present work, a new approach of HHG from the interaction of ultra-short laser pulse with plasma plumes has been studied. This approach is similar to the HHG from gas media. However, there are certain distinct advantages of HHG from plasma plumes over the earlier approach (*i.e.* HHG from gas media), such as : availability of a large number of target materials, possibility of exploration of nano-structured materials, less stringent requirement of vacuum etc. This has led to a plethora of new results in the experimental studies on HHG from plasma plumes carried out by him. The salient ones are listed below.

The enhancement in the intensity of particular harmonic orders in HHG from certain material plasma plumes was observed. This phenomenon, its dependence on laser chirp and other parameters was investigated. An experimental study on the propagation of harmonics through the plasma was carried out. Improvement in the stability and cut-off of the HHG, which is important for their practical use, was carried out through the optimization of laser and plasma parameters. In order to increase the conversion efficiency of the HHG process, several novel targets (nano-structured media, fullerene, CNT etc.) were used to explore the effect of enhanced non-linear optical properties on harmonic conversion. Generation of spectrally broadened harmonics was observed during experimentation with nano-structured plasma. An experimental study on the generation of broadband harmonics and its analysis was also carried out. A detailed experimental study of HHG from two-colour laser excitation and observation of both even and odd harmonics was carried out.

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2. ***H. Singhal***, **R. A. Ganeev, P. A. Naik, A. K. Srivastava, A. Singh, R. Chari, R. A. Khan, J. A. Chakera and P. D. Gupta, "Study of high-order harmonic generation from nanoparticles", *J. Phys. B 43, 025603 (2010)***

3. R. A. Ganeev, ***H. Singhal***, P. A. Naik, I. A. Kulagin, P. V. Redkin, J. A. Chakera, M. Tayyab, R. A. Khan, and P. D. Gupta, "Enhancement of high-order harmonic generation using a two-colour pump in plasma plumes", *Phys. Rev. A 80, 033845 (2009)*
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5. R. A. Ganeev, ***H. Singhal***, P. A. Naik, J. A. Chakera, A. K. Srivastava, T. S. Dhami, M. P. Joshi, and P. D. Gupta, "Influence of C_{60} morphology on high-order harmonic generation enhancement in fullerene-containing plasma", *J. App. Phys. 106, 103103 (2009)*
6. ***H. Singhal***, R. A. Ganeev, P. A. Naik, V. Arora, U. Chakravarty, and P. D. Gupta, "Dependence of high order harmonics intensity on laser focal spot position in preformed plasma plumes", *J. App. Phys. 103, 013107 (2008)*
7. R. A. Ganeev, ***H. Singhal***, P. A. Naik, U. Chakravarty, V. Arora, J. A. Chakera, R. A. Khan, M. Raghuramaiah, S. R. Kumbhare, R. P. Kushwaha, and P. D. Gupta, "Optimization of the high-order harmonics generated from silver plasma", *Appl. Phys. B 87, 243 (2007)*
8. R. A. Ganeev, ***H. Singhal***, P. A. Naik, V. Arora, U. Chakravarty, J. A. Chakera, R. A. Khan, I. A. Kulagin, P. V. Redkin, M. Raghuramaiah, and P. D. Gupta, "Harmonic generation from indium-rich plasmas", *Phys. Rev. A 74, 063824 (2006)*

Name : **Raghunath Chowdhury**
Enrolment No. : **CHEM01200804009**
Constituent Institute : **Bhbha Atomic Research Centre Mumbai**
Title : **Micheal Additon Reaction for the Synthesis of Functionalized Organic Molecules And Their Applications**

Abstract

Michael addition involves the addition of a carbon or hetero atom based nucleophile to an alkene or alkyne attached to electron withdrawing groups. The reaction is well known for C-C and C-X bond formations with good regio-, stereo- and enantiocontrol. The work presented in the thesis consists of the use of catalyzed and uncatalyzed versions of Michael additions in C-C bond forming reactions. Also, the application of some of the Michael adducts in the syntheses of natural products and their analogs have been carried out with brevity.

The thesis has been divided into five chapters. In Chapter 1, the recent developments of Michael addition reactions using metal and organocatalyts have been presented. Chapter 2 describes a domino Michael-HWE-elimination route for the synthesis of highly functionalized 1,3-butadienes with very high regio- and stereoselectivity. This reaction provided a diverse array dienes which could be used in organic synthesis as well as in material chemistry. In Chapter 3, the Michael addition reaction of alkyl-methyl-ketones to a silylmethylene malonate using organocatalysts have been described. The reaction took place with complete regiocontrol, high enantioselectivity and excellent yields. Efficient syntheses of chiral _-silyl carbonyl compounds which are known to be the potential intermediate in organic synthesis have also been achieved. The Chapter 4 presents the applications of the _-silyl carbonyl compounds derived in Chapter 3 for the syntheses of natural products and their analogs or their advanced intermediates. In Chapter 5, the development of an organocatalyzed Michael addition reaction of unmodified aldehydes to silylmethylene malonate has been described. The reaction took place with high diastereo- and enantioselectivity. The derived _-silyl aldehydes were further parlayed to various heterocyclic skeletons. Some advanced intermediates of a few natural and unnatural products have also been developed and presented in this chapter.

Publlications

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2. **Chowdhury R.; Ghosh S. K.Enantioselctive Route to β-Silkl-δ-keto Ester by Organocatalyzed Regioselective Conjugate Addition of Methyl Ketones to a Silk1methylene Malonate and Their Use in the Syntheses of Natural Product Intermediates. Synthesis 2011, 1936-1945. (Invited article for thespecial issue organocatalysts)**
3. **Chowdhury R.; Ghosh S. K Organocatalytic Mciheal addition of aldehydes to a β-silklmethlene malonate to form intermediates for enantioselective synthesis of**

hydroxylated valerolactones and piperidines. Tetrahedron: Asymmetry, 2010, 21, 2696-2702.

4. Chowdhury R.; Ghosh S. K Highly Region- and Enantioselective Organocatalytic Conjugate Addition of Alkyl Methyl Ketones to a β-silklmethlene malonate Org. Lett. 2009, 11, 3270-3273.
5. Chowdhury R.; Ghosh S. K Sequential Doublw Olefination of 2-(Arylmethylidene)-Phosphonoacetonitrile with Dimsyl Lithium and Aldehydes: A Domino Route to Densely Subsituted1, 3-Butadienes. Eur. J.Org.chem.,2008, 3868-3874.

Name : **Pintu Kundu**
Enrolment No. : **CHEM01200604001**
Constituent Institute : **Bhbha Atomic Research Centre Mumbai**
Title : **Diversity oriented synthetic strategies for functionalized organo-silicon compounds And their applications**

Abstract

This thesis describes the use of different properties of silicon for the development of diverse organic reactions and methods to provide functionalized organic molecules with desired levels of regio-, stereo-, and chemo-selectivities. The content of the thesis have been divided into five chapters.

An introduction of diversity oriented synthesis and an overview of organosilicon chemistry have been presented in Chapter 1. The novel features of organo-silicon compounds was stated along with the various effects shown by a silicon group. Chapter 2 deals with the diversity oriented synthesis of functionalized cyclopropanes, cyclobutanes, allyl and homoallyl silanes by the reaction of silylmethylene malonates with varying quantities of dimethylsulfoxonium methylide under different reaction conditions. Molecules containing stereochemically defined two (or more) silicon-bearing centres and terminal functionalities are useful intermediates in organic synthesis. Highly stereoselective syntheses of the *meso* diastereoisomer of 3,4-bis-silylated adipates have been reported. But, there is no method available for making them both in racemic or enantiomerically pure form. In Chapter 3, a magnesium-mediated intramolecular reductive coupling reaction to synthesize C_2-symmetric 3,4-bis-silylsubstituted adipic acid derivatives has been described. The C_2-symmetric

derivatives were used successfully for the synthesis of both the enantiomers of 2,6-dioxabicyclo[3.3.0]octane-3,7-dione. Magnesium-induced *C*-silylation at the β-position of ethyl cinnamates as well as β-silyl acrylates has been discussed in Chapter 4. The reductive silylation procedure was found to be applicable with a variety of silyl chlorides including Me_3SiCl, $PhMe_2SiCl$ and silyl chlorides which do not form the corresponding silyl lithium easily such as *p*-$TolMe_2SiCl$, *p*-$AnsMe_2SiCl$ and $AllMe_2SiCl$. Chapter 5 deals with the asymmetric synthesis of bio-active azasugars such as D-fagomine and its stereoisomer D-3,4-di-epi fagomine from C_2-symmetric 3,4-bis-silylsubstituted adipates.

Publications

Journal publications

1. **Pintu K. Kundu and Sunil K. Ghosh. Silicon-mediated asymmetric synthesis of fagomine and 3,4-di-epi-fagomine. *Tetrahedron: Asymmetry*, 2011, *22*, 1090-1096.**
2. **Pintu K. Kundu and Sunil K. Ghosh. Magnesium-induced regiospecific C-silylation of suitably substituted enoates and dienoates. *Tetrahedron*, 2010, *66*, 8562-8568.**

3. Pintu K. Kundu and Sunil K. Ghosh. Magnesium-mediated intramolecular reductive coupling: a stereoselective synthesis of C_2-symmetric 3,4-bis-silyl-substituted adipic acid derivatives. *Org. Biomol. Chem.*, 2009, *7*, 4611-4621.
4. Pintu K. Kundu, Rekha Singh and Sunil K. Ghosh. Silicon assisted diversified reaction of a β-silylmethylene malonate with dimethylsulfoxonium methylide. *J. Organomet. Chem.*, 2009, *694*, 382-388.
5. Pintu K. Kundu and Sunil K. Ghosh. Functionalized organosilicon compounds: synthesis and applications. *Society for Materials Chemistry,* 2011, accepted.
6. Symposium and conference publications and presentations
7. Pintu K. Kundu and Sunil K. Ghosh. Silicon-mediated asymmetric synthesis of some bio-active molecules. *National Conference on Chirality*, 2011, The M. S. University of Baroda, Vadodara, India (Oral Presentation).
8. Pintu K. Kundu and Sunil K. Ghosh. Organo-silicon compounds in diversified organic synthesis. *Chemistry Research Scholars' Meet,* 2011, IGCAR, Kalpakkam, India (Oral Presentation).
9. Pintu K. Kundu and Sunil K. Ghosh. Diversity oriented synthetic strategies for functionalized organo-silicon compounds and their applications. *23rd Research Scholars' Meet*, 2011, N. G. Acharya & D. K. Marathe College, Mumbai, India (Oral Presentation).
10. Pintu K. Kundu and Sunil K. Ghosh. Diversity oriented synthesis of functionalized small molecules using organo-silicon compounds. *3rd DAE-BRNS International Symposium on Materials Chemistry*, 2010, BARC, Mumbai, India (Poster Presentation).

Name : **Ispita Mandal**
Enrolment No. : **PHYS08200605003**
Constituent Institute : **Harish Chandra Research Institute, Allahabad**
Title : **Asspects of Supersymmetric Strategies for Functionallized Organo-Silicon Compounds and their Applications**

Abstract

The first part of my thesis is concerned with black holes in string theory. Black holes are classical solutions of the equations of motion of general theory of relativity. Each black hole is surrounded by an event horizon that acts as a one way membrane. Thus classically the horizon of a black hole behaves as a perfect black body at zero temperature. However, in quantum theory, a black hole behaves as a thermodynamic system with de_nite temperature, entropy etc. In order to investigate the statistical origin of black hole entropy, we need a quantum theory of gravity. Since string theory gives a framework for studying classical and quantum properties of black holes, we shall carry out our investigation in string theory.

One of my research projects focusses on the identification of the hair degrees of freedom for an extremal black hole. Macroscopic entropy of an extremal black hole is expected to be determined completely by its near horizon geometry. Thus two black holes with identical near horizon geometries should have identical macroscopic entropy, and the expected equality between macroscopic and microscopic entropies will then imply that they have identical de-generacies of microstates. An apparent counterexample is provided by the 4D-5D lift relating BMPV black hole to a four dimensional black hole. The two black holes have identical near horizon geometries but di_erent microscopic spectrum. We suggest that this discrepancy can be accounted for by black hole hair, { degrees of freedom living outside the horizon and contributing to the degeneracies. We identify the hair and show that after their contributions are removed from the microscopic degeneracies of the respective systems, the result for the two black holes match exactly.

The second part of my thesis deals with the Galilean Conformal Algebras (GCA), which correspond to the generators of a non-relativistic conformal symmetry obtained by a parametric contraction of the relativistic conformal group. In the paper \Supersymmetric Extension of Galilean Conformal Algebras", we extend the analysis to include supersymmetry in four space-
time dimensions and construct the N = 1 Super Galilean conformal algebra. We could also extend the finite algebra to an infinite one. In a subsequent work, \Supersymmetric Extension of GCA in 2d", we derive the in_nite dimensional Supersymmetric GCA in the case of two spacetime dimensions by performing group contraction on 2d superconformal algebra.

Publications

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7. Conformal Nonlinear Fluid Dynamics from Gravity in Arbitrary Dimensions. Authors: Sayantani Bhattacharyya, R. Lognayagam, Ispita Mandal, Shiraz Minwalla, and Ankit Sharma. Ref: arXiv: 0809.4272 [hep-th], JHEP 0812:116, 2008

Name : **Mangesh B. Borage**
Enrolment No. : **ENGG03200704004**
Constituent Institute : **Raja Ramanna Centre for Advanced Technology, Indore**
Title : **Resonant Converter Topologies For Constant Current Power Supplies And Constant Current Power Supplies and Their Applications**

Abstract

Resonant converters have been an active area of research in power electronics field due to variety of topologies, diverse, peculiar and useful characteristics, and, wide applicability for voltage regulator modules, fluorescent lamps ballasts, power factor correction, capacitor charging, induction heating, welding, inductive power transfer, high-voltage power supply etc., due to soft switching, high frequency operation, high efficiency, and small size. While the majority of the previous work on resonant converters has been directed towards developing methods of analysis and control techniques for the mentioned applications, very little has been done to explore their suitability for application as a constant-current power supply, which is either inherently required or can be advantageously applied in electric arc welding, laser diode drivers, magnet power supplies, capacitor charging, illumination systems, battery charging, electrochemical processes etc.

Immittance converter topologies are suitable for transforming a voltage source to a current source and are deemed to be a promising alternative for developing topologies suitable for constant-current power supplies. This dissertation is dedicated to present an orderly search procedure for identification of a family of lumpedelement immittance converter topologies suitable for power converter circuits, termed here as the resonant immittance converter topologies (RICs). In all 24 RIC topologies are identified with three and four reactive elements, of which 15 are suitable for application as a constant-current power supply.

Analysis and design procedure is exemplified with selected topologies. Fundamental frequency ac analysis is performed to gain insight into the steady-state characteristics, derive closed-form expressions for converter gain and the ratings of various components. A methodology to design the converter by minimizing the *kVA/kW* rating of resonant network is presented. Experimental results on prototype converters demonstrate the converter performance and current source behaviour. Two topological extensions, namely RICs with inherent constant-current constant-voltage characteristics and multiphase RICs, are proposed featuring inherent over-load protection and improvement in converter dynamics, respectively, which are important and useful in many practical applications.

Feasibility of asymmetrical pulse width modulation control is analyzed with state-space model that identifies four distinct operating modes. The mode-boundaries are obtained and plotted on the *D-Q* plane showing a region for the converter design wherein all the switches operate under zero-voltage-switching. An equivalent circuit model is proposed

and a small-signal model is subsequently derived. These models greatly simplify and speed-up the transient and small-signal analysis. It has been shown that the open-loop transient and small-signal ac behaviour of resonant immittance converters is governed by only the filter and the converter along with the resonant immittance network does not contribute to the dynamics. Applicability of resonant immittance converters in some of the application areas such as high-voltage dc power supply, capacitor charging power supply and a constant-current charger for ultracapacitor is demonstrated with application-specific design issues and prototype implementation. Application of multiphase topologies with various source-switch configurations as pulsed current sources is suggested and discussed.

Publlications

1. **Mangesh Borage, K. V. Nagesh, M. S. Bhatia, Sunil Tiwari, "Design of LCL-T Resonant converter including the effect of transformer winding capacitance," IEEE Transactions on Industrial Electronics, Vol. 56, NO. 5, pp. 1420-1427, May 2009.**
2. **Mangesh Borage, K. V. Nagesh, M. S. Bhatia, Sunil Tiwari, "Characteristics and design of an asymmetrical duty-cycle-controlled LCL-T resonant converter," IEEE Transactions on power Electronics, Vol. 24, No. 10, pp. 2268-2275, October 2009.**
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4. **Mangesh Borage K. V. Nagesh, M. S. Bhatia and Sunil Tiwari, "Resonant immmittance converter topologies", IEEE Transactions on Industrial Electronics, Vol. 58, no. 3, pp. 971-978, March 2011.**

Name : **Satyananda Kar**
Enrolment No. : **PHYS06200704001**
Constituent Institute : **Institute For Plasma Research, Gandhinagar**
Title : **Plasma Response to Transient High Voltage Pulses**

Abstract

The present thesis reports on experimental investigation of plasma response to transient high negative and positive voltage pulses in a low pressure unmagnetized argon plasma. The main aim is to study the excitation and propagation characteristics of electrostatic waves, particle balance in plasmas during pulse biasing, wave excitation after pulse withdrawal, and wave excitation using capacitive coupling. The experiments are performed using single pulse excitation.

In the first part of the thesis, plasma response to negative high voltage pulse has studied *for the applied pulse width less than the ion plasma period*. The used electrode was a metallic stainless steel (SS) disc, which was immersed in a low pressure argon plasma. Plasma was generated by impact ionization of argon gas neutrals by primary electrons coming out from dc biased hot thoriated tungsten filaments of diameter 0.25 mm. The experiments have done for to estimate the number of electrons leaving the system and to trace the origin of these repelled electrons (near the electrode or bulk plasma). The results indicate that the electrons that are lost to the chamber wall come from the ion matrix sheath and bulk plasma as well.

In the second part, the ion rarefaction waves are excited by applying a negative high voltage pulse to a metallic electrode though the applied pulse width is less than the ion plasma period. According to general understanding, for the applied pulse width less than the ion plasma period, ions are collectively undisturbed and no energy is given. Hence no ion rarefaction waves should be excited. But contrary, excitation of ion rarefaction wave is observed.

When the metallic electrode is biased pulsed positive, solitary electron holes (SEHs) are excited. Here the applied pulse widths were varied from less than to greater than ion plasma period. The electron holes are the positive potential structures and propagate with comparable to electron thermal speed.

In the last part, we have studied the excitation of plasma waves for a dielectric material covered metallic electrode. In our experiment we have used Kapton as the dielectric material. Here the applied pulse widths were varied from less than to greater than ion plasma period. First the experiments were done for positive pulse bias to the dielectric covered metallic electrode. From the dielectric thickness of 0.1-0.5 mm, solitary electron holes and from 0.6-0.9 mm thickness, solitary ion holes are excited. Solitary ion holes are the negative potential structures, propagate with less than or comparable to ion thermal speed. For the negative bias to the dielectric exciter, ion rarefaction waves are excited for the dielectric thickness of 0.1-0.9 mm. After 0.9 mm dielectric thickness no structures are excited for both positive and negative bias.

Publications

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2. **S. Kar, S. Mukherjee, G. Ravi and Y. C. Saxena, "Possible excitation of solitary electron holes in a laboratory plasma", *Physics of Plasmas*, 2010, 17, 102113.**
3. **S. Kar, S. Mukherjee and Y. C. Saxena, "Excitation of ion rarefaction waves in a low pressure plasma by applying a short high negative voltage pulse", *Physics of Plasmas*, 2011, 18, 053506.**
4. **S. Kar and S. Mukherjee, "Excitation of electrostatic plasma waves using a dielectric covered metallic electrode", *Physics of Plasmas*, 2011, 18, 112303.**

Name : **Shima P. D**
Enrolment No. : **CHEM02200704007**
Constituent Institute : **Indira Gandhi Center for Atomic Research Kalpakkam**
Title : **Synthesis, Characterization, Thermal And Rheological Studies in Nanofluids**

Abstract

Nanofluids got intense scientific attention after the first report of unusual k enhancement for copper (Cu) nanofluids, at very low particle loading. Subsequent to that, numerous theoretical and experimental studies have been carried out on k of nanofluids. Despite several experimental studies on thermal conductivity of nanofluids, it is not clear whether the k enhancement in nanofluids are anomalous or within the predictions of effective medium theory of Maxwell. For better understanding of nanofluid k, it is necessary to use model nanofluids with long ter stability. Moreover, colloidal chemistry, sedimentation, and agglomeration are some of the important issues to be looked at carefully during k measurements. Towards this goals, systematic k studies in nanofluids of magnetite (Fe3O4), copper oxide (CuO) and silver (Ag) nanoparticles of average diameter of < 10 nm to provide better insight into k enhancement in nanofluids.

The important findings of this thesis are briefly described below. Stable nanofluids exhibit moderate k enhancement within the predictions of effective medium theory(EMT), where unstable nanofluids exhibit k enhancement beyond EMT predictions. An invariant k, viscosity and particle size distribution are observed with time after sonication in stable nanofluids, whereas they are time dependent in unstable nanofluids. Aggregation in nanofluids is essentially governed by surface chemistry of the nanoparticles and hence surface functionalization is very important for improved stability and performance of nanofluids. Anomalous k enhancement is observed in a magnetically polarizable nanofluid in presence of external magnetic field due to effective conduction of heat through the chain like aggregates of nanoparticles, when the field orientation is parallel to the heat flow. In the absence of magnetic field, magnetically polarizable nanofluids exhibit series modes of conduction where the k/kf is found to be within the lower Maxwell limits. No significant change in k/kf is observed for magnetite nanofluids when the magnetic field direction is perpendicular to the direction of heat flow, irrespective of the strength of applied magnetic field and particle loading. A series to parallel mode of conduction through nanoparticle and the base fluid is also realized by varying the magnetic field orientation in a magnetically polarizable nanofluid. The k of aqueous nanofluids increase with temperature while it shows a decrease in non-aqueous nanofluids. However, the k/kf remains constant with an increase in temperature, irrespective of the nature of base fluid. In stable nanofluids, the average particle size remains constant with temperature, indicating negligible aggregation with rise in temperature. Absolute viscosity η decreases with an increase in temperature in both the base fluids and nanofluids and the η ratio remains almost constant with an increase in temperature. Steric stabilization and superparamagnetic nature of nanoparticles render magnetite nanofluids reversibly tunable k and η enhancements, which can be exploited for a number of technological

applications in nanoelectromechanical system (NEMS) and microelectromechanical system (MEMS) based devices. The k studies under controlled aggregation, size and temperature unambiguously confirm that Brownian motion induced microconvection is not the key mechanism responsible for k enhancement of nanofluids.

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Name : **Basudha Misra**
Enrolment No. : **PHYS10200604005**
Constituent Institute : **The Institute of Mathematical sciences, Chennai**
Title : **Some aspects of the phenomenology of B mesons**

Abstract

The variation of the measured $B^0_d - \overline{B^0_d}$ mixing phase β/ϕ_1 in $b \to c\bar{c}s$ and $b \to s\bar{q}q$ (where $q = u, d, s$) modes is regarded as a possible probe of New Physics. It has been speculated that this discrepancy is a signal of New Physics. Within the Standard Model the amplitude for modes involving $b \to s$ transitions, get contributions from two amplitudes with different weak phases. Unless the contribution from one of the amplitudes is negligible, one would expect some discrepancy between the various measurements. Estimates of this discrepancy using hadronic assumptions have indicated that the sign of the discrepancy within SM is opposite to the observed value.

We demonstrate using a model independent approach that the deviation in measured $B^0_d - \overline{B^0_d}$ mixing phase caused by pollution from another amplitude, within the Standard Model, is always less in magnitude, and has the same sign as the weak phase of the polluting amplitude. The exception is to have large destructive interference between the two amplitudes. We show that any deviation larger than a few degrees is only possible if the observed decay rate results from fine tuned cancellations between significantly larger quark level amplitudes. These simple observations have very significant consequences for signals of New Physics.

One of the eligible New Physics candidate is the leptoquark model. Leptoquarks are hypothetical gauge particles which can be either scalar or vector. These particles allow having tree level transitions from a quark to lepton or vice versa which are not permitted in the standard model. In our work, upper bounds at the weak scale are obtained for all $\lambda_{ij}\lambda_{ik}$ type product couplings of leptoquark model which may affect $K^0 - \overline{K^0}$, $B^0_d - \overline{B^0_d}$ and $B^0_s - \overline{B^0_s}$ mixing. For $B^0_d - \overline{B^0_d}$ we use both Δm_B and $\sin(2\beta)$ where as for $B^0_s - \overline{B^0_s}$ we use Δm_{B_s}

and $\sin(2\beta_s)$ constraints. For $K^0 - \overline{K^0}$ we use the results on Δm_K and ε_K. Due to the presence of large theoretical uncertainties, ε'/ε is not considered in our analysis. The relevant mixing correlated leptonic and semileptonic decay channels are also presented in the analysis. We constrain all the possible product couplings in this sector, including some which were not considered earlier. The constraints obtained for the leptonic and semi-leptonic decay modes are much tighter than the bounds obtained from mixing for most of the cases. We also present the bounds on the real and imaginary parts of $\lambda\lambda$ which carry the information of the phase of new physics. This is a new observation, not considered in earlier literature.

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Title : **Evolution of Galaxies and the Intergalactic Medium at High Redshift.**

Abstract

Research presented in this thesis follows two threads in the broad area of cosmology: (1) properties of the intergalactic medium (IGM), and (2) formation of galaxies and their evolution.

Mainly from observations of absorption systems in high-redshift quasar spectra, the intergalactic medium has been inferred to be ionized, as well as chemically enriched, up to redshift of about six. This effect is termed reionization. It has been the focus of large amount of research in the last decade. With this in mind, this thesis deals with the following issues: (1) the problem of constraining early star formation from reionization-related observations; and (2) developing selfconsistent models of reionization and suggesting new observables. Apart from these two issue, we also look at galaxy formation in greater detail in this thesis. Understanding how observed small scale structure, including galaxies, can emerge in the well-accepted Cosmological Constant-Cold Dark Matter (LCDM) cosmological model is an important open problem. This thesis includes (1) predictions for the evolution of the neutral hydrogen content in galaxies and its large-scale distribution in the universe over a range of redshifts, and (2) a study of assembly of supermassive black holes in nuclei of high redshift galaxies.

In the first component of this thesis, we use a simplified approach for studying formation of stars in collapsed haloes, and the resulting ionization and enrichment of the IGM. We consider a set of LCDM models allowed by observations and constrain parameters related to star formation with the help of the observed IGM metallicity and its Thomson scattering optical depth. We find that a normal' initial mass function (IMF) may satisfy these two constraints. Observations require a significant fraction of metals to escape from haloes to the IGM. We can also place constraints on the ratio of escape fraction for metals and ionizing photons, we find that this ratio is of order unity for most models. An important conclusion of this work is that star formation without a significant evolution of the IMF is sufficient for satisfying the two constraints considered here. One can consider other sources of ionizing radiation, indeed at least some of these must be present. But these help in reducing only the escape fraction for ionizing radiation. This highlights the significance of the constraint arising from enrichment of the IGM for epoch of reionization studies.

In the second component of this thesis, we study the reionization and thermal history of the universe in overdense regions by refining our reionization model described above to include several physical processes. Observations of galaxy luminosity function at high redshifts typically focus on overdense regions. We find that reionization proceeds differently in such regions. They are ionised earlier because of enhanced number of

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sources and star formation. In addition, these regions have higher temperatures because of enhanced recombinations and hence effect of radiative feedback is enhanced too. In particular, the shape of the galaxy luminosity function for biased regions is very different from that for average regions. There is a significant enhancement in the number of highmass galaxies because of bias, while there is a reduction in low-mass galaxies resulting from enhanced radiative feedback. This order of magnitude change should be detectable in near future [Kulkarni and Choudhury, 2010]. Also, because of the enhanced feedback, luminosity function in overdense regions is more sensitive to reionization history compared to average regions. This will serve as an additional probe of radiative feedback and hence reionization at high redshifts.

In the third component of this thesis, we consider the issue of deriving analytic estimates of formation rates of dark matter haloes [Mitra et al., 2011]. The commonly used Sasaki prescription [Sasaki, 1994] gives unphysical results when applied to the Sheth-Tormen form of mass function.We develop a new prescription to calculate halo formation rate that avoids the assumption of scale invariance of halo destruction rate efficiency made by Sasaki. We show that the basis for the Sasaki ansatz does not hold. Two prominent features of the halo destruction rate are the rapid fall at large masses, and a pronounced peak close to the scale of non-linearity. Using the excursion set approach for the Sheth-Tormen mass function leads to positive halo formation rates, unlike the generalization of the Sasaki ansatz where formation rates at some mass scales are negative.

In the fourth component of this thesis, in addition to considering globally averaged analytical models of the kind discussed above, we perform semi-analytic simulations of galaxy formation that allow us to go beyond the average and consider, for example, the effect of clustering on galaxy properties. In particular, we study the distribution of neutral hydrogen (H I) in post-reionization universe, when most neutral hydrogen is confined to the interstellar medium of galaxies. Our estimates of the density of neutral hydrogen agrees well with low-redshift observations. We also the H I power spectrum and study its evolution.

Supermassive black holes (SMBHs) are known to exist in the local as well as high-redshift universe. However, the assembly of these SMBHs is an not understood. In the fifth component of this thesis, we study the dynamical aspect of SMBH assembly by examining the formation of groups of multiple SMBHs in gas-poor galactic nuclei due to the high merger rate of galaxies at high redshifts. We calculate the relative likelihood of binary, triple, and quadruple SMBH systems, by using accurate direct-summation N-body simulations. We show that halos that are cluster-sized today will generally have more than two closely interacting SMBHs at redshifts of about 5. We also show such systems can survive for several Myr before slingshot effects and gravitational wave recoil deplete them. Most of these high mass galaxies are left with a single SMBH at zero redshift. The existence of multiple SMBH systems leads to many interesting observational signatures.

In summary, the chief contribution of this thesis has been (1) to state conditions under which observed metal enrichment of IGM at high redshift is consistent with accepted reionization scenarios; (2) to provide a new, independent observable to constrain reionization history and feedback at high redshift; (3) to develop a better analytical technique to calculate formation rate of dark matter haloes; (4) in using accurate N-body simulations to understand dynamical

effects associated with SMBH assembly in galactic nuclei, and (5) to understand post-reionization distribution of HI using a consistent semi-analytic model of galaxy formation.

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Title	**:**	**Investigations on the Kitaev Model and Some of its Generalisations**

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Name : **Soumya Paul**
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Title : **A Computational Study of Strategy Switching in Large Games**

Abstract

In this thesis, we start out by introducing the notion of strategy-switchesin traditional games: finite extensive form games, games on graphs as well as repeated strategic form games. We observe that there are many interesting questions one can ask about these games when the number of strategies used to play the games and/or the number of switches between these strategiesis considered as a resource.

We first study the traditional two-player finite extensive form games as well as games on graphs, with parity and Muller conditions where the strategies of players are restricted to a finite subset S of the set of all strategies.

We ask the following questions: Given a finite set of strategies S, is it possible for a player to play a winning strategy by just switching between the strategies in S? If so what is the minimum number of strategies / strategy-switches required from the set S? We give algorithms for these questions and analyse their running time complexity.

Such questions are relevant in situations when playing a strategy involves a cost. We look at repeated strategic form games where the players incur a cost if they switch their strategies between two successive rounds. We show that under such a setting the notion of feasible payoffs for the players changes and we prove a folk theorem.

We then turn our attention to large games. We look at the eventual dynamics of concurrent-move games when the strategies of the players are explicitly specified. We introduce a logical syntax for the specification of the strategies of the players for this purpose. After that, we introduce the notion of probabilistic switching, which naturally generates mixed strategies. We again analyse the eventual outcome of the game when the players switch strategies probabilistically.

In social situations, a natural consequence of switching strategies by players is that the game form itself changes intrinsically. The actions that are played by a small number of players may become too costly for the society to sustain and hence may cease to be available. This results in a change in the game form we look at games that change intrinsically based on the actions / strategies played by the players. There is an implicit player - the society, who maintains the available actions of the players and incurs certain costs in making them available. If and when it feels that an action a is being played by a small number of players and/or it becomes too expensive for it to maintain the action a, it removes a from the set of available actions.This results in a change in the game and the players have to strategise afresh taking this change into account. The restrictions of the society are again specified using a logical syntax. We are interested in which game forms eventually arise and remain stable thereafter.

We then study the converse question: which actions of the players should the society restrict and how should it restrict them so that the social cost is minimised in the eventuality? We address this question both in the case when the players are maximisers and when they play according to strategy specifications.

Our focus then shifts to the study of the rationale behind the strategy- switching by the players. we look at imitation as a heuristic strategy for players. We consider n-player games where some of the players are optimisers (play best response strategies) and the rest are imitators. The players have preferences over the strongly connected components in the arena. We justify and consider the case where the strategies of both the imitators and the optimisers are given in terms of finite automata. We analyse how worse-off the players are playing imitative strategies rather than best-responses.

For games involving a large number of players, we look at games where the players are arranged in neighbourhoods. The neighbourhood structure is given by a graph G which we call the neighbourhood graph. The vertices of the graph correspond to the players and the cliques in G are the neighbourhoods and the edges in G correspond to the visibility structure of the players. Although the payoffs of the players are a_ected only by the moves of the players in her own neighbourhoods, their strategising can depend on what they can view of their own and also other neighbourhoods. We consider two cases, one where the players stick to their own neighbourhoods throughout the course of the game and the other where players can also switch neighbourhoods. We study games with both of the above neighbourhood structures where the players play simple imitative strategies. We also study general games with such neighbourhood structures.

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Name : **Amaldev Manuel**
Enrolment No. : **MATH10200605003**
Constituent Institute : **Institute of Mathematical Sciences, Chennai**
Title : **Counter Automata and Classical Logics for Data Words**

Abstract

This thesis takes shape in the ongoing study of automata and logics for data words– finite words labelled with elements from an infinite alphabet. The notion of datawords is a natural way for modelling unboundedness arising in different areas ofcomputation. The contribution of this thesis is two-fold, which we discuss briefly below.

On the automata side, after introducing two known models – Register automata and Data automata – we formulate a model of computation for data words, namelyClass Counting Automaton (CCA). CCA is a finite state automaton equipped with countably infinitely many counters where counters can be increased or reset. Decrement is not allowed to preserve decidability. We prove basic facts about this model and compare its expressive power with respect to the earlier models. It is shown that this automaton sits (roughly) in between register automata in terms of expressiveness and complexity of decision problems. We also study several extensions some of which subsume earlier models.

In the second part we look at the two-variable logics (first-order logic restricted to two variable) on logical structures which correspond to data words, continuing the study initiated in [BDM+11]. First, it is shown that two-variable logic ostructures with two linear orders and their successor relations is undecidable. Then we consider first-order structures with successors of two linear orders and show that finite satisfiability of two-variable logic is decidable on these structures. We use suitably defined automata for proving this result. Later, we generalize the above proof to the case of k-bounded ordered data words – first-order structures with a linear successor and a total preorder with an additional restriction of kboundedness on the preorder – and prove a similar result. A corollary of this result is that two-variable logic is decidable on structures with two successors and at most one order relation. The decidability results are sharpened by showing lower bounds for decidable fragments and exhibiting undecidability results for richer fragments.

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Name : **Sandeep K Goyal**
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Title : **Controlled Entanglement Dynamics in Open Quantum Systems**

Abstract

The study of entanglement in quantum systems has assumed great importance in recent times. With the advent of quantum information theory (QIT), the creation, analysis and manipulation of quantum systems has now entered the realm of everyday possibility. One of the primary resources of this powerful theory is entanglement { indispensable for essential quantum information tasks such as quantum teleportation, super-dense coding, communication complexity problems and one-way computation, among others.

Most, if not all, quantum systems are fragile by nature. This is because they are \open" systems and can not be shielded from dissipative interactions with the surrounding environment which creates entanglement between the system and its surrounding environment. This entanglement with the surrounding environment causes a loss of the quantum nature of the system { a phenomenon known as decoherence { and leads to an inevitable loss in the entanglement in the system.

In this thesis, we have studied the evolution of entanglement in open quantum systems by varying the dimensionality of the system as well as the natureof the dissipative interaction between the bath and the system. Our focus has been on the time of the onset of Entanglement Sudden Death | a phenomenon characterized by the complete loss of entanglement in a _nite amount of time. For _nite dimensional systems connected to a local thermal bath, we have found that ESD does not take place for any pure state at zero temperature, but does so for all states at non-zero temperatures. Squeezing the bath delays the onset of ESD for _nite non-zero temperatures, but allows ESD to take place even at zero temperatures. However, best results are obtained by setting the system-bath interaction to be of the quantum non-demolition type, in which case ESD is never seen at any temperature whatsoever. As regards the evolution of two-mode Gaussian states of an infinite system of coupled harmonic oscillators, we have looked for the transition of the system to classicality which ensures that the system has reached separability. We have found that, when the system interacts with a local thermal bath at non-zero temperature, every two-mode Gaussian state makes the transition to classicality within a nite amount of time. This does not always happen at zero temperatures. For squeezed thermal baths, we have found that classicality is achieved infinite times even at zero temperatures.

In addition to the study of entanglement dynamics in various settings, we have also studied and modified existing ways of controlling the loss of entanglement in open quantum systems, and have also suggested and executed new methods of doing so. Our analysis of the effectiveness of decoherence control procedures on the evolution of entanglement has led to counterintuitive and surprising results. We have found that, while these control procedures are procient in delaying the loss of coherence in the

system, some of them are counter-productive when it comes to preservation of entanglement in the system. For the case of a thermal bath of photonic crystals interacting locally with a two-qubit system, we have found

that the amount of entanglement at the asymptotic limit increases with an increase in the detuning parameter Δ. Modulation of he system-bath coupling at a frequency much higher than the correlation time scale of the local thermal bath is another method of controlling decoherence. We have found that for a two-qubit system in contact with a local thermal bath, the time to ESD increased with the modulation frequency of the system-bath coupling. A third control procedure is the technique of resonance fluorescence, where the atomic transition is driven using an external coherent single-mode field in resonance with the transition itself, and the only control parameter is the transition frequency , also called the Rabi frequency. We have found that, for the same two-qubit system in contact with a local thermal bath and exposed to such an external field, an increase in Ω decreases decoherence but at the same time also decreases the time to ESD. Finally, the technique of dynamical decoupling involves switching the decoupling interactions on and off at a rate much faster than the one set by the environment. Bang-bang decoupling is one such technique where fast radio frequency pulses are applied in order to average out unwanted effects of the environment and thus control decoherence. However, as in the previous case, dynamical decoupling also causes a faster loss of entanglement.

In the final part of the thesis, we have proposed a new method of shielding the entanglement in the system from dissipative environmental effects. In this scheme, we install an ancillary system in a fixed initial state and let it interact with the main system through exchange interactions. The presence of the ancilla modifies the rate at which the system evolves | mathematically, it changes the form of the superoperator L which governs the dynamics of the system density operator with its own time derivative. We have, through numerical computations, shown that the ancilla, in its ground state, is able to enhance the lifespan of the entanglement in the system. For the case of a two-qubit system interacting with a local thermal bath as well as with an n-qubit ancilla, we have further shown that increasing the size of the ancilla, that is, increasing n improves its performance.

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   S. R. Hassan, Sandeep Goyal, R. Shankar, David Senechal
   (http://arxiv.org/abs/1201.5874)

Name : **Sanyasinaidu Boddu**
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Title : **Synthesis and Characterization of Lanthanide Ions Doped Nanomaterials**

Abstract

The doctoral work of Mr. Sanyasinaidu involves the synthesis and characterisation of variety of inorganic nanomaterials doped with lanthanide ions. These are luminescent nanomaterials and are potential candidates for various optical applications. A variety of inorganic matrices with nanosize dimensions varying from oxides (Ga_2O_3, Sb_2O_3), phosphates ($SbPO_4$, $BiPO_4$, $GaPO_4$), gallate ($ZnGa_2O_4$) to tungstates ($CaWO_4$, $SrWO_4$, $BaWO_4$) doped by lanthanide ions like Eu^{3+}, Tb^{3+}, Dy^{3+}, Ce^{3+}, Er^{3+} and Sm^{3+} have been synthesised and characterised. Choice of the material (host) has been made by considering the environment around the cation which would be substituted by incoming lanthanide ion, phonon energy of the lattice and luminescent character of the host. By judiciously selecting the solvent and experimental conditions tunability in size and shape of the nanomaterials has been achieved. Some of the nano-materials have been incorporated into sol-gel and polymer films with a view to make luminescent films for different applications. Salient features of the present study are briefly mentioned below. A clear understanding of the effect of shape as well as lanthanide ions doping on the luminescent properties of binary oxide nanomaterials like Ga_2O_3 and Sb_2O_3 has been achieved. Phosphates like $SbPO_4$ and $BiPO_4$ are found to be good hosts for lanthanide ions due to the existence of energy transfer from host to lanthanide ions and associated improved luminescence. A synthetic methodology has been developed to synthesize $BiPO_4$ in desirable phases (monoclinic, hexagonal etc) and shapes. The work on $ZnGa_2O_4$ nanoparticles has lead to the development of bright blue light emitting nanoparticles that can be incorporated in polymers like Poly methyl methacryllate (PMMA). These nanoparticles are also found to have quantum yield of blue light emission around 10%, which is higher than that of the conventionally used pyrene based compounds. Compounds like $CaWO_4$, $SrWO_4$ and $BaWO_4$ are found to be excellent host for getting multi colour emission. Near infra red emission from ions like Er^{3+} and Nd^{3+} are also found to be quite strong from these materials.

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10. Tunable blue emission from ZnGa2O4 nanoparticles by In3+ doping B. S. Naidu, P.V Satyam, V. Sudarsan, R. K. Vatsa (Manuscript under preparation) Room temperature synthesis of multicolour emitting dispersiable CaWO4:Ln3+ (Ln = Eu, Tb, Sm, Dy) nanoparticles B. S. Naidu, B. Vishwanadh, V. Sudarsan, R. K. Vatsa (Manuscript under preparation)

Name : **Jugal Chowdhury**
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Title : **Linear and Nonllinear Global Gyrokinetic Study of Microinstabilities in Tokamaks**

Abstract

The present dissertation is dedicated to the study of the stability and transport properties of many microinstabilities which play an important role in causing anomalous transport of energy and particles in tokamaks using global, linear and nonlinear, gyrokinetic formulations. In particular, it highlights (1) effects of the nonadiabatic passing electrons on the ion temperature gradient (ITG) mode, trapped electron coupled ion temperature gradient mode (ITG-TEM) and trapped electron mode (TEM) by linear, global, gyrokinetic numerical study; (2) the behaviour of the ion temperature gradient driven modes in the presence of highly steep density profile typically observed in the transport barriers inside the tokamak; a linear and nonlinear gyrokinetic study on the occurrence of the short wavelength ion temperature gradient mode (SWITG); (3) a linear, global, gyrokinetic stability analysis of the universal toroidal mode, which although is thought to be ubiquitous, yet overshadowed by the temperature gradient driven modes; (4) the stabilization of the microinstabilities by the hot ions (those ions having temperature higher than the thermal ions), and finally, the redistribution of the hot ions by microturbulence with the help of linear and nonlinear, global, gyrokinetic simulations.

The role of the nonadiabatic passing electrons on the ion temperature gradient and trapped electron modes has been studied. Addressing the fully nonadiabatic passing electrons in time dependent linear and nonlinear codes has been an uphill task in the presence of full ion dynamics with true ion to electron mass ratio in terms of the computational cost. These particles are therefore considered either adiabatic or nonadiabatic with reduced ion to electron mass ratio. Thus, the effect of these nonadiabatic passing electrons on the growth rate and global mode structures of the ITG mode, ITG-TEM and TEM is often overlooked. With a global, spectral, gyrokinetic model it is possible to incorporate the full dynamics of the passing nonadiabatic electrons in the linear limit without any assumption regarding the ion to electron mass ratio. Strong effects of these nonadiabatic passing electrons near the mode rational surfaces where k||-->0 on the ITG mode, ITG-TEM and TEM have been observed.

The veracity of a nonadiabatic passing electron model is established only if it can produce modes inherent to the nonadiabatic passing electrons, one of which is the electron temperature gradient driven (ETG) mode. We have thus, extended our study from the ion scales of ITG mode, ITG-TEM and TEM to the electron scales of the ETG mode and compared it with the already known results on the ETG mode. With the inclusion of the space charge effect in the form of Debye shielding, the model enables one to study the pure ETG mode in the presence of fully nonadiabatic ions.

The density gradient driven instability, known as the universal drift instability, is studied in the toroidal geometry and its linear properties have been discussed in both electrostatic and electromagnetic limit. The global mode structure and stability properties of the low *n*

(toroidal mode number) toroidal universal mode along with its coupling to the trapped electrons have been studied perhaps for the first time to our knowledge.

Although ions are considered adiabatic at shorter wavelength or high wave number regime, they can behave nonadiabatically giving rise to a temperature gradient driven mode even at the high wave number regime. This mode, hitherto known to be slab like, is named as the short wavelength ion temperature gradient (SWITG) mode and studied only in the local limit. We have presented a linear, global, gyrokinetic study of the mode and shown that in the presence of trapped electrons this mode can be further unstable and exhibit toroidal nature. A nonlinear, flux tube, gyrokinetic simulation of the SWITG mode also has been carried out which shows that in spite of the linear dominance of the mode compared to the standard ITG mode, the former has very low contribution to the net thermal ion transport.

The behaviour of the energetic ions in tokamak plasmas is another issue that has derived much attention in the fusion community. Presence of these particles are inevitable in the fusion grade plasmas because of the various auxiliary heating schemes and fusion produced *alpha* particles. The study of the influence of these energetic ions on the kinetic ballooning mode (KBM), toroidal Alfven eigenmode (TAE), etc., is very much important. These particles can give rise to the unstable modes on their own, for example, energetic particle modes (EPM).

We as a first step, have incorporated a second species of ions with higher energy than the thermal ions to a existing linear, global, gyrokinetic model and studied its effects on the ITG modes. It is observed that these energetic particles stabilize the ITG mode strongly. The He ions are found to be more stabilizing. Conversely, the effect of the microturbulence driven by the ITG mode and TEM on the energetic ions is studied considering the energetic species as passive tracers using a global, nonlinear, gyrokinetic simulation. Microturbulence plays an important role in the redistribution of the energetic ions. The system size dependence and energy scaling of the energetic ions have been discussed. The transport of passing and trapped energetic ions is found to display different energy scalings.

Publlications

1. **Nature of energetic ion transport by ion temperature gradient driven turbulence and size scaling, J. Chowdhury, W. Wang, S. Ethier, J Manickam and R. Ganesh. Under review, Physics of Plasmas.**
2. **Radial transport of energetic ions in the presence of trapped electron mode turbulence,**
   J. Chowdhury, W. Wang, S. Ethier, J Manickam and R. Ganesh, Physics of Plasmas 18, 112510 (2011).

3. Nonlinear Short Wavelength Ion Temperature Gradient turbulence, J. Chowdhury, S
4. Brunner, R. Ganesh, X Lapillonne, L. Villard and F. Jenko, Research Report 520, September, 2011, Institute for Plasma Research. To be submitted to Physics of Plasmas
5. Toroidal universal drift instability: A global gyrokinetic study, J. Chowdhury, R. Ganesh, S. Brunner, J. Vaclavik, and L. Villard, Physics of Plasmas 17, 102105 (2010).
6. Nonlocal effects in gyrokinetic turbulence simulations using GENE, T. Gorler, X. Lapillonne, S. Brunner, J. Chowdhury, T. Dannert,
F. Jenko, B. F. McMillan, F. Merz, D. Told and L. Villard, Journal of Physics: Conference Series 260, 012011 (2010).
7. Gyrokinetic simulations of turbulent transport: size scaling and chaotic behaviour, L. Villard, A. Bottino, S. Brunner, A. Casati, J. Chowdhury, T. Dannert,
R. Ganesh, X. Garbet, T. Gorler, V. Grandgirard, R. Hatzky, Y. Idomura, F. Jenko, S. Jolliet, S. K. Aghdam, X. Lapillonne, G. Latu, B. F. McMillan,
F. Merz, Y. Sarazin, T. M. Tran and T. Vernay, Plasma Phys. Control. Fusion 52, 124038 (2010).
8. Sluggish response of untrapped electrons and global electrostatic micro-instabilities in a tokamak, J. Chowdhury, R. Ganesh, P. Angelino, J. Vaclavik, L. Villard and S. Brunner, Journal of Physics: Conference Series 208, 012058 (2010).
9. Short wavelength ion temperature gradient mode and coupling with trapped electrons, J. Chowdhury, R. Ganesh, J. Vaclavik, S. Brunner, L. Villard, and P. Angelino, Physics of Plasmas 16, 082511 (2009).
10. A comprehensive gyrokinetic description of global electrostatic microinstabilities in a tokamak, J. Chowdhury, R. Ganesh, S. Brunner, J. Vaclavik, L. Villard, and P. Angelino, Physics of Plasmas 16, 052507 (2009).
11. \Role of nonadiabatic untrapped electrons in global electrostatic ion temperature gradient driven modes in a tokamak, J. Chowdhury, R. Ganesh, P. Angelino, J. Vaclavik, L. Villard, and S. Brunner, Physics of Plasmas 15, 072117 (2008).

Name : **Sachin Jain**
Enrolment No. : **PHYS07200604034**
Constituent Institute : **Institute of Physics, Bhubaneswar**
Title : **Transport Properties of Strongly Coupled Gauge Theories From Holography**

Abstract

The gauge/gravity duality allows us to gain insights into various properties of strongly coupled gauge theories. In particular, the transport coefficients of strongly coupled gauge theories which are hard to compute otherwise, can be computed easily using gauge/gravity duality. Even though these theories, in several ways, are different from theories such as QCD, they do share qualitatively similar behavior. For instance, it has been shown that for gauge theories with gravity duals, the shear viscosity to entropy density ratio is universal and falls with in the experimentally observed range at RHIC. Motivated by this, in this thesis we study other transport properties such as electrical and thermal transport properties of strongly coupled gauge theories at finite temperature and chemical potential. Assuming the gravity theory has a gauge theory dual, under general assumptions on the gravity side we show that transport coefficients of boundary theory such as electrical or thermal conductivities are universal i.e. they are independent of details of background geometry. Moreover these transport coefficients can be expressed in terms of thermodynamic quantities of the gauge theories. We also study how these transport coefficients evolve radially by evaluating them on the hypothetical hypersurface at any radial position and find that there is a smooth interpolation between the conductivities of fluid at the horizon described by the membrane paradigm and the fluid at the boundary described by gauge/gravity duality.

Publlications

1. **"Proof of universality of electrical conductivity at finite chemical Potential", Sayan K. Chakrabareti, Shankhadeep chakrabortty, Sachin Jain, JHEP 1102, 073 (2011) [arXiv:1011.3499 [hep-th]].**
2. **"Universal thermal and electrical conductivity from holography",Sachin jain,JHEP 1011, 092 (2010) [arXiv:1008.2944 [hep-th]].**
3. **"Universal properties of thermal and electrical conductivity of gauge theory plasmas from holography", Sachin Jain, JHEP 1006, 023 (2010) [arXiv:0912.2719 [hep-th]].**
4. **"Holographic electrical and thermal conductivity in strongly coupled gauge theory with multiple chemical potentials", Sachin Jain, JHEP 1003, 101 (2010) [arXiv:0912.2228 [hep-th]].**
5. **"Viscosity to entropy ratio at extremality",Sayan K. Chakrabarti, Sachin Jain, Sudipta Mukherji, JHEP 1001, 068 (2010) [arXiv:0910.5132 [hep-th]].**
6. **"Notes on R-charged black holes near criticality and gauge theory",Sachin Jain, Sudipta Mukherji, Subir Mukhopadhyay, JHEP 0911:051, (2009) arXiv:0906.5134 [hep-th]].**
7. **"Spiky Strings in $ADS_4 \times CP^3$ with Neveu-Schwarz Flux",Sachin Jain, Kamal L. Panigrahi, JHEP 0812:064, (2008) arXiv:0810.3516 [hep-th].**
8. **"w_∞ 3-algebra ",Shankhadeep Chakrabortty, Alok Kumar, Sachin Jain, JHEP 0809:091, (2008) arXiv:0807.0284 [hep-th].**

Name : **Neeldhara Misra**
Enrolment No. : **MATH10200705001**
Constituent Institute : **Institute of Mathematical Science, Chennai**
Title : **Kernels for the F-Deletion Problem**

Abstract

In this thesis, we use the parameterized framework for the design and analysis of kernelization algorithms for NP-complete problems. The notion of kernelization formalizes preprocessing or data reduction, and refers to poly- nomial time algorithms that transform any given input into an equivalent instance whose size is bounded as a function of the parameter alone. The center of our attention in this thesis is the F-Deletion problem, a vastly general question that encompasses many fundamental optimization problems as special cases. In particular, we provide evidence supporting a conjecture about the kernelization complexity of the problem, and this work branches o_ in a number of directions, leading to results of independent interest.

Let F be a _nite family of graphs. The F-Deletion problem takes as input a graph G on n vertices, and a positive integer k. The question is whether it is possible to delete at most k vertices from G such that the remaining graph contains no graph from F as a minor. This question encompasses a number of fundamental problems. The generic kernelization algorithm is based on a non-trivial application of protrusion techniques, previously used only for problems on topological graph classes. We also demonstrate an approxima- tion algorithm achieving an approximation ratio of O(log(3=2)OPT), where OPT is the size of an optimal solution on general undirected graphs. The approximation algorithm is used crucially in the kernelization routines. On an independent note, we also study the parameterized complexity of the Colorful Motifs problem from the perspective of kernelization.

Publications

1. **N. Misra, G. Philip, V. Raman, and S. Saurabh. On parameterized independent feedback vertex set. In COCOON, pages 98{109, 2011**
2. **F. V. Fomin, D. Lokshtanov, N. Misra, G. Philip, and S. Saurabh. Hitting forbidden minors: Approximation and kernelization. In 28th International Symposium on Theoretical Aspects of Computer Science (STACS), pages 189{200, 2011**
3. **A. M. Ambalath, R. Balasundaram, H. C. Rao, V. Koppula, N. Misra,G. Philip, and M. S. Ramanujan. On the kernelization complexity of colorful motifs. In International Workshop in Parameterized and Exact Computation (IPEC) 2010, 2010**

Annex 6

Titles of M.Tech, M.Phil & M.Sc. (Engg.) theses for which results were notified during April 1, 2011 to March 31, 2012

Titles of M.Tech. Theses for which results were notified during April 1, 2011 to March 31, 2012

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
1	Shri Gurpartap Singh	09.03.12	Microstepping Controller Drive with Programmable Microstep Resolution
2	Shri Saurabh Kumar Neema	18.04.11	Development of Data Processing Algorithms for Event Acquisition using ANALOG Memory ASIC
3	Shri Tejaswi Poorlupadi	18.04.11	Design and Analysis of Hydrodynamic Bearings for High Speed Rotating Machines with Light Loads
4	Shri Dhirendra Singh(NFC)	18.04.11	CFD and Modeling for Rotating Disc Contractor
5	Shri Arun S.	30.04.11	Rotordynamic Study of Ultra High Speed Cryogenic Turboexpander Rotors
6	Shri Abhishek Kumar Srivastava	11.05.11	Study of Heat Transfer and Pressure Drop in a Natural Circulation Loop with Molten Salt
7	Shri Jai Prakash	18.05.11	Theoretical Modeling and Design of Air Core High Voltage Impulse Transformer
8	Shri Mathew Dominic	18.05.11	Optimzation of Time Cordination Scheme for Relays in a Large Power Distribution Network
9	Shri Somesh	18.05.11	Study, Analysis and Design Intrusion Detection System at VECC based on Classification Methods
10	Shri Balaji M. Chavan(NPCIL)	25.05.11	Modeling of Containment Spray System(CSS) for Heat and Iodine Removal during Accident Condition for PHWR
11	Shri Shailendra Kumar Tiwari(NFC)	25.05.11	Parametric Simulation of ADU Precipitation Process for Ceramic Fuel Fabrication
12	Shri Tarun Mohan Joshi(NPCIL)	25.05.11	Transient Simulation and Analysis of Automatic Load Transfer in 700 Mwe Nuclear Power Plant
13	Shri Swagat Rajput(RMP)	25.05.11	Study of Shocks Under Strong Rotation
`4	Shri Rohit Sah	25.05.11	Development of Simplified Methodology to predict the behaviour of Free Standing Glove Box Structure subjected to Seismic Loading
15	Shri Atul Anand Dhas	25.05.11	Assessment of Ductile Fracture behavior of Reactor Pressure Vessel Material using Damage Mechanics
16	Shri Saurabh Sharma(NPCIL)	25.05.11	Numerical Solution of Poison Injection in Moderator inside Calandria for 220 Mwe PHWRs
17	Shri Sudhanshu Srivastava	25.05.11	Study and Analysis of Active Power Filter
18	Shri Abhishek Singh	25.05.11	A Study on Designing High Speed Data Acquisition System on Embedded Technology
19	Shri Saurabh Srivastava	31.05.11	Design, Analysis and Development of Remote Control System for HVPS of Microwave Ion Source
20	Shri Pranab Singha Roy	31.05.11	Development of a Generalized Framework for Automatic Parallelization of FORTRAN 77 Codes
21	Shri Shuaib Ahmad Khan	31.05.11	Study and Design of the Front End Electronics for the ALICE Forward Calorimeter
22	Shri Kulbir Singh	16.06.11	Assesment of Simplified Tube Sheet Analysis based on 3-D Finite Element

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
23	Shri Pranav Paliwal	09.03.12	Computational Fluid Investigations on Cellur Convection
24	Shri Ullas K. Purohit	22.07.11	CFD and Modeling for Centrifugal Extractor
25	Ms. Deepika Dutta	10.08.11	Study and Analysis of Time memory Tradeooff Cryptanalysis and Development of Parallel Framework for Fast Cryptanalysis
26	Shri Pankaj Ahuja	17.08.11	Prediction of Crack Growth Initiation Load of a Piping System having Through-Wall Circumferential Crack
27	Ms. Pratibha Singh	19.08.11	Study and Characterisation of Synthesizable PSL Assertions
28	Shri Atul Kumar Singh	19.08.11	Design Optimization of High Speed Disk for Neutron Chopper
29	Shri Jitendra Kumar Pandey	19.08.11	Pre-Operational Vibration Test of a Representative Piping Section in NPP: A Study to evaluate the Test Procedure through Experimental and Analytical Tools
30	Shri Rajesh Yadav	19.08.11	Design Standards of Underground Hardened Structure with Base Isolation Systems
31	Shri Ashit Kanti Dey	23.08.11	Parametric Studies on the Nodular Corrosion Susceptibility of Zirconium Based Alloys
32	Shri Vinay Karanam	23.08.11	Evaluation of Sub-Channel Flow Mixing Coefficient for Typical PWR Fuel Bundles having Spacers using CFD Analysis
33	Shri Rahul Aggarwal	28.08.11	Raman Spectroscopy Study of GaAsP/AlGaAs Single Quantum Well
34	Shri Sandeep S. Sathe	06.09.11	Establishing Corrosion behaviour of Candidate Materials in Nitric Acid Containing Free and Complexed Fluoride
35	Shri Aniruddh Nain	08.09.11	Diagnostic and Prognostic using Reliabilty based Method for Diesel Generator
36	Shri Jigar V. Patel	08.09.11	Development of a Code for Computing Radiative Electromagnetic Fields in Control Rooms, Control Equipment Rooms and Cable Rooms of a Nuclear Reactor
37	Shri Abhishek Jaju	08.09.11	Development and Evaluation of a Haptic Interface for Master-Slave Control of an Industrial Robot
38	Shri Umesh Pratap Singh	08.09.11	Corrosion Behaviour of Hyper Duplex Stainless Steel in Various Metallurgical Conditions for Sea Water Cooled Condensers
39	Shri Anubhav Gupta	08.09.11	High Temperature Oxidation Behaviour of Zirconium Based Alloys- Effect of Material and Fabrication Parameters
40	Shri Amarjeetsingh Surendralal Bishnoi	20.09.11	Programmable Pulsed Optically Stimulating Luminescence(POSL) Reading System for Radiation Dosimetry
41	Shri Yogesh R. Sagane	30.09.11	Performance Evaluation of Dynamic Share-Driven Approach for MIL-STD-1553B Network

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
42	Shri Jitendra Kumar	09.03.12	Numerical Investigation of Thermal Behaviour of Multi-Stream Plate and Fin Heat Exchangers for Helium Cryogenic Systems
43	Shri Amit Kumar Mishra	10.10.11	Design of Compensator for Vanadium Self Powered Neutron Dtector
44	Shri Jay Praful Shah	10.10.11	Study, Analysis and Design of Fault Tolerant System for AHWR Fuelling Machine Z-Drive Motion and Weight Compensation
45	Shri Ajay Kumar	30.09.11	Design Upgradation of Control and Instrumentation for Automation of Submarine Main Propulsion System and its Reliability Assessment
46	Shri Shibaji Basu	30.09.11	Computational and Experimental Modelling of Decaying Magnetic Field for Electromagnetic Forming Applications
47	Shri A. R. Ramakrishnan	30.09.11	Development of a Failure Model for Effect of an EMP Event on Nuclear Plant Protection System Components
48	Shri Prafulla Kumar Sharma	30.09.11	Study and Modeling of Evaporator System in Spent Fuel Reprocessing Plant
49	Shri Nishith Kishore	10.10.11	Design and Analysis of Lateral Flexible Element under Rotational Field
50	Shri Binu Kumar	10.10.11	Analytical Prediction of Response of Spent Fuel Storage Stacks Submerged in Water Under Seismic Load
51	Ms. Manomita Mollick	21.10.11	Compatibility Studies of Refractory and Insulation Material at Various Temperature Zone in a Joule Heated Ceramic Melter
52	Shri Gaurav Sisaudiya	21.10.11	A Secure Information System
53	Ms. Santwana Kumari(BARCTS, RRCAT)	21.10.11	Design of Digital Feedback Controller for Switch Mode Power Supply
54	Shri Sachin Chandrabhan Aher	21.10.11	Development of Simplified Procedure for Seismic Qualification of Piping System Connecting the Sliding Glove Boxes of Nuclear Fuel Fabrication Facilities
55	Shri Hari Prasad Kolla	21.10.11	Design and Validation of FPGA Based High Resolution Time to Digital Converter and Hit Pattern Register using Micro Controller Soft Core
56	Shri Ashish Mahawar	21.10.11	Design and Development of Pulsed 200 W Solid State Power Amplifier at 1.3 GHz
57	Shri Dipta Pritam Dutta(BARCTS, Mumbai)	22.10.11	On-Line Monitoring and Tuning of Resonant Frequency for Radio Frequency Quadrupole(RFQ) LINAC
58	Shri Mayank Kothiyal	22.10.11	Modelling and Simulation for Speed and Power Factor Control of Heavy Duty Pump Motors for Energy Optimization in Process Loops of Nuclear Reactors
59	Ms. Priyanka Sharma	22.10.11	Swept Source Based Polarization Sensitive Optical Coherence Tomography for Biological Tissue Imaging

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
60	Shri Saurav Suman	09.03.12	Thermo-mechanical Modeling, Development and Testing of Ceramic to Metal Seal for High Pressure High Temperature Application
61	Shri Deepak Sharma	22.10.11	Design Optimization and Experimental Verification of Refueling Tooling
62	Shri Suranjit Kumar	22.10.11	Fracture Assessment Methodology to Demonstrate the Fracture Integrity of the Dissimilar Metal Pipe Welds
63	Shri Shakti Kumar Mishra	22.10.11	High Voltage Breakdown Studies in Electron Beam Evaporation System and Methodologies to Solve the Arc Discharge Problem
64	Shri Dheeraj Gupta	25.10.11	Improving the Accuracy and Effectiveness of Intrusion Detection Systems
65	Shri Rakesh P. T.(BARCTS,Mumbai-RSE)	25.10.11	Atmospheric Turbulence Modelling and Plume Exposure Dose Calculations
66	Shri Ravindra Saini	25.10.11	Simulation and Analysis of Thermionic Electron Gun
67	Shri Gautam Kumar	25.10.11	Upgradation of Control Logic and Interlock System in INDUS-2 Klystron Amplifier System
68	Shri Munendra Singh	25.10.11	Study and Development of Power Amplifier Stage for Active Magnetic Bearing
69	Shri Vishnu Kumar Gauttam	01.11.11	Analysis, Design and Development of a Scanning Magnet Power Supply with Saw-Tooth Bipolar Output Current
70	Shri Abhinav Kumar	01.11.11	Digital Pulse Shape Discrimination for Nuclear Data by Fuzzy Clustering
71	Shri Faisal Dastageer	01.11.11	Seismic Analysis of IFFCO Jetty using Bhuj Earthquake Data
72	Shri Anil Pathrose	01.11.11	Investigation of Hysteresis Phenomena in Natural Circulation Loop
73	Ms. Chandraprabha Dewangan	01.11.11	Modeling, Analysis and Design of Linear Generator
74	Shri Mukund Kumar	21.11.11	Coherent Extreme Ultra-violet Generation from ultra-short Laser Produced Plasma Plumes
75	Shri Puneet Maheshwari	23.11.11	Analysis and Development of VME based Prototype Event Receiver
76	Ms. Shweta Verma	23.11.11	Studies on Optical Properties of Nanoparticles Grown by Pulsed Laser Deposition
77	Shri Pankaj Kumar	23.11.11	Studies on Pulsed Amplification of Single Mode CW Tunable Dye Laser Beam by Copper Vapour Laser Pumped Dye Laser Amplifier
78	Shri Siddhartha Shankar Pany	23.11.11	Simulation and Analysis of Electron Beam Trajectory in Scanning Electron Microscope Column
79	Shri Anirban Roy Choudhury	23.11.11	Generation of Program Invariants using Abstract Interpretation Framework

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
80	Shri Sai Kiran Kaza	09.03.12	Process Modeling for Production of Different Qualities of Desalinated Water from Low Temperature Evaporation(LTE) Desalination Process using Different Types of Waste Heat
81	Shri Nileshkumar R. Bobade	23.11.11	Mathematical Modeling and Analysis of Adaptive PID Control for the PHT Pressure Control
82	Shri Nikhil U. Kane	25.11.11	Modeling of Signal Processing for Beam Position Monitoring System
83	Shri Debmalya Mukherjee	25.11.11	Defect Characterization using Multi-Sensor Data
84	Shri Girish Dantale	25.11.11	Modeling and Simulation of Antenna Stabilisation and Control System of SATCOM Terminal of an Airborne Platform
85	Ms. Shuchita Bahadur	25.11.11	Development of Radioactive Hot-Spot Identification System(HSIS) for Reactor Environment
86	Shri Phanikarthik Vonteddu	29.11.11	Simulation Studies on the Thermal Decomposition of Ammonium Diuranate in a Rotary Furnace at about 700 C to Produce U-Oxide of Specified Quality
87	Ms. Basundhara Jain	14.12.11	Study of Data Security Technique in Large Data base Applications
88	Shri Ashwin Rathod	14.12.11	Modelling, Design, Analysis, Prototyping and Experimental Validation of a Fabry-Perot Interferometric Temperature Sensor
89	Shri Reju K.	19.12.11	Design and Development of DC Current Transformer(DCCT)
90	Shri Ram Kumar Maity	21.12.11	Computational Fluid Dynamic Investigations of Partial and Total Blockage Detection in Fuel Sub-Assemblies of FBR
91	Shri Mohammad Khursheed	24.12.11	Study of Beam Transport and Measurement of Beam Size in the CUTE-FEL Setup
92	Shri Sanga Ramesh	03.01.12	FPAA Based Hybrid Circuit Design for RTU
93	Shri Arjun Pradeep	03.01.12	Studies on Steady State and Transient Gas-Liquid Distribution of a Fully Miscible Solute in a Liquid Solvent
94	Shri R. Vignesh	03.01.12	Mathematical Modeling of Vacuum Furnace and Design of Feedback Control Mechanism for its Pressure Control
95	Shri Kamal Sharma	03.01.12	Developing and Optimizing Strategies for Robotic Peg-in-Hole Insertion with a Force/Torque Sensor
96	Shri Prabhat Ballabh	03.01.12	Development of Design Patterns of Human Machine Interface(HMI) Objects in Computer Based Systems of Nuclear Power Plants
97	Shri Goutam Chourashia	03.01.12	Mathematical Modeling of Hot Cell Ventilation System to Design Adjustable Speed Drive Based Control System for Hot Cell Pressure Control

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
98	Shri Amit Kumar	09.03.12	Optimization of Supporting Arrangement for 30 Mega Watt High Flux Research Reactor Internals for Thermal and Siesmic Load
99	Shri Nagendra Kumar	03.01.12	Characterization of AHWR Fuel Elements
100	Ms.Vinita Daiya	03.01.12	Design and Development of Base Station for Wireless Sensor Network for Nuclear Reactors
101	Shri Santanu Roy	03.01.12	Design of Two Phase Flow Meter using Gamma Ray Densitometer Technique for Blow Down Experiments
102	Shri Yuva Raj Nitin	03.01.12	Modelling and Optimization of Various Process Parameters in the Positron Emission Tomography (PET) Radiochemistry Model by the use of Statistical Process Control Methods
103	Ms. Swatilekha Bhattacherjee	03.01.12	Wireless Sensors Network for Process Variables Measurement
104	Shri Anoj Kumar	03.01.12	Neutronic Signal Processing for Signal from Fission Counter for Measurement of Flux in a Fasr Breeder Reactor
105	Shri Govind Kumar Mishra	03.01.12	Design and Development of Embedded System for FBR-500 Mwe Reactor Power Setback System
106	Shri R. Nanda Kumar	03.01.12	Thermal Hydraulic Design of Sodium Heated Once Through Steam Generator Through 1-D and 3-D CFD Simulations
107	Shri Sunil Kumar Sahu	03.01.12	Design and Development of a Highly Stable High Voltage Power Supply and Evaluation of High Frequency Transformer Winding Techniques
108	Shri Arya Das	03.01.12	Studies on Osmotic Transport of Water in Liquid Emulsion System
109	Shri Jagannath Sahu	03.01.12	Development of Simplified Designer Method for Seismic Analysis of Piping System with Non-linear Supports
110	Shri Muthu Saravanan	03.01.12	Numerical Investigation of Single Sodium Droplet Combustion in Atmospheric Air
111	Shri Pradeep Kumar Gupta	21.01.12	Studies on Self Pulsing Operation in Nd3+ Doped Vanadate Crystal under Quasi-3 Level Laser Transition at 914 nm
112	Shri Deepak Daiya	21.01.12	Experimental and Theoretical Studies on Large Beam Size Pulse Compression using Tiled Grating Compressor
113	Shri Vivek Singh	21.01.12	Transverse Laser Cooling of an Atomic Beam of Meta Stable Kr Atoms
114	Shri Chiranjit Debnath	21.01.12	Synthesis of Lithium Niobate Nanoparticles by Sol-Gel Method
115	Shri Abin C. Joy	21.01.12	Development of Online Tsunami Alerts Software using Multi Station Tide Gauge Data
116	Ms. Rajni Modi	21.01.12	Study of Aerosol Deposition in Piping System under Flow Conditions

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
117	Shri Saikat Sen	09.03.12	Analytical and Experimental Investigation into Thermowell Design for its Use in Nuclear Power Plants
118	Shri Rupesh Kumar Choudhary	21.01.12	Studies on Deposition and Characterization of Aluminium Nitride Coatings
119	Shri Nigam Kumar Singh	21.01.12	Development of an Adaptive Filtering Technique for Channel Equalization of Magnetic Flux Leakage(MFL) Sensor Channel
120	Shri Rajesh Patel(BARCTS, RRCAT)	21.01.12	Classification of Visual Evoked EEG Responses on the Presentation of Symbols Corresponding to Numbers using Support Vector Machine
121	Shri Sourabh Agarwal	21.01.12	Separation Studies of Cesium by Ion Exchange Process using Ammonium Molybdophosphate-Polyacrylonitrile(AMP-PAN) Resin
122	Shri Khan Mohammad Khan	21.01.12	Combined Raman Spectroscopy-Optical Coherence Tomography(RS-OCT) for Tissue Analysis
123	Shri Lingam Srinivas	21.01.12	Analysis and Design of Phase Staggered PWM Generation for Switching Power Converters using FPGA
124	Shri Rahul Jain	21.01.12	Design and Testing of Processing Electronics for a Double Slit Type Beam Emittance Monitor
125	Shri Thondapu Shivananda Reddy	21.01.12	Analytical and Experimental Investigation for Minimising Parasitic Components in High Frequency, High Voltage Transformers
126	Shri Surajit Ghosh	21.01.12	Design and Development of Trimmer Control System of RF System of K-130 Cyclotron
127	Shri Dheeraj Sharma	23.01.12	FPGA Based Digital Low Level RF Feed-back Control System for Accelerators
128	Shri T. Sakthivel	23.01.12	Effect of Specimenn Thickness on Type IV Cracking in Modified 9Cr-1Mo Steel Weld Joint
129	Shri Vipin M. V.	23.01.12	Drift Status Monitoring for Field Instrument to Minimize the Calibration Outage
130	Shri Balram Kumar Nayan(BARCTS, Mumbai)	23.01.12	Study Of Electron Beam Dump for 50 MeV, 100 kW Electron Beam
131	Shri Kunver Adarsh Pratap Singh	23.01.12	Study, Investigaion and Implementation of Low Level RF System for Characterizing SCRF Cavities in Vertical Test Stand at RRCAT
132	Shri Chandrakant Upadhyay	03.02.12	Online Identification of Failed Fuel Sub-Assembly Avoiding DND Trip and Necessity of FFLM using the Digital Signal Processing of Signals Obtained from various DND Systems
133	Shri A. Santhana Raj	03.02.12	Design and Development of Single Board Computer with FPGA Based 32 bit Processor Using IP Cores and High I/O Interfaces for Condition Monitoring of Rotating Equipments

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
134	Shri Rajesh Vadarevu	09.03.12	Design of VME Bus based 3 Channel ENDAT Interface Card for Absolute Optical Encoders
135	Shri Aditya Gour	11.02.12	Development of Softcore Processor based Remote Terminal Unit for FBR
136	Shri Dinesh M. Janglekar	11.02.12	Investigation of Depressurization in Once Through Type Steam Generators of Fast Breeder Reactors
137	Shri Jaideep Chakraborty	11.02.12	Fuzzy Logic Based Feed Water Flow Control Model for Fast Breeder Reactor
138	Ms. Reshmi V.	11.02.12	Modeling and Simulation of Electrolytic Partitioning of Uranium and Plutonium in PUREX Process
139	Shri Ashutosh Pratap Singh	11.02.12	Conceptual Design, Modeling and Simulation of In-Service Inspection(ISI) Device for Main Vessel and Safety Vessel of FBR having Reduced Annular Inter-Space(235+-25mm)
140	Shri Umesh Kumar	11.02.12	Study of Flow Accelerated Corrosion in Carbon Steel Feeder Pipes
141	Shri Abhishek Agarwal	11.02.12	Performance Evaluation of High Speed Axial Flux Synchronous Reluctance Motor
142	Ms. N. Praveena	11.02.12	Development of Glass Matrix for Vitrification of High Level Radioactive Liquid Waste of Kalpakkam Reprocessing Plant and Analysis of Physico-Chemical Characteristics of Vitrified Waste Product
143	Shri Aravind M.	11.02.12	Measurement of Fracture Toughness Along the Length of Unirradiated Pressure Tube
144	Shri Rohit Mishra	11.02.12	Study and Analysis of Data Logging System for INDUS Accelerators
145	Ms. Poonam Swain(BARCTS, HYD)	16.02.12	Study of Power Line Quality Degradation by Research Lab Equipments Due to Harmonics
146	Shri Vishal Gupta(BARCTS, HYD)	16.02.12	Design and Development of One Wire Communication Protocol for Gamma Ray Spectral Logging System
147	Shri Vipin Saklani(BARCTS, HYD)	16.02.12	Design and Development of Digital Signal Processing Based Multi Channel Analyzer
148	Shri Ashok Kumar	16.02.12	Stability of Thin Walled Torispherical Dished Head for Pool Type Sodum Cooled Fast Reactor
149	Shri Venkatesh Aligati	16.02.12	Diffusion of Actinides in an Electrorefiner(DIFAC): A Computational Model
150	Shri Vikram Shukla	16.02.12	CFD Based Analytical Studies on Hydrogen Gas Distribution & Passive Catalytic Recombiner Performance
151	Ms. Bhagyashree Deshpande	09.03.12	Network Access Control Through Vulnerability Assessment of an End-system
152	Shri Abinash Sahu	09.03.12	Development of an Indigenous, Graphite Walled Ionization Chamber based Dosimeter for Radiotherapy

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
153	Shri Gauri Shankar Sahoo	09.03.12	Directional Neutron Dose Distribution in Heavy Ion Accelerator Environment using Cr-39 Detectors with Improved Etching and Image Analyzing Technique
154	Shri Sabyasachi Rout	09.03.12	Multivariate Statistical Modeling of Geochemical Factors of Soils, Sediments and Ground Water
155	Shri Gaurav Baluni	09.03.12	Identification of Objects in Range Scan for Work Space Modeling
156	Shri Amit Kumar Pandey	09.03.12	Depth Finding for Robotics Application using Active Stereo Vision
157	Shri Saurabh Kumar Singh	09.03.12	Hydrodynamic Study of Transportation of Liquids through Capilliary Action
158	Shri Hirakendu Basu	09.03.12	Association and Transport of Trans Uranics and Trace Metals with Colloidal Particles in the Aquatic Environment
159	Shri Bathula Sreekanth	09.03.12	Modeling of Aerosol Particle Size Distribution from Burst Releases
160	Shri Lalit Mohan Sharma	09.03.12	Performance Optimization of Optical Computed Tomography(OCT) System for 3-D Dose Mapping in Radiotherapy using Gel Dosimeter
161	Shri Puneet Srivastava	09.03.12	Task Space Trajectory Planning Among Cooperative Robots through Mirror Motions
162	Ms. Poulami Chakraborty	09.03.12	Corrosion of 9Cr-1Mo Steel in Liquid Lead-Lithium Eutectic Loops, With and Without the Presence of Magnetic Field
163	Shri Prashal Mahadeo Khot	09.03.12	Fabrication of Thoria Based Mixed Oxide Fuel by Impregnated Agglomerate Pelletization (IAP) Technique and Their Characterization
164	Ms. Ankita Srivastava	09.03.12	Application of Formal Verification Techniques for Safety Analysis in a Model Based Design
165	Shri Bijendra Kumar	09.03.12	Direct Dissolution and In-situ Extraction of UO2 Fuel Pellet by Organic-Acid Complexes Without Supercritical Carbon Dioxide
166	Shri Balasubramonian	09.03.12	Thermodynamic Modeling of Non Idealities in Nuclear Solvent Extraction System
167	Shri Ushnish Sarkar	09.03.12	Development and Evaluation of Constrained Motion and Obstacle Avoidance in a Servo Manipulator
168	Shri Vakamalla Subba Reddy	09.03.12	Study of Influence of Oil Squeeze Film Damping on Vibration Response of Flexible Rotor during Crossing of Critical Speeds
169	Ms. Pammy Goswami	09.03.12	Study of the Effect of Silica and Aluminium Silicate on Micro Stucture and Thermo-Physical Properties of UO2 Fuel Pellets
170	Shri Soumya Prakash Nayak	09.03.12	Design, Development and Characterization of an Air Cored High Voltage Tapered Transmission Line Transformer

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
171	Shri Chetan Datta Kulkarni	09.03.12	Design, Analysis, Simulation and Control of Special Type Permanent Magnet Brushless DC Machine
172	Shri Rahul Krishna Bhat	28.03.12	Design Simulation of Stabilized Antenna Control System
173	Ms. S. Harjyoth Kaur(BARCTS, HYD)	28.03.12	Evolution of a Flux Mapping Algorithm using Kalman Filtering
174	Shri Omkar Ram Gogte	28.03.12	Design and Performance of High Speed Switched Reluctance Motor
175	Ms. Shelly Agarwal(NTC, Kalpakkam)	28.03.12	Assessing the Performance of Network Computer Based Systems
176	Ms. Paridhi Aggarwal(BARCTS, HYD)	28.03.12	Study of Plant and SubStation Equipment for 700 Mwe NPP & Stability Analysis

Titles of M.Phil theses for which results were notified during April 1, 2011 to March 31, 2012

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
1.	Shri Santu Kaity	09.03.12	Studies on Chemical Compatibitlity of T91 Cladding Material with Uranium based Metallic Fuels for Fast Reactor
2.	Shri Arijit Sengupta	18.05.11	Preparation and Characterization of High Purity Americium

Titles of M.Sc. (Engg.) theses for which results were notified during April 1, 2011 to March 31, 2012

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
1	Ms. Jyoti Jha	09.03.12	Design of High Frequency Coil and Glass Crust Thickness for Cold Crucible Induction Melting
2	Shri Sunil G. Kulkarni	11.05.11	Development of Control Algorithm for Linearization of Complex Gain of the Radio Frequency(RF) Power Amplifier
3	Shri Punit Arora	22.10.11	MultiAxial Fatigue Investigations on Carbon Steel Piping Material of Indian PHWRs
4	Shri Sushil Kumar Bahuguna	23.11.11	Realization of Real Time DSP Application Blocks

Sr.No	Name of the Student	Date of Notification of degree	Thesis Title
5	Shri Soumitra Kar	01.12.11	Synthesis and Characterization of Thin Film Mixed-Matrix Membranes for Separation Studies
6	Shri Indranil Banerjee	03.01.12	CFD Simulation of Flow through Single and Multi Vane Spiral Pump using Moving Node LSKUM-NS
7	Shri Mahesh Kumar Patankar	03.01.12	Design, Simulation and Virtual Fabrication of Silicon Nitride based Multi Functional MEMS Pressure Sensor
8	Shri Gautam Kumar Pandey	03.02.12	Investigation of Foot Leakage Flow Through The Top Labyrinth of PFBR Sub-Assemblies
9	Shri Pradip Kumar Biswas	03.01.12	Design, Analysis and Calibration of a Flexure based Micro Positioner

Annex 7

Memorandum of Understanding with Jadavpur University and with Indian Statistical Institute, Kolkata

MEMORANDUM OF UNDERSTANDING
BETWEEN
HOMI BHABHA NATIONAL INSTITUTE
AND
JADAVPUR UNIVERSITY

This MEMORANDUM OF UNDERSTANDING is made BY AND BETWEEN HOMI BHABHA NATIONAL INSTITUTE, a deemed to be University under the aegis of the Department of Atomic Energy, Government of India, having registered Office at Knowledge Management Group, BHABHA ATOMIC RESEARCH CENTRE, CENTRAL COMPLEX, MUMBAI – 400 085 and local Office at Dean Academic (Engineering Science), VECC, HBNI, Sector – I, Block – AF, Bidhan Nagar, Kolkata – 700 064, hereinafter referred to as the 'HBNI' (which expression unless excluded by or repugnant to the subject shall mean and include its successor-in-office and assigns) of the ONE PART

AND

JADAVPUR UNIVERSITY, a body corporate under Jadavpur University Act, 1981 having its Main Campus at 188, Raja S. C. Mallik Road, Kolkata – 700 032, hereinafter referred to as Jadavpur University (which expression shall where the context so admit include its successors and permitted assigns) of the OTHER PART.

For the purpose of academic programmes, the following units of DAE are the Constituent Institutions (CIs) of HBNI :

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

Registrar
JADAVPUR UNIVERSITY

JADAVPUR UNIVERSITY LAW CELL KOLKATA-700032

Ravinder Puri
R. Puri
Dean, Homi Bhabha
Institute
Training School Complex, Anushaktinagar, Mumbai 400

RECOGNISING the long-standing collaboration and cooperation between Jadavpur University and some of the CIs of HBNI (For example, School of Nuclear Application and Study at Jadavpur University) and in view of the establishment of HBNI, while continuing the existing programmes as of present, there is scope of further expansion of the existing collaboration and cooperation, the Jadavpur University and HBNI, collectively referred to as "Partner Institutes".

HEREBY agree to create a long-term institutional partnership in education and research, including the possibility of enhanced funding for collaborative research in areas of mutual interest supported by extramural funding through the Board of Research in Nuclear Sciences (BRNS), a body under DAE, according to the broad framework set forth in this Memorandum of Understanding (MoU).

1. **Objective**

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

2. **Modalities of Cooperation**

2.1. A student registered under a supervisor for M. Sc. (Engg.)/M.E/M.Tech./Ph.D. (Sc.)/Ph.D. (Engg.) in one Partner Institute (hereinafter referred to as Parent Institute) should have a co-supervisor from the other Partner Institute. To that end, the Supervisor from the Parent Institute of the student will identify and seek concurrence of a faculty member from the Partner Institute to take up the responsibility of being a co-supervisor. The arrangement will come into effect after the supervisor and the co-supervisor obtain approval for the same from their respective institute.

2.2. The students in one Partner Institute may carry a part of the course work in the other Partner Institute with credit transfer if applicable and in vogue. In particular,

a) The credits to be awarded to the student for attending a course in the Partner Institute will be determined by the Parent Institute of the student

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Registrar
JADAVPUR UNIVERSITY

2

Ravinder Puri
Dean, Homi Bhabha National Institute
Training School Complex, Anushaktinagar, Mumbai 400 094

in consultation with the partner institute.

b) To facilitate the process of a student attending a course in the Partner Institute, the supervisor of the student will put up the proposal (in consultation with appropriate academic bodies of the Department) to the Dean, Faculty of Engineering and Technology, Jadavpur University/Dean (HBNI) – as the case may be. This will be as per Ph.D. Regulations in vogue in the Partner Institutes.

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

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

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

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

2.7. In case of disputes, initial approach will be to sort that out amicably between the partners, otherwise law of the land will prevail.

3. Implementation

3.1. This MoU becomes effective from the later of the dates on which it is signed by the Partner Institutes and will be valid for an initial period of five years. The agreement may be extended by mutual consent. In case one Partner Institute wishes to cancel the MoU, written intent to that effect will have to be communicated by June of that year. The MoU in that event will cease to be operative from the end of the year i.e. from December 31 of the year in

JADAVPUR UNIVERSITY LANCELL KOLKATA-700032

Registrar
JADAVPUR UNIVERSITY

3

Ravinder Puri
डा. रवि. आर. पुरी/Dr. R. R. Puri
डीन, होमी भाभा राष्ट्रीय संस्था
Dean, Homi Bhabha National Institute

question. However, the commitments already made under this MoU before its lapse or termination will be fulfilled.

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

- From HBNI - (1) Dean, HBNI
  (2) Dean Academic (Engg. Sciences) of the CI.
- From Jadavpur University - (1) Dean, Faculty of Engg. and Technology
  (2) Principal Secretary, F.E.T.

Signed on 27th day of June, 2011

For and on behalf of
Homi Bhabha National Institute

(R.R.PURI)
Dean, Homi Bhabha National Institute

डॉ. आर. आर. पुरी/Dr. R. R. Puri
डीन, होमी भाभा राष्ट्रीय संस्थान
Dean, Homi Bhabha National Institute
प्रशिक्षण विद्यालय संकुल, अणुशक्तिनगर, मुंबई ४०० ०९४.
Training School Complex, Anushaktinagar, Mumbai 400 094.

Witnessed by:

R.P.Patel
Associate Dean
Homi Bhabha National Institute.

For and on behalf of
Jadavpur University

(Dr. Pradip Kumar Ghosh)
Registrar, Jadavpur University
Registrar
JADAVPUR UNIVERSITY

Witnessed by:

(Niladri Chakraborty)
Dean
Faculty of Engg & Technology
Jadavpur University.

JADAVPUR UNIVERSITY LAW CELL KOLKATA-700 032

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MEMORANDUM OF UNDERSTANDING

BETWEEN

HOMI BHABHA NATIONAL INSTITUTE

AND

INDIAN STATISTICAL INSTITUTE, KOLKATA

1. Preamble

The Indian Statistical Institute, Kolkata (hereafter referred to as ISI) is a premier institution devoted to the research, teaching and application of statistics, mathematics, computer science, natural sciences and social sciences and the Homi Bhabha National Institute (hereafter referred to as HBNI), a Deemed to be University, is a newly established institute under the aegis of the Department of Atomic Energy (hereafter referred to as DAE), Government of India. For the purpose of academic programmes, the following units of DAE are the Constituent Institutions (CIs) of HBNI:

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

RECOGNISING the long-standing collaboration and cooperation between ISI and some of the CIs of HBNI and in view of the establishment of HBNI, while continuing the existing programmes as of present, there is scope of further expansion of the existing collaboration and cooperation, the ISI and HBNI, collectively referred to as "Partner Institutes"

HEREBY agree to create a long-term institutional partnership in education and research, including the possibility of enhanced funding for collaborative research in areas of mutual interest supported by extramural funding through the Board of Research in Nuclear Sciences (BRNS), a body under DAE, according to the broad framework set forth in this Memorandum of Understanding (MoU).

1

2. Objective

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

3. Modalities of Cooperation

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

3.2 The M.Sc (Engg) / M. Tech. / Ph.D. students in one Partner Institute may carry a part of the course work in the other Partner Institute with credit transfer. In particular,

a) The credits to be awarded to the student for attending a course in the Partner Institute will be determined by the Partner Institute of the student.

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

3.3 The Parent Institute shall be responsible for paying to the Partner Institute the tuition fee, if any, for participation of its students in the course work conducted at the Partner Institute, provided it is approved a priori, by the competent authorities of the Parent Institute.

3.4 The exchange of faculty for lectures and research for short periods shall be initiated or further strengthened.

3.5 A mechanism shall be formulated to identify the research areas of

mutual interest and for possible funding for the same from BRNS.

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

4 Implementation

4.1 This MoU becomes effective from the later of the dates on which it is signed by the Partner Institutes and will be valid for an initial period of five years. The agreement may be extended by mutual consent. In case one Partner Institute wishes to cancel the MoU, written intent to that effect will have to be communicated. The MoU in that event will cease to be operative after six months from the date of communication. However, the commitments already made under this MoU before its lapse or termination will be fulfilled.

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

- From HBNI – Dean, HBNI
- From ISI – Dean of Studies

Signed on (date) ....22nd.....day of ....June....., 2011

For and on behalf of
Homi Bhabha National Institute

(R.B. GROVER)
Director, HBNI

For and on behalf of
Indian Statistical Institute, Kolkata

(BIMAL K. ROY)
Director, ISI
निदेशक / Director
भारतीय सांख्यिकी संस्थान
INDIAN STATISTICAL INSTITUTE
203, बैरकपुर ट्रंक रोड, Barrackpore Trunk Road, Kol-700 108.

Witness by:

(R.R. PURI)
Dean, HBNI

(BHABANI P. SINHA)
Dean of Studies, ISI
Dean of Studies
Indian Statistical Institute
203, Barrackpore Trunk Road
Kolkata-700 108

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Annexure 8

Receipts & Payments for the financial year ending on 31.3.2012

HOMI BHABHA NATIONAL INSTITUTE

RECEIPTS & PAYMENT ACCOUNT
FOR THE YEAR ENDING ON 31.03.2012

Previous Year	PAYMENTS	Current Year		Previous Year	RECEIPTS	Current Year	
Amt. (Rs.)		Amt. (Rs.)	**Amt. (Rs.)**	Amt. (Rs.)		Amt. (Rs.)	**Amt. (Rs.)**
				6672080.00	Opening balance		**8954617.00**
					(as per savings a/c 30128322512)		
				2593000.00	Receipt/Admission/Registration Fees		**4087192.00**
64584.00	Re-imbursement of tution fees		**169872.00**				
0.00	Financial Assistance for Ph. D Conf.		**503952.00**		Bank Interest on savings		
				115434.00	as on 30.06.2011	165708.00	
0.00	Miscellaneous expenditure		**56198.00**	138777.00	as on 31.12.2011	203163.00	**368871.00**
100.00	Bank Charges		**313.00**	10.00	Bank Charges	0.00	**0.00**
	(MICR SB CHQ-05072011)				(SC charges refunded)		
500000.00	Registration Charges		**10000.00**				
	(Processing fees for changes)						
0.00	**Furniture & Fixture**						
	Study Table & Chairs	50,625.00					
	Stainless Steel Cupboard	49,036.00					
	Hitachi Projector Lamp	30,859.00	**130520.00**				
0.00	**Revenue Expenditure**						
	Shreelipi Hindi Software	7,848.00	**7848.00**				
0.00	Membership Fees		**1025.00**				
0.00	Salaries & Wages		**184661.00**				
0.00	Printing & Stationery		**2360.00**				
8954617.00	Excess of Receipts over Payment		**12343931.00**				
	(represented by bank balance in						
	a/c 3012832251-2 as on 31.03.12)						
9519301.00			**13410680.00**	9519301.00			**13410680.00**

23/4/12

(Shri R. Pasupathy)
Dy. Controller of Accounts (F)

Volume 2 contains the following information :

Annex 1 : Composition of the Bodies of the Institute

Annex 2 : Composition of Standing Committees

Annex 3 : Faculty list updated upto March 2012

Annex 4 : Admission and Results Status

Annex 5 : Abstracts of Ph.D. theses for which results were notified during April 1, 2011 to March 31, 2012

Annex 6 : Titles of M.Tech, M.Phil & M.Sc. (Engg.) theses for which results were notified during April 1, 2011 to March 31, 2012

Annex 7 : Memorandum of Understanding with Jadavpur University and with Indian Statistical Institute, Kolkata

Annex 8 : Receipts & Payments for the financial year ending on 31.3.2012

DIRECTOR
Prof. R. B. Grover
Email : rbrgrover@hbni.ac.in

DEAN
Prof. R. R. Puri
Email : rrpuri@hbni.ac.in

ASSOCIATE DEAN AND PUBLIC INFORMATION OFFICER
Dr. R.P. Patel
Email rppatel@hbni.ac.in

For more details, please visit website : *www.hbni.ac.in*

Back cover page : Rear entrance of Training School Complex
Anushaktinagar, Mumbai 400 094

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Bhabha Atomic Research Centre, Mumbai 400 085, India