THE INSTITUTE OF MATHEMATICAL SCIENCES

C. I. T. Campus, Taramani,

Chennai - 600 113.

ANNUAL REPORT

Apr 2009 - Mar 2010

Telegram: MATSCIENCE Fax: +91-44-2254 1586

Telephone: +91-44-2254 3100, 2254 1856 DID No.: 2254 3xxx (xxx = extension)

Website: http://www.imsc.res.in/

e-mail: office@imsc.res.in

Foreword

This year's annual report is being presented with three of the Institute members receiving fellowships of science academies and two of them receiving various awards.

In the last few years, we have seen an increase in the quantum of students joining us and this year we continue to see this trend. Currently the numbers are coming close to 100 this year. We also see a change in the profile of students, with many of them better prepared than a decade ago. I especially feel proud that our outreach programmes and efforts of our faculty individually sometimes and Institutionally at others has contributed in part to this change.

I am also happy to report that the members of our Institute continue to undertake this effort in various forms, including the elctronic media to reach a wider audience of students.

As with every year, this year continues to be academically productive for the members of our Institute. We organised several conferences and workshops this year. These include the school on Loop Quantum Gravity, 2nd Complex systems school, ATM workshops on Topology of Manifolds and Analytic Number Theory at IMSc.

The off-site conference organization by IMSc faculty continue to vigorous. This academic year the conference organized outside are : Mathematical Physics symposium at the RMS annual conference, Interactive Training camp at IMA Bhubaneswar, Annual Foundation School, Data to Theory approach to LHC physics, Structural aspects of Rationality, Molecular Motors, Tracks and Transport, Formal Theories of Communication, Italy - India conference on Diophantine equations and analytic number theory, Instructional workshop on graph colourings and the Arhus-Chennai computational complexity workshop.

The Subashish Nag Memorial lecture was given this year by Prof Georg Schumacher of the University of Marburg, Germany.

This report was compiled through the efforts of a Annual Report Committee comprising of Drs Krishna Maddaly, V Arvind, Rahul Sinha, Paul Pandian, Mrs Usha Devi and Mr Parthiban. I owe my gratitude to all of them.

May, 2010 **R. Balasubramanian**

Contents

Chapter 1

The Institute

1.1 Board

Dr **P. Mukherjee**, IA & AS., Joint Secretery(R&D), Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Shri **V. R. Sadasivam**, IDAS, Joint Secretary (Finance) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Shri **K. Ganesan**, IAS, Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St. George, Chennai 600 009
(**Member**)

Prof. **R. Balasubramanian**, Director, The Institute of Mathematical Sciences, Chennai
(**Member Secretary**)

1.2 Executive Council

Prof. **S. K. Joshi**, Honorary Scientist Emeritus CSIR, Vikram Sarabhai Professor, National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi 110 012
(**Chairman**)

Prof. **Mustansir Barma**, Director, Tata Institute of Fundamental Research, Mumbai 400 005
(**Member**)

Prof. **C. S. Seshadri**, Director, Chennai Mathematical Institute, Plot Nos. D19 & D20, SIPCOT Information Technology Park, Padur Post, Siruseri-603 103, Kancheepuram District.
(**Member**)

Prof. **Amitava Raychaudhuri,** Director, Harish Chandra Research Institute, Chhatnag Road, Jhusi, Allahabad 211 019
(**Member**)

Dr. **P. Mukherjee**, IA&AS., Joint Secretary (R&D) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Shri **V. R. Sadasivam**, IDAS., Joint Secretary (Finance) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Shri **K. Ganesan**, I.A.S., Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St. George, Chennai 600 009
(**Member**)

Prof. **R. Balasubramanian**, Director, The Institute of Mathematical Sciences, Chennai
(**Member Secretary**)

1.3 Faculty

Name	*Userid*	*Tel. Ext.*

Mathematics

Balasubramanian R.	balu	200
Chakraborty Partha Sarathi	parthac	252
Chatterjee Pralay	pralay	305
Iyer Jaya N.	jniyer	306
Kesavan S.	kesh	209
Kodiyalam Vijay	vijay	212
Krishna M	krishna	309
Mohari, Anilesh	anilesh	314
Mukhopadhyay Anirban	anirban	251
Nagaraj D. S.	dsn	271
Paranjape Kapil H.	kapil	325
Prasad Amritanshu	amri	207
Raghavan K. N.	knr	264
Sankaran P.	sankaran	211
Sanoli Gun	sanoli	202
Srinivas K.	srini	215
Sunder V. S.	sunder	210

Physics

Adhikari Ronojoy	rjoy	253
Anishetty Ramesh	ramesha	321
Baskaran G.	baskaran	303
Basu Rahul	rahul	311
Date G.	shyam	304
Digal Sanatan	digal	259
Ghosh Sibasish	sibasish	216

Govindarajan T. R.	trg	205
Indumathi D.	indu	302
Jayaraman T.	jayaram	
Kalyana Rama S.	krama	313
Kaul R.	kaul	317
Menon Gautam I.	menon	266
Mishra A. K.	mishra	323
Murthy M. V. N.	murthy	326
Partha Mukhopadhyay	parthamu	260
Prashanth Jaikumar R.	jaikumar	261
Rajesh Ravindran	rrajesh	255
Ray Purusattam	ray	319
Sathiapalan Balachandran	bala	320
Shankar R.	shankar	327
Sharatchandra H. S.	sharat	254
Shrihari Gopalakrishna	shri	315
Siddharthan Rahul	rsidd	204
Simon R.	simon	120
Sinha Nita	nita	267
Sinha Rahul	sinha	268
Sinha Sitabhra	sitabhra	301
Sinha Sudeshna	sudeshna	203
Sujay K.Ashok	sashok	265
Syed Raghib Hassan	shassan	208
Vemparala Satyavani	vani	257
Venkata Suryanarayana Nemani	nemani	263

Theoretical Computer Science

Arvind V.	arvind	218
Kamal Lodaya	kamal	310

Meena B. Mahajan	meena	307
Venkatesh Raman	vraman	220
Ramanujam R.	jam	269
Subramanian C.R.	crs	324
Saket Saurabh	saket	213
Vikram Sharma	vikram	316

1.4 Scientific Staff

Subramoniam G.	gsmoni	221
Ravindra Reddy	ravi	222

1.5 Technical Staff

Paul Pandian M.	pandian	383
Arangarajan R.	arajan	247
Mohan S.	mohan	300
Venkatesan G.	gvenkat	384
Usha Devi P.	usha	385

1.6 Project Scientists

Balakrishnan Radha	radha	219
Mani H.S.	hsmani	316
Rajasekaran G.	graj	206

1.7 Project Consultant

Jayaraj V.	jayaraj	276

1.8 Project Staff

Adwait Mevada	adwait	170
Archana S.	archana	167
Dhinesh Kumar V.	dinesh	226
Gayathri Jayaraman	gjayaraman	170
Hari Priya	tvhpriya	170
Jayakumar	njkumar	149
Kandavel	kandavel	149
Kavita Gangal	kavita	170
Mangalapandi	mangal	217
Prabhu	prabhugtt	149
Raina P.M.	raina	226
Sharanya Ravi	sharanya	170
Sivasubbu Raj B.	sivaraj	340
Sridhar S.	ssridhar	170
Srinivasan N.S.	nss	375
Srinivasan G.	gsvasan	170
Umadevi S.	umadevi	170

1.9 Post-Doctoral Fellows

Mathematics

Alexander Clark	gary	258
Jitendriya Swain	jitumath	103
Kunal Mukherjee	kunal	379
Lavanya S	lavanya	256
Mahender Singh	mahender	103
Prem Laxman Das	mprem	
Subhash B.	subhash	102
Sudeep Singh Parihar	sudeep	256
Tamil Selvi A.	tamilselvi	308
Tanusree Khandai	tanusree	258
Tejas Kalelkar	tejas	105
Vivek Mohan Mallick	vivekm	104

Physics

Anatha Pradhap Mishra	apmishra	380
Ayan Chatterjee	kchatterjee	101
Debaprasad Maity	debu	
Gnanasangeetha	sangee	322
Ponmurugan M.	mpn	308
Meena Devi	meenadevi	308
Moitri Maity	sujit	102
Mridupawan Deka	mpdeka	101
Muthukumar B.	bmuthu	104
Rakesh Tibrewala	rtibs	260
Rupak Dutta	rupak	260
SanthoshG.	santthosh	322
Shiv Chaitanya K.V.S.	shivchait	101
Subhadip Mitra	subhadip	258

Sujit Kumar Choudhary	sujit	105

Theoretical Computer Science

Ramesh H.	hramesh	203
Karthick T.	karthick	258

1.10 Ph.D. Students

Name	*Userid*	*Tel. Ext.*

Mathematics

Ajay Singh Thakur	thakur	239
Anil Kumar C.P.	anilkcp	242
AnoopT.V.	tvanoop	242
Chattopadhyay Pratyusha	pratyusha	112
Dhriti Ranjan Dolai	dhriti	171
Dubey Umesh Venkatesh	dubey	239
Kajal Das	kajaldas	171
Krishanu Dan	krishanu	172
Krishna K.S.	ksk	122
Krishnan Rajkumar	rkrishnan	239
Madhushree Basu	madhu	114
Mubeena T.	mubeena	122
Pal Sarbeswar	spal	107
Pampa Paul	pampa	241
Panchugopal Bikram	panchugopal	171
Pooja Singla	pooja	
Prateep Chakraborty	prateepc	171
Prem Prakash Pandey	premsmg	122
Ravinder B.	bravinder	171
Samuel Preena	preena	112

Satyajit Guin	gsatyajit	171
Sundar S.	ssundar	239
Swagata Sarcar	swagata	
Tapas Chatterjee	tapasc	171
Tupurani Srikanth	tanumoy	241

Physics

Abhrajit Laskar	abhra	242
Amit Kumar Bhattacharjee	amit	238
Anoop Varghese	anoop	116
Archana Mishra	amishra	241
Basudha Mishra		
Belliappa A.B.	belliappa	241
Bhowmick Samrat	samr	109
Chakravarty Gaurav	gaurav	236
Dibyakrupa Sahoo	dibyakrupa	242
Diganta Das	diganta	113
Karthik I.	ikarthik	111
Krishnakumar Sabapathy	kkumar	116
Mohd. Ismail	mohammad	242
Neeraj Kumar Kamal	neeraj	106
Nirmalya Kajuri	nirmalya	241
Oindrila Ghosh	oindrila	241
Pinaki Patra	pinaki	241
Pradeep Kanth J. Maruthi	maruthi	236
Rajarshi Pal	srajarshi	242
Rajeev Singh	rajeev	116
Rohan Raghava Poojary	ronp	237
Saket Abhinav	abhinav	238
Sandeep K. Goyal	goyal	119
Sandipan Sengupta	sandi	113

Sircar Nilanjan	nilanjan	118
Somdeb Ghose	somdeb	119
Soumyajit Pramanik	soumyajit	115
Sourish Kumar Maitra	sorish	237
SriluckshmyP.V.	sriluckus	240
Srimoyee Sen	srimoyee	172
Sudhir Narayanan Pathak	sudhirnp	106
Syed Mohammed Kamil	kamil	106
Tanmay Singal	stanmay	242
Tanumoy Mandal	tanumoy	114
Tathagata Ghosh	ghoshtatha	237
Vallan Bruno Cruz A.	bruno	108
Varun Pradeep Vaidya	varunvaidya	172

Theoretical Computer Science

Aiswarya Cyriac	aiswarya	172
Amaldev	amal	111
Aravind N.R.	narvind	299
Bal Sri Shankar	balsri	172
Das Bireswar	bireswar	115
Geevarghese Philip	gphilip	110
Karteek Srinivasaiah	karteek	114
Kunal Dutta	kdutta	237
Neeldhara Misra	neeldhara	119
Prajakta Nimbhorkar	prajakta	240
Praveen M.	praveen	111
Pushkar S. Joglekar	pushkar	240

Raghavendra Rao B.V.	bvrr	299
Ramachandra Phawade	ramachandra	108
Ramanujan M.S.	msramanujan	238
Santanu Das	sanjone	171
Sheerazuddin S.	sheeraz	108
Somnath Sikdar	somnath	272
Soumya Paul	soumya	121
Sreejith A.V	sreejith	110
Srikanth Srinivasan	srikanth	238
Yade Vasudev	yadu	121

1.11 Administrative Staff

Name	*Userid*	*Tel. Ext.*
Saraswathi Ramaraj *Registrar*	registrar	150
VishnuPrasad, S. *Admn. Officer*	svishnu	151
Gayatri, E. *Accounts Officer*	gayatri	152

Amulraj, D.
Ashfack Ahmed
Babu, B.
Balakrishnan, J.
Ganapathi, R.
Geetha, M.
Gopinath, S.
Indra, R.
Janakiraman, J.
Jayanthi, S.
Johnson, P.
Moorthy, E.
Munuswamy, N.
Muthukrishnan, M.
Nityanandam, G.
Otheeswaran Usha
Padmanabhan, T.
Parijatham, S.M.
Parthiban, V.
Prema, P.
Radhakrishnan, M. G.
Rajasekaran, N.
Rajendran, C.
Ramesh, M.
Ravichandran, N.
Ravindran, A.
Rizwan Shariff, H.
Sankaran, K.P.
Selvaraj, M.
Tamil Mani, M.
Varadaraj, M.
Vasudevan, T.V.
Venugopal, T.
Vidhya Lakshmi

Chapter 2

Research and Teaching

2.1 Mathematics

2.1.1 Research Summary

Algebra

An attempt is underway to generalize results of [**R**] to Schur algebras.

Algebraic Geometry

The study of mappings from projective spaces to Grassmanian and the cohomology classes arising out of such maps being continued.

Analytic Number Theory

A general method to prove the irrationality of certain constants using the Padé approximations of asymptotic expansions is being studied. A complete proof of the irrationality of $\zeta(2)$ has been developed using this method.

Group Theory

Is every locally compact abelian group which admits a symplectic self-duality isomorphic to the product of a locally compact abelian group and its Pontryagin dual? Several sufficient conditions, covering all the typical applications were found. Counterexamples were produced by studying a seemingly unrelated question about the structure of maximal isotropic subgroups of finite abelian groups with symplectic self-duality (where the original question always has an affirmative answer) [**P7**].

Mathematical Physics

A version of Szego's theorem for the d-dimensional lattice is proved. The version proved obtains the density of states of a bounded discrete Shrodinger type operator with respect to a Schrodinger type operator with discrete spectrum as the density of states of the associated symbols of these operators.

Modular forms

One of the oft-quoted conjecture in the theory of modular forms is Lehmer's conjecture. Let

$$\Delta(z) \;=\; \sum_{n=1}^{\infty} \tau(n) e^{2\pi i n z}.$$

be the cusp form of Ramanujan. Then Lehmer's conjecture asserts that $\tau(p) \neq 0$, where p is a prime. Equivalently, for any $n \geq 1$, $\tau(n) \neq 0$. In general, proving such non-vanishing of all Fourier coefficients of a modular form is rather difficult. In [**G3**], a variant of Lehmer's conjecture was considered. More precisely, for a normalised eigenform $f(z) = \sum_{n=1}^{\infty} a(n) e^{2\pi i n z}$ of weight 2 with rational integer Fourier coefficients $\{a(n)\}$, let $S := \{n \leq x \mid (n, a(n)) \;=\; 1\}$. When f is of CM-type, it has been proved that

$$\#\{n \leq x \mid (n, a(n)) = 1\} = (1 + o(1)) \frac{u_f x}{\sqrt{\pi} (L_3(x) \log x)^{\frac{1}{2}}} \; ,$$

where the constant u_f can be made explicit.

In [**G2**], a conjecture of Zagier has been established. This conjecture asserts the existence of a canonical subspace of the space of modular forms of weight $k+1/2$ (k even) for $\Gamma_0(4N), N$ odd and square free which is mapped into the space of modular forms of weight $2k$ for the full modular group under the Shimura map $\mathcal{S}_t$ when t is congruent to 1 modulo 4. This subspace is different from the Kohnen's + space and contains $\Theta^{2k+1}(z)$ when $k \equiv 2 \pmod 4$.

Non Commutative Geometry

The local index formula of Connes and Moscovici produces the chern character as a cyclic cocycle prescribed directly in terms of the spectral data underlying the noncommutative manifold. This formula shows features not seen in the classical case of Riemannian spin manifolds. But one can apply this formula provided the under lying spectral triple is regular with finite dimension spectrum. There are not many examples of these. We devise general schemes to produce regular spectral triples with finite dimension spectrum. More elaborately we show that the existence weak heat kernel expansion (WHKE) allows one to conclude regularity and finiteness of dimension spectrum. Then we prove that if the original spectral triple satisfies WHKE then it's quantum double suspension will also satisfy. Finally we show that the usual heat kernel expansion implies WHKE. Therefore combining all these we get if we iteratively quantum double suspend compact spin manifolds we get regular spectral triples with finite dimension spectrum.

Noncommutative geometric investigation of spaces often requires good understanding of the K-groups of the associated C*algebras. We compute the K-groups of quantum SU(n)/SU(n-2) and explicitly identify one set of generators.

Operator Algebras

Our efforts were mainly concentrated on [**Ko4**], which is a continuation of our earlier work [**Ko3**] on the GJS construction, from depth two to arbitrary finite depth. We first showed that there was an analogue of the GJS construction whose input data was not a subfactor planar algebra but a weighted bipartite graph. We then used this to show that any standard invariant (or subfactor planar algebra), with finite depth, could be realised by a subfactor of an interpolated free group factor with finite parameter. This is to be compared with the result proved by Popa-Shlyakhtenko asserting that any standard invariant (or subfactor planar algebra) could be realised by a subfactor of the free group factor LF_n.

It was shown in [**Ko5**] that a subfactor planar algebra of finite depth is singly generated and finitely presented.

Noncommutative geometric investigation of spaces often requires good understanding of the K-groups of the associated C*algebras. We compute the K-groups of quantum SU(n)/SU(n-2) and explicitly identify one set of generators.

Representation Theory

A simple algebraic approach to the study of the Weil representation associated to a finite abelian group was developed. As a result, a simple proof of a generalisation of a well-known formula for the absolute value of its character was obtained. A new result about its decomposition into irreducible representations was obtained [**P6**]. Further work, as yet unpublished, applies techniques from enumerative combinatorics to extract deeper information about this representation.

The Stone-von Neumann-Mackey Theorem for locally compact abelian groups was proved using the Peter-Weyl theorem and the theory of Fourier transforms for finite dimensional real vector spaces. A theorem of Pontryagin and van Kampen on the structure of locally compact abelian groups (which is evident in any particular case) was assumed [**P5**].

Inductive algebras for the irreducible unitary representations of the universal cover of the group of unimodular two by two matrices were classified. The classification of homogeneous shift operators is obtained as a direct consequence. This gave a new approach to the results of Bagchi and Misra [**P8**].

Topology

The Stone-Čech compactification of products of the Alexandroff line (and the half-line) have been explicitly described. Using such a description, the torsion subgroup of the group of all self-homeomorphisms of these spaces have been classified (up to isomorphism). [**Aw**]

A characterization of groups which act chaotically on the space of rational numbers has been obtained. It has been shown that there are continuously many pairwise distinct conjugacy classes of such actions of many interesting groups (which include the infinite cyclic groups and free groups finite rank). [**Sa**]

We show that a surface S embedded in a closed, orientable 3-manifold M is incompressible if and only if for every triangulation τ of M, S can be isotoped to a τ-normal surface $S(\tau)$ of minimal PL-area.[**K**]

We investigated free involutions on finitistic spaces X having the mod 2 cohomology algebra of the product of two projective spaces and determined completely the possible mod 2 cohomology algebra of the orbit space. We also gave applications of our results to the non-existence of $\mathbb{Z}_2$-equivariant map from $\mathbb{S}^k \to X$.

In a joint project with I B S Passi and M K Yadav, we investigated the well known problem of lifting and extension of automorphisms in abelain group extensions.

Transcendental number theory

The classical digamma function is the logarithmic derivative of the gamma function. Understanding of the values of this transcendental function at rational arguments is crucial for studying the non-vanishing as well as algebraic nature of L-functions associated to periodic functions at the critical point $s = 1$.

For a number field K over which the q th cyclotomic polynomial is irreducible, it has been conjectured by Murty-Saradha that the the $\varphi(q)$ numbers $\psi(a/q)$ with $1 \leq a \leq q$ and $(a, q) = 1$ are linearly independent over K. In [**G4**], it has been proved that there exists a number q_0 such that the conjecture is true for all q co-prime to q_0.

In the same work, an alternate interpretation of a conjecture of Rohrlich about multiplicative independence of the gamma values has been formulated. This interpretation allowed us to make some progress in relation to this conjecture. In a more ambitious direction, Lang had suggested a much stronger generalisation of the conjecture of Rohrlich. Some progress in relation to the Lang-Rohrlich conjecture has also been made.

2.1.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**A**]
S. D. Adhikari*, S. Gun, and P. Rath*.
Remarks on some zero-sum theorems.
Proc. Indian Acad. Sci. Math. Sci., **119(no. 3)**, 275, 2009.

[**At**]
Tamilselvi A.
Robinson - schensted correspondence for the g - vertex colored partition algebra.
2009.
(To be published).

[**Aw**]
V. V. Awasthi and P. Sankaran.
Torsion subgroups of homeomorphism groups of products of the long lines.
2009.
(Submitted).

[**B**]
R. Balasubramanian, Garg Gagan*, **and C.E VaniMadhavan***.
Analysis of the lattice sieve.
In *Number Theory and Applications*, page 1 to 13. Hindustan Book Agency, May 2009.
(Submitted).

[**C**]
Partha S. Chakraborty and Sundar Shanmugasundaram.
K-groups of some quantum steiffel manifolds.
2010.
(Preprint: ***).

[**Ch1**]
Partha Sarathi Chakraborty and Arupkumar Pal*.
Equivariant spectral triples and poincaré duality for $su_q(2)$.
Transactions of the American Mathematical Society, **362(8)**, 4099, 2010.
(To be published).

[**Ch2**]
Partha Sarathi Chakraborty and Sundar Shanmugasundaram.
The weak heat kernel expansion and the quantum double suspension.
2010.
(Preprint: ***).

[**Cha1**]
Rabeya Basu*, **Pratyusha Chattopadhyay, and Ravi A. Rao***.
Some remarks on symplectic injective stability.
2010.
(Submitted).

[**Cha2**]
Pratyusha Chattopadhyay and Ravi A Rao*.
Elementary symplectic orbits and improved k_1-stability.
Journal of K-Theory, 2010.
(To be published).

[**G1**]
S. Gun.
On solutions of polynomial congruences.
Acta Arithmetica, 2010.
(To be published).

[**G2**]
S. Gun, M. Manickam*, **and B. Ramakrishnan***.
A canonical subspace of modular forms of half-integral weight.
Math Annalen, 2009.
(To be published).

[**G3**]
S. Gun and K. Murty*.
A variant of Lehmer's conjecture, ii: The CM-case.
Canadian Journal of Mathematics, 2009.
(To be published).

[**G4**]
S. Gun, M. R. Murty*, **and P. Rath***.
Linear independence of digamma function and a variant of a conjecture of Rohrlich.
J. Number Theory, **129(no. 8)**, 1858, 2009.

[**G5**]
S. Gun, M. R. Murty*, **and P. Rath***.
Transcendence of the log gamma function and some discrete periods.
J. Number Theory, **129(no. 9)**, 2154, 2009.

[**G6**]
S. Gun, M. R. Murty*, **and P. Rath***.
On a conjecture of Chowla and Milnor.
2010.
(Submitted).

[**K**]
Tejas D. Kalelkar.
Incompressibility and normal minimal surfaces.
Geometriae Dedicata, **142(1)**, 61, 2009.

[**Ko1**]
Vijay Kodiyalam and V. S. Sunder.
On the Guionnet-Jones-Shlyakhtenko construction for graphs.
2009.
(Submitted).

[**Ko2**]
Vijay Kodiyalam and V. S. Sunder.
From subfactor planar algebras to planar algebras.
International Journal of Mathematics, **20(10)**, 1207, 2009.

[**Ko3**]
Vijay Kodiyalam and V. S. Sunder.

Guionnet-Jones-Shlyakhtenko subfactors associated to finite-dimensional Kac algebras.
Journal of Functional Analysis, **257**, 3930, 2009.

[**Ko4**]
Vijay Kodiyalam and V.S. Sunder.
On the Guionnet-Jones-Shlyakhtenko construction for graphs.
2009.
(Preprint: e-print arXiv (math. OA) 0911.2047).

[**Ko5**]
Vijay Kodiyalam and Srikanth Tupurani.
Universal skein theory for finite depth subfactor planar algebras.
2010.
(Submitted).

[**M**]
Krishna M and Jitendriya Swain.
Szego theorem on the lattice.
2010.
(Preprint:).

[**Mu1**]
Florian Luca*, **Anirban Mukhopadhyay, and Srinivas Kotyada**.
Some results on oppenheim's "factorisatio numerorum" function.
Acta Arithmetica, **142(1)**, 41, 2010.

[**Mu2**]
Florian Luca*, **Anirban Mukhopadhyay, and Kotyada Srinivas**.
Some results on oppenheim's "factorisatio numerorum" function.
Acta Arithmetica, 2009.
(To be published).

[**N**]
D. Nagaraj and Laytimi Fatima*.
"vector bundles generated by sections and morphisms to grassmannians".
In *"Quadratic forms, linear algebraic groups, and cohomology"*, Jun 2010.
(To be published).

[**P1**]
J. S. Athreya*, **Anish Ghosh***, **and Amritanshu Prasad**.
Ultrametric logarithm laws I.
Discrete and continuous dynamical systems, Series S, **2**, 337, 2009.

[**P2**]
Anne-Marie Aubert*, **Uri Onn***, **Amritanshu Prasad, and Alexander Stasinski***.
On cuspidal representations of general linear groups over discrete valuation rings.
Israel Journal of Mathematics, **175**, 391, 2010.

[**P3**]
Nir Avni*, Uri Onn*, Amritanshu Prasad, and Leonid Vaserstein*.
Similarity classes of 3×3 matrices over local principal ideal rings.
Communications in Algebra, **37(8)**, 2601, 2009.

[**P4**]
Thomas J. Haines*, Robert E. Kottwitz*, and Amritanshu Prasad.
Iwahori-hecke algebras.
Journal of the Ramanujan Mathematical Society, 2009.
(To be published).

[**P5**]
Amritanshu Prasad.
An easy proof of the Mackey-Stone-von Neumann theorem.
2009.
arXiv:0912.0574 (Submitted).

[**P6**]
Amritanshu Prasad.
On character values and decomposition of the Weil representation associated to a finite abelian group.
Journal of Analysis, 2010.
arXiv:0903.1486 (To be published).

[**P7**]
Amritanshu Prasad, Ilya Shapiro*, and M. K. Vemuri*.
Locally compact abelian groups with symplectic self-duality.
2009.
arXiv:0906.4397 (Submitted).

[**P8**]
Amritanshu Prasad and M. K. Vemuri*.
Inductive algebras and homogeneous shifts.
Complex analysis and operator theory, **Online First**, 1, 2009.

[**P9**]
Amritanshu Prasad and M. K. Vemuri*.
Inductive algebras for finite Heisenberg groups.
Communications in Algebra, **38**, 509, 2010.

[**R**]
K. N. Raghavan and Shyamashree Upadhyay*.
Hilbert functions of points on Schubert varieties in Orthogonal Grassmannians.
Journal of Algebraic Combinatorics, **31(3)**, 355, 2010.

[**S**]
V. Lakshmibai*, P. Sankaran, and K. N. Raghavan.

Wahl's conjecture holds in odd characteristics for symplectic and orthogonal Grassmannians.
Central European Journal of Mathematics, **7(2)**, 214, 2009.

[**Sa**]
Parameswaran Sankaran.
Chaotic group actions on the rationals.
Indian Journal of Pure and Applied Mathematics, **40(3)**, 221, 2009.

[**Si1**]
Inder Bir Singh Passi*, **Mahender Singh, and Manoj Kumar Yadav***.
Automorphisms of abelian group extensions.
Journal of Algebra, 2010.
(To be published).

[**Si2**]
Mahender Singh.
Orbit spaces of free involutions on the product of two projective spaces.
Results in Mathematics, **57(1-2)**, 53–67, 2010.

[**Sn1**]
Nagaraj D. S and Parvati Shastri*.
On the determination of diophantine triples.
In S. D. Adhikari and B. Ramakrishnan, editors, *Number Theory and Applications.*, page 139. Hindustan book Agency, Sep 2009.

[**Sn2**]
Biswas I* **and Nagaraj D. S**.
Vector bundles over a nondegenerate conic.
J. Aust. Math. Soc., **86(no. 2)**, 145, 2009.

[**Su1**]
V. S. Sunder.
von Neumann algebras and ergodic theory.
In *'Perspectives in Mathematical Sciences II, Pure Mathematics'*, page 199. World Scientific, Jun 2009.

[**Su2**]
S. Jijo* **and V. S. Sunder**.
Kaç algebras, quantum doubles and planar algebras.
Contemporary mathematics, **490**, 97, 2009.

[**Sun**]
V. S. Sunder.
Light cones are intervals.
In Sheldon Axler et al, editor, *Operator Theory: Advances and Applications, Vol. 207*, page 359. Birkhauser Verlag, Basel, Switzerland, 2010.
(To be published).

[**Sund**]
V.S. Sunder.
Paul Halmos - expositor *par excellence.*
In Sheldon Axler et al, editor, *Operator Theory: Advances and Applications, Vol. 207*, page 3. Birkhauser Verlag, Basel, Switzerland, 2010.
(To be published).

Books/Monographs Authored/Edited

The list below follows the same conventions as those followed for the list of publications.

2.2 Physics

2.2.1 Research Summary

Biological Physics

With the group of Sandhya Koushika (NCBS, Bangalore) a detailed program involving the modeling of vesicular transport in *C. Elegans* neurons has been initiated. Preliminary studies indicate that three types of transport mechanisms appear to be involved. These are smooth anterograde, staggered anterograde and retrograde motion. Computational models which, given a relatively small number of assumptions, can reproduce the major features of the experimental data as well as contain useful predictions for mutants which lack one or the other motor function are being developed.

A theory of stretching fluctuations of DNA has been developed, in collaboration with P. Ranjith of IIT, Bombay, in an attempt to understand recent experiments by Mathew-Fenn et al (Science, 2008). The theoretical modeling suggests that the effects of stretching may have been overestimated in the experiments. A variety of methodologies which can unambiguously predict the relative importance of bending and stretching fluctuations to the dynamics of short DNA strands have been proposed.

A short pedagogical review article summarizing the field of "Active Matter", dealing with the physical description of living, biological matter has been completed[**M1**].

In certain situations (e.g., in people suffering from an ischemic heart), the normal periodic activity of the heart can be hampered by arrhythmias, i.e., disturbances in the natural rhythmic activity of the heart. A fatal arrhythmia occurring in the ventricles is Ventricular Fibrillation (VT), during which there is no coherent activation of the muscle cells so that the heart stops beating. Death follows within minutes, unless large electrical shocks are applied to "reset" the heart to its normal rhythm. The problem with such treatment is that not only is it painful, but it also causes damage to the heart tissue, creating scars which can act as substrate for future arrhythmias. The underlying cause for VF is the onset of spatiotemporal chaos, through the spontaneous formation and subsequent breakup of electrical spiral waves. For this reason, physicists have tried to devise control methods (based on the principles of nonlinear dynamics) that use electrical pulses of extremely low magnitude. A long-standing puzzle is what happens when a spiral wave is pinned by an inexcitable obstacle. A classic result by Wiener suggests that it is impossible to remove such a pinned wave by applying high-frequency stimulation at a remote location (pacing). However, the fact that pacing seems to be effective in most cases suggests that the theoretical understanding of the processes involved in pacing-spiral wave interaction is incomplete. Recently a new theoretical advance has been made in explaining this phenomena [**Sinh2**]. It has been shown that the success of pacing depends critically on the size of the obstacle. Analytical calculations show that the obstacle radius must be smaller than the free spiral wave core radius in order for pacing to successfully remove the source of reentrant excitation. Other types of heterogeneities, such as a gradient in the parameter values governing excitability of the medium, mat also play an important role in arrhythmia genesis and termination. While it is known that spiral waves can drift in such a gradient, the direction was always thought to be in the direction of lower excitability. However, a recent work has shown that anomalous drift is possible in certain circumstances, where the spiral wave drifts towards the region of higher excitability. This is of great importance, as this can result in spiral breakup and thus initiate the potentially life-threatening ventricular fibrillation. Understanding the conditions for the occurrence of anomalous drift may have consequences for better treatment of arrhythmias.

The biological cell responds to different stimuli in its environment by using a complicated machinery of reaction cascades involving several different types of molecules. In order to make the intra-cellular signaling system robust with respect to noise, nature has used a network architecture rather than a set of parallel input-output information pathways. This seems to be a design that has been used in several other biological systems, clearly underlining its efficiency [**Sinh5**]. The utility of networks can be analyzed in subsets of the intra-cellular signaling system, such as the module of two parallel Map-kinase pathways that control the response to Leishmania infection. A low parasite load is seen to turn on an anti-parasitic response, while a higher parasite load is often seen to result in a pro-parasitic response, although both are mediated by the same receptor, CD40. This switch-like behavior downstream of the receptor has now been understood as an outcome of a series of reciprocal inhibitory interactions between two parallel pathways.

Sequence analysis, regulatory genomics, evolutionary biology, multiple sequence alignment.

Classical and Quantum Gravity, Black Holes, Cosmology

Loop Quantum Gravity is a promising approach to a quantum theory of gravity. A school was conducted to introduce this program to graduate students. The lecture notes of are available as [**D**]. A more detailed study of matter couplings in the LQG framework is undertaken with a specific emphasis to understand the possible (non-)existence of axial anomaly.

Condensed Matter Physics

A theory of "Peak Effect Anomalies" associated with the long-standing problem of the peak effect in type-II superconductors has been proposed[**M3**]. It is suggested that these anomalies can be associated with unusual dynamical attributes of the depinned phase close to but above the depinning transition in the vicinity of an underlying structural phase transition such as melting. Experimental data of the past two decades which deals with this problem are being re-analysed with such a physical picture and its predictions in mind. It appears that this physical picture is a powerful one with possible wider applications in the study of driven disordered systems. Ongoing work with Thierry Giamarchi (Geneva) addresses simpler models for which analytical statements can possibly be made. Ongoing work with Surajit Sengupta (IACS, Kolkata) addresses polymorphic phase transitions in the pure case and the effects of shear on such systems.

Two identical atoms in a spherical harmonic oscillator interacting with a zero-range interaction which is tuned to produce an s-wave zero-energy bound state is analysed. The quantum spectrum of the system is known to be exactly solvable. It is noted that the same partial wave quantum spectrum is obtained by the one-dimensional scale-invariant inverse square potential. Long known as the Calogero-Sutherland-Moser (CSM) model, it leads to Fractional Exclusion Statistics (FES) of Haldane and Wu. The statistical parameter is deduced from the analytically calculated second virial coefficient. When FES is applied to a Fermi gas at unitarity, it gives good agreement with experimental data without the use of any free parameter thus providing a microscopic origin for the validity of FES in cold atoms [**Mur2**]

A generalized Anderson-Newns Hamiltonian is employed to model electrochemical electron transfer kinetics via a potential energy surface approach. Important novel features of this treatment are inclusion of the electrode induced broadening of the reactant level and the effect of solvent dynamics on the pre-exponential factor, which is determined by a numerical integration of the Kramers' diffusion controlled barrier crossing rate expression. An interpolation scheme is provided to treat nonadiabatic, transition-state theory adiabatic, and solvent dynamical effects in the weak coupling (nonadiabatic) and strong coupling (adiabatic) limits in a unified manner. The derived rate expressions are valid for arbitrary values of the electrode-reactant coupling term V, solvent polarization mode frequency ω_r, and longitudinal solvent dielectric relaxation time τ_L. A comparison of the results obtained here with the earlier treatments of electron transfer reactions is presented, and the relevance of the present formalism for experimental systems is provided. The density of states based approach for the heterogeneous electron transfer reaction is briefly discussed [**Mi5**].

CP-Violation, Neutrinos, B-Physics and New Models

The activity in B-physics and CP-violation was focused toward the Belle collaboration of which IMSc is a member. Progress was made on observation of several decay modes of B mesons and the measurements of the branching ratios [**Sin2**, **Sin7**, **Sin3**, **Sin4**, **Sin5**, **Sin6**, **Sin1**].

We also participated in writing and reviewing a 277 pages report on the Physics at Super B Factory which will serve as a physics issues guide for the upcoming B meson facilities at e^+e^- colliders [**Sin8**].

Precision measurements of the leading atmospheric parameters at a standard neutrino factory with a muon sensitive detector is discussed. The oscillation of the muon and electron neutrinos in the neutrino factory beam to tau neutrinos adds to the muon events sample (both right sign and wrong sign) via leptonic decays of the taus produced through charge-current interactions in the detector. In particular, how this affects a precision measurement of the atmospheric mixing parameters and the deviation of $\nu_\mu - \nu_\tau$mixing from maximality, is studied. In spite of the enhancement of the number of events due to the additional tau contribution, the determination of the atmospheric mixing angle and the deviation from maximality will be poorer. It is shown that it is impossible to devise satisfactory cuts to remove this tau contamination. Neglect of these tau contributions will lead to an incorrect conclusion about the precision obtainable at a neutrino factory [**I2**, **I1**].

The phenomenological aspects of warped-space (AdS) extradimensional models were reviewed in Ref. [**Go3**]. Ways to test such a hypothesis at the Large Hadron Collider (LHC) are being explored. Such constructions are usually constrained by precision electroweak measurements and evading these while solving the gauge hierarchy problem usually necessitates adding new particle representations under a new gauge group. Various methods to search for these new particles at the LHC are being explored [**Go2**].

The presence of dark matter is firmly established in observational cosmology. A new particle in an extension of the standard model (SM) could play the role of dark matter. Many proposals exist for what this new particle could be. One of them is that dark matter could be in a hidden sector by which is meant that it does not carry any SM gauge quantum numbers. A hidden sector dark matter candidate coupled to the SM via the SM Higgs boson was explored, and the implications of this hypothesis to cosmology, collider (LHC) and dark matter direct detection were analyzed [**Go1**].

Mathematical Physics

N-particles interacting pair-wise by an inverse square potential in one dimension (Calogero-Sutherland-Moser model) is analysed. When trapped harmonically, its classical canonical partition function for the repulsive regime is known in the literature. A concise re-derivation of this result is first presented. The equation of state is then calculated both for the trapped and the homogeneous gas. Finally, the classical limit of Wu's distribution function for fractional exclusion statistics is obtained and the classical virial expansion of the homogeneous gas using this distribution function is derived [**Mur1**]

Nonlinear Dynamics, Solitons and Chaos

The optical phase shift between the left and right circularly ploarized light after it traverses a nonplanar cyclic path described by the boundary curve of a closed strip with n twists is calculated, for various widths of the strip. While this phase shift increases monotonically with the width for all the multi-twisted strips, it has a minimum at a certain critical width for $n = 1$, thereby singling out the Mobius geometry. Possible applications are pointed out. [**B2**]

Soliton propagation in the Bose-Einstein condensate (BEC) of a system of hard-core bosons is studied. For this strongly repulsive system, the evolution equation for the order parameter is shown to be different from the usual Gross-Pitaevskii equation (GPE) that arises in a weakly repulsive bosonic system. In contrast to the GPE which supports a dark soliton that dies at the speed of sound, the hard-core system supports two kinds of solitons. The first is GPE-like, while the second soliton is a novel phenomenon in the BEC context, in the sense that it is an antidark soliton which is "immortal", persisting all the way up to the sound speed. The energy-momentum dispersion relations of these solitons show similarities with Lieb's modes. (A press release of this work in December 2009 has appeared in several websites such as sciencedaily, sciencenews, physorg, etc.) [**B1**]

The well known dark soliton of the Gross-Pitaevskii equation that arises in the Bose-Einstein condensate (BEC) of weakly repulsive bosons, is also shown to arise in the BEC of a strongly repulsive system of hard-core bosons in the continuum version of the lattice Bose-Hubbard model, in the special case of half-filling. A connection between this soliton and a magnetic soliton in a pseudospin model is established.[**B3**]

A statistical mechanical theory of the spatio-temporally chaotic dynamics seen in experiments on sheared nematic liquid crystals has been developed, using coupled map lattice techniques. The results indicate regimes of spatio-temporal intermittency as a prelude to chaos, in addition to regimes in which the behavior is regular. The scaling of the largest Lyapunov exponent with sub-system size and with spatial coupling has been studied, in addition to a variety of other quantities. This is the first coupled-map lattice approach to the problem of rheological chaos in driven complex fluids.

Complex networks occur all around us, especially in the biological context, ranging from the protein contact network at the level of molecules to food webs at the level of ecological communities. Over the past few years, research has focussed on the issue of how network structure affects the dynamics that such a system is capable of, and in turn, how does any constraint on dynamics affect the kind of structure that the network will have. The first question has recently been addressed in a study looking at the role that modular structure plays in the functioning of networks. The existence of modules (i.e., subgroups of nodes which have a higher connection density than the overall network) has been observed in a large class of complex networks in nature. Independently, many of these networks have also been reported to exhibit the clustered small-world property of having low average path length, while at the same time having local clustering of nodes. The recent study has shown that these two properties are in fact related, with a modular network being almost indistinguishable from a small-world network with respect to any kind of structural measure. However, the two are found to have quite different dynamical properties, with the former exhibiting a characteristic time-scale separation between intra- and inter-modular activity. This is important for a large class of systems, including the nervous system, where fast local synchronization of activity is essential for information processing but global synchronization is undesirable and is considered to be clinically pathological (e.g., in epilepsy). Such meso-level organization has recently been observed in an actual nervous system, that of the invertebrate *C. elegans*, whose entire somatic inter-neuronal wiring diagram has been analyzed in this study [**P2**].

In a follow-up study of Ising spins placed on modular networks, it has been shown that the network structure can result in a novel kind of phase corresponding to "modular" order [**P1**]. This involved spins in the same module being arranged in parallel, while spins in different modules may be directed oppositely. The interesting point is that two modules may get frozen in opposite alignments, despite the interaction between every pair of connected spins favoring parallel alignment. This study also has ramifications to the study of how polarization can occur in a society due to interaction networks, despite every individual trying to align his/her opinion to that of their neighbors.

QFT, Topological QFT, Conformal Field Thoery

We analyse aspects of symmetry breaking for Moyal spacetimes within a quantisation scheme which preserves the twisted Poincaré symmetry. Towards this purpose, we develop the LSZ approach for Moyal spacetimes. The latter gives a formula for scattering amplitudes on these spacetimes which can be obtained from the corresponding ones on the commutative spacetime. This formula applies in the presence of spontaneous breakdown of symmetries as well.We also derive Goldstone's theorem on Moyal spacetime. The formalism developed here can be directly applied to the twisted standard model[**T1**]

We study the deformed statistics and oscillator algebras of quantum fields defined in κ-Minkowski spacetime. The twisted flip operator obtained from the twist associated with the star product requires an enlargement of the Poincaré algebra to include the dilatation generators. Here we propose a novel notion of a fully covariant flip operator and show that to the first order in the deformation parameter it can be expressed completely in terms of the Poincaré generators alone. The R-matrices corresponding to the twisted and the covariant flip operators are compared up to first order in the deformation parameter and they are shown to be different. We also construct the deformed algebra of the creation and annihilation operators that arise in the mode expansion of a scalar field in κ-Minkowski spacetime. We obtain a large class of such new deformed algebras which, for certain choice of realizations, reduce to results known in the literature.

We study polynomial deformations of the fuzzy sphere, specifically given by the cubic or the Higgs algebra. We derive the Higgs algebra by quantizing the Poisson structure on a surface in $\mathbb{R}^3$. We find that several surfaces, differing by constants, are described by the Higgs algebra at the fuzzy level. Some of these surfaces have a singularity and we overcome this by quantizing this manifold using coherent states for this nonlinear algebra. This is seen in the measure constructed from these coherent states. We also find the star product for this non-commutative algebra as a first step in constructing field theories on such fuzzy spaces[**T2**].

Statistical Mechanics

The interfacial properties of nematic systems coexisting with their isotropic phase has been studied using a variety of numerical methods and analytic tools. Precise variational ansatzes are shown to yield very accurate results for order in the case of oblique anchoring[**K2**]. In the case of planar anchoring, an analytic solution yields better results than previous approximate methods and constitutes the most accurate computation of the properties of this interface to date[**K1**]

There is no general calculation of the vacuum matrix element of an arbitrary product of parafields in the literature. Employing graphical and combinatorial methods Wick's Theorem for parafields are provided [**Mi1**].

In recent times there has been a surge of interest in applying statistical mechanics to understand socio-economic phenomena. The aim is to seek out patterns in the aggregate behavior of interacting agents, which can be individuals or groups or companies or nations. One such pattern is of social inequality, i.e., the distribution of resources across all societies. A well-known scaling relation in economics known as Pareto Law has asserted that the distribution of income (as well as wealth) across different societies has a power-law tail with a characteristic exponent α;according to the stricter version of this law, $\alpha = 1.5$ for all societies. This has recently come under attack, as a large number of empirical studies have observed various values of α for different national economies. Also, some groups have tried to present models that seek to explain how this distribution comes about through simple asset-exchange type mechanisms [**Sinh3**, **S**].

A prominent feature of modern economic life is the existence of financial markets. The availability of large quantities of electronic data recording transactions in such markets has meant that physicists interested in looking for universalities in economics have found such data irresistible. Based on the study of price fluctuations, it had been suggested that the corresponding distribution has a power law with exponent -3. To explain the universality of this "inverse cubic law" and other empirical features of the market, a simple mean-field-like model has been proposed that quantitatively reproduces them [**Sinh6**].

Statistical methods can be used to infer the existence of generating rules underlying symbol sequences in nature. Recently, a method has been developed for reconstructing the syntactic structure of linguistic sequences and it has been applied on the corpus of undeciphered inscriptions obtained from the ruins of the Indus Valley Civilization (2500-1900 BCE) [**Sinh1**, **Sinh4**]. This method, based on the concepts of complex network theory, uncovers the regularities in the sign associations and is used to build segmentation trees of the sequences. These results are currently being used to reconstruct the grammar underlying the sequences.

The response of a granular system at rest to an instantaneous input of energy in a localised region was studied. This problem is a generalisation of the classic Taylor-Sedov problem of the spreading of energy following an intense localized nuclear explosion. Introducing inelasticity changes the exponents characterizing the problem. It is shown that, in d dimensions, the radius of the resulting disturbance increases with time t as t^{α}, and the energy decreases as $t^{-\alpha d}$, where the exponent $\alpha = 1/(d+1)$ is independent of the coefficient of restitution. These results agree with an exact calculation in one dimension and event driven molecular dynamic simulations of hard sphere particles in two and three dimensions [**J1**]. These results find application in a recent experiment where shock propagation is studied in a fast flowing dilute layer of glass beads, following the impact of a spherical steel ball whose diameter is much larger than the size of an individual glass bead. The above results match well with the experimental results [**J2**].

Constant fluxes of conserved quantities in stationary wave turbulence exactly determine the inertial range scaling of appropriate flux-carrying correlation functions just as energy conservation determines the scaling of the third order structure function in hydrodynamic turbulence. This constraint on the flux-carrying correlation function, referred to as a constant flux relation requires no assumption of weak nonlinearity. It thus provides a natural departure point for the study of strong wave turbulence. The theoretical results are derived for general wave turbulence and illustrated for simple finite dimensional toy model. It is predicted that the energy cascade in strong wave turbulence, provided that a local cascade is possible, would be of a different character to most familiar cascade mechanisms and must involve a non-trivial conversion between linear wave energy and nonlinear wave self-interaction energy [**Ra1**]

Recent experimental results available in the literature on ZrO2/NiCr functionally graded materials show that the distribution of mechanical properties strongly depend on the variation of the microstructure. The modulus of elasticity, rather than increasing monotonically from the elastic modulus of pure NiCr to that of pure ZrO2, shows anomalous behavior by decreasing to a minimum and then increasing as the percentage composition of ZrO2 is increased. The composite show a maximum of 40fraction of ZrO2. Exisitng micro-mechanical models predict a monotonic behavior in the elastic modulus, thus, are unable to capture the counter intuitive variation in elastic properties. In the current work, the composite is modeled using a two dimensional spring network model on a square lattice with two body central forces between nearest and next-nearest neighbors and three body forces that incorporate the bending rigidity of the material. The anomalous variation in the elastic modulus of the composite is well captured by incorporating a weak interface between the constituent materials. This is modeled by making a fraction of the bonds between the constituent materials weaker than the homogeneous [**Ra2**]

The inflated phase of two dimensional lattice polygons is studied. These polygons are constrained to have fixed area A and variable perimeter, when a weight $\mu^t \exp[-Jb]$ is associated to a polygon with perimeter t and b bends. The mean perimeter is calculated as a function of the fugacity μ and the bending rigidity J. In the limit $\mu \to 0$, the mean perimeter has the asymptotic behaviour $t/4\sqrt{A} \simeq 1 - K(J)/(\ln \mu)^2 + \mathcal{O}(\mu/\ln \mu)$. The constant $K(J)$ is found to be the same for both types of polygons, suggesting that self-avoiding polygons should also exhibit the same asymptotic behaviour.

String Theory

Applications of string theory techniques to condensed matter physics have turned out to be quite useful. In particular non fermi liquid behaviour in strongly correlated electron systems have been studied.In this context properties of strongly coupled CFT's with non-zero background electric charge in 1+1 dimensions are analysed by studying the dual gravity theory - which is a charged BTZ black hole. Correlators of operators dual to scalars, gauge fields and fermions are studied at both T=0 and $T \neq 0$. In the T=0 case it can be compared 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 is seen. The fermion Green function shows quasiparticle peaks with approximately linear dispersion but the detailed structure is that of a non-Fermi liquid. The real part of the conductivity (given by the current-current correlator) also vanishes as $\omega \to 0$ as expected. The boundary is expected to be a Luttinger liquid but with modifications due to the absence of Lorentz/scale invariance (because of the background charge). A boundary Action that produces the observed non-Luttinger -liquid like behaviour (k-independent non-analyticity at $\omega = 0$) in the Greens function is discussed. [**S**]

Study of string worldsheet theory in non-trivial backgrounds using hamiltonian framework has been continued. In [**Mu1**] attempt has been made to use spacetime supersymmetry in the context of type IIB R-R plane-wave to cure the operator ordering problem in the computation of Virasoro algebra noticed earlier. It was shown that certain integrated version of the Virasoro anomaly terms can be calculated indirectly by computing the second order dynamical supersymmetry variations of the energy-momentum tensor. The results show that indeed all such terms vanish indicating conformal invariance. However, the direct method, which does not use supersymmetry, needs to be understood in order to derive supergravity equations of motion as Virasoro anomaly. To this end, a background independent formulation of the problem has been studied in [**Mu2**]. In this approach the worldsheet theory is viewed as a theory of a particle with infinite-dimensional general covariance. Then using DeWitt's argument (Phys.Rev.85:653-661,1952) a quantum theory is developed such that its position space representation is manifestly covariant under general coordinate transformation. This leads to the construction of certain background independent quantum version of the classical Virasoro generators, called DeWitt-Virasoro (DWV) generators. It was shown that in spin-zero representation these generators satisfy the Witt algebra with additional anomalous terms that vanish for Ricci-flat backgrounds. This construction seems to suggest a resolution of the operator ordering problem for the pp-wave mentioned earlier in a particular way. In an ongoing work the above argument has been generalized to incorporate higher rank tensor representations which are important in string theory. It has been found, as reported in [**Mu3**], that the DWV algebra remains the same in arbitrary tensor representations.

2.2.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**B1**]
Radha Balakrishnan, Indubala I. Satija*, and Charles W. Clark*.
Particle-hole asymmetry and brightening of solitons in a strongly repulsive Bose-Einstein condensate.
Physical Review Letters, **103**, 230403, 2009.

[**B2**]
Indubala I. Satija* and Radha Balakrishnan.
Geometric phases in twisted strips.
Physics Letters A, **373**, 3582, 2009.

[**B3**]
Indubala I. Satija* and Radha Balakrishnan.
The Gross-Pitaevskii soliton: Relating weakly and strongly interacting bosonic condensates and the magnetic soliton.
2010.
(Preprint: IMSc-2010/3/5).

[**Bh**]
A. K. Bhattacharjee, R. Adhikari, and Gautam I. Menon.
Fluctuating Nematodynamics using the Stochastic Method of Lines.
Journal of Chemical Physics, 2010.
(Submitted).

[**C**]
Sujit K. Choudhary, Sibasish Ghosh, Guruprasad Kar*, and Ramij Rahaman*.

Analytical proof of gisiné theorem.
Physical Review A, 2010.
(To be published).

[**Cr1**]
Vallan Bruno A. Cruz, A. Mishra, and Wolfgang Schmickler*.
Electron tunneling between two electrodes mediated by a molecular wire containing a redox center.
Chemical Physics, 2009.
(To be published).

[**Cr2**]
Vallan Bruno A. Cruz, A. Mishra, and Wolfgang Schmickler*.
Electron transfer reaction through an adsorbed layer.
2009.
(Preprint: arXiv:0912.2856).

[**Cr3**]
Vallan Bruno A. Cruz, A. Mishra, and Wolfgang Schmickler*.
Electron transfer rate between a electrode and a bridged redox.
2009.
(Preprint: arXiv:0912.3083).

[**D**]
Ghanashyam Date.
Lectures on LQG/LQC.
Mar 2010.
These lecture notes are the written version of the lectures given at the *School on Loop Quantum Gravity* at IMSc.(Preprint: IMSc/2010/3/3, arXiv:1004.2952).

[**G**]
Ali Ahanj*, Pramod S. Joag*, and Sibasish Ghosh.
Classical protocol for simulation of spin measurement correlation of binary spin-s singlet state.
International Journal of Quantum Information, 2010.
(To be published).

[**Go1**]
Shrihari Gopalakrishna.
Hidden sector dark matter and lhc signatures.
In *Proceedings of 17th International Conference on Supersymmetry and the Unification of Fundamental Interactions (SUSY 09), Boston, Massachusetts, 5-10 Jun 2009. AIP Conf.Proc.1200:778-781,2010.*, page 778. AIP, Sep 2009.

[**Go2**]
Shrihari Gopalakrishna, Gregory Moreau*, and Ritesh Singh*.
Single custodian production in warped extra dimensional models.

In *Les Houches 2009. Physics at TeV Colliders*, Jan 2010.
(To be published).

[**Go3**]
Hooman Davoudiasl*, **Shrihari Gopalakrishna, Eduardo Ponton***, **and Jose Santiago***.
Warped 5-dimensional models: Phenomenological status and experimental prospects.
New J.Phys, 2009.
arXiv:0908.1968 [hep-ph] (To be published).

[**Goy1**]
Sandeep K. Goyal and Sibasish Ghosh.
Entanglement dynamics under local lindblad evolution.
2010.
(Preprint: arXiv:1003.1248 (quant-ph)).

[**Goy2**]
Sandeep K. Goyal and Sibasish Ghosh.
Entanglement dynamics under local lindblad evolution.
2010.
(Preprint: 1003.1248).

[**I1**]
D. Indumathi and Nita Sinha.
Tau contribution and precision measurement of theta(23) at a neutrino factory.
In *Proceedings o the 11th International Workshop on Neutrino Factories, Superbeams and Betabeams: NuFact09, Chicago, Illinois, 20-25 Jul 2009.* AIP, Nov 2009.
0911.0895 (Submitted).

[**I2**]
D. Indumathi and Nita Sinha.
Effect of tau neutrino contribution to muon signals at neutrino factories.
Physical Review D, **80**, 113012, 2009.

[**Iv**]
Solomon J. Ivan, Simon R., and Sanjay M. Kumar*.
Review article.
Physical Review A, 2009.
quant-ph/0812.2800 (Submitted).

[**J1**]
Zahera Jabeen, R. Rajesh, and Purusattam Ray.
Universal scaling dynamics in a perturbed granular gas.
Europhysics Letters, **89**, 34001, 2010.

[**J2**]
Zahera Jabeen, R. Rajesh, and Purusattam Ray.

Comment on “blast shocks in quasi-two-dimensional supersonic granular flows”.
Physical Review Letters, 2010.
(Submitted).

[**Ja**]
Jampa Maruthi Pradeep Kanth, Satyavani Vemparala, and Ramesh Anishetty.
Long-distance correlations in molecular orientations of liquid water and shape-dependent hydrophobic force.
Physical Review E, **81(2)**, 021201, 2010.

[**Jay**]
Gayathri Jayaraman and Rahul Siddharthan.
Sigma-2: An evolutionary approach to multiple sequence alignment.
2010.
(Submitted).

[**K1**]
S. M. Kamil, A. K. Bhattacharjee, R. Adhikari, and Gautam I. Menon.
Biaxiality at the isotropic-nematic interface with planar anchoring.
Physical Review E, **80**, 041705, 2009.

[**K2**]
S. M. Kamil, A. K. Bhattacharjee, R. Adhikari, and Gautam I. Menon.
The isotropic-nematic interface with an oblique anchoring condition.
Journal of Chemical Physics, **131**, 174701, 2009.

[**Ka**]
Jampa Maruthi Pradeep Kanth and Ramesh Anishetty.
Molecular mean field theory for liquid water.
2010.
(Preprint: arXiv:1004.1547v1).

[**M1**]
Gautam I. Menon.
Active Matter.
In *Dynamics of Complex Fluids*. Springer, 2010.
(To be published).

[**M2**]
Gautam I. Menon and Sriram Ramaswamy*.
Universality Class of the Reversible-Irreversible Transition in Sheared Suspensions.
Physical Review E, **79**, 061108, 2009.

[**M3**]
Ankush Sengupta*, Surajit Sengupta*, and Gautam I. Menon.
Driven Disordered Polymorphic Solids: Phases and Phase Transitions, Dynamical Coexistence and Peak Effect Anomalies.

Physical Review B, 2010.
(To be published).

[Mi1]
Oscar W. Greenberg* **and Ashok K. Mishra**.
Study of the vacuum matrix element of products of parafields.
J. Mathematical Physics, **51**, 023530, 2010.

[Mi2]
Ram Kishore* **and Ashok K. Mishra**.
Second quantized representation of observables for orthofermions.
Physica B: Condensed Matter, **404**, 3253, 2009.

[Mi3]
Ram Kishore* **and Ashok K. Mishra**.
Thermodynamic and transport properties of infinite u hubbard model.
J. Physics, 2009.
(To be published).

[Mi4]
Ashok K. Mishra and Ram Kishore.
Distinct solutions of the infinite u hubbard model through nested bethe ansatz and gutzwiller projection operator approach.
Physica B: Condensed Matter, **404**, 3257, 2009.

[Mi5]
Ashok K. Mishra and David H. Waldeck*.
A unified model for electrochemical rate constant that incorporates solvent dynamics.
J. Physical Chemistry C, **113**, 17904, 2009.

[Mit]
Mithun K. Mitra, Gautam I. Menon, and R. Rajesh.
Asymptotic Behaviour of Convex and Column Convex Polygons with Fixed Area and Varying Perimeter.
Journal of Statistical Mechanics: Theory and Experiment, 2010.
(Submitted).

[Mu1]
Partha Mukhopadhyay.
Dynamical supersymmetry analysis of conformal invariance for superstrings in type IIB R-R plane-wave background.
Phys.Rev.D, **80(12)**, 126007, 2009.

[Mu2]
Partha Mukhopadhyay.
On a coordinate independent description of string worldsheet theory.

2009.
(Preprint: arXiv:0912.3987 [hep-th]).

[**Mu3**]
Partha Mukhopadhyay.
String worldsheet theory in hamiltonian framework and background independence.
2010.
(Preprint: arXiv:1003.6103 [hep-th]).

[**Mur1**]
R. Bhaduri*, **M. Murthy, and Diptiman Sen***.
The virial expansion of a classical interacting gas.
Journal of Physics: Mathematical and Theoretical, **43**, 045002, 2010.

[**Mur2**]
R. Bhaduri*, **M. Murthy, and M. Srivastava***.
Cold atoms at unitarity and inverse square interaction.
Journal of Physics B: Atomic, Molecular and Optical Physics, **42**, 235302, 2009.

[**Mur3**]
M. Brack*, **A. Koch***, **M. Murthy, and J. Roccia***.
Exact and asymptotic local virial theorems for finite fermionic systems (revised).
Submitted to Journal of Physics A: Mathematical and Theoretical, 2010.
cond-mat/arXiv:0903.2172 (Submitted).

[**P1**]
Subinay Dasgupta*, **Raj K. Pan, and Sitabhra Sinha**.
Phase of ising spins on modular networks analogous to social polarization.
Physical Review E (Rapid Communications), **80(2)**, 025101, 2009.

[**P2**]
Raj K. Pan, Nivedita Chatterjee*, **and Sitabhra Sinha**.
Mesoscopic organization reveals the constraints governing caenorhabditis elegans nervous system.
PLoS ONE, **5(2)**, e9240, 2010.

[**R**]
Jitesh R. Bhatt*, **Bipin R. Desai***, **Ernest Ma***, **G. Rajasekaran, and Utpal Sarkar***.
Neutrino condensate as origin of dark energy.
Physics Letters B, **687**, 75, 2010.

[**Ra1**]
C. Connaughton*, **R. Rajesh, and O. Zaboronski***.
Is there an energy cascade in strong wave turbulence?
In D. Tordella and K. R. Sreenivasan, editors, *Proceedings of EUROMECH Colloquium 512 – Small scale turbulence and related gradient statistics*, page 39, Oct 2009.

[**Ra2**]
V. Amol*, **A. Banerjee***, **and R. Rajesh**.
Simulation of mechanical response of zro2/nicr fgm.
In *In Proceedings of the third international congress on computational mechanics and simulation (ICCMS 09, IIT Bombay)*, page 247, Dec 2009.

[**S**]
Balachandran Sathiapalan, Nilanjan Sircar, R. Shankar, Debaprasad Maity*, **and Swarnendu Sarkar***.
Properties of cfts dual to charged btz black-hole.
Journal of High Energy Physics, 2009.
arXiv:0909.4051 (Submitted).

[**Sh**]
Indrajit Mitra* **and H. S. Sharatchandra**.
Accounting for monopole configurations in yang-mills theory in three euclidean dimensions.
2009.
arXiv:0809.5175 (Submitted).

[**Si**]
K. G. Guruharsha*, **M. Ruiz-Gomez***, **H. A. Ranganath***, **R. Siddharthan, and K. VijayRaghavan***.
The complex spatio-temporal regulation of the drosophila myoblast attractant gene duf/kirre.
PLoS ONE, **4(9)**, e6960, 2009.

[**Sid**]
Rahul Siddharthan.
Dinucleotide weight matrices for predicting transcription factor binding sites: Generalizing the position weight matrix.
PLoS ONE, **5(3)**, e9722, 2010.

[**Sim1**]
S. Chaturvedi*, **N. Mukunda***, **and R. Simon**.
Wigner distributions for finite-state systems without redundant phase-point operators,.
Jour. Phys. A: Math. Theor., **43(7)**, art. no. 075302, pp. 1 – 21, 2010.

[**Sim2**]
N. Mukunda*, **S. Chaturvedi***, **and R. Simon**.
Hamilton's theory of turns revisited.
Pramana – Jour. Phys., **74(1)**, 1 – 10, 2010.

[**Sim3**]
B.N. Simon*, **S. Simon***, **F. Gori***, **M. Santersiero***, **R. Borghi***, **N. Mukunda***, **and R. Simon**.
Nonquantum entanglement resolves a basic issue in polarization optics.
Phys. Rev. Lett., **104(2)**, art. no. 023901, 2010.

[**Sim4**]
B.N. Simon*, **S. Simon***, **N. Mukunda***, **F. Gori***, **M. Santarsiero***, **R. Borghi***, **and R. Simon**.
A complete characterization of pre-mueller and mueller matrices in polarization optics.
Jour. Opt. Soc. Am. A, **27(2)**, 188 – 199, 2010.

[**Sim5**]
S. Simon*, **S. P. Rajagopalan***, **and R. Simon**.
The structure of states and maps in quantum theory.
Pramana – Jour. Phys., **73(3)**, 471 – 483, 2009.

[**Sin1**]
Chiang C. C.*, **..., Rahul Sinha, et al.**
Search for $B^0 \to K^{*0}\overline{K}^{*0}$, $B^0 \to K^{*0}K^{*0}$ and $B^0 \to K^+\pi^-K^\mp\pi^\pm$ decays.
Phys. Rev., **D81**, 071101, 2010.
arXiv:1001.4595[hep-ex].

[**Sin2**]
Kyeong S. H.*, **..., Rahul Sinha, et al.**
Measurements of charmless hadronic $b \to s$ penguin decays in the $\pi\pi k\pi$ final state and observation of $B^0 \to \rho^0 K^+\pi^-$.
Phys. Rev., **D80**, 051103, 2009.
arXiv:0905.0763[hep-ex].

[**Sin3**]
Adachi I.*, **..., Rahul Sinha, et al.**
Measurement of $B \to D^{(*)}\tau\nu$ using full reconstruction tags.
2009.
arXiv:0910.4301[hep-ex].

[**Sin4**]
Adachi I.*, **..., Rahul Sinha, et al.**
Observation of inclusive $B \to X_s\eta$ at belle.
2009.
arXiv:0910.4751[hep-ex].

[**Sin5**]
Adachi I.*, **..., Rahul Sinha, et al.**
Observation of radiative $B^0 \to \phi K^0\gamma$ decays.
2009.
arXiv:0911.1779[hep-ex].

[**Sin6**]
Adachi I.*, **..., Rahul Sinha, et al.**
Observation of the decay $B_s^0 \to J/\psi\eta$ and evidence for $B_s^0 \to J/\psi\eta'$.
2009.
arXiv:0912.1434[hep-ex].

[**Sin7**]
Adachi I.*, **...and Rahul Sinha, et al.**
Measurement of the form factors of the decay $B^+ \to \bar{D}^{*0}\ell^+\nu_\ell$ and determination of the CKM matrix element $|V_{cb}|$.
2009.
arXiv:0909.4398[hep-ex].

[**Sin8**]
Aushev. T.*, **..., Rahul Sinha, et al.**
Physics at super B factory.
2010.
arXiv:1002.5012[hep-ex].

[**Sinh1**]
Sitabhra Sinha, Raj K. Pan, Nisha Yadav*, **Mayank Vahia***, **and Iravatham Mahadevan***.
Network analysis reveals structure indicative of syntax in the corpus of undeciphered indus civilization inscriptions.
In S. Somasundaran C. Banea, A. Moschitti and F. M. Zanzotto, editors, *Proceedings of the 2009 Workshop on Graph-based Methods for Natural Language Processing, ACL-IJCNLP 2009*, page 5. The Association for Computational Linguistics, Aug 2009.

[**Sinh2**]
Alain Pumir*, **Sitabhra Sinha, S. Sridhar, Mederic Argentina***, **Marcel Horning***, **Simonetta Filippi***, **Christian Cherubini***, **Stefan Luther***, **and Valentin Krinsky***.
Wave-train-induced termination of weakly anchored vortices in excitable media.
Physical Review E (Rapid Communications), **81(1)**, 010901, 2010.

[**Sinh3**]
Sitabhra Sinha and Bikas K. Chakrabarti*.
Towards a physics of economics.
Physics News, **39(2)**, 33, 2009.

[**Sinh4**]
Sitabhra Sinha, Ashraf M. Izhar, Raj K. Pan, and Bryan K. Wells.
Network analysis of a corpus of undeciphered indus civilization inscriptions indicates syntactic organization.
Computer Speech and Language, 2010.
(In Press).

[**Sinh5**]
Sitabhra Sinha, T. Jesan*, **and Nivedita Chatterjee***.
Systems biology: From the cell to the brain.
In N. Mukunda, editor, *Current Trends in Science: Platinum Jubilee Special*, page 199. Indian Academy of Sciences, Bangalore, 2009.

[**Sinh6**]
S. V. Vikram* **and Sitabhra Sinha**.
A mean-field model of financial markets: Reproducing long-tailed distributions and volatility correlations.
In S. R. Chakravarty B. Basu, B. K. Chakrabarti and K. Gangopadhyay, editors, *Econophysics and Economics of Games, Social Choices and Quantitative Techniques*, page 98. Springer-Italia, 2010.

[**Sinha1**]
W. L. Ditto*, **A. Miliotis***, **K. Murali***, **and Sudeshna Sinha**.
The chaos computing paradigm.
In H. G. Schuster, editor, *Reviews of Nonlinear Dynamics and Complexity*, page 1. Wiley-VCH, 2010.

[**Sinha2**]
K. Murali*, **I. Raja Mohamed***, **Sudeshna Sinha, W. L. Ditto***, **and A. R. Bulsara***.
Realization of reliable and flexible logic gates using noisy nonlinear circuits.
Applied Physics Letters, **95**, 194102, 2009.

[**Sinha3**]
Sudeshna Sinha.
Clipping chaos to cycles.
In M.A.F. Sanjuan and C. Grebogi, editors, *Recent Progress in Controlling Chaos*, page 239. World Scientific, 2010.

[**Sinha4**]
Sudeshna Sinha, J. M. Cruz*, **T. Buhse ***, **and P. Parmananda***.
Exploiting the effect of noise on a chemical system to obtain logic gates.
Europhysics Letters, **86**, 60003, 2009.

[**Sr**]
S. Sridhar, Sitabhra Sinha, and Alexander V. Panfilov*.
Anomalous drift of spiral waves in heterogeneous excitable media.
2009.
(Preprint: arxiv: 0909.4398).

[**T1**]
Govindarajan T R.
Spontaneous breaking of symmetry in moyal spacetime with twisted poincare symmetry.
In *25th Max Born Symposium: The Planck Scale*, Aug 2009.

[**T2**]
Govindarajan T R, Padmanabhan P*, **and Shreecharan T**.
Beyond fuzzy spheres.
J.Phys, **A43**, 05203, 2009.

[**V**]
Satyavani Vemparala, Carmen Domene*, **and Michael L. Klein***.
Computational studies on the interactions of inhalational anesthetics with proteins.
Accounts of Chemical Research, **43**, 103, 2010.

Books/Monographs Authored/Edited

The list below follows the same conventions as those followed for the list of publications.

[**S**]
Sitabhra Sinha, Arnab Chatterjee*, **Anirban Chakraborti***, **and Bikas K. Chakrabarti***.
Econophysics: An Introduction.
Wiley-VCH, Berlin, 2010.
(To be published).

2.3 Theoretical Computer Science

2.3.1 Research Summary

Algorithms and Data Structures

In parameterized complexity each problem instance comes with a parameter k and the parameterized problem is said to admit a *polynomial kernel* if there is a polynomial time algorithm (the degree of polynomial is independent of k), called a *kernelization* algorithm, that reduces the input instance down to an instance with size bounded by a polynomial $p(k)$ in k, while preserving the answer. This reduced instance is called a $p(k)$ *kernel* for the problem. If $p(k) = O(k)$, then it is called a *linear kernel*. A central notion in parameterized complexity is *fixed parameter tractability (FPT)*, which means, for a given instance (x, k), solvability in time $f(k) \cdot p(|x|)$, where f is an arbitrary function of k and p is a polynomial in the input size.

In [**S3**] two meta-theorems on kernelization are given. The first theorem says that all problems expressible in Counting Monadic Second Order Logic and satisfying a compactness property admit a polynomial kernel on graphs of bounded genus. The second result says that all problems that have finite integer index and satisfy a weaker compactness condition admit a linear kernel on graphs of bounded genus. These theorems unify and extend all previously known kernelization results for planar graph problems. Combining these theorems with the Erdős-Pósa property the paper obtains various new results on linear kernels for a number of packing and covering problems.

Bidimensionality theory has turned out to be a powerful framework in the development of meta-algorithmic techniques. It was introduced by as a tool to obtain sub-exponential time parameterized algorithms for bidimensional problems on H-minor free graphs. Later it was extended to obtain polynomial time approximation schemes (PTASs) for bidimensional problems. In [**S6**], a third meta-algorithmic direction for bidimensionality theory is established by relating it to the existence of linear kernels for parameterized problems. It is shown that "essentially" all bidimensional problems not only have sub-exponential time algorithms and PTASs but they also have linear kernels. In particular, it is proved that every minor (respectively contraction) bidimensional problem that satisfies the separation property and is of finite integer index, admits a linear kernel for classes of graphs that exclude a fixed graph (respectively an apex graph H) H as a minor. Results in [**S6**] imply that a multitude of bidimensional problems, which include Dominating Set, Feedback Vertex Set, Edge Dominating Set, Vertex Cover, r-Dominating Set, Connected Dominating Set, Cycle Packing, Connected Vertex Cover, Almost Constant Treewidth, and various other vertex covering and packing problems, admit linear kernels on the corresponding graph classes. For most of these problems no polynomial kernels on H-minor-free graphs were known prior to this work.

In [**S1**] and [**S4**] linear vertex kernels for specific problems have been made. In particular [**S1**] presents an algorithm that for any graph G and integer $k \geq 0$ in time polynomial in the size of G either finds a spanning tree with at least k internal vertices, or outputs a new graph G_R on at most $3k$ vertices and an integer k' such that G has a spanning tree with at least k internal vertices if and only if G_R has a spanning tree with at least k' internal vertices. In other words, it shows that the parameterized Maximum Internal Spanning Tree problem with parameter k being the number of internal vertices, has a $3k$-vertex kernel. This result is based on an innovative application of a classical min-max result about hypertrees in hypergraphs, that is, "a hypergraph H contains a hypertree if and only if H is partition connected." In [**S4**] a linear vertex kernel for Feedback Arc Set in Tournaments (FAST). That is, the paper gives a polynomial time algorithm which given an input instance T to FAST obtains an equivalent instance T' on $O(k)$ vertices. In fact, given any fixed $\epsilon > 0$, it finds a kernel with at most $(2+\epsilon)k$ vertices in polynomial time.

In [**Ra2**] and [**Ra3**] subexponential parameterized algorithms have been made. In [**Ra2**] Partial Vertex Cover and Partial r-Dominating Set are studied. In Partial Vertex Cover one is given a graph $G = (V, E)$ and positive integers k and t, and the task is to check whether there exists a set of vertices $C \subseteq V$ such that $|C| \leq k$ and there are at least t edges incident to C. Similarly in Partial r-Dominating Set (P-r-DS) one is given a graph $G = (V, E)$ and positive integers k, r and t, and the objective is to determine whether there exists a set of vertices $D \subseteq V$ such that $|D| \leq k$ and there are at least t vertices at distance at most r from some vertex in D. In [**Ra2**] algorithms with running time $2^{O(\sqrt{k})}n^{O(1)}$ is given for Partial Vertex Cover and Partial r-Dominating Set on apex-minor free graphs. Compared to previously known algorithms for these problems these algorithms are significantly faster and simpler.

In [**Ra3**] subexponential time algorithms for problems on directed graphs are obtained. Two different methods are developed two achieve subexponential time parameterized algorithms for problems on sparse directed graphs. These approaches are exemplified our with two well studied problems. For the first problem, k-Leaf Out-Branching, which is to find an oriented spanning tree with at least k leaves, [**Ra3**] obtains an algorithm solving the problem in time $2^{(\sqrt{k}\log k)}n+n^{(1)}$ on directed graphs whose underlying undirected graph excludes some fixed graph H as a minor. For the special case when the input directed graph is planar, the running time is improved to $2^{(\sqrt{k})}n + n^{(1)}$. The second example is a generalization of the Directed Hamiltonian Path problem, namely k-Internal Out-Branching, which is to find an oriented spanning tree with at least k internal vertices. An algorithm solving the problem in time $2^{(\sqrt{k}\log k)} + n^{(1)}$ on directed graphs whose underlying undirected graph excludes some fixed apex graph H as a minor is given in [**Ra3**]. It is also observed that for any > 0, the k-Directed Path problem is solvable in time $((1+)^k n^{f()})$, where f is some function of . These methods are based on non-trivial combinations of obstruction theorems for undirected graphs, kernelization, problem specific combinatorial structures and a layering technique similar to the one employed by Baker to obtain PTAS for planar graphs.

In [**S2**] the classical Bandwidth problem is studied from the viewpoint of parameterized algorithms. In the Bandwidth problem one is given a graph $G = (V, E)$ together with a positive integer k, and asked whether there is an bijective function $\beta : \{1, \ldots, n\} \to V$ such that for every edge $uv \in E$, $|\beta^{-1}(u) - \beta^{-1}(v)| \leq k$. The problem is notoriously hard, and it is known to be -complete even on very restricted subclasses of trees. The best known algorithm for Bandwidth for small values of k is the celebrated algorithm by Saxe, which runs in time $2^{O(k)}n^{k+1}$. In a seminal paper, Bodlaender, Fellows and Hallet, ruled out the existence of an algorithm with running time of the form $f(k)n^{(1)}$ for any function f even for trees, unless the entire W-hierarchy collapses. The article [**S2**] initiates the search for classes of graphs where Bandwidth is fixed parameter tractable. An algorithm with running time $2^{O(k\log k)}n^2$ is presented for Bandwidth on AT-free graphs, a well-studied graph class that contains interval, permutation, and co-comparability graphs.

Many hard problems can be solved efficiently when the input is restricted to graphs of bounded treewidth. By the celebrated result of Courcelle, every decision problem expressible in monadic second order logic is fixed parameter tractable when parameterized by the treewidth of the input graph. Moreover, for every fixed $k \geq 0$, such problems can be solved in linear time on graphs of treewidth at most k. In particular, this implies that basic problems like Dominating Set, Graph Coloring, Clique, and Hamiltonian Cycle are solvable in linear time on graphs of bounded treewidth. A significant amount of research in graph algorithms has been devoted to extending this result to larger classes of graphs. It was shown that some of the algorithmic meta-theorems for treewidth can be carried over to graphs of bounded clique-width. Courcelle, Makowsky, and Rotics proved that the analogue of Courcelle's result holds for graphs of bounded clique-width when the logical formulas do not use edge set quantifications. Despite of its generality, this does not resolve the parameterized complexity of many basic problems concerning edge subsets (like Edge Dominating Set), vertex partitioning (like Graph Coloring), or global connectivity (like Hamiltonian Cycle). There are various algorithms solving some of these problems in polynomial time on graphs of clique-width at most k. However, these are not fixed parameter tractable algorithms and have typical running times $O(n^{f(k)})$, where n is the input length and f is some function. It was an open problem, explicitly mentioned in several papers, whether any of these problems is fixed parameter tractable when parameterized by the clique-width. The [**S8**] resolves this problem by showing that Edge Dominating Set, Hamiltonian Cycle, and Graph Coloring are $W[1]$-hard parameterized by clique-width.

However the lower bounds obtained in [**S8**] were weak when compared to the upper bounds on the time complexity of the known algorithms for these problems when parameterized by the clique-width. In [**S5**] the asymptotically tight bounds for Max-Cut and Edge Dominating Set are obtained by showing that both problems cannot be solved in time $f(t)n^{o(t)}$, unless Exponential Time Hypothesis (ETH) collapses; and can be solved in time $n^{O(t)}$, where f is an arbitrary function of t, on input of size n and clique-width at most t. These lower bounds are obtained by giving non-trivial structure-preserving "linear FPT reductions".

In [**Ph**], we show that the k-Dominating Set problem is fixed parameter tractable (FPT) and has a polynomial kernel for any class of graphs that exclude $K_{i,j}$ as a subgraph, for any fixed $i, j \geq 1$. This strictly includes every class of graphs for which this problem had been previously shown to have FPT algorithms and/or polynomial kernels. In particular, our result implies that the problem restricted to bounded-degenerate graphs has a polynomial kernel, solving an open problem posed by Alon and Gutner.

In [**Mi2**], we investigated the Connected Feedback Vertex Set (CFVS) problem from the point of view of parameterized algorithms. CFVS is the connected variant of the classical Feedback Vertex Set problem, and is defined as follows: given a graph $G = (V, E)$ and an integer k, decide whether there exists $F \subseteq V$, $|F| \leq k$, such that $G[V \setminus F]$ is a forest and $G[F]$ is connected. We showed that Connected Feedback Vertex Set can be solved in time $O(2^{O(k)}n^{O(1)})$ on general graphs and in time $O(2^{O(\sqrt{k}\log k)}n^{O(1)})$ on graphs excluding a fixed graph H as a minor. Our result on general undirected graphs uses, as a subroutine, a Fixed Parameter Tractable (FPT) algorithm for the Group Steiner Tree problem, a variant of the well studied Steiner Tree problem. The FPT algorithm that we developed for Group Steiner Tree seems to be of independent interest; we believe that it could be useful for obtaining FPT algorithms for other connectivity problems.

Automata, Logic and Concurrency

The coverability and boundedness problems for Petri nets are known to be complete for exponential space. A parameter is identified based on the communication graphs between the buffers (the places which may be unbounded) and the problems are shown to be in paraPSPACE (parameterized polynomial space) with respect to this parameter. Similar complexity bounds hold for modelchecking a logic based on such counting properties. This means that systems that have sparse communication patterns can be analyzed more efficiently than using previously known algorithms for general Petri nets [**Pr**].

It is known that the formula automaton construction for linear temporal logic can be extended to allow modulo counting properties, where the numeric constants are written in unary. The construction is shown to extend, with identical complexity, to the constants being written in binary, which is exponentially succinct as well as natural for specifications. The satisfiability of a weaker extension, which allows only the modulo counting of length from the beginning of the word, is proved complete for the third level (Σ_3^P) of the polynomial hierarchy.

[**R4**] and [**R1**] continue our investigations into formal verification of cryptographic protocols. While it is clear that reasoning about security is easily presented in terms of agents' mutual knowledge and ignorance, formalizing these notions is tricky, and [**R4**] sets out the theoretical challenges involved. [**R1**] presents extensions of Dolev-Yao theories for protocols using *zero knowledge* proofs, using a notion of typed terms.

[**P1**] and [**P2**] explore dynamics of games in which players *switch* between strategies and stability questions are addressed. The latter studies endogenous changes in game forms due to switching. The solutions are provided using automata theoretic techniques.

[**Ma**] presents a class of automata over *infinite alphabets* intended to model systems of unboundedly many processes. Reachability problems for such automata are typically undecidable, or when decidable, not known to be elementary. [**Ma**] offers a class of class counting automata using monotone counters, for which emptiness checking is shown to be ExpSpace-complete.

[**R2**] uses a dynamic logic of knowledge to model robotic agents that need to perform tests on whether actions are enabled, but may cause changes to system state in the process. Plan synthesis in the presence of trials is difficult but shown to be decidable.

[**R3**] makes contributions towards automata theoretic foundations for epistemic logics. A class of *epistemic automata* which communicate only by synchronization is studied, whose expressiveness is shown to be the same as that of Mazurkiewicz trace languages and a Kleene theorem is proved using knowledge expressions. The automata are employed to solve the decision problem for a logic of knowledge and time.

Computational Complexity

In [**L2**], the restrictiveness of planarity on the complexity of computing the determinant and the permanent is explored, and it is shown that both problems remain as hard as in the general case, i.e. GapL and $\#\mathsf{P}$ complete. On the other hand, both bipartite planarity and bimodal planarity bring the complexity of permanents down (but no further) to that of determinants. The permanent or the determinant modulo 2 is complete for $\oplus\mathsf{L}$, and it is shown that that parity of paths in a layered grid graph (which is bimodal planar) is also complete for this class. The complexity of grid graph reachability is also related to that of testing existence / uniqueness of a perfect matching in a planar bipartite graph.
(This work appears in [**L2**].)

In the uniform circuit model of computation, the width of a boolean circuit exactly characterises the "space" complexity of the computed function. Looking for a similar relationship in Valiant's algebraic model of computation, in [**M1**], width of an arithmetic circuit is proposed as a possible measure of space. The class VLOG is introduced as an algebraic variant of deterministic log-space Log. In the uniform setting, it is shown that this definition coincides with that of $\mathsf{VPSPACE}$ at polynomial width. Further, to define algebraic variants of non-deterministic space-bounded classes, the notion of "read-once" certificates for arithmetic circuits is introduced. It is shown that polynomial-size algebraic branching programs can be expressed as a read-once exponential sum over polynomials in VLOG, $\mathsf{VBP} \subseteq \Sigma^R \cdot \mathsf{VLOG}$. It is also shown that $\Sigma^R \cdot \mathsf{VBP} = \mathsf{VBP}$, VBPs are stable under read-once exponential sums. Further, it is shown that read-once exponential sums over a restricted class of constant-width arithmetic circuits are within VQP, and this is the largest known such subclass of poly-log-width circuits with this property.
(This work appears in [**M1**].)

Fixed membership testing for many interesting subclasses of multi-pushdown machines is shown in [**L1**] to be no harder than for pushdowns with single stack. The models considered are MVPA, OVPA and MPDA, which have all been defined and studied in the past. Multi-stack pushdown automata, MPDA, have ordered stacks with pop access restricted to the stack-top of the first non-empty stack. The membership for MPDAs is known to be in NSPACE(n) and in P. In [**L1**] it is shown that the P-time algorithm can be implemented in the complexity class LogCFL; thus membership for MPDAs is LogCFL-complete. It follows that membership testing for ordered visibly pushdown automata OVPA is also in LogCFL. The membership problem for multi-stack visibly pushdown automata, MVPA, is known to be NP-complete. However, many applications focus on MVPA with $O(1)$ phases. It is shown in [**L1**] that for MVPA with $O(1)$ phases, membership reduces to that in MPDAs, and so is in LogCFL.

In [**Arv5**, **Arv4**] we study the remote point problem for the Hamming and rank metrics.In [**Arv7**] we relate the remote point problem to proving lower bounds for circuits with help functions. In [**Arv4**] we present a new deterministic parallel algorithm for the remote point problem that produces solutions of the same quality as the earlier sequential algorithm of Alon et al.

In [**Arv1**, **Arv2**], building on our work of last year, we further investigate the connection between automata theory and noncommutative arithmetic circuits. In [**Arv1**] we introduce the Hadamard product of polynomials which turns out to be a useful tool in finding a new deterministic NC^2 algorithm for polynomial identity testing for noncommutative algebraic branching programs over rationals.

In [**Arv3**] we study lower bounds for constant-width arithmetic circuits. We show an infinite width hierarchy for monotone polynomial-size constant-width arithmetic circuits. Specifically, we construct a polynomial that has polynomial size monotone width 2k arithmetic circuits but requires exponential size monotone arithmetic circuits of width k.

Graph Theory and Combinatorics

Let $D \in \mathcal{D}(n,p)$ be a *random* instance obtained by first choosing a random undirected graph $\mathcal{G}(n,2p)$ and then choosing an orientation of the undirected graph uniformly randomly. Given a simple directed graph $D = (V,A)$, let the size of the largest induced acyclic subgraph of D be denoted by $mas(D)$. Also, let the size of the largest induced acyclic tournament be denoted by $mat(D)$.

In [**D2**], sharper concentration results and also improved upper and lower bounds on $mas(D)$ were obtained for $D \in \mathcal{D}(n,p)$. Also, a polynomial-time heuristic to find a large induced acyclic subgraph was analyzed and was shown to produce a solution whose size is at least half of any optimal solution.

It was shown that several of the bounds on forbidden subgraph chromatic numbers obtained in [**Mu**], [**A3**], [**Ar**] and [**A4**] using probabilistic arguments are algorithmically realizable.

In [**D1**], it is shown that for $D \in \mathcal{D}(n,p)$, $mat(D)$ is asymptotically almost surely one of only 2 possible values, namely either b^* or b^*+1, where $b^* = \lfloor 2(\log_{p^{-1}} n) + 0.5 \rfloor$.

It is then shown that almost surely any maximal induced acyclic tournament is of a size which is at least nearly half of any optimal solution. Also, a polynomial time heuristic was analyzed and was show that almost surely it produces a solution whose size is at least $\log_{p^{-1}} n + \Theta(\sqrt{\log_{p^{-1}} n})$. The results also carry over to a related model in which each possible directed arc is chosen independently with probability p. An immediate corollary is that (the size of a) maximum induced acyclic tournament can be approximated within a ratio of $2-o(1)$ for random digraphs.

In [**N**], the acyclic edge coloring conjecture (which states that every graph is acyclically edge colorable with $\Delta + 2$ colors) was shown to be true for some graph classes like Harary graphs and block-line critical graphs.

In [**A2**], some new bounds on the oriented chromatic number of some classes of products (both cartesian and strong product) of graphs were obtained.

Given a property $\mathcal{P}$ (which is closed under isomorphism) of graphs, the intersection dimension of an arbitrary graph G with respect to $\mathcal{P}$ is the minimum k (if it exists) such that G is the intersection of k graphs satisfying $\mathcal{P}$. In [**A1**], it is shown that the intersection dimension of graphs with respect to several hereditary properties can be bounded as a function of the maximum degree. As an interesting special case, it is shown that the circular dimension of a graph with maximum degree Δ is at most $O(\Delta\frac{\log\Delta}{\log\log\Delta})$. Also bounds in terms of treewidth are obtained. The results make use of bounds on forbidden subgraph chromatic numbers obtained earlier.

2.3.2 List of Publications

The list of publications follows the following conventions: firstly, names of (co)authors who are not IMSc members are marked with a superscript *; secondly, the citation labels used for cross-referencing with the research summary are constructed from the last name of the first IMSc author and finally the list is ordered alphabetically according to the labels.

[**A1**]
N. R. Aravind and C. R. Subramanian.
Intersection dimension and maximum degree.
In C.E. Ferreira and Fabio Protti, editors, *5th Latin American Algorithms, Graphs and Optimization Symposium*, pages 353–358. Elsevier, Nov 2009.
ENDM volume 35.

[**A2**]
N. R. Aravind, N. Narayanan, and C. R. Subramanian.
Oriented coloring of some graphs.
2009.
(Submitted).

[**A3**]
N. R. Aravind and C. R. Subramanian.
Forbidden subgraph colorings and the oriented chromatic number.
In J. Kratochvil and M. Miller, editors, *Proceedings of the 20th International Workshop on Combinatorial Algorithms (IWOCA-2009), June 28-July 02, 2009, Opava, Czech Republic*, pages 477–488. Springer-Verlag, 2009.
LNCS volume 5874.

[**A4**]
N. R. Aravind and C. R. Subramanian.

Bounds on vertex colorings with restrictions on the union of color classes.
Journal of Graph Theory, 2010.
(To be published).

[**Ar**]
N.R. Aravind and C.R. Subramanian.
Bounds on edge colorings with restrictions on the union of color classes.
SIAM Journal of Discrete Mathematics, 2009.
(To be published).

[**Arv1**]
V. Arvind, Pushkar Joglekar, and Srikanth Srinivasan.
Arithmetic circuits and the hadamard product of polynomials.
In Ravi Kannan and K. Narayan Kumar, editors, *Foundations of Software Technology and Theoretical Computer Science, FSTTCS 2009.*, page 25. LIPIcs 4 Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Dec 2009.

[**Arv2**]
V. Arvind and Pushkar Joglekar.
Arithmetic circuits, monomial algebras and finite automata.
In Damian Niwinski (Eds.) Rastislav Krlovic, editor, *Mathematical Foundations of Computer Science 2009, 34th International Symposium, MFCS 2009.*, page 78, Aug 2009.

[**Arv3**]
V. Arvind, Pushkar Joglekar, and Srikanth Srinivasan.
On lower bounds for constant width arithmetic circuits.
In Oscar Ibarra Yingfei Dong, Ding-Zhu Du, editor, *20th International Symposium on Algorithms and Computation, ISAAC 2009. Lecture Notes in Computer Science, Volume 5878.*, page 637. Springer Verlag, Dec 2009.

[**Arv4**]
V. Arvind and Srikanth Srinivasan.
The remote point problem, small bias spaces, and expanding generator sets.
In Jean-Yves Marion and Thomas Schwentick, editors, *27th International Symposium on Theoretical Aspects of Computer Science, STACS 2010*, page 59. LIPIcs 5 Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Feb 2010.

[**Arv5**]
V. Arvind and Srikanth Srinivasan.
Circuit lower bounds, help functions, and the remote point problem.
In Andrew Yao, editor, *The First Symposium on Innovations in Computer Science (ICS 2010)*, page 10. Tsinghua University Press, Beijing., Jan 2010.

[**Arv6**]
V. Arvind, J. Koebler*, and W. Lindner*.
Parameterized learnability of juntas.
Theoretical Computer Science, **410(47-49)**, 4928–4936, 2009.

[**Arv7**]
V. Arvind and Partha Mukhopadhyay*.
The monomial ideal membership problem and polynomial identity testing.
Information and Computation, **208(4)**, 351–363, 2010.

[**Arv8**]
V. Arvind and T.C. Vijayaraghavan*.
The orbit problem is in the GapL hierarchy.
Journal of Combinatorial Optimization, DOI: 10.1007/s10878-009-9243-8, 2009.

[**Arv9**]
V. Arvind and T.C. Vijayaraghavan*.
Classifying problems on linear congruences and abelian permutation groups using logspace counting classes.
Computational Complexity, **19(1)**, 57, 2010.

[**D1**]
Kunal Dutta and C. R. Subramanian.
Largest induced acyclic tournament in random digraphs : A 2-point concentration.
In Alejandro Lopez-Ortiz, editor, *Proceedings of LATIN-2010*, pages 627–637. Springer Verlag, April 2010.

[**D2**]
Kunal Dutta and C. R. Subramanian.
Induced acyclic subgraphs in random digraphs : Improved bounds.
2010.
Preprint.

[**L1**]
Nutan Limaye and Meena Mahajan.
Membership testing: Removing extra stacks from multi-stack pushdown automata.
In *Proceedings 3rd International Conference on Language and Automata Theory and Applications (LATA), LNCS 5457.*, pages 493–504. Springer, Apr 2009.

[**L2**]
Samir Datta*, Raghav Kulkarni*, Nutan Limaye, and Meena Mahajan.
Planarity, determinants, permanents, and (unique) matchings.
ACM Transactions on Computation Theory, **1(3)**, Article 10, 2010.

[**L3**]
Nutan Limaye, Meena Mahajan, and Antoine Meyer*.
On the complexity of membership and counting in height-deterministic pushdown automata.
Journal of Automata, Languages and Combinatorics, 2010.
(To be published).

[**L4**]
Nutan Limaye, Meena Mahajan, and Jayalal Sarma M. N.

Upper bounds for monotone planar circuit value and variants.
Computational Complexity, **18(3)**, 377–412, 2009.

[**L5**]
Nutan Limaye, Meena Mahajan, and Prajakta Nimbhorkar.
Longest paths in planar dags in unambiguous log-space.
Chicago Journal of Theoretical Computer Science, 2010.

[**L6**]
Nutan Limaye, Meena Mahajan, and B. V. Raghavendra Rao.
Arithmetizing classes around NC^1 and L.
Theory of Computing Systems, **46(3)**, 499–522, 2010.

[**M1**]
Meena Mahajan and B. V. Raghavendra Rao.
Small-space analogues of Valiant's classes.
In *17th International Symposium on Fundamentals of Computation Theory FCT, LNCS 5699*, pages 250–261. Springer, Sep 2009.

[**M2**]
Meena Mahajan and Jayalal Sarma M. N.
On the complexity of matrix rank and rigidity.
Theory of Computing Systems, **46(1)**, 9–26, 2010.

[**Ma**]
Amaldev Manuel and R. Ramanujam.
Counting multiplicity over infinite alphabets.
In Potapov, editor, *Reachability Problems 2009, Paliseau*, page 141. Springer Lecture Notes in Computer Science Vol 5797, Sep 2009.

[**Mi1**]
Neeldhara Misra, Venkatesh Raman, Saket Saurabh*, and Somnath Sikdar.
The budgeted unique coverage problem and color coding.
In Anna E. Frid et al, editor, *Proceedings of the 4th International Symposium on Computer Science in Russia (CSR 2009)*, page 310. Springer, LNCS 5675, Aug 2009.

[**Mi2**]
Neeldhara Misra, Geevarghese Philip, Venkatesh Raman, Saket Saurabh, and Somnath Sikdar*.
Fpt algorithms for connected feedback vertex set.
In Satoshi Fujita Md. Saidur Rahman, editor, *Proceedings of 4th International Workshop on Algorithms and Computation (WALCOM)*, pages 269–280. Springer, Feb 2010.

[**Mu**]
Rahul Muthu, N. Narayanan, and C. R. Subramanian.
On k-intersection edge colourings.
Discussiones Mathematicae Graph Theory, **29(2)**, 411–418, 2009.

[**N**]
Rahul Muthu*, **N. Narayanan, and C. R. Subramanian**.
Some graph classes satisfying acyclic edge coloring conjecture.
2009.
(Submitted).

[**P1**]
Soumya Paul, R. Ramanujam, and Sunil Simon.
Dynamic restriction of choices: a logical report.
In A. Heifetz, editor, *Theoretical Aspects of Rationality and Knowledge, Stanford*, page 218. Morgan Kaufmann, Jul 2009.

[**P2**]
Soumya Paul, R. Ramanujam, and Sunil Simon.
A model for dynamically switching strategies.
In Löwe Ambos-Spies and Merkle, editors, *Mathematical Theory and Computational Practice*, page 389. Springer Lecture Notes in Computer Science, Vol 5635, Jul 2009.

[**Ph**]
Geevarghese Philip, Venkatesh Raman, and Somnath Sikdar*.
Solving Dominating Set in Larger Classes of Graphs: FPT Algorithms and Polynomial Kernels.
In Amos Fiat and Peter Sanders, editors, *Algorithms - ESA 2009, 17th Annual European Symposium, Copenhagen, Denmark, September 7-9, 2009. Proceedings*, pages 694–705. Springer, LNCS 5757, Sep 2009.

[**Pr**]
M. Praveen and Kamal Lodaya.
Modelchecking counting properties of 1-safe nets with buffers in parapspace.
In Ravi Kannan and K Narayan Kumar, editors, *FSTTCS 2009*, pages 347–358. Schloss Dagstuhl–Leibniz-Zentrum für Informatik, Dec 2009.

[**R1**]
A. Baskar*, **R. Ramanujam, and S. P. Suresh***.
A dolev yao model for zero knowledge.
In Anupam Datta, editor, *Advances in Computer Science – Information Security and Privacy*, page 137. Springer Lecture Notes in Computer Science Vol 5913, Dec 2009.

[**R2**]
Rajdeep Niyogi* **and R. Ramanujam**.
An epistemic logic for planning with trials.
In Horty He and Pacuit, editors, *Logic, Rationality and Interaction*, page 238. Springer LNAI volume 5834, Oct 2009.

[**R3**]
Swarup Mohalik* **and R. Ramanujam**.

Automata for epistemic temporal logic with synchronous communication.
Journal of Logic, Language and Information, **19(2)**, 65, 2010.

[**R4**]
R. Ramanujam and S. P. Suresh*.
Challenges for epistemic theory from security protocols.
In Johan van Benthem and Amitabha Gupta, editors, *Logic at the Crossroads II*, page 115. Amsterdam Universities Press, 2009.

[**Ra1**]
Daniel Lokshtanov*, Venkatesh Raman, Saket Saurabh, and Somnath Sikdar.
On the directed degree preserving spanning tree problem.
In Jianer Chen and Fedor V. Fomin, editors, *International Workshop on Parameterized and Exact Computation (IWPEC 2009)*, page 276. Springer Verlag, Sep 2009.

[**Ra2**]
Fedor Fomin*, Daniel Lokshtanov*, Venkatesh Raman, and Saket Saurabh.
Subexponential algorithms for partial cover problems.
In K. Narayan Kumar Ravi Kannan, editor, *Proceedings of IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS)*, pages 193–201. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Dec 2009.

[**Ra3**]
Frederic Dorn*, Fedor Fomin*, Daniel Lokshtanov*, Venkatesh Raman, and Saket Saurabh.
Beyond bidimensionality: Parameterized subexponential algorithms on directed graphs.
In Thomas Schwentick Jean-Yves Marion, editor, *Proceedings of 27th International Symposium on Theoretical Aspects of Computer Science (STACS)*, pages 251–262. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Mar 2010.

[**Rao1**]
Raghavendra B. Rao and Jayalal M. Sarma*.
On the complexity of matroid isomorphism problem.
In Anna E. Frid et al, editor, *4th International Computer Science Symposium in Russia*, pages 286–298. Springer, LNCS 5675, Aug 2009.

[**Rao2**]
Maurice Jansen* and Raghavendra B. Rao.
Simulation of arithmetical circuits by branching programs preserving constant width and syntactic multilinearity.
In Anna E. Frid et al, editor, *4th International Computer Science Symposium in Russia*, pages 179–190. Springer, LNCS 5675, Aug 2009.

[**S1**]
Fedor Fomin*, Serge Gaspers*, Saket Saurabh, and Stephan Thomasse*.
A linear vertex kernel for maximum internal spanning tree.
In Oscar H. Ibarra Yingfei Dong, Ding-Zhu Du, editor, *Proceedings of 20th International*

Symposium on Algorithms and Computation (ISAAC), pages 275–282. Springer, LNCS 5878, Dec 2009.

[**S2**]
Petr Golovach*, **Pinar Heggernes***, **Dieter Kratsch***, **Daniel Lokshtanov***, **Daniel Meister***, **and Saket Saurabh**.
Bandwidth on at-free graphs.
In Oscar H. Ibarra Yingfei Dong, Ding-Zhu Du, editor, *Proceedings of 20th International Symposium Algorithms and Computation (ISAAC)*, pages 573–582. Springer, LNCS 5878, Dec 2009.

[**S3**]
Hans Bodlaender*, **Fedor Fomin***, **Daniel Lokshtanov***, **Eelko Penninkx***, **Saket Saurabh, and Dimitrios Thilikos***.
Meta Kernelization.
In Daniel Spielman, editor, *Proceedings of 50th Annual IEEE Symposium on Foundations of Computer Science (FOCS)*, pages 629–638. IEEE, Oct 2009.

[**S4**]
Stephane Bessy*, **Fedor Fomin***, **Serge Gaspers***, **Christophe Paul***, **Anthony Perez***, **Saket Saurabh, and Stephan Thomasse***.
Kernels for feedback arc set in tournaments.
In K. Narayan Kumar Ravi Kannan, editor, *Proceedings of IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS)*, pages 37–47. Schloss Dagstuhl - Leibniz-Zentrum fuer Informatik, Dec 2009.

[**S5**]
Fedor Fomin*, **Petr Golovach***, **Daniel Lokshtanov***, **and Saket Saurabh**.
Algorithmic lower bounds for problems parameterized with clique-width.
In Moses Charikar, editor, *Proceedings of the Twenty-First Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, pages 493–502. SIAM, Jan 2010.

[**S6**]
Fedor Fomin*, **Daniel Lokshtanov***, **Saket Saurabh, and Dimitrios Thilikos***.
Bidimensionality and kernels.
In Moses Charikar, editor, *Proceedings of the Twenty-First Annual ACM-SIAM Symposium on Discrete Algorithms (SODA)*, pages 503–510. SIAM, Jan 2010.

[**S7**]
Fedor Fomin*, **Serge Gaspers***, **Dieter Kratsch***, **Mathieu Liedloff***, **and Saket Saurabh**.
Iterative compression and exact algorithms.
Theoretical Computer Science, **411(7-9)**, 1045–1053, 2010.

[**S8**]
Fedor Fomin*, **Petr Golovach***, **Daniel Lokshtanov***, **and Saket Saurabh**.

Intractability of clique-width parameterizations.
SIAM Journal on Computing, **39(5)**, 1941–1956, 2010.

2.4 Student Programmes

2.4.1 Degrees Awarded

Doctoral Degrees Awarded during 2009 – 2010

Mathematics

Name: **Sarkar, Swagata**
Thesis Title: Degrees of maps between complex Grassmann manifolds
Thesis Advisor: Sankaran, Parameswaran
University: HBNI

Physics

Name: **Laddha, Alok**
Thesis Title: Parametrized Theories and Loop Quantization
Thesis Advisor: Date, G.
University: Homi Bhabha National Institute

Name: **Banerjee, Kinjal**
Thesis Title: Studies in Loop Quantization of Cosmological Models
Thesis Advisor: Date, G.
University: Homi Bhabha National Institute

Name: **Mitra, Mithun K.**
Thesis Title: Statistical Mechanics of Pressurized Two-dimensional Polymer Rings
Thesis Advisors: Menon, Gautam I., and Rajesh, R.
University: HBNI

Name: **Pan, Raj K.**
Thesis Title: Modularity and Hierarchy in Complex Systems: Relating network structure to dynamics
Thesis Advisor: Sinha, Sitabhra
University: HBNI

Theoretical Computer Science

Name: **Narayanan, N.**
Thesis Title: Acyclic, k-Intersection Edge Colourings and Oriented Colouring
Thesis Advisor: Subramanian, C. R.
University: Homi Bhabha National Institute

Name: **Limaye, Nutan**

Thesis Title: Exploring LOGCFL using language theory
Thesis Advisor: Mahajan, Meena B.
University: Homi Bhabha National Institute

Name: **Mukhopadhyay, Partha**
Thesis Title: On Polynomial Identity Testing and Related Problems
Thesis Advisor: Arvind, V.
University: Homi Bhabha National Institute

Name: **Rao B V, Raghavendra**
Thesis Title: A study of width bounded arithmetic circuits and the complexity of matroid isomorphism
Thesis Advisor: Mahajan, Meena B.
University: Homi Bhabha National Institute

Name: **Simon, Sunil**
Thesis Title: A logical study of strategies in games
Thesis Advisor: Ramanujam, R.
University: HBNI

Doctoral Theses Submitted during 2009 – 2010

Mathematics

Name: **Singla, Pooja**
Thesis Title: Representations and conjugacy classes of general linear groups over principal ideal local rings of length two
Thesis Advisor: Prasad, Amritanshu
University: Homi Bhabha National Institute

Physics

Name: **Misra, Basudha**
Thesis Title: Some aspects of the phenomenology of B mesons
Thesis Advisor: Sinha, Rahul
University: HOMI BHABHA NATIONAL INSTITUTE

Theoretical Computer Science

Name: **Das, Bireswar**
Thesis Title: Some Complexity Theoretic Aspects of Graph Isomorphism and Related Problems
Thesis Advisor: Arvind, V.
University: Homi Bhabha National Institute

Name: **Nimbhorkar, Prajakta**
Thesis Title: Complexity Analysis of Some Problems in Planar Graphs, Bounded Tree-width Graphs and Planar Point Sets.
Thesis Advisor: Mahajan, Meena B.
University: HBNI

Name: **Sikdar, Somnath**
Thesis Title: Parameterizing from the Extremes: Feasible parameterizations of some NP-hard problems
Thesis Advisor: Raman, Venkatesh
University: HBNI

Masters Theses during 2009 – 2010

Theoretical Computer Science

Name: **Dutta, Kunal**
Thesis Title: Random Graphs : A Study of some Invariants and Algorithms
Thesis Advisor: Subramanian, C. R.
University: Homi Bhabha National Institute

Name: **Misra, Neeldhara**
Thesis Title: Infeasibility of Polynomial Kernels
Thesis Advisor: Raman, Venkatesh
University: HBNI

2.4.2 Lecture Courses During 2009 – 2010.

The following **lecture courses** were offered during 2009 – 2010.

Course Title	Period	Lecturer
Mathematics		
Arithmetic	Jan-Apr 2009	Sankaran, Parameswaran
Complex Analysis	Jan-Mar 2009	Krishna, M.
Functional Analysis	Jan-Apr 2009	Sunder, V. S.
Linear algebraic groups	Jan-Apr 2009	Raghavan, K. N.
Topology II	Jan-Apr 2009	Nagaraj, D. S.
Functors, Monads, Programming	Feb-Mar 2009	Paranjape, Kapil H.
Algebra	Aug-Nov 2009	Gun, S.
Combinatorics of Free Probability	Aug-Dec 2009	Kodiyalam, Vijay
K-theory for Banach Algebras	Aug-Dec 2009	Chakraborty, Partha S.
Locally Compact Abelian Groups	Aug-Dec 2009	Prasad, Amritanshu

Measure Theory	Aug-Dec 2009	Krishna, M.
Number Theory	Aug-Oct 2009	Gun, S.
Representation Theory	Aug-Nov 2009	Raghavan, K. N.
Vector bundles and K-Theory	Aug-Dec 2009	Kalelkar, Tejas D.
Complex Analysis	Jan-Apr 2010	Srinivas, K.
Quantum Mechanics	Jan-Mar 2010	Krishna, M.
Topology II	Jan-May 2010	Prasad, Amritanshu

Physics

Quantum Field theory I	Jan-Apr 2009	Sathiapalan, Balachandran
Advanced Particle Physics	Aug-Apr 2010	Sinha, Rahul
Electrodynamics	Aug-Dec 2009	Sinha, Rahul
Mathematical Physics	Aug-Dec 2009	Mishra, Ashok K.
Quantum Mechanics	Aug-Dec 2010	Ghosh, Sibasish
Particle Physics	Jan-Apr 2010	Sinha, Nita

Theoretical Computer Science

Computational Complexity	Jan-Apr 2009	Mahajan, Meena B.
Concurrency theory	Jan-Apr 2009	Lodaya, Kamal
Logic I	Jan-May 2009	Ramanujam, R.
Circuit Complexity (reading course)	Aug-Nov 2009	Mahajan, Meena B.
Computational Complexity - II	Aug-Dec 2009	Mahajan, Meena B.
Design and analysis of algorithms	Aug-Dec 2009	Subramanian, C. R.
Programming languages	Aug-Dec 2009	Lodaya, Kamal
Theory of Computation	Aug-Dec 2009	Ramanujam, R.
Advance Graph Theory	Jan-Apr 2010	Saurabh, Saket
Matchings in Graphs	Jan-Apr 2010	Mahajan, Meena B.
Parameterized Complexity	Jan-Apr 2010	Saurabh, Saket
Logic	Feb-May 2010	Lodaya, Kamal
Approximation Algorithms	Aug-Dec 2010	Raman, Venkatesh

In addition, the following **lecture courses** were offered during 2009 – 2010 by IMSC faculty in the National Undergraduate programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer

Mathematics

Tutorials in Differential Topology	Dec-Dec 2009	Singh, Mahender

Physics

Quantum Mechanics II	Jan-Apr 2009	Rajasekaran, G.
Mathematical Physics II (Probability Theory and Numerical Method	Mar-Apr 2009	Ghosh, Sibasish
Quantum Mechanics III	Aug-Dec 2009	Rajasekaran, G.
Particle Physics (for CMI students at IIMsc)	Jan-Apr 2010	Sathiapalan, Balachandran

2.4.3 Summer Students

Every summer, a small number of students from various institutes/universities come to our instituteand work on some learning/research projects with some faculty member for a period of four to six weeks.The following students visited the institute during Apr, 2009 - Mar, 2010.

Student	Faculty
Mathematics	
Maiti, Arun, Chennai Mathematical Institute	Chakraborty, Partha S.
Das, Sayan, Indian Statistical Institute, Kolkata	Chakraborty, Partha S.
Verma, Rashi, Integrated Msc. (Physics) student of UM-DAE-CBS	Krishna, M.
Singh, Akshay Kumar, IISER-kolkata	Krishna, M.
ME, Lakshmi Priya, Integrated MS student at IISER, Pune.	Krishna, M.
Venkat, Guhan, IISER Pune	Prasad, Amritanshu
Nandi, Santanu, Vivekananda University	Sankaran, Parameswaran
Banerjee, Tathagata, Ramakrishna Mission Vivekananda University, Belur	Sunder, V. S.
Giri, Sumit, Indian Statistical Institute	Sunder, V. S.
Physics	
James, Albin, IIT Madras	Basu, Rahul
Vivek, Manali, St Stephen's College, Delhi University	Basu, Rahul
Joe, Anton, IIT Kharagpur	Date, G.
Sekhar, Aswin, Christ University, Bangalore	Menon, Gautam I.
Jayaseelan, Maitreyi, University of Hyderabad	Simon, R.
Sahayaraj, Sylvester, Madrad Christian College, Tambaram	Simon, R.
Kansal, Mukta, St Stephen's College, Delhi	Sinha, Sitabhra
Sourav, S. B., Indian Institute of Technology-Madras, Chennai	Sinha, Sitabhra
Vikram, S. V., Indian Institute of Technology-Madras, Chennai	Sinha, Sitabhra
Dasgupta, Abhishek, IISER-Kolkata	Sinha, Sitabhra
Soni, Jalpa, Gujarat University, Ahmedabad	Sinha, Sitabhra

Yadav, Mohit, Indian Institute of Technology, Guwahati	Sinha, Sitabhra

Theoretical Computer Science

Bharat Ram, R, Chennai Mathematical Institute, Chennai	—
Sandipan Bhattacharya, Jadavpur University, West Bengal	—
Soumyottam Chatterjee, Indian Statistical Institute, Kolkata	—
Anwesha Das, Siliguri Institute of Technology, West Bengal	—
Minati De, Indian Statistical Institute, Kolkata	Raman, Venkatesh
Vidhwath Shankar, National Institute of Technology, Karnataka	—
Sekar, Shreyas, IIT Roorkee	Raman, Venkatesh
Nishkarsh Swarnkar, National Institute of Technology, Karnataka	

2.4.4 Other Students

Students also do their projects under the supervision of our faculty during the academic year.The following students visited the institute during Apr, 2009 - Mar, 2010.

Student	Faculty

Mathematics

Ramesh, Arjun, BITS Pilani	Krishna, M.

Physics

Lugani, Jasleen, Physics Department, IIT-Delhi	Ghosh, Sibasish
Badrinarayanan, Shrinath, SASTRA University, Thanjavur	Siddharthan, Rahul
Sundaram, Vasavi, Anna University	Siddharthan, Rahul
Pradhan, Neeraj, BITS-Pilani	Sinha, Sitabhra

Theoretical Computer Science

Murali, Prakash, BITS Pilani, Goa Campus	Saurabh, Saket

2.5 Honours and Awards

Balasubramanian, R. was awarded TAAExcellence Award , for 2009, by the TIFR Alumni Association.

Nagaraj, D. S. was awarded Fellow, for 2010, by the Indian Academy of Sciences.

Rajasekaran, G. was awarded JC Banerji Memorial Lecture Award, for 2009, by the The National Academy of Sciences, India for For significant contributions in the area of Quantum Field Theory/High Energy Physics.

Rajasekaran, G. was awarded Early Pioneer Award, for 2009, by the Tata Institute of Fundamental Research Alumni Association. Given on the occasion of the Birth Centenary of Homi Bhabha

Sinha, Sudeshna was awarded Fellow of Indian Academy of Sciences, for 2010, by the Indian Academy of Sciences, Bangalore.

Chapter 3

Other Professional Activities

This chapter lists the activities carried out by the individual members of the institute in their professional capacity.

Arvind, V.

Member of National Board of Higher Mathematics during Jan 2007 – Dec 2009.

Balasubramanian, R.

Chairman of Sectional committee for Mathematics of indian academy of Sciences during Jan 2008 – Dec 2009.

Vice president of Malibnet during Mar 2009 – Mar 2010.

Chairman of Scientific committee of Indo-French Institute of Mathematics (IFIM)

Member (2007-2010) of Science Engineering Research Council (SERC)of DST

Member of Governing Council, HRI, Allahabad

member of the Advisory Board of Indian Jour of Pure and applied Mathematics

member of Academic Advisory committee of IISER , Trivandrum

member of Governing council of Institute of mathematics and applications , Bhubaneshwar during Jan – Mar, 2010.

Convener of Local Organising Committee for ATM workshop on Analytic Number theory held at IMSc during Feb 17 – Mar 2, 2010.

Convener of International Organising Committee for Italy India Conference on Diophantine equations and analytic number theory held at Scoula Normale Superiore di Pisa during Mar

8 – Mar 14, 2010.

Basu, Rahul

NOC member of National Organising Committee of WHEPP XI during Jan 2009 – Jan 2010.

co-convener of Organising Committee of Data to Theory Approach to LHC Physics during Mar – Dec, 2009.

Convener of National Organising Committee for Data to Theory Approach to LHC Physics held at Indian Institute of Advanced Study, Shimla during Dec 16 – Dec 20, 2009.

Date, G.

Secretary of The Indian Association for General Relativity and Gravitation

Convener of Local Organising Committee for School on Loop Quantum Gravity held at IMSc during Sep 8 – Sep 18, 2009.

Gopalakrishna, Shrihari

Lecture at Stella Maris College on Mar 5, 2010. A seminar titled "The Large Hadron Collider" was delivered in the "Popular Lectures on Physics 2010" series.

Gun, S.

Member of Local Organising Committee for Jacobi and Siegel modular forms held at IMSc during Nov 23 – Dec 5, 2009.

Jaikumar, Prashanth

Convener of Local Organising Committee for Neutrinos in Particle Astrophysics and Cosmology held at Mahabalipuram, Tamil Nadu, India during Apr 5 – Apr 7, 2009.

Kesavan, S.

Reviewer of Mathematical Reviews

Member of Board of Studies in Mathematics, Kanchi Mamunivar PG Centre, Pondicherry

Fellow of Forum d' Analystes

Member of Editorial Board, Journal of the Kerala Mathematical Association

Member of Board of Studies in Mathematics, Homi Bhabha National Institute

Member of Executive Committee, ICM, 2010

Member of Board of Studies in Mathematics (Postgraduate), University of Madras

Member of Board of Studies, Ramanujan School of Mathematics and Computer Science, Pondicherry University

Member of National Board for Higher Mathematics

Convenor of Academic Council, Chennai Mathematical Institute

Krishna, M.

Convener of National Organising Committee for Mathematical Physics Symposium - Ramanujan Mathematical Society Annual Conference held at Indian Statistical Institute Bangaluru during May 11 – May 13, 2009.

Lodaya, Kamal

co-chair of Programme Committee, 3rd ISLA, Hyderabad, 2010 during Jan 2009 – Jan 2010.

Mahajan, Meena B.

member of Programme Committee, International Conference on Foundations of Software Technology and Theoretical Computer Science FSTTCS during May – Dec, 2009.

member of Programme Committee, Workshop on Algorithms and Computation WALCOM 2010, Dhaka, 10-12 Feb 2010 during Sep 2009 – Feb 2010.

member of Programme Committee, IEEE Conference on Computational Complexity, 9-12 June, Boston. during Dec 2009 – Mar 2010.

Menon, Gautam I.

Member of Board of Studies for Physical Sciences, Homi Bhabha National Institute. Also Balancing Member on the Board of Studies for Biological Sciences during Apr 2006 – Apr 2009.

Associate Member of Centre for Computational Materials Science, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore during Feb 2007 – Feb 2010.

Associate Member of Advanced Materials Research Unit, S.N. Bose National Centre for Basic Sciences, Kolkata during Jan 2008 – Jan 2010.

Convener of Local Organising Committee for Molecular Motors, Tracks and Transport held at GRT Sunway, Pondicherry during Jan 23 – Jan 28, 2010.

Misra, Neeldhara

Part of the Organizing Team at IMSc on Feb 28, 2010. IMSc Science Day Event More details at www.imscscienceday.com

Raghavan, K. N.

Treasurer of Ramanujan Mathematical Society

Secretary of Forum D'Analystes

Member of Local Organising Committee for Annual Foundational School I held at Chennai Mathematical Institute during Dec 3 – Dec 26, 2009.

Rajasekaran, G.

Member of Scientific Steering Committee of INO

Chairman of Board of Studies in Physics,CMI

Member of Academic Council,CMI

Popular Science Lectures at Centre for Experiencing Socio-Cultural Interaction, Madurai on Aug 24, 2009. Gave two lectures entitled "Cultural Values of Science" and "A Overview of Physics"

Newspaper article at Chennai on Sep 24, 2009. The HINDU published the article "A Great Opportunity for Indian Science".

Popular Science Talk at IMSc on Sep 22, 2009. Gave a talk to students of colleges on "Is there a Final Theory?".

Popular Science Talk at IMSc on Oct 8, 2009. As a part of Homi Bhabha Centenary Celebration at IMSc, talked on Homi Bhabha's scientific contributions and his institution building activities.

Popular Science Talks at American College,Madurai on Nov 30, 2009. Gave two talks to students of PG Colleges in Madurai:1.INO and its importance 2.Homi Bhabha, the Scientist and Institution Builder par Excellence

Popular Science Lecture at Central School,IIT,Chennai on Dec 23, 2009. Gave an inaugural talk on "The Cultural Values of Science" to Physics Teachers from many Central Schools assembled for a Training Programme.

Member of TIFR Mid-term Review Panel during Jan – Feb, 2010.

Newspaper article in Tamil at Chennai on Jan 25, 2010. DINAMANI (a Tamil Newspaper) published the article: "India ariviyal ongi valara oru vaippu".

Popular Science Talks at American College,Madurai and Madurai Kamaraj University on Jan 6, 2010. Talked on Neutrinos and INO

Popular Science Talks at Arulanandar College, Karumathur, Theni District, Tamil Nadu on Mar 10, 2010. Talked on Neutrinos and INO to students of Schools and UG Colleges in the neighborhood

Popular Science talk at The American College,Madurai on Mar 11, 2010. Talked on Neutrinos and INO to the PG students and faculty of Madurai Colleges

Raman, Venkatesh

member of Steering Committee of the International Workshop on Parameterized and Exact Computation during Jul 2005 – Mar 2010.

Member of Program Committee of CATS 2010 Conference during Apr – Dec, 2009.

Chair of Program Committee of International Symposium on Paramaterized and Exact Computation (IPEC 2010)

Member of Board of Studies in Mathematics at Cochin University of Science and Technology (CUSAT)

Member of Board of Studies in Mathematics at PSG Tech College, Coimbatore during Feb – Mar, 2010.

Gave 12 Public Lectures on Theoretical Computer Science at IIT Chennai on Feb 6, 2010. This is a series of lectures aimed at mathematically matured public to discuss undergraduate and advanced topics in Computer Science; gave 12 lectures starting in February, every Saturday

Ramanujam, R.

Member of Program Committee of ICALP – Track B (International colloquium on automata, languages and programming) during Oct 2008 – Aug 2009.

Chairman of Executive Committee of the Association for Logic in India during Jan 2009 – Mar 2010.

Member of Council of the Association for Symbolic Logic during Jan 2009 – Mar 2010.

Editor of Editorial Board of "Knowledge, Rationality and Action", a section of Synthese during Jan 2009 – Mar 2010.

Editor of Editorial Board of Journal of Philosophical Logic during Sep 2009 – Mar 2010.

Convener of International Organising Committee for Structural Aspects of Rationality held at IIT, Kanpur during Dec 13 – Dec 14, 2009.

Convener of International Organising Committee for Formal theories of communication held at Lorentz Center, Leiden, The Netherlands during Feb 22 – Feb 26, 2010.

Sankaran, Parameswaran

Convener of Local Organising Committee for ATM Workshop on Topology of Manifolds held at IMSc during Feb 1 – Feb 13, 2010.

Wrote an article on 'Poincaré conjecture' at Mathematical Newletter of the Ramanujan Mathematical Society on Mar 1, 2010.

Saurabh, Saket

Lecturer at IIT Madras on Feb 6, 2010. An Invitation to Theoretical Computer Science is a series of lectures organized every Saturday at IIT(Madras). The aim of which is to invite the general computer science and mathematics students to the exciting world of theoretical computer science.

Sinha, Rahul

Member of Expert Panel on Fast Track Proposals for Young Scientists in Physical and Mathematical Sciences. during Jan 2009 – Jan 2010.

Sinha, Sitabhra

Adviser of Government of India Expert Committee on H1N1 virus spread during Nov 2009 – Mar 2010.

Convener of Local Organising Committee for 2nd IMSc Complex Systems School held at IMSc during Jan 4 – Jan 29, 2010.

Sridhar, S.

Member of Local Organising Committee for Complex Systems School 2010 held at IMSc during Jan 4 – Jan 29, 2010.

Srinivas, K.

Invited Speaker at Patrician College of Arts and Science, Adyar, Chennai on Jul 27, 2009. Delivered a talk with the theme ' Mathematics in day-to-day life. About 120 college students of undergraduate leel participated. It was demonstrated how simple mathematical concepts like divisibility, congruences are used in encoding-decoding messages.

Member of Advisory Committee for Interactive Mathematics Training Camp held at Institute of Mathematics and Applications, Bhubaneswar during Sep 24 – Oct 4, 2009.

External Examiner of Ph D Interview Committee, N.I.T. Rourkela during Nov – Nov, 2009.

Chief-Guest and Invited speaker at Ramanujan Museum & Math Education Center, Royapuram, Chennai on Dec 22, 2009. Delivered a talk on ‘Some contributions of Ramanujan’ on the eve of Ramanujan Birth Day.

Subramanian, C. R.

Member of Organizing Committee for the ICM-2010 Satellite Workshop on ”Algebraic and Probabilistic Aspects of Combinatorics and Computing” during Jan 2009 – Mar 2010.

Convener of National Organising Committee for Instructional Workshop on Graph Colorings held at Kalasalingam University, Krishnan Koil, Tamilnadu during Mar 10 – Mar 15, 2010.

Sunder, V. S.

Member of Editorial Board of the ‘Texts and Readings in Mathematics’ (or the TRIM) series published by the Hindustan Book Agency.

Convener of Board of Sciences, Math. Sciences, HBNI

Gave a lecture on ‘Catalan Numbers’ at CESCI, Madurai on Aug 25, 2009. This was a two-day program organised by the Chennai chapter of INSA called ‘Wonder of Science’ to school students in the Madurai area.

Chapter 4

Colloquia

4.1 Conferences/Workshops Held at IMSc

4.1.1 School on Loop Quantum Gravity

It was felt for some time that although Loop Quantum Gravity has emerged as a serious candidate theory of quantum gravity, there has been no school of sufficient duration to provide an opportunity for graduate students to learn the basics of the theory. With this in mind a *School on Loop Quantum Gravity* was organized at IMSc during Sept 8 - 18, 2009. The goal set was to introduce the basic formalism of loop quantum gravity and to illustrate its main achievements so far, namely illustration of big bang singularity resolution and illustrating specific model of micro-structure of black hole horizons leading to the entropy computation.

The 10 days program was divided in two parts: first week was dedicated to the basic formalism while the second week was devoted to the two main applications, namely black hole entropy and loop quantum cosmology.

The lectures were given by Ghanashyam Date, Romesh Kaul (IMSc), Amit Ghosh, Parthasarathi Majumdar (SINP), Alok Laddha (RRI) and Kinjal Banerjee (IUCAA). In all there were 21 participants registered for the school – 12 out-station and remaining local. A total of 30 sessions of 90 minutes each were held. Thanks to the initiative of Srijit Bhattacharjee, SINP, the proceedings were video-graphed.

The funding for the school came from the XI$^{\text{th}}$ Plan project entitled *Numerical Quantum Gravity and Cosmology.*

4.1.2 Jacobi and Siegel modular forms

The goal of this workshop was to teach different aspects of Jacobi and Siegel modular forms to young researchers.

4.1.3 2nd IMSc Complex Systems School

This intensive four-week school during Jan 4 29, 2010, organized in cooperation with the Santa Fe Institute, Santa Fe, USA, was meant to introduce advanced masters and graduate students as well as postdocs in various quantitative sciences to research on complex phenomena in physical, biological and social systems. It was a follow-up of the first complex systems school held in January 2006. The school consisted of lectures by distinguished scientists on foundations, techniques current research areas in complex systems research, and hands-on team projects on complex systems topics that were carried out by the participants. There were 36 participants, including one from abroad, who came from diverse disciplines of physics, bioscience, economics and engineering. The last 2 days of the School were given over to project presentations by the participants. The list of speakers at the School were as follows:

- V. Balakrishnan (IIT Madras): *Introduction to Nonlinear Dynamics*
- R Balasubramanian (IMSc, Chennai): *Goldbach Conjecture: An Invitation to Number Theory*
- Amitabha Bose (NJIT, Newark): *Introduction to Computational Neuroscience*
- Bikas K. Chakrabarti (SINP, Kolkata): *Econophysics*
- Nivedita Chatterjee (SN-VRF, Chennai): *How Neurons Talk*
- Nandini Chatterjee-Singh (NBRC, Manesar): *Cognitive Neuroscience: Understanding the neurobiology of language*
- Sibasish Ghosh (IMSc, Chennai): *Information Theory*
- Neelima Gupte (IIT Madras): *Analysis of Communication Networks*
- Herve Isambert (Inst Curie, Paris): *Evolution of Biomolecular Networks*
- Neo Martinez (PEaCE Lab, Berkeley) : *Structure and Dynamics of Complex Ecological Networks*
- Gautam I. Menon (IMSc, Chennai): *Statistical Mechanics: Information, Disorder and Complexity*
- Alain Pumir (ENS Lyon): *Nonlinear Dynamics in Biology*
- R. Rajesh (IMSc, Chennai): *Non-equilibrium Statistical Mechanics*
- Uma Ramakrishnan (NCBS, Bangalore): *Genetic Variation in Populations*
- R. Ramanujam (IMSc, Chennai): *Game Theory*
- Hari Rao (Bangalore): *Complexity: An Evolving View (An Artist's Perspective)*
- Jari Saramaki (HUT, Helsinki): *Complex Networks*
- R. Shankar (IMSc, Chennai): *Accelerated Climate Change and the Himalayan Glaciers*

- L. S. Shashidhara (IISER Pune): *Pattern Formation in Biology*
- Anindya Sinha (NIAS, Bangalore): *Social Networks and Cognition in Primates*
- Sitabhra Sinha (IMSc, Chennai): *Modeling Socio-economic Phenomena*
- Somdatta Sinha (CCMB, Hyderabad): *Mathematical Models in Biology*
- D. Eric Smith (SFI, Santa Fe): *Understanding the Origin of Life/ Computational Historical Linguistics*
- N. Srinivasan (CBCS-UA, Allahabad): *Dynamics and Modeling in Cognitive Science*
- Lakshmi Subramanian (Jamia Milia, New Delhi): *Networks in the Indian Ocean: Some Reflections*
- Nisha Yadav (TIFR, Mumbai): *The Indus Valley Civilization and its Writing*

4.1.4 Complex Systems School 2010

I was primarily involved as the mentor for the student projects at the school. In addition I also played an active role in ensuring local organisation and smooth running of the school.

4.1.5 ATM Workshop on Topology of Manifolds

The Wokshop was funded by NBHM as part of the ATM Schools. There were 20 participants in all of which ten were outstation participants. There were three lecture courses on the following topics: (1) Topology of aspherical manifolds, by Prof. Goutam Mukherjee, ISI Kolkata, (2) Quasi-toric manifolds by Prof. Mainak Poddar, ISI Kolkata, and, (3) structures on manifolds by Prof. P. Sankaran, IMSc. There were four talks by participants and four special lectures by experts.

4.2 Other Conferences/Workshops Organized by IMSc

4.2.1 Neutrinos in Particle Astrophysics and Cosmology

This was a satellite meeting of the ICTS program Aspects of Neutrinos. The focus for the satellite meeting was on neutrino astrophysics and cosmology.

4.2.2 Mathematical Physics Symposium - Ramanujan Mathematical Society Annual Conference

This is a symposium on Mathematical Physics as part of the Annual RMS conference. Had a participation from India and abroad. This symposium covered several areas of Mathematical Physics.

4.2.3 Interactive Mathematics Training Camp

Every year IMA, Bhubaneswar organizes an Interactive Mathematics Training Camp for BSc/MSc students of Orissa. This year about 40 students were selected. Professors Kumaresan, Arindam Singh, Deepak Dalai, Muruganandam and K. Srinivas offered basic courses in Mathematics. The academic coordination was done by K. Srinivas.

4.2.4 Annual Foundational School I

This is an annual school run as part of the ATM (Advanced Training in Mathematics) Schools.

4.2.5 Data to Theory Approach to LHC Physics

The conference/workshop was aimed at training people in the Data to Theory Approach to LHC physics.

4.2.6 Structural Aspects of Rationality

Predicting rational play is the central concern of game theory, and game models are built on rationality assumptions. Re-examining notions of rationality in new contexts has led to many interesting questions for game theory, as for instance in games of infinite duration, motivated by computation theory. The Workshop was intended as an occasion for exchanging ideas on foundations of game theory, especially on structural and computational arguments for the analysis of solution concepts.

The satellite workshop of the FSTTCS conference featured keynote talks by Anuj Dawar (Cambridge), Lukasz Kaiser (Aachen), Mamoru Kaneko (Tsukuba), Eric Pacuit (Tilborg), Jerome Renault (Toulouse) and Olivier Roy (Groningen). In addition Florian Horn (Paris), Marie Leclau (Paris), Soumya Paul (Chennai), Sunil Simon (Amsterdam) and Ashutosh Trivedi (Oxford) gave shorter research presentations.

4.2.7 Molecular Motors, Tracks and Transport

Studies in molecular motors and intracellular transport lie at the intersection of various fields. Indeed, few other fields of biology intersect as closely with physics and engineering. Such studies require combining an understanding of basic mechanics at the molecular level the motor is essentially a protein molecule which can move carrying cargo with a host of exciting experiments, ranging from single molecule biophysics and biochemical experiments to in vivo biology. To the theoretically minded, the field is rich both in data and in problems requiring modeling, while the experimentalist is confronted with the challenge of refining the accuracy of data measured in the wet and perpetually noisy environment of the cell, a problem common to many fields.

The "Molecular Motors, Tracks and Transport" workshop, held at Puduchery between January 23rd and 28th, put together several Indian scientists working in the field of motor proteins and cytoskeletal filaments, with a select number of scientists in the same field working outside India, in several institutions from the USA , Germany and France. This meeting brought together biologists, physicists and applied mathematicians interested in different aspects of molecular motors. There were close to 60 participants in all. The workshop was intended to chip away at the barriers inhibiting biologists, physicists, engineers and applied mathematicians from talking to each other. A central objective was to motivate physicists to confront biological data and biologists to appreciate theoretical approaches. The workshop, sponsored jointly by the Institute of Mathematical Sciences (IMSc), Chennai and the National Centre of Biological Sciences (NCBS), Bangalore, was organized by Gautam Menon of IMSc and Sandhya Koushika of NCBS. This meeting was the third in a series referred to as the M2T2 workshops, after the acronym for the name of the meeting. (Previous workshops were held at the TIFR (Mumbai) in 2007 and at Mahabaleshwar in 2008.)

The interests of the participants were varied, while centering around basic questions in transport and organization via motor molecules and cytoskeletal filaments. The talks covered genetic studies of the motor molecular kinesin II (Krishanu Ray, TIFR), the action of drugs on microtubules (Dulal Panda, IITB) and the study of motors in the mitotic spindle as well as intraflagellar transport in sensory cilia (John Scholey, UCSD). Modeling approaches were represented by theoretical work on transitions within anaphase in mitosis (Gul Civelekoglu-Scholey, UCSD), and models for microtubule dynamic instability (F Nedelec, EMBL, Heidelberg). Some talks combined both experiments and modeling, defining mechanisms for the establishment of cellular polarity and the origins of transcriptional pauses (Stefan Grill, Max-Planck Institut, Dresden). The nature of kinetochore-microtubule interactions and the control of the spindle checkpoint (Arshad Desai, UCSD) were also discussed in some detail, as were experiments on the transport of lipid droplets in the Drosophila early embro (Michael Welte, Rochester). The problem of genome segregation in the somewhat sloppy division of Entamoeba Hystolytica was addressed (Anuradha Lohia, Bose Institute). The crucial issue of cooperativity between different motors bound to cargo was addressed (Roop Mallik, TIFR), as was the issue of the regulation of synaptic transport (Koushika). Other participants gave short talks on a variety of problems, including the development of microfluidic devices for the study of C. elegans development, the calibration of optical traps, the mechanics of axons, fluctuation relations for molecular motors and simple models for motor-microtubule pattern formation.

4.2.8 Formal theories of communication

Formal theories of interaction and communication are of interest in logic, linguistics and computation theory. While a single grand theory of communication may not exist, there is sufficient motivation to look for mathematical models that are broad enough to address many of these questions. Automata theory and game theory provide tools for studying communication, but combining the strengths of the two paradigms seems to be challenging.

In this context, the workshop featured participation by game theorists, logicians, computer scientists and linguists. Samson Abramsky (Oxford), Johan van Benthem (Amsterdam), Cristina Bicchieri (Philadelphia), Herbert Clark (Stanford), Peter Gärdenfors (Lund), Jeoren Groenendijk (Amsterdam) and Rohit Parikh (New York) gave keynote talks. With 18 contributed talks, panel discussion, group discussions and problem sessions, the workshop saw intense interaction among participants.

4.2.9 Instructional Workshop on Graph Colorings

This instructional workshop was DST funded and was organized jointly by C R Subramanian (IMSc) and Prof S Arumugam (Kalasalingam University). There were nearly 15 (90 minute) lectures by experts on theoretical and algorithmic aspects of several graph coloring notions and also on proof techniques. There were also tutorials and problem sessions on almost every day. CRS gave a set of four lectures on various coloring notions.

4.3 Seminars

4.3.1 Institute Seminar Week (ISW-2010)

After a gap of two years, the **Institute Seminar Week** was held from March 15 to 19, 2010, from 9 Am till 1 PM on every day. ISW-2009 was not held in view of the immediately preceding Institute Review held during January 2009. The seminar coordinators were Amritanshu Prasad (Mathematics), Venkata Suryanarayana Nemani (Theoretical Physics) and C.R. Subramanian (Theoretical Computer Science). There were 40 talks of 25 minutes duration each. The purpose of the ISW was to to provide a general introduction or update on the developments in each of the three disciplines to all members of the institute.

List of Seminars at ISW 2010

1. **Rahul Siddharthan**
   Evolution and sequence alignment

2. **Shilpa Gondhali**
   Vector Field Problem for (smooth) Manifolds

3. **Shrihari Gopalakrishna**
   New Physics at the Large Hadron Collider (LHC)

4. **A. V. Sreejith**
   Coding a Tiling problem in a logic

5. **Balachandran Sathiapalan**
   BTZ black holes and Luttinger Liquids

6. **Mahendar Singh**
   Automorphisms of abelian group extensions

7. **Sitabhra Sinha**
   The Mathematical Modeler and H1N1

8. **G Santhosh**
   An exact quantum spin liquid with fermi surface

9. **Rajeev Singh**
   Fascinating Spatio-temporal Patterns in Chemical Oscillator Arrays

10. **Kunal Dutta**
    The Combinatorics of Finite Abelian Groups

11. **R. Simon**
    New Entanglement in the Classical World

12. **D. Indumathi**
    India-based Neutrino Observatory (INO) Status Update

13. **S. Sridhar**
Can weak currents remove cardiac chaos

14. **Srikanth Srinivasan**
Computing the determinant

15. **G. Baskaran**
Crowded electrons at your pencil tip

16. **Ajay Thakur**
On normal form of a family of matrices depending on parameters

17. **V.S. Sunder**
From Graphs to Free Group Factors

18. **Samrat Bhowmick**
String Based Cosmology - Some issues

19. **Kunal Krishna Mukherjee**
Maximal abelian subalgebras of finite von Neumann algebras

20. **Gautam Menon**
The Evolving Landscape of Spring Theory

21. **Neeldhara Misra**
Iterated Compression - Try, try till you succeed - or fail

22. **Geevarghese Philip**
Kernalizations : Making molehills out of mountains

23. **R. Shankar**
Creating and manipulating topological qubits

24. **Abhinav Saket**
Unpaired Majorana modes in a Quantum spin chain

25. **Sujit Kumar Choudhary**
Gisin-like theorem for three qubits

26. **Krishna Rajkumar**
The Selberg Class of L-functions

27. **Md Izhar Ashraf**
Can we reconstruct the grammar of a language we cannot read ?

28. **Nita Sinha**
Tau contributions and precision measurements at Neutrino Factories

29. **Kunal Dutta**
Largest Induced Acyclic Tournaments in Random Digraphs - A 2-point concentration

30. **Somdeb Ghose**
Noise-induced Oscillations in Synthetic Biology

31. **Sandeep Goyal**
    Topological Mott transition
32. **Jitendriya Swain**
    Fourier multipliers for the Sobolev spaces on the Heisenberg group
33. **Tejas Kalelkar**
    Normal surfaces in 3-manifolds
34. **Partha Mukhopadhyay**
    From worldsheet to spacetime
35. **Krishnakumar Sabapathy**
    Bosonic Gaussian Channels
36. **Moitri Maiti**
    Transport properties in graphene junctions
37. **Gyan Prakash**
    Approximate groups, fields and some applications
38. **Kamal Lodaya**
    When is communication difficult ?
39. **Tupurani Srikanth**
    Planar algebras and presentations
40. **Rahul Sinha**
    Beautiful New Physics

4.3.2 Institute Seminars

Date	Speaker Affiliation	Title
2-4-2009	Ralph Meyer Mathematisches Institut Georg-August-Universitt Gttingen	Equivariant embedding theorems for proper groupoid actions
3-4-2009	Subir Sarkar Oxford University	Cosmology beyond the Standard Model
3-4-2009	Johannes Koebler Humboldt University, Berlin	Nondeterministic Instance complexity and proof systems with advice
6-4-2009	C. P. Anil Kumar IMSc	Van Kampen Theorem-II
6-4-2009	Vikram Sharma MPI Saarbrucken	Guaranteeing robustness in geometric computation
8-4-2009	A. Bharathi Material Science Division, IGCAR	Competing superconducting and magnetic order in the Fe arsenides
13-4-2009	Kedar Damle TIFR, Mumbai	$S \geq 3/2$ triangular and kagome lattice antiferromagnets with strong easy axis anisotropy.
13-4-2009	Arindam Banerjee IMSc	Tannaka's theorem about algebraic groups
15-4-2009	Bala Sathiapalan IMSc	Gauge Invariant Action for the Bosonic String and the Tachyon Potential
16-4-2009	Amritanshu Prasad IMSc	Locally compact abelian groups with symplectic self-duality
22-4-2009	K Lakshmanan VIT University	MCS formalisms and their application to bio-molecular structures

23-4-2009	Tejas Kalelkar IMSc	Incompressibility and normal minimal surfaces
27-4-2009	Manoj Gopalakrishnan Department of Physics, IIT Madras, Chennai	Optimization strategies for efficient chromosome capture during cell division
27-4-2009	Number Theory Journal Club	Arithmetic progression in sumsets.
28-4-2009	Murali Srinivasan IIT, Bombay	Symmetric chains, Gelfand-Tsetlin chains, and the Terwilligeralgebra of the binary Hamming scheme
29-4-2009	D. Shankar National Institute of Oceanography, Dona Paula, Goa	Wind-forced ocean circulation of the north Indian Ocean
30-4-2009	M. K. Vemuri Chennai Mathematical Institute	Inductive algebras and homogeneous shifts
30-4-2009	Number Theory Journal Club	Polynomial Freiman-Ruzsa conjecture
4-5-2009	T. V. Anoop IMSc	Weighted eigenvalue problems with weights in Lorentz spaces
5-5-2009	Gyan Prakash	Number Theory Journal Club
6-5-2009	Dileep Jatkar HRI, Allahabad	Counting Black hole hair degrees of freedom
8-5-2009	Number Theory Journal Club	Polynomial Freiman-Ruzsa Conjecture-III
15-5-2009	N. Saradha TIFR, Mumbai	Pillai's problem and its generalizations.
15-5-2009	Gyan Prakash	Arithmetic progression in sumsets III
20-5-2009	Phoolan Prasad IISc, Bangalore	Kinematical Conservation Laws (KCL): Equations of Evolution of Curves and Surfaces

21-5-2009	Ronojoy Adhikari The Institute of Mathematical Sciences	Markov chains for the Indus script
26-5-2009	Dilip Raghavan University of Toronto, Canada	On Suslin's Problem
28-5-2009	Soumya Paul IMSc	Stability under Strategy Switching and Dynamic Restriction of Choices
29-5-2009	Gyan Prakash	Arithmetic progression in sumsets
3-6-2009	V Ravindran HRI, Allahabad	Soft gluon resummation for Higgs production at the LHC
3-6-2009	D. Surya Ramana	Large Sieve
4-6-2009	Dr Aparna Basu CSIR, New Delhi	Using Networks To Uncover Hidden Patterns in Bibliometry & Terrorism
6-6-2009	D. Surya Ramana	Large Sieve
8-6-2009	D. Surya Ramana	Large Sieve
9-6-2009	Prajakta Nimbhorkar IMSc	Planar Graph Isomorphism is in Logspace
9-6-2009	D Surya Ramana	Large Sieve
10-6-2009	Bryan K Wells IMSc, Chennai	Archaeology of the Indus Civilization
10-6-2009	Amritanshu Prasad	Counting subgroups of a finite abelian group
12-6-2009	D. Surya Ramana	Large Sieve
13-6-2009	D. Surya Ramana	Large Sieve
16-6-2009	S Arunachalam Centre for Internet and Society, Bangalore	National Mission on Education through ICT

16-6-2009	Neeldhara Misra IMSc	On the infeasibility of obtaining polynomial kernels
16-6-2009	Prof. Francesco Fidaleo Università di Roma "TOR VERGATA"	On the Entangled Ergodic Theorem
17-6-2009	D. Surya Ramana	Large Sieve
18-6-2009	D. Surya Ramana	Large Sieve
18-6-2009	Amit De Chennai Mathematical Institute	Topics in Differential Geometry and Topology
19-6-2009	Satyadev Nandakumar Iowa State Univ	Dynamics, measure and dimension in the theory of computing
22-6-2009	D. Surya Ramana	Large Sieve
24-6-2009	P.B. Sunil Kumar Department of Physics, IIT Madras, Chennai	Strain hardening, avalanches and strain softening in dense cross-linked actin networks
25-6-2009	Ayan Mukhopadhyay HRI, Allahabad	Kinetic Theory and Pure Gravity in AdS
25-6-2009	Tushar Prabhu Indian Institute of Astrophysics, Bangalore	Astronomy from High Altitutdes
26-6-2009	Kunal Dutta IMSc	Random Graphs : A study of some invariants and algorithms
2-7-2009	R. Srinivasan Chennai Mathematical Institute	Toeplitz CAR flows
8-7-2009	Krishnendu Sengupta Indian Association for Cultivation of Science, Kolkata.	Probing a Dirac liquid with a STM tip: Case study of graphene
10-7-2009	Sasanka Roy IISc, Bangalore	Approximate shortest descent path on a terrain

15-7-2009	Jnanadeva Maharana Institute of Physics, Bhubaneswar	Symmetries of Nonrelativistic System
15-7-2009	R. Balasubramanian	On a paper of Granville
17-7-2009	Mangala Sunder IIT Madras	The National Programme on Technology Enhanced Learning (NPTEL) and Education Mission: Open education versus Open Sources
20-7-2009	Samarth Chandra TIFR, Mumbai	Ground states and low temperature behavior of spin systems
20-7-2009	Surender Baswana IIT Kanpur	Approximate shortest paths oracle under vertex failure
20-7-2009	Surender Baswana IIT Kanpur	Approximating arbitrary metric by tree metric
23-7-2009	B V Raghavendra Rao IMSc	On the Complexity of Matroid Isomorphism Problem
23-7-2009	Purusottam Rath CMI	The Schmidt Subspace Theorem and its applications
24-7-2009	Miklos Santha CNRS, Universit Paris-Sud, Orsay, France and NUS Singapore	Quantum walk based search algorithms
27-7-2009	Arijit Chakraborty Cornell University, USA	Effect of truncation on heavy-tailed models.
27-7-2009	Prof. Rohini Godbole Centre for High Energy Physics, Indian Institute of Science	CP of the Higgs Boson at the Colliders using the process $t\bar{t}\Phi$
28-7-2009	Amritanshu Prasad	The Moebius function for finite abelian groups
28-7-2009	Steve Bonta Penn State University, Altoona	The Indus Valley Fish Signs: Implications for Interpreting the Seal Inscriptions

28-7-2009	K Thulasiraman University of Oklahoma, USA	Structural Survivability in Layered Networks: A Unified Theory of Logical Topology Survivability Based on Circuits/Cutsets Duality
29-7-2009	T.V. Ramakrishnan Banaras Hindu University/Indian Institute of Science	Superconductivity, Strong Correlations and Disorder
29-7-2009	S. D. Adhikari HRI	Weighted zero-sum problems: recent progress
31-7-2009	G.S. Agarwal Oklahoma State University	How Much Quantum Noise is Detrimental to Entanglement?
31-7-2009	Rajeeva Karandikar Cranes Software and IISc	Some connections between analysis and probablity
31-7-2009	Rajeeva Karandikar Cranes Software and IISc	Some connections between analysis and probablity
4-8-2009	R Balasubramanian	On a paper of Granville
5-8-2009	M. Muthukumar University of Massachusetts, Amherst	Puzzles in DNA Mobility
6-8-2009	K.R. Parthasarathy ISI Delhi	Fock space and Brownian motion
7-8-2009	Joseph Cheriyan University of Waterloo	Network design with metric costs
10-8-2009	T M Murali Virginia Tech, USA	Network Legos: Cross-conditional Analysis of Cellular Responses
11-8-2009	Shibaji Roy SINP, Kolkata	Non-supersymmetric branes and closed string tachyon condensation I
11-8-2009	John Augustine Visiting scientist, IMSc	Energy Efficient Shortest Path Algorithms for Convergecast in Sensor Networks

11-8-2009	Ramaratnam venkatesan	Eliptic curve cryptology
12-8-2009	Shibaji Roy SINP, Kolkata	Non-supersymmetric branes and closed string tachyon condensation II
13-8-2009	Pushkar Joglekar IMSc	Arithmetic circuits, monomial algebras and finite automata
13-8-2009	T. Senthil MIT, Cambridge, USA	Critical Fermi surface and non-fermi liquids
14-8-2009	Prof. K. R. Parthasarathy Indian Statistical Institute	Brownian Motion and Fock Space II
17-8-2009	Pooja Singla IMSc	Representation theoretic proof of Robinson-Schensted correspondence
17-8-2009	R. Balasubramanian	Exponential sums
18-8-2009	R. Balasubramanian	On a paper of Granville II
24-8-2009	Prem Prakash Pandey IMSc	Consecutive integers and perfect powers
26-8-2009	Purusottam Rath CMI	Subspace Theorem I
27-8-2009	B V Raghavendra Rao IMSc	Small space analogues of Valiant's classes.
31-8-2009	Prem Prakash Pandey IMSc	Consecutive integers and perfect powers
31-8-2009	Brian Hemphill Department of Sociology and Anthropology, California State University, Bakersfield CA, USA	A Dental Morphological Investigation of the Population History of South Asia: A Rationale, a Case Study, and a Prospectus
1-9-2009	R. Balasubramanian	Number Theory Journal Club
2-9-2009	Number Theory Journal Club	Number Theory Journal Club

7-9-2009	Anil Kumar IMSc	Poisson Summation Formula and some of its consequences
7-9-2009	Professor T N Ananthakrishnan, FNA Formerly Entomology Research Institute, Loyola College, Chennai and Zoological Survey of India, Kolkata	Dimensions of Phenotypic Plasticity: Mechanism, Consequences & Impact on Biodiversity
8-9-2009	Analabha Roy Center for Complex Quantum Systems, The University of Texas at Austin	Dynamics of Quantum Control in Cold-Atom Systems
9-9-2009	Archisman Ghosh University of Kentucky	Slowly varying dilaton cosmologies and their field theory duals
9-9-2009	Apoorva Khare University of California	The category O over semisimple Lie algebras
10-9-2009	Dinakar Ramakrishnan California Institute of Technology	Modular forms and Calabi-Yau manifolds.
10-9-2009	Chandrashekar Chatterjee S.N.Bose Institute,Kolkatta	Duality and dual confinement of monopoles in SU(2) gauge theory with two adjoint scalars
14-9-2009	T. Srikanth IMSc	Existence and uniqueness of integrals in finite dimensional Hopf algebras
14-9-2009	Andreas Fuls Institut fr Geodsie und Geoinformationstechnik, Technical University Berlin, Germany	Obstacles and Pitfalls in the Decipherment of Ancient Writing Systems
15-9-2009	Number Theory Journal Club	Number Theory Journal Club
16-9-2009	Andreas Fuls Institut fr Geodsie und Geoinformationstechnik, Technical University Berlin, Germany	Indus Fish Signs and the Indus System of Weights

16-9-2009	Number Theory Journal Club	Number Theory Journal Club
17-9-2009	Tribikram Gupta IMSc	Role of disorder in inducing metal-insulator transition in 2D
22-9-2009	Welcome to Physics-One day Program for College Students	Welcome to Physics-One day Program for College Students
22-9-2009	Prem Prakash Pandey	Catalan's Conjecture
23-9-2009	Purusottam Rath	Subspace Theorem III
24-9-2009	Prof M G K Menon Formerly DIrector, TIFR	Bhabha Centenary
29-9-2009	Prem Prakash Pandey	Catalan Conjecture
30-9-2009	Partha Mukhopadhyay IMSc	A phase-space operator method for string worldsheet theory and general covariance
30-9-2009	TRG IMSc	Faculty meeting
30-9-2009	Number Theory Journal Club	Number Theory Journal Club
2-10-2009	R. Balasubramanian	Exponential Sums
5-10-2009	Mubeena T. IMSc	Gromov-Hausdorff Convergence
8-10-2009	G. Rajasekaran IMSc, Chennai	Scientific Contribution of Homi Bhabha
8-10-2009	A. P. J. Abdul Kalam Former President of India	Home Bhabha centenary
12-10-2009	P. Ranjith Department of Biosciences and Bioengineering, IITB, Mumbai	Role of ATP Hydrolysis in the dynamics of actin filaments

13-10-2009	Thomas Vojta Missouri University of Science and Technology, USA	Quantum Phase Transitions
14-10-2009	Suneeta Varadarajan Dept of Maths, Univ. of Alberta	Some applications of Ricci flow in physics
15-10-2009	Siddhartha Gadgil IISc, Bangalore	Field theory and exotic structures on R^4
16-10-2009	Antakshari Competition Antakshari Competition	Antakshari Competition
19-10-2009	Anil Kumar IMSc	The simple group of order 168
22-10-2009	K. Narayan CMI	Cosmological singularities, gauge theory duals and strings
22-10-2009	R. Balasubramanian	Exponential Sums
23-10-2009	Purusottam Rath	Subspace theorem
26-10-2009	R. Balasubramanian	Exponential sums
26-10-2009	Pratyusha Chattopadhyay IMSc	Equality of Orbits and its application to injective K_1 stability
29-10-2009	K. Ravishankar SUNY New Paltz	Strong hydrodynamics for monotone particle systems on Z.
30-10-2009	R. Balasubramanian	Exponential Sums
3-11-2009	Prof. Andreas Winter Bristol Univ. (U.K.) and National Univ. of Singapore	"Information Causality" or: what makes quantum mechanics so special?
3-11-2009	Amritanshu Prasad	Mackey-Stone-von Neumann theorem
4-11-2009	Harvendra Singh SINP, Kolkata	The scalar-tensor $B-F$ theory:(STBF vs LBLG)

5-11-2009	Kunal Krishna Mukherjee IMSc	Masas and Bimodule Decompositions of II_1 Factors
6-11-2009	Peter Borowski UBC, Vancouver and IITM, Chennai	A stochastic polymer model for the dynamics of the Min proteins in E.coli
6-11-2009	Amritanshu Prasad IMSc	Mackey-Stone-von Neumann theorem-II
10-11-2009	Chirag Kalelkar NCL, Pune	Strain-Rate Frequency Superposition in Large-Amplitude Oscillatory Shear
10-11-2009	Dipendra Prasad TIFR	Weil representation and Howe duality
12-11-2009	Tanusree Khandai IMSc	Weyl modules for Multiloop Lie algebras
12-11-2009	Sanjib Sabhapandit RRI, Bangalore	Dynamics of polymers in shear flow
13-11-2009	Arvind Ayyer CEA, Saclay	Exact solution of the simplest open reaction-diffusion model
13-11-2009	Dipendra Prasad TIFR	Weil Representation and Howe duality
16-11-2009	Tapas Chatterjee IMSc	Cartan's criterion for Solvability and Semi-simplicity of a Lie algebra
17-11-2009	Dipendra Prasad TIFR	Weil representation and Howe duality
18-11-2009	M Ram Murty Queens University	The Riemann hypothesis today
19-11-2009	Gerard t Hooft Universiteit Utrecht	Instantons and scalar mesons
19-11-2009	Srikanth Srinivasan IMSc	On Lower Bounds for Constant Width Arithmetic Circuits
20-11-2009	Dipendra Prasad TIFR	Weil representation and Howe duality

23-11-2009	Nutan Limaye TIFR Mumbai	Counting perfect matchings in planar graphs in polynomial time
24-11-2009	Pradeep Murugesan Northeastern University, Boston, USA	Experimental Implication of Static and Dynamic Casimir Effect Instabilites
25-11-2009	Satoshi Nawata TIFR, Mumbai	LHC Phenomenology for String Hunters
25-11-2009	Eric Laenen NIKHEF, Utrecht Universiteit & Amsterdam Univ	Top Physics at the LHC
26-11-2009	V. Arvind IMSc	What are Expander Graphs?
26-11-2009	Ronald Dickman UFMG, Brazil	Effect of Diffusing Disorder on an Absorbing-State Phase Transition
27-11-2009	Michael Laessig University of Cologne, Germany	From fitness landscapes to seascapes: nonequilibrium dynamics of selection and adaptation
27-11-2009	Jayasri Das Sarma IISER, Kolkata	Complexity in Neuro-degenerative Diseases: The Advent of Systems Biology
30-11-2009	Rakesh Tibrewala IMSc	Gravitational Collapse in Loop Quantum Gravity
30-11-2009	Umesh Dubey IMSc	Simple surface singularities
1-12-2009	Srikanth Srinivasan IMSc	Circuit Lower Bounds, Help Functions, and the Remote Point Problem
2-12-2009	Gautam Menon IMSc, Chennai	Understanding Peak Effect Anomalies
3-12-2009	B. Subhash IMSc	Linear Morse Functions on Orbits Spaces

3-12-2009	N.D. HariDass CHEP, IISc	Some exact results on conformally invariant effective string theories
7-12-2009	Sandipan Sengupta IMSc	Quantum realizations of Hilbert-Palatini second-class constraints
9-12-2009	R. S. Raghavan Virginia Tech, Blacksburg VA USA	"NEUTRINOS INWARD BOUND" -Frontiers Beyond Particle Physics
9-12-2009	K G Guruharsha Harvard Medical School	The Drosophila Protein Interaction Network
9-12-2009	Michel Waldschmidt Institut de Mathematiques de Jussieu	Recent Diophantine results on zeta values: a survey
10-12-2009	Ritesh Singh University of Wurzburg	A bottom-up approach to new-physics at colliders
11-12-2009	Piotr Pragacz Institute of Mathematics of Polish Academy of Sciences	Positivity of Thom polynomials for singularities of mappings and Lagrange singularities.
11-12-2009	Shiva Kasivishwanathan Los Alamos National Laboratory, USA.	Dr.
14-12-2009	Nilanjan Sircar IMSc	BTZ Balck-hole and Luttinger Liquids.
16-12-2009	Prabha Mandyam Institute for Quantum information, Caltech	Optimal uncertainty relations for a special class of MUBs
16-12-2009	Siddhartha Sarkar IISER Bhopal	Finite group actions on surfaces
17-12-2009	Mohan Ravichandran Sabanci University, Istanbul	Generalizing triangular algebras
17-12-2009	Tapash Chakrabarty University of Manitoba, Canada	DNA Magnetism

18-12-2009	Piotr Pragacz Institute of Mathematics of Polish Academy of Sciences	One-parameter basis in which any Legendrian Thom polynomial has positive expansion.
18-12-2009	Jnanadeva Maharana Institute of Physics, Bhubaneswar	Toroidal Compactification of type IIB theory with fluxes
23-12-2009	N. G. Deshpande University of Oregon	Probing the Generation structure at LHC
23-12-2009	V. Kumar Murty University of Toronto	Sato-Tate Conjecture
24-12-2009	Tullio Ceccherini University of Sannio, Benevento, Italy	Cellular automata and groups: dynamical aspects of infinite groups
24-12-2009	R Parthasarathy TIFR	Unitary highest weight modules of U(p,q)
28-12-2009	N. Narayanan IMSc	Acyclic, k-intersection edge colourings and oriented colourings
28-12-2009	T. S. Jayram IBM Almaden Research center	Information Complexity and the Geometry of Communication
28-12-2009	M. Ram Murty Queen's University	Ramanujan and the Zeta Function
28-12-2009	V. Kumar Murty University of Toronto	A variant of Lehmer's Conjecture
30-12-2009	Nutan Limaye	Exploring LogCFL using language classes.
30-12-2009	Jayadev Athreya Yale University	A Random Minkowski Theorem
4-1-2010	Vikram Soni Jamia Millia Islamia, New Delhi	Beyond Emissions: A real climate change agenda for the developing world

5-1-2010	Roderich Moessner Max Planck Institute, Dresden, Germany	A statistical mechanician's view of quantum complexity: the random quantum k-satisfiability problem
6-1-2010	Mohan Balasubramanian Temasek Life Sciences Laboratory, Singapore	Cell Division Machines: Assembly Mechanisms
7-1-2010	Giuseppe Marmo Universita Federico II di Napoli, Naples, Italy	Differential Geometric Aspects of Quantum Mechanics
8-1-2010	Fanny Dufour Universite de Geneve	T2KK: Adding a Mton water Cherenkov detector in Korea, in the line of the T2K beam.
11-1-2010	Abhinav Kumar MIT	Lattices, sphere packings, spherical codes and energy minimization
12-1-2010	Indu Satija George Mason University, USA	Time-Reversal Invariant Topological Insulators With Ultra-Cold Atoms in Optical Lattices
12-1-2010	Koushik Balasubramanian MIT	TBA (String Theory-AdS/CFT)
12-1-2010	Pampa Paul IMSc	Classification of Simply Connected Riemannian Globally Symmetric Spaces.
13-1-2010	Alessandra Carbone Department of Computer Science and Laboratory of Microorgasms Genomics, Universit Pierre et Marie Curie, Paris, France	Periodic distribution of genes in bacterial genomes
13-1-2010	Fedor Fomin University of Bergen, Norway	Exact Algorithms for NP-hard Problems
13-1-2010	Abhinav Kumar MIT	K3 surfaces, Kummer surfaces and genus 2 curves
15-1-2010	R.Ganesh University of Toronto, Canada	Superflow instabilities in an optical lattices

18-1-2010	N. Sukumar Rensselaer Polytechnic, NY, USA	Some mathematical problems from Cheminformatics
18-1-2010	Abhinav Kumar MIT	Explicit equations for Hilbert modular surfaces
19-1-2010	S Viswanath IISc	Tensor product stabilization in Kac-Moody series
19-1-2010	Aravind Srinivasan Univ of Maryland, USA	New constructive aspects of the Lovasz Local Lemma
19-1-2010	M. Waldschimdt University of Paris VI	Chudnovsky's theorem on elliptic algebraic independence
19-1-2010	Sarbeswar Pal IMSc	The moduli of vector bundles over a compact Riemann surface
20-1-2010	Nishanth Chandran UCLA	Position Based Cryptography
21-1-2010	S Viswanath IISc	Some special functions associated to infinite root systems
21-1-2010	M. Waldschimdt University of Paris VI	Chudnovsky's theorem on elliptic algebraic independence
22-1-2010	S Viswanath IISc	Some special functions associated to infinite root systems
22-1-2010	Olivier Ramare University of Lille	Introduction to local models of pseudo-characters
22-1-2010	Prof. Kishore Marathe CUNY	Geometric topology and gauge field theory
25-1-2010	A P Balachandran Syracuse University	Non-Pauli effects from Noncommuting spacetimes
25-1-2010	O Ramare CNRS- University of Lille I	Introduction to the local models and pseudo characters

25-1-2010	O. Ramare CNRS- University of Lille I	Introduction to the local models and pseudo characters
27-1-2010	M. Waldschimdt University of Paris VI	Chudnovsky's theorem on elliptic algebraic independence
28-1-2010	Swagata Sarkar IMSc	Degrees of Maps between complex Grassmann manifolds
29-1-2010	M. Waldschimdt University of Paris VI	Chudnovsky's theorem on elliptic algebraic independence
1-2-2010	Dr M Srinivasan Formerly Associate Director, Physics Group, BARC	Condensed Matter Nuclear Science
3-2-2010	Prof. M. E. Cates The University of Edinburgh	Designing and Understanding Soft Materials by Computer Simulation
4-2-2010	Olivier Ramare CNRS - Universite des Sciences et Technologies de Lille	The Selberg sieve for prime numbers: a selection of (fairly!) recent advances
4-2-2010	K. S. Viswanathan Simon Fraser University	Horava-Lifshitz theory of Gravity
5-2-2010	K G Arun Washington University	Audible Universe
5-2-2010	O. Ramare CNRS- University of Lille I	Introduction to the local models and pseudo characters
8-2-2010	Ponmurugan M	Uniform energy distribution from biased sampling
9-2-2010	Moitri Maiti IMSc.	Transport properties in graphene junctions
9-2-2010	Jurgen Stilck Universidade Federal Fluminense, Niteroi	Model with multiple monomers per site for the colapse transition of polymers
9-2-2010	Matthew Blow Oxford University	Wetting on flexible and anisotropic surfaces

10-2-2010	Charulatha Venkataraman	Photoinduced proton-coupled electron transfer and the study of isotope effect in the dynamics.
10-2-2010	Prof. J. V. Narlikar IUCAA, Pune	Searches for micro-life in the earth's atmosphere
11-2-2010	S. Thangavelu IISc	Geometric Quantization and the Segal-Bargmann Transform
12-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	Bjorken-like sum rules and the Isgur-Wise function
12-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	Isgur-Wise functions and the Lorentz group
12-2-2010	O. Ramare CNRS- University of Lille I	Introduction to the local models and pseudo characters
13-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	Bakamjian-Thomas relativistic quark model
13-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	Aspects of Flavor Physics in 2010.
15-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	Introduction to Large Energy Effective Theory
15-2-2010	Prof. Luis Oliver LPT, Orsay , University of Paris	$B_q - \bar{B}_q$ mixing and possible New Physics
16-2-2010	Prabodh Shukla NEHU, Shillong	Hysteresis in Random Field XY and Heisenberg Models
16-2-2010	O. Ramare CNRS- University of Lille I	Introduction to the local models and pseudo characters
17-2-2010	Zahera Jabeen IMSc	Shock propagation in granular gases
18-2-2010	Charulatha Venkataraman	Photoinduced proton-coupled electron transfer and the study of isotope effect in the dynamics.

22-2-2010	Aleksy Tralle University of Warmia and Mazury, Olsztyn	Introduction to symplectic topology
23-2-2010	Thomas Thundat Oak Ridge National Laboratory	On the mechanism of subsurface force microscopy
23-2-2010	Liangyi Zhao Nanyong Technological University and Max-Planck Institut für Mathematik	On Primes in Quadratic Progressions
23-2-2010	Madhushree Basu IMSc	$LF_9 \simeq M_4 LF_{129}$–Investigating Free Products of Free Group Factors with Matrix Algebras
24-2-2010	Suresh Govindarajan IIT-Madras	Understanding black hole entropy in string theory
24-2-2010	Sanjay Kumar Banaras Hindu University	Force induced melting of constrained DNA
24-2-2010	Aleksy Tralle University of Warmia and Mazury, Olsztyn	Introduction to symplectic topology
25-2-2010	Guruprasad Kar Indian Statistical Institute, Kolkata	Does IC condition render PR-box non-physical for ever?
2-3-2010	Prajakta Nimbhorkar IMSc	Log-space Algorithms for Paths and Matchings in k-trees
3-3-2010	Prof. Georg Schumacher University of Marburg, Germany	Differential geometric properties of Teichmüller and moduli spaces
3-3-2010	S. Sundar	KK-Theory
8-3-2010	Prahladh Harsha TIFR, Mumbai	Approximation Algorithms

10-3-2010	Soumen Roy Instt. for Genomics and Sytems Biology/Dept. of Medicine, The University of Chicago	Networks and Emergence
10-3-2010	Prahladh Harsha TIFR, Mumbai	Approximation Algorithms
12-3-2010	Ramakrishnan Iyer University of Southern California	Dispersive Water Waves and Non-Critical Strings
12-3-2010	Prahladh Harsha TIFR, Mumbai	Limits to Approximability
19-3-2010	Naresh Dadhich IUCAA, Pune	Fluid sphere in higher dimensions and its universality
22-3-2010	Jaydeep Chipalkatti University of Manitoba and IIT, Bombay	Ideals of general binary orbits
23-3-2010	Prem Prakash Pandey IMSc	What if the ring is nice but not very nice?
24-3-2010	Radha Balakrishnan Matscience	Immortal Solitons in a Strongly Repulsive Bose-Einstein Condensate
25-3-2010	V. S. Varadarajan UCLA	Super Lie groups and their unitary representations
26-3-2010	V. S. Varadarajan UCLA	The Geometry of the Physical World
29-3-2010	B V Raghavendra Rao IMSc	A study of width bounded arithmetic circuits and the complexity of matroid isomorphism
29-3-2010	V. Kumar Murty University of Toronto	The Euler-Kronecker constant of a number field
30-3-2010	Mahendra Verma IIT Kanpur	Dynamo Transition

31-3-2010	Manas Sardar Materials Science Division, IGCAR	Can Gold Become Magnetic ?
31-3-2010	Sebastian Kuhnert Humboldt University, Berlin	A Logspace Isomorphism Test for Interval Graphs

Chapter 5

External Interactions

5.1 Collaborative Projects with Other Institutions

5.1.1 Arithmetic vs Boolean complexity: the case of small-depth circuits

Boolean and arithmetic circuits provide complementary views on important algorithmic problems. This applies both for the design of efficient algorithms within these models as well as for the search for lower bounds. Both directions have seen remarkable progress during recent years. This project, funded by the DST, Government of India, and the DAAD, Germany, aims to clarify the relationship between these two computation models. In particular, research activity is centred on the connections between arithmetic circuits and small counting complexity classes. Resolving relations between these classes will also affect practical questions, as a number of algorithmic problems like testing for perfect matchings are intimately linked to such tractable complexity classes within P.

Participants in this project are Meena Mahajan (IMSc, principal investigator, Indian side), Heribert Vollmer (Leibniz University, Hannover, principal investigator, German side), Samir Datta (CMI, Chennai), B V Raghavendra Rao (formerly IMSc, now University of Saarlandes, Germany) and Michael Thomas (Hannover). The project is for 2 years, June 2009 to May 2011.

5.1.2 Biology of CD40 signalling in uninfected and *Leishmania*-infected macrophages

This is a DBT project involving Rahul Siddharthan, Sitabhra Sinha and Gautam Menon from IMSc, together with Bhaskar Saha of the NCCS Pune and Parag Sadhale of the Indian Institute of Science, Bangalore

5.1.3 Electron transport along monoatomic electrochemical wires and chains

A DST-DAAD project involving IMSc and University of Ulm, Gemany. A.K. Mishra and Vallan Bruno Cruz are the project members from Indian side and Prof. W. Schmickler and Ms. Sonja Bartenschlager are German participants.

5.1.4 India-based Neutrino Observatory (INO) Project

INO group at IMSc is an active participant in the collaboration. The INO group at IMSc consists of D. Indumathi, Prashanth Jaikumar (On leave from IMSc), M.V.N. Murthy, G. Rajasekaran and Nita Sinha. In addition a full time project member N.S. Sreenivasan is involved in the INO group activities related to engineering aspects and clearances.

IMSc group has been leading the site related activities of the project. The project was earlier proposed to be located in Singara in Nilgiris mountains of Tamil Nadu. However due to the proximity to the newly declared Tiger Reserve at Mudumalai sanctuary, the project did not get forest clearance. Anticipating such a development, the IMSc group had initiated studies related to alternative sites for the Project. After a study of many possible sites in South India, a new site at Bodi West Hills in Theni district of Tamil Nadu has been chosen, based on scientific/geological/ecological criteria, as the location for INO project. IMSc group is now currently engaged in persuing all avenues to ensure the necessary statutory clearance for the project at the new site as well as contributing to the preparation of the Detailed Project Report.

As in previous years, the IMSc group continues to be associated with the Physics analysis and Simulations relevant to the Magnetised Iron Calorimeter (ICAL) detector at INO. Apart from the physics results that can be studied with atmospheric neutrinos and neutrinos from long base-line neutrino beams, the group is also engaged in studies such as track recognition and reconstruction using ICAL detector.

The members of the group continue to take active part in INO outreach activities, such as giving popular lectures at various universities and other such institutions with the long term goal of creating awareness and interest in INO as well as generate human resources necessary for such a large project. As part of the outreach activities an INO Cell has now been formed at the American college, Madurai. This Cell, with active participation by IMSc group, is now engaged in carrying out public outreach programmes in Theni region where the project is expected to be located.

5.1.5 Physical Properties Relevant to Nanoscale Devices and Biological Motors in the Brownian Regime

Joint project with A.M. Jayannavar (IOP, Bhubaneswar) and Surajit Sengupta (SNBNCBS, Kolkata), funded by the Nanoscience and Nanotechnology Initiative of the DST, India. Our general goal in this project is posed in terms of the following questions which we will attempt to address: What are the generic ingredients of models for machines which can do work in a thermal (Brownian) environment? How do physics requirements constrain the design, performance and efficiency of nanoscale machines? Are there general principles governing how biological systems perform work at the nano-scale? Can we use models devised for understanding the functioning of nano-scale biological motors for insights into guiding principles for the construction of man-made devices at that scale? Finally, what materials properties of nano-scale devices might be optimally selected if they are to be used as machine components?

5.1.6 Preserving species and genetic diversity through spatial heterogeneity and temporal fluctuations

This is a project funded by the Indo-US Science and Technology Forum under their Frontiers of Science program. A joint collaboration between IMSc and the group of Prof Adam P. Arkin at UC Berkeley, the project is investigating the role played by spatiotemporal inhomogeneity of species fitness in maintaining species and genetic diversity (thereby increasing robustness) of a biological system.

5.1.7 Wave Propagation in disordered excitable media and simulated cardiac tissue

This was an IFCPAR project (no. 3404-4) funded by the Indo-French Centre for the Promotion of Advanced Research, being carried out in collaboration with Prof Alain Pumir of ENS-Lyon, France. Originally funded for three years and scheduled to end in Feb 2009, it was given an extension of 1 additional year (i.e., to continue upto Feb 2010) by the funding agency based on the project performance.

5.2 Institute Associateships

The Institute has established short-term associateships in **Mathematics, Theoretical Physics and Theoretical Computer Science** to enable teachers from colleges and universities to work at the institute. The programme is envisaged to develop interaction between the members of the faculty of the institute and scientists in the university system. Under this programme, an associate can visit the institute once or twice a year, up to a total of 90 days per year, each visit lasting a minimum of three weeks. The tenure of an associate will be for a period of three years and (s)he is expected to visit the institute at least twice during this period.

The institute will bear the expenses of round-trip travel (by rail) from the Associate's normal place of work to Chennai and will also pay a daily allowance to cover local expenses at Chennai. During their stay at Chennai, Associates will be accommodated in the institute Guest House.

Associates who visited the institute during the period 01.04.09 to 31.03.2010 are :

K. Lakshmanan
VIT, Vellore
06.04.09 to 02.05.09

Manish Dev Shrimali
LNM Institute of Information Technology, Jaipur
07.06.09 to 20.06.09

J. Sekar
RKM Vivekananda College, Chennai
11.05.09 to 15.06.09 02.12.09 to 02.12.09

Sukanta Das
Bengal Engineering & Science University, Shibpur, West Bengal
19.07.09 to 15.08.09

5.3 Conference Participation and Visits to Other Institutions

A V, Sreejith

Participated in *Formal methods Update meeting* held at IIT, Roorkee during Jul 13 – Jul 15, 2009.

Participated in *Foundations of Software Technology and Theoretical Computer Science* held at Kanpur during Dec 15 – Dec 17, 2009.

Participated in *Circuits, Logic and Games,* held at Dagstuhl during Feb 7 – Feb 12, 2010.

Arvind, V.

Participated in *Dagstuhl Seminar on "Algebraic Methods in Computational Complexity".* held at Dagstuhl Castle, Saarland, Germany. during Oct 7 – Oct 11, 2009.

Participated in *FSTTCS 2009* held at IIT, Kanpur during Dec 13 – Dec 15, 2009.

Balakrishnan, Radha

Visited George Mason University, Fairfax, USA during May 1 – May 29, 2009. For collaborative research

Visited School of Physical Sciences, Jawaharlal Nehru University, New Delhi during Mar 8 – Mar 9, 2010. Seminar titled "Particle-hole asymmetry and solitons in the Bose-Einstein condensate of a strongly repulsive system of bosons"

Balasubramanian, R.

Participated in *Valedictory function of International Mathematical Olympiad training camp* held at Homi Bhabha centre , Mumbai on May 27, 2009. Chief guest

Participated in *Ramanujan Rediscovered . Elliptic functions , q series , partition and related Number Theory* held at Bangalore during Jun 1 – Jun 5, 2009. An invited lecture on Ramanujan's identity in zeta function

Participated in *Advances in Mathematics : Focus on Women in Mathematics* held at JNU, New Delhi during Oct 5 – Oct 7, 2009. Lectured on Additive Combinatorics

Participated in *Refresher Couse on Current trends in Mathematics and Applications* held at Mathematics Department , University of Delhi during Oct 5 – Oct 15, 2009. Gave two lectures on cryptology

Basu, Madhushree

Participated in *Annual Conference of the Ramanujan Mathematical Society* held at Indian Statistical Institute, Bangalore during May 11 – May 13, 2009.

Participated in *Workshop and Conference in Analysis and its Application*

held at Indian Institute of Science during May 14 – May 27, 2009.

Basu, Rahul

Visited CERN Geneva during May 13 – Jun 7, 2009. Part of a workshop

Participated in *Top Quark Theory Institute* held at CERN Geneva during May 17 – Jun 7, 2009.

Visited Nikhef, Amsterdam during Jun 8 – Jun 15, 2009. Research Collaboration

Participated in *Corfu Summer Institute* held at Corfu Summer Institute during Aug 30 – Sep 6, 2009. Speaker

Participated in *WHEPP XI* held at PRL, Ahmedabad during Jan 2 – Jan 13, 2010.

Participated in *Strong Interactions in the 21st Century* held at TIFR, Mumbai during Feb 10 – Feb 12, 2010.

Chakraborty, Partha S.

Visited Indian Statistical Institute during Sep 7 – Sep 13, 2009. Collaborative research with Prof. Arup Pal

Visited Indian Statistical Institute, Delhi during Oct 26 – Nov 1, 2009. Collaborative research with Prof. Arup Pal. Gave a seminar titled Noncommutative Geometry of Quantum Spheres.

Participated in *2nd Indo-Brazil Symposium in Mathematics* held at TIFR, Bangalore during Dec 14 – Dec 18, 2009. Invited Speaker

Visited Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore during Mar 22 – Mar 26, 2010. Collaborative research with Prof. K. B. Sinha.

Date, G.

Participated in *Loops'09* held at Beijing Normal University, Beijing, China during Aug 3 – Aug 7, 2009. Gave a talk on *topological terms in Hilbert-Palatini formulation.*

Participated in *Preparatory SERC School in Theoretical High Energy Physics* held at Indian Institute of Technology Madras, Chennai during Oct 18 – Oct 30, 2009. Gave a course of 12 lectures on *General Relativity and Cosmology.*

Ghosh, Sibasish

Visited School of Physicsl Sciences, JNU, New Delhi during May 18 – May 24, 2009. We (myself and Prof. S. M. Roy of SPS, JNU) have partly completed our collaborative work on chain of Hardy-type local reality constraints for n qubits during this visit. I have also given a seminar, entitled "Complete proof of Gisin's theorem for three q

Visited Indian Statistical Institute, Kolkata during Jun 14 – Jun 25, 2009. We (myself, G. Kar of ISI–Kolkata, S. Bandyopadhyay of Bose Institute – Kolkata and A. Roy of Assam Univ.) have started working on the issue of distinguishability of bi-partite pairwise orthogonal pure states by one-way LOCC and its connection with tele

Participated in *International School on Quantum and Nano Computing Systems and Applications (QANSAS-2009)* held at Dayalbagh Educational Institute, Dayalbagh, Agra during Dec 15 – Dec 18, 2009. I have given there an invited talk entitled "Entanglement sudden death in bipartite quantum systems under local heat bath dynamics".

Participated in *International Programme on Quantum Information (IPQI-2010)* held at Institute of Physics, Bhubaneswar during Jan 4 – Jan 30, 2010. I have given three invited talks for the school part on quantum information theory and one invited talk, entitled, "Analytical proof of Gisin's theorem for three qubits", for the conference part.

Participated in *The 2nd IMSc Complex Systems School* held at IMSc during Jan 4 – Jan 29, 2010. I have given here three invited talks on classical information theory

Participated in *TPSC Advanced Research Workshop* held at Department of Physics, University of Pune during Feb 17 – Feb 18, 2010. I have give there an invited talk, entitled "What is quantum information theory?"

Participated in *National Workshop On Quantum Entanglement (WOQE-2010)* held at Department of Physics, Pondicherry University during Feb 17 – Feb 19, 2010. I have given an invited there, entitled "Entanglement detection, manipulation and quantification".

Participated in *Workshop on complex quantum systems* held at Institute for Mathematical Sciences, National Univ. of Singapore during Mar 1 – Mar 29, 2010. I have actively participated in the workshop to learn the emerging interdisciplinary area of quantum many-body systems and quantum information theory, and to initiate collaborative work(s) with the people at Centre for Quantum Technologies at National Univ. of Singapore.

Gopalakrishna, Shrihari

Visited Kodaikanal Observatory during Dec 3 – Dec 5, 2009. Lectured at the Kodai Winter school on the topic "Dark Matter in Particle Physics".

Participated in *Workshop on High Energy Physics Phenomenology (WHEPP XI)* held at Physical Research Laboratory (PRL), Ahmedabad during Jan 2 – Jan 12, 2010. Coordinated the warped-space LHC phenomenology activities at the workshop.

Gun, S.

Participated in *International conference on analytic number theory* held at TIFR during Oct 5 – Oct 9, 2009.

Participated in *Workshop on Analytic Number Theory* held at IMSc during Feb 17 – Mar 2, 2010.

Jaikumar, Prashanth

Participated in *Neutrinos in Particle Astrophysics and Cosmology* held at Mahabalipuram, Tamil Nadu, India during Apr 5 – Apr 7, 2009. Convenor; gave a talk

Visited International Center, Goa during Apr 8 – Apr 13, 2009. Gave an invited talk

Participated in *Aspects of neutrinos (NuGoa09)* held at Goa, India during Apr 8 – Apr 15, 2009. Gave an invited talk

Jampa, Maruthi Pradeep Kanth

Participated in *Gordon Research Conferences - Chemistry and Physics of Liquids* held at Holderness, New Hampshire, U.S.A. during Aug 2 – Aug 7, 2009.

Kalelkar, Tejas D.

Participated in *Advanced Instructional School on Atiyah-Singer Index Theorem* held at Indian Institute of Technology, Bombay during Jul 6 – Aug 1, 2009.

Participated in *Instructional Workshop on Topology of Manifolds* held at IMSc during Feb 1 – Feb 14, 2010.

Kesavan, S.

Visited NISER, Bhubaneswar during Apr 22 – Apr 23, 2009. Delivered a NISER Colloquium talk

Visited Chennai Mathematical Institute on Jun 4, 2009. Delivered an invited talk in the summer programme

Participated in *UNICAL INTCON09, International Conferenc eon Number Theory, PDE and Geometry* held at University of Calicut during Aug 27 – Aug 29, 2009. Delivered an invited plenary talk.

Participated in *Workshop on PDE and related analysis* held at IISC., Bangalore during Aug 31 – Sep 18, 2009. Delivered a series of five lectures

Visited IIT, Madras on Oct 22, 2009. Delivered a colloquium talk

Participated in *Platinum Jubilee Meeting of the Indian Academy of Sciences* held at IISc., Bangalore during Nov 12 – Nov 14, 2009. Delivered an invited talk

Participated in *IISc - CSIC Workshop* held at IISc., Bangalore during Nov 16 – Nov 19, 2009. Delivered an invited talk

Participated in *Advanced Foundational School (AFS) - VI* held at Chennai Mathematical Institute during Dec 3 – Dec 31, 2009. Delivered a series of five lectures

Participated in *Conference on control and inverse problems* held at IISc., Bangalore during Dec 16 – Dec 18, 2009. Delivered an invited talk

Participated in *National symposium in mathematics for young researchers* held at IIT, Gandhinagar during Feb 26 – Feb 28, 2010. Delivered an invited talk

Visited HRI, Allahabad on Mar 31, 2010. Delivered the HRI Colloquium talk

Kodiyalam, Vijay

Participated in *Analysis and its applications* held at I.I.Sc., Bangalore during May 14 – May 23, 2009. Gave a course of 5 lectures on "From subfactor planar algebras to subfactors"

Visited Pondicherry University on Jan 25, 2010. Gave a talk on the "Razumov-Stroganov conjecture"

Krishna, M.

Participated in *Analysis and its Applications* - held at Indian Institute of Science, Bangaluru during May 25 – May 27, 2009. Gave a talk on "Lifshitz Tails"

Participated in *Workshop on Operator Theory* held at Institute of Mathematics and Applications, Bhubaneswar during Dec 7 – Dec 12, 2009. Gave a course of lectures on "Spectral Theory"

Participated in *Eleventh Discussion meeting in Harmonic Analysis* held at NISER Bhubaneswar during Jan 6 – Jan 9, 2010.

Lodaya, Kamal

Visited TIFR, Mumbai during Apr 26 – May 24, 2009. Gave a series of lectures on "Languages and monoids".

Participated in *8th Formal methods update meeting* held at IIT Roorkee during Jul 13 – Jul 15, 2009. Gave the second part of a talk on "Reachability in Petri nets".

Participated in *Calcutta Logic Circle annual meet* held at IBRAD, Kolkata during Sep 18 – Sep 20, 2009. Gave a talk on "Collecting garbage concurrently (but correctly)".

Visited TIFR. Mumbai during Sep 21 – Sep 25, 2009.

Participated in *Workshop on Structural aspects of rationality* held at IIT Kanpur during Dec 13 – Dec 14, 2009.

Participated in *29th FSTTCS conference* held at IIT Kanpur during Dec 15 – Dec 17, 2009.

Participated in *3rd Indian school on logic and applications* held at University of Hyderabad during Jan 18 – Jan 29, 2010.

Participated in *2nd workshop on Automata, concurrency and timed systems* held at Chennai Mathematical Institute during Feb 1 – Feb 3, 2010. Gave a talk on "LTL can be more succinct".

Participated in *Workshop on Formal theories of communication* held at Lorentz Center, Leiden University during Feb 22 – Feb 26, 2010. Gave a talk on "Communication in Petri nets".

Mahajan, Meena B.

Visited Leibniz University Hannover, Germany. during Sep 13 – Sep 25, 2009. Research collaboration under a DST-DAAD sponsored project

Participated in *Dagstuhl Seminar on Algebraic Methods in Computational Complexity* held at Leibniz Centre for Informatics, Dagstuhl, Germany during Oct 12 – Oct 16, 2009. Gave a talk titled "Small-space analogues of Valiant's classes".

Visited Max-Planck Institute for Informatics, Saarbrucken, Germany during Oct 19 – Oct

20, 2009. Gave a talk titled ”Counting paths in pebbled mountain ranges”.

Participated in *Dagstuhl seminar on Circuits, Logic and Games* held at Leibniz Centre for Informatics, Schloss Dagstuhl, Germany. during Feb 8 – Feb 12, 2010. Gave a survey talk ”Valiant's classes”.

Visited Leibniz University, Hannover, Germany during Feb 12 – Feb 19, 2010. Research collaboration under a DST-DAAD sponsored project

Maiti, Moitri

Participated in *ICTS Condensed Matter Programme 2009* held at The Fountain Hotel, Mahabaleshwar, India during Dec 5 – Dec 23, 2009.

Mallick, Vivek M.

Participated in *Differential Geometric Methods in Algebraic Geometry* held at Tata Institute of Fundamental Research, Mumbai during Apr 6 – Apr 17, 2009.

Menon, Gautam I.

Visited INSA, New Delhi on Apr 28, 2009. Participated in the drafting of a “Vision Document for Indian Science” commissioned by INSA, together with 20 other Indian scientists. Attended a follow-up meeting in IISER, Pune on 27, November 2009. The final document was submitted to INSA in February

Participated in *Frontiers and Directions in Condensed Matter Physics* held at Indian Institute of Science, Bangalore during May 25 – May 29, 2009. Invited Talk on “The Irreversible-Reversible Transition”

Visited Mysore University during Sep 8 – Sep 16, 2009. Gave a set of 15 lectures on “Statistical Thermodynamics and Kinetic Theory” to the integrated Masters students. Also presented a Colloquium in the Physics Department on ”de Gennes: A Life in Science”

Visited NCBS, Bangalore on Oct 6, 2009. Visited the laboratory of Sandhya Koushika for a research collaboration

Participated in *Meeting of Experts on Infectious Disease Modeling* held at PHFI, Delhi on Nov 11, 2009. Invited Talk on “Fundamentals of Infectious Disease Modeling”. Also attended a follow-up meeting on March 4, 2010 at PHFI, New Delhi

Participated in *INCF Multiscale Modeling Meeting* held at NCBS, Bangalore during Nov 19 – Nov 21, 2009. Invited talk on “Pattern Formation in Motor Microtubule Mixtures and Vesicular Transport via Motors”

Visited University of Geneva, Switzerland during Dec 5 – Dec 12, 2009. Seminar and collaborative research in the group of T. Giamarchi. Gave a seminar on "Driven Disordered Polymorphic Solids and Peak Effect Anomalies"

Participated in *102nd Statistical Mechanics Conference* held at Rutgers University, USA during Dec 13 – Dec 15, 2009. Invited talk on"Bending and Stretching Fluctuations of Short DNA Molecules"

Visited Brandeis University, USA during Dec 16 – Dec 17, 2009. MRSEC Colloquium speaker, on "Bending and Stretching Fluctuations of Short DNA Molecules"

Visited University of Massachusetts, Amherst on Dec 18, 2009. Colloquium talk on "Bending and Stretching Fluctuations of Short DNA Molecules"

Participated in *SERC School on Rheology of Complex Fluids* held at IIT Madras during Jan 4 – Jan 8, 2010. Invited Talk on "Active Fluids"

Participated in *IInd IMSC School on Complex Systems* held at IMSC, Chennai during Jan 4 – Jan 28, 2010. 5 Lectures on "Statistical Mechanics for Complex Systems"

Participated in *Breaking Barriers: From Physics to Biology* held at NCBS, Bangalore during Jan 9 – Jan 11, 2010. Chaired a session

Participated in *Molecular Motors, Tracks and Transport* held at Sunway Grand, Pondicherry during Jan 23 – Jan 28, 2010. Invited talk on "Pattern Formation in Motor-Microtubule Mixtures"

Participated in *ICTS Program on Non-equilibrium Statistical Physics* held at IIT Kanpur during Jan 30 – Feb 9, 2010. ICTS Plenary Lecture on "Stretching Fluctuations and Loop Formation in Short Double-Stranded DNA molecules"

Participated in *SPS March Meeting on Soft Matter* held at School of Physical Sciences, JNU, Delhi during Mar 3 – Mar 5, 2010. Invited Talk on "Coupled Maps for Rheochaos"

Participated in *Discussion Meeting on Soft, Fragile and Granular Matter* held at TIFR. Mumbai on Mar 7, 2010. Invited Talk on "The Soft-Matter/Biological Physics Interface"

Mishra, Ashok K.

Visited Central Electrochemical Research Institute, Karaikudi during Jul 15 – Jul 23, 2009. Held discussions and gave a talk on a unified model for the electrochemical rate constant.

Mukhopadhyay, Anirban

Visited Universite Paris Sud-11 during Jun 1 – Jun 30, 2009. discussed some questions in analytic number theory with Professor Etienne Fouvry .

Participated in *Activits Additives et Analytiques* held at Universite Lille 1, Lille, France during Jun 30 – Jul 4, 2009.

Participated in *Analytic Number Theory.* held at TIFR, Mumbai during Oct 5 – Oct 9, 2009. gave a talk on "Class numbers with many prime factors".

Mukhopadhyay, Partha

Visited Harish-Chandra Research Institute during Apr 1 – Apr 8, 2009. Seminar: "Conformal invariance of superstrings in type IIB R-R plane-wave background"

Participated in *Sixth International Symposium on Quantum Theory and Symmetries (QTS6)* held at University of Kentucky, USA during Jul 20 – Jul 25, 2009. Gave an invited talk on "String worldsheet theory in hamiltonian framework and background independence"

Visited Centre for High Energy Physics, Indian Institute of Science, Bangalore during Sep 11 – Sep 18, 2009. Seminar: "A phase-space operator method for string worldsheet theory and general covariance"

Visited Tata Institute of Fundamental Research, Mumbai during Sep 18 – Sep 23, 2009. Seminar: "A phase-space operator method for string worldsheet theory and general covariance"

Visited Department of Physics, McGill University, Canada during Oct 8 – Oct 16, 2009. Seminar: "A phase-space operator method for string worldsheet theory and general covariance"

Participated in *Science without boundaries - inaugural event of International Centre for Theoretical Sciences* held at Indian Institute of Science, Bangalore during Dec 27 – Dec 31, 2009.

Visited Institute of Physics, Bhubaneswar during Mar 14 – Mar 17, 2010. Seminar: "From worldsheet to spacetime"

Murthy, M.V.N.

Visited IGCAR, Kalpakkam on Jun 25, 2009. Lecture on "Powering the Sun" at Summer Training Programme in Physics and Chemistry (STIPAC)

Visited Bombay Natural History Society on Oct 16, 2009. Talk on "INO- its scientific goals, environmental impacts and mitigation"

Participated in *SERC Nuclear Physics and Astrophysics School* held at Department of

Physics, University of Calicut during Feb 4 – Feb 6, 2010. Delivered series of three lectures on "Neutrinos from Supernova" and a colloquium on " Big world of small Neutrinos: An Introduction to INO".

Visited Salim Ali Centre for Ornithology and Natural Conservation on Mar 29, 2010. Talk on "Neutrino physics and INO"

Participated in *"Big Bang and Particle Physics" UGC sponsored workshop for college teachers* held at JSS college for women Chamarajanagara, Karnataka on Mar 31, 2010. Talk on "Powering the sun and solar neutrinos"

Nagaraj, D. S.

Visited Univesity of D'Artois, France. during May 1 – May 31, 2009. Gave talk titled "Blow-up and Vector bundles"

Visited University of Lille, France. during Jun 1 – Jun 30, 2009. Gave a talk titled "On symmetric power of space curve"

Visited IIT Madras and CMI during Jul 6 – Jul 10, 2009. Participated in the annual CAAG meeting and gave a talk titled "Vector Bundles on Symmetric Powers"

Visited School of IT Sciences Dr G R Damodaran College of Science, Coimbatore, Tamil nadu, India. on Mar 19, 2010. Gave a key note address titled "Algebraic Geometry and application" in the workshop on "National Workshop on Research Paradigms in Communication and Data Engineering" held on 18th and 19th March 2010

Paranjape, Kapil H.

Visited LNM Institute of Information Technology during Apr 1 – Apr 3, 2009. Gave a talk on "What is Pi?" for 1st-2nd year undergraduate students.

Visited IIT, Kanpur during Apr 4 – Apr 5, 2009. Gave a talk on "The work of M. Gromov"

Paul, Pampa

Participated in *ATM Workshop on Topology of Manifolds* held at IMSc during Feb 1 – Feb 13, 2010.

Philip, Geevarghese

Participated in *Workshop on Introduction to Graph and Geometric Algorithms* held at Department of Computer Science and Automation, Indian Institute of Science, Bangalore during Jul 15 – Jul 18, 2009.

Visited Department of Informatics, University of Bergen, Bergen, Norway during Aug 9 – Sep 15, 2009. Visited Prof. Fedor Fomin and other researchers at the Department of Informatics, University of Bergen, from 9/8/2009 to 5/9/2005, and from 12/9/2009 to 15/12/2009.

Participated in *17th Annual European Symposium on Algorithms (ESA 2009)* held at IT University of Copenhagen, Copenhagen, Denmark. during Sep 7 – Sep 9, 2009. Presented a paper titled "Solving Dominating Set in Larger Classes of Graphs: FPT Algorithms and Polynomial Kernels".

Participated in *4th International Workshop on Parameterized and Exact Computation (IWPEC)* held at IT University of Copenhagen, Denmark during Sep 10 – Sep 11, 2009.

Participated in *WorKer 2009: The first workshop on kernels.* held at University of Bergen, Bergen, Norway during Sep 12 – Sep 13, 2009. Presented a talk titled "Polynomial kernels for Dominating Set in larger classes of graphs".

Participated in *Dagstuhl Seminar 09511 : Parameterized complexity and approximation algorithms* held at Schloss Dagstuhl - Leibniz Center for Informatics, Wadern, Germany during Dec 13 – Dec 17, 2009.

Participated in *National Conference on Discrete Mathematics and its Applications* held at St. Berchmans' College, Changanacherry, Kerala, India. during Dec 29 – Dec 31, 2009. Gave lectures titled "Basic Graph Algorithms" and "Approximation and Fixed-Parameter Algorithms".

Participated in *Workshop on Algorithms and Computation (WALCOM 2009)* held at Bangladesh University of Engineering and Technology, Dhaka, Bangladesh during Feb 10 – Feb 12, 2010. Presented a paper titled "FPT Algorithms for Connected Feedback Vertex Set".

Participated in *Instructional Workshop on Graph Algorithms* held at National Centre for Advanced Research in Discrete Mathematics (n-CARDMATH), Kalasalingam University, Srivilliputtur, Tamil Nadu during Feb 19 – Feb 23, 2010. Gave lectures on Approximation Algorithms and Fixed Parameter Tractability.

Prasad, Amritanshu

Participated in *Workshop on persepectives in Mathematics* held at HBCSE and TIFR, Mumbai during Dec 21 – Dec 22, 2009. Invited speaker

Participated in *XIth discussion meeting in Harmonic Analysis* held at NISER, Bhubaneswar during Jan 6 – Jan 9, 2010.

Participated in *Workshop on Analytic Number Theory* held at IMSc, Chennai during Feb 17 – Mar 2, 2010.

Praveen, M.

Visited Department of Informatics, University of Bergen, Norway. during Sep 2 – Sep 14, 2009. Collaborated with Fedor Fomin, Saket Saurabh and Daniel Lokshtanov on FPT algorithms for apex minr free classes of graphs.

Visited LIAFA, Paris. during Sep 15 – Sep 26, 2009. Gave a talk based on our paper [**Pr**].

Participated in *Formal Methods Update Meeting 2009* held at IIT Roorkee during Dec 13 – Dec 15, 2009. I gave a talk on Kosaraju's proof of decidability of the reachability problem for Petri nets.

Participated in *Foundations of Software Technology and Theoretical Computer Science* held at IIT Kanpur during Dec 15 – Dec 17, 2009. Presented our paper [**Pr**].

Raghavan, K. N.

Visited Indian Statistical Institute, Bangalore on Apr 13, 2009. academic work

Visited Indian Statistical Institute, Bangalore during Apr 22 – Apr 30, 2009. academic work; gave talk entitled "KRS bases and Kazhdan-Lusztig cells"

Participated in *Twenty fourth Annual Conference of the Ramanujan Mathematical Society* held at Indian Statistical Institute, Bangalore during May 10 – May 13, 2009. participated as member of the Executive Council of the Society

Participated in *Advanced Instructional School in Commutative Algebra* held at Indian Institute of Technology, Bombay during May 25 – Jun 3, 2009. participated as a resource person

Visited Indian Statistical Institute, Bangalore during Jul 1 – Jul 17, 2009. research collaboration

Visited Indian Statistical Institute, Bangalore during Jan 4 – Jan 5, 2010. research collaboration

Participated in *International Conference on Algebra and its applications* held at Aligarh Muslim University, Aligarh during Feb 20 – Feb 22, 2010. plenary speaker

Participated in *National Symposium in Mathematics for young researchers* held at Indian Institute of Technology, Gandhinagar during Feb 26 – Feb 28, 2010. plenary speaker

Visited Indian Institute of Science, Bangalore on Mar 8, 2010. Meeting of the Ramanujan Mathematical Society

Rajasekaran, G.

Participated in *Neutrinos, Astrophysics and Cosmology* held at Mahabalipuram (organized by IMSc) during Apr 5 – Apr 7, 2009. Gave a lecture "A4 Symmetry and the neutrino mass matrix"

Participated in *Aspects of neutrinos* held at Goa (organized by the International Centre for Theoretical Sciences,TIFR) during Apr 8 – Apr 15, 2009. Talked on "Unification of neutrino mixing with quark mixing"

Participated in *Future of Neutrino Physics* held at TIFR, Mumbai during Apr 17 – Apr 19, 2009. Gave three lectures:1. Is there a Final Theory? 2. Broken symmetry (Nobel Prize in Physics 2008) 3.Miniprojects with megaresults

Visited Indira Gandhi Centre for Atomic Research, Kalpakkam on May 25, 2009. Gave a Lecture to students of a summer programme on "Homi Bhabha, the Scientist and Institution Builder, par Excellence"

Participated in *Homi Bhabha Birth Centenary Celebration* held at TIFR Centre for Applicable Mathematics, Bangalore during Jul 20 – Jul 24, 2009. Gave two lectures on "Homi Bhabha, Scientist and Institution Builder par Excellence"

Visited Centre for High Energy Physics, IISc, Bangalore on Jul 22, 2009. Gave a lecture on "Homi Bhabha's Contributions to Theeoretical Physics"

Visited Chennai Mathematical Institute on Aug 12, 2009. Gave a General Colloquium on "Homi Bhabha, the Scientist and Master Builder of Institutions"

Participated in *School on Loop Quantum Gravity* held at Institute of Mathematical Sciences during Sep 8 – Sep 18, 2009.

Participated in *Inter-University Accelerator Centre Acquaintance Programme* held at VIT University,Vellore on Oct 20, 2009. Gave the Inaugural Talk titled "A Great opportunity for Indian Science"

Visited Tata Institute of Fundamental Research, Mumbai during Oct 29 – Oct 30, 2009. Gave five lectures on High Energy Physics and Neutrinos to the Graduate students and INO students

Participated in *Homi Bhabha Birth Centenary Celebration* held at TIFR, Mumbai on Oct 31, 2009.

Participated in *INO Collaboration Meeting* held at Punjab University, Chandigarh during Nov 23 – Nov 24, 2009.

Participated in *International School on High Energy Astrophysics* held at Solar Observatory, Kodaikanal during Dec 1 – Dec 11, 2009. Gave 4 lectures on High Energy Physics

Visited Dept of Nuclear Physics,University of Madras during Dec 6, 2009 – Mar 31, 2010. Teaching Quantum Mechanics every Sunday for three hours to those MSc students and teachers who want to improve their understanding of the subject. Participants number about 30.

Visited The American College, Madurai during Mar 28 – Mar 31, 2010. Gave a minicourse of 6 lectures on High Energy Physics and Neutrinos to students and faculty of the postgraduate colleges in Madurai

Rajkumar, Krishnan

Participated in *International Conference on Analytic Number Theory* held at T.I.F.R., Mumbai during Oct 5 – Oct 9, 2009.

Raman, Venkatesh

Visited University of Bergen, Norway during Apr 24 – May 30, 2009. Gave talks on 'Polynomial Kernels for Dominating Set in bounded degenerate graphs', 'Parameterizing beyond the guarantee', and 'Succinct Data Structures'

Participated in *National Instructional Workshop on Graph Algorithms* held at National College, Tiruchi during Jun 6 – Jun 7, 2009. Academic Coordinator of the workshop, gave talks on NP-completeness, Approximation and Randomization

Participated in *Introduction to Graph and Geometric Algorithms* held at Indian Institute of Science, Bangalore during Jul 15 – Jul 16, 2009. Gave a talk on 'Fixed Parameter Algorithms'

Participated in *GTAANS 2009 (Graph Theory, Algorithms and Networks)* held at SCSVMV University,Kancheepuram on Jul 21, 2009. Gave a talk on 'Coping with NP-completeness: Approximation and Parameterized Complexity

Visited PSG Institute of Technology, Coimbatore during Nov 14 – Nov 15, 2009. Gave talks on 'Algorithms, NP-completeness and Coping Strategies' and on 'Opportunities for a Research Career'

Participated in *FSTTCS 2009* held at IIT Kanpuar during Dec 14 – Dec 16, 2009. Gave a talk in the contributed session on 'Subexponential Algorithms for Partial Vertex Cover problems'

Participated in *National Conference on Discrete Mathematics: Theory, Algorithms and Applications* held at St. Berchman's College, Chenganassery, Kottayam, Kerala during Dec 29 – Dec 31, 2009. Gave lectures on data structures, NP-completeness

Participated in *Introduction to Graph and Geometric Algorithms (IGGA)* held at National Institute of Technology, Tiruchi during Jan 8 – Jan 9, 2010. Gave a talk on 'Fixed Parameter Algorithms'

Participated in *Instructional Course on Graph Theory* held at Annamalai University, Chidambaram during Jan 10 – Jan 11, 2010. Gave a talk on 'Minmax Theorems in Graph Theory' and 'Turan's theorem'

Participated in *Instructional Course on Graph Algorithms* held at Kalasalingam University, Krishnankoil during Feb 3 – Feb 6, 2010. Was the academic programme coordinator and organized resource persons

Participated in *Instructional Course on Advanced Graph Algorithms* held at Kalasalingam University, Krishnankoil during Feb 19 – Feb 22, 2010. Coordinated the academic program, organized resource persons, gave lectures on Approximation Algorithms

Visited PSG Institute of Technology, Coimbatore on Mar 27, 2010. Gave a talk on 'Randomization in Computing'

Ramanujam, R.

Participated in *Theoretical Aspects of Rationality and Knowledge* held at Stanford University, USA. during Jul 6 – Jul 8, 2009. Presented paper on Dynamic restriction of choices.

Participated in *Workshop on Logic and Security, in the Indian School on Logic and Applications* held at University of Hyderabad during Jan 18 – Jan 22, 2010. Gave a talk titled "Logics underlying the Dolev Yao model".

Visited Chalmers University, Goteborg, Sweden during Feb 12 – Feb 15, 2010. Gave two talks, one on game theory and the other on security theory.

Visited Groningen University, Groningen, The Netherlands during Feb 17 – Feb 18, 2010. Gave a talk titled "What can imitation achieve ?"

Visited Laboratory for Specification and Verification, Ecole Normales Superieure de Cachan, France during Mar 1 – Mar 6, 2010. Gave a talk titled "Simple dynamics in large games", and another titled "Dolev Yao theories with disjunctions".

Sankaran, Parameswaran

Participated in *Annual Meeting of Ramanujan Mathematical Society* held at Indian Statistical Institute, Bangalore. during May 11 – May 13, 2009.

Participated in *Platinum Jubilee Meeting-I of Indian Academy of Sciences* held at Indian Institute of Chemical Technology, Hyderabad during Jul 2 – Jul 4, 2009. Gave an invited talk on ‘Maps between Grassmann manifolds’.

Participated in *Bratislava Topology Symposium on Group actions and Homogeneous spaces* held at Comenius University, Bratislava during Sep 7 – Sep 11, 2009. Gave an invited talk on ‘Maps between Grassmann manifolds’.

Visited TIFR-Centre for Applicable Mathematics, Bangalore during Oct 21 – Oct 22, 2009. Gave a colloquium talk on ‘Generalized Calabi-Eckmann manifolds’.

Participated in *National Seminar on Topology and its Applications* held at Kannur University, Kannur, Kerala during Nov 25 – Nov 26, 2009. Gave an invited talk on ‘Calabi-Eckmann manifolds and their generalizations’

Participated in *Annual Foundation School (Part-I)* held at Chennai Mathematical Institute, Siruseri, Chennai. during Dec 3 – Dec 30, 2009. Gave a course of lectures on Introduction to Algebraic Topology.

Visited Vivekananda College, Mylapore on Feb 19, 2010. Gave the Prof. K. Subramanian Memorial Endowment Lecture on 2-by-2 matrices.

Sathiapalan, Balachandran

Visited IIT Madras (SERC school) during Oct 4 – Oct 16, 2009. Participated in the SERC school: Took tutorials for Quantum Field Theory (Lectures by Suresh Govindarajan)

Participated in *KS Krishnan Meeting - Holographic Methods in Condensed Matter Physics* held at IMSc during Dec 21 – Dec 22, 2009. Gave a talk on ”AdS/CFT (Holography), BTZ black holes and Luttinger Liquids”

Participated in *Science Without Boundaries* held at IISc Bangalore during Dec 28 – Dec 30, 2009.

Visited Chennai Mathematical Institute on Mar 2, 2010. Talk on ”BTZ Balck Holes and Luttinger Liquids” also gave a lecture on Luttinger Liquids

Saurabh, Saket

Visited Department of Informatics, University of Bergen, Norway. during Nov 30 – Dec 5, 2009. Visited Prof. Fedor Fomin.

Participated in *Bertinoro Workshop on Algorithms and Graphs* held at University Residential Center Bertinoro (Forl-Cesena), Italy. during Dec 6 – Dec 11, 2009. Gave a talk.

Participated in *Dagstuhl Workshop on Parameterized complexity and approximation algorithms* held at Dagstuhl, Germany. during Dec 13 – Dec 17, 2009. Gave a talk.

Participated in *Instructional Workshop on Graph Algorithms* held at Kalasalingam University, Anand Nagar. during Feb 19 – Feb 23, 2010. Organized a three day school on Parameterized Algorithms and Complexity with Neeldhara Misra and Geevarghese Philip.

Participated in *Research Promotion Workshop on Introduction to Graph and Geometric Algorithms* held at National Institute of Technology, Rourkela. during Mar 25 – Mar 27, 2010. Invited Speaker

Simon, R.

Participated in *Koli Workshop on "Partial Electromagnetic Coherence and 3D Polarization"* held at Koli Mountain, Finland during May 24 – May 27, 2009. Plenary talk on "Entanglement in Classical Optics"

Visited University of Joensuu, Joensuu, Finland during Aug 23 – Aug 29, 2009. Conducted experiment on Geometric Phase for Mixed States

Visited Roma Tre University, Rome during Oct 4 – Oct 9, 2009. Collaborative research on Entanglement in Classical Optics

Participated in *Refresher Course on Theoretical Physics* held at Bishop Moore College, Mavelikara, Kerala during Dec 7 – Dec 19, 2009. A Course of ten lectures on Quantum Mechanics

Singh, Mahender

Participated in *ATM workshop on topology of manifolds* held at IMSc during Feb 1 – Feb 13, 2010.

Sinha, Nita

Participated in *Neutrinos in Particle Astrophysics and Cosmology* held at Mahabalipuram, Tamil Nadu, India during Apr 5 – Apr 7, 2009.

Participated in *Aspects of Neutrinos* held at International Center, Goa during Apr 8 – Apr 15, 2009. Chaired a session

Participated in *Workshop Towards Neutrino Technologies* held at International Centre for Theoretical Physics, Trieste during Jul 13 – Jul 17, 2009.

Participated in *11th International Workshop on Neutrino Factories, Superbeams and Beta Beams, Nufact09* held at Illinois Institute of Technology, Chicago, USA during Jul 20 – Jul 25, 2009. Presented a poster

Participated in *4th Plenary meeting of the International design study for the Neutrino Fac-*

tory held at Tata Institute of Fundamental Research, Mumbai during Oct 12 – Oct 14, 2009.

Participated in *Workshop on High Energy Phenomenology, Whepp XI* held at Physical Research Laboratory, Ahmedabad during Jan 2 – Jan 11, 2010.

Participated in *NuHorizons III* held at Harish-Chandra Research Institute, Allahabad. during Feb 8 – Feb 10, 2010. Presented an invited talk

Sinha, Sitabhra

Visited Indian Institute of Science Education and Research (IISER), Kolkata during Apr 20 – Apr 23, 2009. Taught a module in the Systems Biology core course for 2nd year undergraduate program.

Participated in *International Conference on Frontiers and Directions in Condensed Matter Physics* held at Indian Institute of Science, Bangalore during May 25 – May 29, 2009. Invited talk on "Novel phase and dynamical behavior in collective phenomena on complex networks".

Participated in *3rd International Conference on Complex Systems and Applications* held at Universite du Havre, Le Havre during Jun 29 – Jul 2, 2009. Lecture on "Dynamical consequences of mesoscopic organization in complex systems".

Visited Ecole Normale Superieure (ENS-Lyon), Lyon, France during Jul 1 – Jul 10, 2009. As part of IFCPAR collaborative project

Participated in *National Symposium of Theoretical and Mathematical Biology* held at IISER-Pune, Pune during Oct 10 – Oct 11, 2009. Invited talk on "Understanding the mind of a worm".

Participated in *National Symposium of Dynamics on Networks* held at IISER-Pune, Pune during Nov 13 – Nov 14, 2009. Invited talk on "Dynamics on Modular Networks".

Participated in *Indo-Russian Workshop on Complex Networks: Dynamics and Synchronization* held at Indian Institute of Chemical Biology, Kolkata during Dec 1 – Dec 2, 2009. Invited talk on "Complex dynamics in modular networks: Emergence of novel phase and multiple time-scales".

Participated in *International Symposium on Complex Dynamical Systems and Applications* held at Digha Science Center, Digha during Dec 4 – Dec 6, 2009. Invited talk on "Dynamics of complex wave activity in the heart: The role of inhomogeneities and gradients".

Participated in *SERC School on Nonlinear Dynamics* held at Department of Physics, University of Delhi, Delhi during Dec 21 – Dec 24, 2009. Gave 5 lectures on the dynamics of complex networks.

Visited Dept of Applied Mathematics, University College of Science, Calcutta University, Kolkata during Feb 10 – Feb 11, 2010. Invited talk on "Complex Networks in Biology"

Participated in *Meeting on Mathematical Biology* held at Department of Mathematics, Indian Institute of Science, Bangalore during Feb 25 – Feb 26, 2010. Planning session for the IMI Special Year on Mathematical Biology 2010-11.

Participated in *Workshop on Modeling the Spread of Influenza A(H1N1) disease in India* held at Public Health Foundation of India, New Delhi on Mar 4, 2010. Invited talk on "Estimating the Basic Reproductive Number for Influenza A(H1N1)v Epidemic in India".

Participated in *Econophys-Kolkata V: International Workshop on Econophysics of Order-Driven Markets* held at Saha Institute of Nuclear Physics, Kolkata during Mar 9 – Mar 13, 2010. Invited talk on "A Mean-field model for reproducing the *stylized facts* of financial markets".

Visited Indian Institute of Science Education and Research (IISER), Kolkata during Mar 22 – Mar 24, 2010. Taught a module in the Systems Biology core course for 2nd year undergraduate program.

Participated in *Seminar on Recent Advances in the Study of the Indus Script* held at Indus Research Center, Roja Muthiah Research Library, Chennai on Mar 27, 2010. Invited talk on "New approaches to reconstructing the syntactic structure of the Indus Valley inscriptions".

Participated in *Workshop on "Statistical Mechanics in Biological Systems"* held at Department of Physics, University of Mysore, Mysore on Mar 31, 2010. Two invited lectures on "Complex networks in biology".

Sivakumar, Lavanya

Participated in *Instructional Workshop On Graph Colourings* held at Kalasalingam University, Srivilliputhur, Virudhunagar during Mar 10 – Mar 15, 2010. Gave a seminar on "Cycles and Chromatic Bounds"

Sridhar, S.

Participated in *Conference on Mathematical Biology* held at IISER Pune during Oct 10 – Oct 11, 2009.

Participated in *ICTS Workshp/Conference on Non-equlibrium statistical physics* held at IIT Kanpur during Jan 30 – Feb 8, 2010. My poster titled, "Role of heterogeneities in the dynamics and control of spiral waves in excitable media" was judged the best poster at the conference

Srinivas, K.

Participated in *UGC Staff Refresher course* held at University of Goa, Goa during Apr 9 – Apr 10, 2009. Resource person, delivered a few talks on complex analysis.

Visited NEC, Kovilpatti during Jun 5 – Jun 6, 2009. Invited as Chief Guest, delivered a talk in the CSIR sponsored programme with the title 'Number Theory and Its recent research directions in Cryptography'

Participated in *MTTS 2009* held at Department of Mathematics, University of Sambalpur, Orissa during Jun 10 – Jun 23, 2009. Resource person, taught a course on elementary number theory.

Visited NIAS, Bangalore during Jul 21 – Jul 22, 2009. To collaborate with K. Ramachandra

Participated in *Mathematics for Engineering* held at NITTR, Taramani, Chenai on Aug 12, 2009. Resource person, delivered a 3 hour lecture on Mathematics for Engineering.

Visited Department of Mathematics, Andhra University during Aug 20 – Aug 21, 2009. Delivered a talk on some recent developments in cryptography.

Visited IISER, Pune during Sep 18 – Sep 22, 2009. Collaborated with Professor Santhanam.

Participated in *International conference on Analytic Number Theory* held at TIFR, Mumbai during Nov 5 – Nov 9, 2009. Delivered an invited talk on " Hardy's theorem for General Dirichlet Series "

Visited N.I.T. Rourkela during Nov 28 – Nov 29, 2009. Delivered a talk on Number Theory and Public Key Cryptography

Participated in *UGC sponsored National Seminar on Applications of Algebra and Number Theory* held at National College,Tiruchi during Dec 4 – Dec 5, 2009. Delivered a talk on Applications of Number Theory

Participated in *Italy-India Italy-India Conference on Diophantine and Analytic Number Theory* held at Scuola Normale Superiore, Pisa, Italy during Mar 8 – Mar 14, 2010. Delivered an invited talk on "Some results on the zeros of the functions in Selberg class".

Subhash, B.

Participated in *ATM workshop in topology* held at Institute of Mathematical Sciences, Chennai during Feb 1 – Feb 13, 2010.

Subramanian, C. R.

Participated in *Dr. Homi J. Bhabha Birth Centenary Workshop on "Introduction to Graph and Geometric Algorithms"* held at Indian Institute of Science, Bangalore during Jul 15 –

Jul 18, 2009. Gave a talk on "Randomized Algorithms for Counting Problems"

Participated in *Research Promotion Workshop on Introduction to Graph and Geometric Algorithms*

held at National Institute of Technology, Tiruchirapalli during Jan 7 – Jan 9, 2010. Gave a talk on "Randomized Algorithms"

Visited Annamalai University during Jan 9 – Jan 11, 2010. Visited the Department of Mathematics while attending the Teachers Training Workshop on Graph Theory

Participated in *Teachers Training Workshop on Graph Theory* held at Department of Mathematics, Annamalai University during Jan 10 – Jan 11, 2010. Gave a set of 3 lectures on "Graph Coloring".

Participated in *Research Promotion Workshop on "Introduction to Graph and Geometric Algorithms"* held at Institute of Technology-Banaras Hindu University (IT-BHU), Banaras during Jan 27 – Jan 29, 2010. Gave a talk on "An Introduction to Randomized Algorithms"

Visited Kalasalingam University during Mar 10 – Mar 15, 2010. An Instructional Workshop on Graph Colourings was held at n-CARD center.

Sunder, V. S.

Participated in *The 24th Annual Conference of the Ramanujan Math Society* held at Indian Statistical Institute, Bangalore during May 11 – May 13, 2009. Delivered the 'M N Gopalan Endowment Lecture' and spoke on *von Neumann algebras and free probability*

Visited TIFR-CAM, Bengaluru on Nov 10, 2009. Lectured at the weekly colloquium on *Free probability: classical and free central limit theorems*

Visited ISI, Bengaluru on Nov 11, 2009. gave a colloquium lecture titled *Central Limit Theorems - classical and free*

Visited Chennai Math Institute on Dec 18, 2009. Gave a lecture in the 'Unity in Mathematics' series, on *The Perron-Frobenius Theorem*

Participated in *Discussion Meeting in Harmonic Analysis* held at NISER, Bhubaneswar during Jan 6 – Jan 9, 2010.

Visited Chennai Math Institute during Jan 25 – Jan 28, 2010. Gave a series of three lectures as part of their 'Semester on Analysis' programme, on *Catalan Numbers, Non-commutative probability spaces* and *Classical and free central limit theorems.*

Participated in *Workshop on Functional Analysis and Harmonic Analysis* held at Kerala School of Mathematics, Kozhikode during Feb 4 – Feb 6, 2010. Gave four lectures devoted to the Gelfand Naimark theorems and to the GNS construction from the point of view of positive-definite kernels.

Swain, Jitendriya

Participated in *The 24th Annual Conference of the Ramanujan Mathematical Society.* held at Indian Statistical Institute, Bangalore during May 11 – May 13, 2009. Gave a talk on Fourier multipliers for the Sobolev spaces on the Heisenberg group on 12th May, 2009 in Indian Statistical Institute, Bangalore.

Participated in *Workshop in Analysis and its Applications* held at Indian Institute of Science, Bangalore during May 14 – May 23, 2009.

Participated in *Conference in Analysis and its Applications* held at Indian Institute of Science, Bangalore during May 27 – May 30, 2009.

Participated in *Workshop: Discussion meeting in Harmonic analysis -11, 2010.* held at National Institute Science education and research, Bhubaneswar during Dec 28, 2009 – Jan 5, 2010.

Participated in *Conference: Discussion meeting in Harmonic analysis -11* held at National Institute of Science education and Research. Bhubaneswar. during Jan 6 – Jan 9, 2010. Gave a talk on Szego limit theorem on the lattice on 6th Jan, 2010 in National Institute of Science Education and Research, Bhubaneswar.

T, Mubeena

Participated in *ATM workshop on Topology of manifolds* held at IMSc during Feb 1 – Feb 13, 2010.

5.4 Visitors from Other Institutions

5.5 Visitors

Name	*Date*	*Affiliation*
Nishant Suri	01/09/08 - 05/10/09	IMSc Visitor
Ghurumuruhan Ganesan	27/01/09 - 23.07.09	IMSc Visitor
G.M.S.K.Chaitanya	29/03/09 - 16.04.09	University of Mysore
Ralf Meyer	01/04/09 - 05/04/09	Mathematics Institute University
E.Natarajan	01/04/09 - 30.06.09	IIT
Subir Sarkar	03/04/09 - 08/04/09	Oxford University
L.Sriram Kumar	04/04/09 - 07/04/09	HRI
Urijit Yajnik	04/04/09 - 07/04/09	IIT
Vikram Sharma	05/04/09 - 07/04/09	Max Plank Institute
Tushar Prabhu	05/04/09 - 08/04/09	Indian Institute of Astrophysics
K.Lakshmanan	06/04/09 - 02/05/09	VIT
A.Bharathi	08/04/09 - 08/04/09	Material Science Division
Amit Ghosh	08/04/09 - 09/04/09	SINP
Mahindera Agrawal	12/04/09 - 13.04.09	IIT
Jaikumar Radhakrishnan	12/04/09 - 13.04.09	TIFR
Kedar Damle	13/04/09 - 14.04.09	TIFR
N.Mukunda	15/04/09 - 22.04.09	IISc
Madhavan Varadarajan	20/04/09 - 22.04.09	RRI
Sudip Mondal	20/04/09 - 26.04.09	TIFR Campus
Murali K.Srinivasan	26/04/09 - 29.04.09	IIT
P.Murugan	27/04/09 - 28.04.09	CERI
R.Thangadurai	03/05/09 - 09/05/09	HRI
Dilip Jatkar	04/05/09 - 10/05/09	HRI
I.Arnold Emerson	11/05/09 - 15.05.09	Vellore Inst. Of Technology
Pramod Padmanabhan	11/05/09 - 22.06.09	Syracuse Univ. USA
J.Segar	11/05/09 - 15.06.09	Dept of Physics
Aruna Rajagopal	14/05/09 - 30.06.09	St.Stephans College
Vinay Kumaraswamy.V	14/05/09 - 04/06/09	CMI
Shamak Vilas Deo	14/05/09 - 04/06/09	ISI
Aditya C.Kamatachi	14/05/09 - 04/06/09	CMI
Saradha Natarajan	15/05/09 - 17.05.09	TIFR
Sreerup Raychoudhry	15/05/09 - 15.05.09	TIFR
Prabir Roy	15/05/09 - 15.05.09	SINP
Jyoti Prasad Saha	17/05/09 - 25.05.09	Serampure college
Mohit Yadav	18/05/09 - 25.07.09	IIT
Onkar S.Parrikar	18/05/09 - 01/07/09	Birla Inst. Of Tech. Zuarinagar
Anton Joe	18/05/09 - 30.06.09	Sonnet

S.Arunagiri	20/05/09 - 19.11.09	IMSc Visitor
V.Ravindran	30/05/09 - 02/06/09	HRI
Sarit Maitra	31/05/09 - 05/06/09	Bajkul Milani Mahavida
Aparna Basu	31/05/09 - 06/06/09	CSIR
D.Surya Ramana	01/06/09 - 23.06.09	HRI
I.Abhishek	04/06/09 - 02/07/09	Bharathiar Univ. Coimbatore
Manish Dev Sharmili	07/06/09 - 20.06.09	LNM Institute
Swarnendu Sarkar	09/06/09 - 01/07/09	University of Delhi
Francesco Frideles	11/06/09 - 17.06.09	Uragata
Indirajit Mitra	14/06/09 - 10/07/09	Indian Associate for the Science
Rajdeep Niyogi	17/06/09 - 01/07/09	IIT
Ayan Mukhopadhyay	22/06/09 - 30.06.09	HRI
P.T.Sumesh	22/06/09 - 07/06/09	INCASR
Tushar Prabhu	24/06/09 - 28.06.09	Indian Institute of Astrophysics
Jasloon Lugani	25/06/09 - 07/10/09	IIT
J.Meena Devi	26/06/09 - 29.06.09	American College
Ashim Avinash Sahu	02/07/09 - 12/12/09	BITS
Neeraj Pradhan	02/07/09 - 12/12/09	BITS
Ashim Avinash Sahu	02/07/09 - 15/12/09	BITS
Neeraj Pradhan	02/07/09 - 16/12/09	BITS
Sourendu Gupta	08/07/09 - 10/07/09	TIFR
Sasanka Roy	09/07/09 - 10/07/09	IISc
J.Maharana	11/07/09 - 17.07.09	IOP
Shitikanth	11/07/09 - 17.07.09	IIT
Pritish Kamath	11/07/09 - 18.07.09	IIT
Subinay Dasgupta	12/07/09 - 25.07.09	Univ. of Calcutta
M.Muthukumar	15/07/09 - 05/08/09	Univ. of Massachusetts
Sourender Baswana	18/07/09 - 21.07.09	IIT
Sukanta Das	19/07/09 - 15.08.09	Bengal Eng. Sci.Univ.
Samarath Chandra	19/07/09 - 20.07.09	TIFR
John Augustine	20/07/09 - 21.08.09	TRD and DC
V.Kumar Murthy	20/07/09 - 08/08/09	Univ. of Toronto
P.T.Sumesh	21/07/09 - 04/08/09	JNCASR
Stevan Bonta	23/07/09 - 15.08.09	IMSc Visitor
Rohini M.Godbole	25/07/09 - 29.07.09	IISc
Arijit Chakraborty	26/07/09 - 29.07.09	Cornell University
K.R.Parthasarathy	26/07/09 - 18.08.09	ISI
S.D.Adhikari	27/07/09 - 31.07.09	HRI
K.Thulasiraman	28/07/09 - 28.07.09	Univ. Oklahoma
R.Lenin Raj	30/07/09 - 31.12.09	Anna University
G.S.Agarwal	31/07/09 - 01/08/09	Dept. of Physics
Sayantan Ghosh	02/08/09 - 04/11/09	IISCER
Rajesh Rao	07/08/09 - 11/08/09	Univ. of Washington
Vahia. M.N.	07/08/09 - 12/08/09	TIFR
Nisha Yadav	07/08/09 - 12/08/09	TIFR
Hrishikesh Joglekar	08/08/09 - 11/08/09	TIFR

Bikas K.Chakraborty	09/08/09 - 10/08/09	SINP
Shibaji Rey	09/08/09 - 14.08.09	SINP
Mythily Ramaswamy	10/08/09 - 10/08/09	TIFR Campus
B.Ramakrishnan	10/08/09 - 23.08.09	HRI
S.D.Adhikari	16/08/09 - 23.08.09	HRI
Jerrael K.Mani	20/08/09 - 31.01.10	IMSc Visitor
Mayukh Nilay Khan	21/08/09 - 30.04.09	IIT
K.L.N.S.S.Sharma	21/08/09 - 31/01/10	IIT
Srinivas Raghavendra	24/08/09 - 27.08.09	Dept. of Economy
Anirban Polley	30/08/09 - 05/09/09	RRI
Analabha Roy	07/09/09 - 11/09/09	Univ. of Texas
Archisman Ghosh	07/09/09 - 10/09/09	Univ. of Kentucky
C.R.Nikhil Balaji	07/09/09 - 29.12.09	Kochadai
Apoorva Khare	08/09/09 - 11/09/09	Yale Univ. USA
Upendra Kulkarni	09/09/09 - 11/09/09	ISI
Andreasfuls	13/09/09 - 27.09.09	Technical Institute
Aditya Gilra	15/09/09 - 19.09.09	TIFR
M.G.K.Menon	22/09/09 - 26.09.09	IMSc Visitor
R.Thangadurai	24/09/09 - 03/10/09	HRI
Samir Kunkri	25/09/09 - 16.10.09	Mahadevananda Ma-havidya
Lois Sofia	26/09/09 - 18.10.09	St.Stephenis College
Mahindra Agarwal	29/09/09 - 30.09.09	IIT
Mukta Kansal	01/10/09 - 16.10.09	St.Stephenis College
Swarup Poria	01/10/09 - 13.10.09	Univ. of Calcutta
Farook Rahaman	02/10/09 - 23.10.09	Jadavpur Univ
Ramji Rahaman	03/10/09 - 10/10/09	Univ.of Bergan
Ram Kishore	04/10/09 - 24.10.09	IMPE
Kamales Kar	05/10/09 - 29/12/09	SINP
Rashmi Agarwal	09/10/09 - 18.10.09	M.L.S.U. Udaipur
Sedhartha Gadgil	14/10/09 - 16.10.09	IISc
J.Meena Devi	21/10/09 - 24.10.09	American College
Sumesh P.T.	22/10/09 - 31.10.09	INCASR
K.Ravishankar	22/10/09 - 11/06/09	State Univ. New Paltz
Kavita R.Gangal	24/10/09 - 31.10.09	Thane
J.Solomon Ivan	29/10/09 - 13.11.09	RRI
Andreas Winter	01/11/09 - 06/11/09	Univ. of Briston
Suratno Basu	02/11/09 - 21.11.09	ISI
J.Segar	04/11/09 - 02/12/09	Vivekananda College
Dipendra Prasad	09/11/09 - 24.11.09	TIFR
Arnab Mitra	09/11/09 - 24.11.09	TIFR
C.G.Venketasubramanian	09/11/09 - 22.11.09	Univ. of Hyderabad
Arvind Ayyer	10/11/09 - 17.11.09	Gif-sur-Yvetto
Sanjib Sabhapadit	11/11/09 - 16.11.09	RRI
Ram Murthy	15/11/09 - 31.12.09	Queen's University
Sumesh P.T.	16/11/09 - 30.11.09	JNCASR
P.T.Sumesh	16/11/09 - 07/12/09	JNCASR
Satoshi Nawata	21/11/09 - 28/11/09	TIFR
Eric Laenen	21/11/09 - 29/11/09	NIKHEF

Nutan Limaye	21/11/09 - 29/11/09	TIFR
Pradeep Murugesan	23/11/09 - 24/11/09	Boston Univ. USA
Anuradha Mishra	23/11/09 - 29/11/09	Univ. of Mumbai
Chandrashekar Madaiati	23/11/09 - 29/11/09	Perimeter Inst. Waterloo
Jayasri Das Sarma	26/11/09 - 29/11/09	IISER
Sukumar Nagamani	30/11/09 - 22/01/10	R.E.Centre for Chemiformer Research
N.D.Hari Dass	01/12/09 - 12/12/09	IISc
R.Thangadurai	02/12/09 - 28.12.09	HRI
Shilpa Gondhali	03/12/09 - 31.03.09	TIFR
V.Umaiyal	03/12/09 - 28/02/10	SASTRA University
J.Abharna	03/12/09 - 26/02/10	SASTRA University
Karam Deo Shankhadhar	06/12/09 - 21/12/09	HRI
Jita Parida	07/12/09 - 31.12.09	IMA Bhubaneshwar
R.S.Raghavan	08/12/09 - 13/12/09	Virginia Tech. USA
Pragacz	08/12/09 - 22/12/09	IMPAN
Ritesh K.Singh	09/12/09 - 12/12/09	Uni-Wuerzburg
Shitikanth	09/12/09 - 23/12/09	IIT
Pritish Kamath	09/12/09 - 24/12/09	IIT
Chandan Biswas	12/12/09 - 02/01/10	IISc
Shanta Laishram	12/12/09 - 03/01/10	TIFR
Mohan Ravichandran	13/12/09 - 19/12/09	Sabanci Univ. Istanbul
CH.Seshadri	13/12/09 - 31/12/09	Univ. of Hyderabad
Siddhartha Sarkar	14/12/09 - 18/12/09	IISER
J.Maharana	14/12/09 - 23/12/09	IOP
B.Kaushik Subramanian	15/12/09 - 13.01.09	Univ. of Mysore
B.Shrinath	15/12/09 - 08/03/10	IMSc Visitor
Tapash Chakraborty	16/12/09 - 18/12/09	Univ. of Maritobe
Oesterle Joseph	17/12/09 - 04/01/09	Univ. of Paris
N.G.Deshpande	20/12/09 - 26/12/09	Inst. Of Theoretical Science
A.M.M.Pruisken	20/12/09 - 06/01/09	Univ. of Amsterdam
P.P.Divakaran	21/12/09 - 29.12.09	IUCAA
Siddharth Parameswaran	21/12/09 - 22/12/09	Princeton Univ. USA
Kalpesh Kapoor	21/12/09 - 31/12/09	IIT
B.Ramakrishnan	22/12/09 - 01/01/10	HRI
Kapil Paranjape	22/12/09 - 31/12/09	IISER
B.Ramakrishnan	22/12/09 - 01/01/10	HRI
Sujata Ghosh	23/12/09 - 30/12/09	Univ. of Groningen
Nutan Limaye	23/12/09 - 03/01/10	TIFR
N.Narayanan	24/12/09 - 29.12.09	HCV Campus
Tullio Ceccherini Silberstein	24/12/09 - 25/12/09	Universita Del
Sudeshna Sinha	25/12/09 - 01/03/10	IISER
Vikram Soni	25/12/09 - 02/01/10	JAMIA
Jayadev Athreya	25/12/09 - 31/12/09	Yale University
Ajay Patvardhan	26/12/09 - 01/01/10	St.Xaviers College

Sunil Easaw Simon	27/12/09 - 18/01/10	ILLC
Ajit A.Diwan	28/12/09 - 28.12.09	IIT
Rick Mukherjee	28/12/09 - 30/12/09	Max Planck Complex Systems
Somenath Biswas	29/12/09 - 30/12/09	IIT
Abhishek Dasgupta	29/12/09 - 08/01/10	IISER
Ganesh Ramachandran	30/12/09 - 17/01/10	Univ. of Toronto
Fedor Fomin	04/01/10 - 16/01/10	Univ. of Bergan
P.T.Sumesh	04/01/10 - 08/01/10	JNCASR
Gillseppe Marmo	05/01/10 - 09/01/10	Napoli
Alain Punir	05/01/10 - 23/01/10	Ecole Normale Sup
Fanny Dufour	07/01/10 - 11/01/10	Univ. of Geneva
Vishal Sood	07/01/10 - 11/01/10	Niels Bohr Inst. Denmark
Indu Satija	07/01/10 - 17/01/10	George Mason Univ. USA
Hans Van Ditmarsch	10/01/10 - 17/01/10	Univ. of Seville
Alessandra Carbone	13/01/10 - 18/01/10	CNRS
A.P.Balachandran	13/01/10 - 10/03/10	Syracuse Univ. USA
Anil Seth	16/01/10 - 18/01/10	IIT
Olivier Ramare	20/01/10 - 24/02/10	Iuniv. Of Lille
Jurgen Fritz Stilck	24/01/10 - 13/02/10	Inst. De Fisica
Swagata Sarkar	24/01/10 - 15/02/10	ISI
Luis Oliver	25/01/10 - 21/02/10	Univ. of Paris
V.Srinivas	28/01/10 - 28/01/10	TIFR
Anirban Polley	01/02/10 - 22/02/10	RRI
Mohan Ravichandran	01/02/10 - 10/02/10	Sabanez Univ. Turkey
P.T.Sumesh	03/02/10 - 05/02/10	JNCASR
Amilkar Quiroz	03/02/10 - 06/03/10	Instituto de Fisica
Basudha Misra	05/02/10 - 18/02/10	IISC
Uday Reddy	06/02/10 - 17/02/10	Univ. of Birmingham
Xavier Martin	08/02/10 - 01/03/10	Tours Univ. France
Md. Manirul Ali	08/02/10 - 12/02/10	Academia Sinica
Madure John	09/02/10 - 19/02/10	IMSc Visitor
Mythily Ramaswamy	10/02/10 - 11/02/10	TIFR
T.V.Anoop	10/02/10 - 11/02/10	TIFR
R.C.Verma	10/02/10 - 26/02/10	Punjabi Univ. Patiala
Rukmani Mohanta	11/02/10 - 16/02/10	Univ. of Hyderabad
Anjan Giri	11/02/10 - 16/02/10	IIT
S.Umashankar	11/02/10 - 17/02/10	IIT
Diptimoy Ghosh	12/02/10 - 15/02/10	TIFR
Avinash Sharma	12/02/10 - 15/02/10	GGS Indraprastha Univ. Delhi
Anirban Kundu	12/02/10 - 15/02/10	Univ. of Calcutta
Aleksy Tralle	15/02/10 - 27/02/10	Univ. of Warmia
Aurenche Patrick	15/02/10 - 26/02/10	LAPTH
D.Paul Joseph	16/02/10 - 28/02/10	Univ. of Madras
Guruprasad Kar	17/02/10 - 28/02/10	ISI
Mithun Kumar Mitra	22/02/10 - 26/02/10	Univ. of Massachusetts
Sanjay Kumar	24/02/10 - 24/02/10	BHU
P.P.Divakaran	25/02/10 - 07/03/10	IUCAA

Bireswar Das	26/02/10 - 08/03/10	NISER
Norbert Hoffmann	02/03/10 - 09/03/10	Freie Universitat
Indiranil Biswas	02/03/10 - 09/03/10	TIFR
Anupam Kumar Singh	03/03/10 - 10/03/10	IISER
R.Ramachandran	03/03/10 - 04/03/10	IISER
Prahladh Harsha	08/03/10 - 12/03/10	TIFR
Soumen Roy	10/03/10 - 10/03/10	Univ. of chicago
Ramakrishnan Iyer	12/03/10 - 12/03/10	USC
Jayendra Baliga	14/03/10 - 19/03/10	NCBS
Pramod Kumar	15/03/10 - 22/03/10	JNCASR
V.Kumar Murty	22/03/10 - 29/03/10	Univ. of Toronto
P.T.Sumesh	22/03/10 - 03/04/10	JNCASR
Rajesh Karan	24/03/10 - 29/03/10	IISC
Mahendra K.Verma	28/03/10 - 31/03/10	IIT

Chapter 6

Infrastructure

6.1 Computer Facilities

Ehnancement of Computer Facility during 2009-2010

Hardware facility:

- An **ANNAPURNA** High Performance Computing Cluster with 12TFLOPS peak performance was commissioned(SGI) and become operational for users to handle their computational studies using NAMD, MILC, PETSc, Gaussian, GROMACS, LAMMPS and other MPI codes.

Processor	:	*Intel Xeon X5570 2.93GHz(Nehalem)*
RAM	:	*12 GB DDR3 1333MHz/node*
Interconnect	:	*4X InfiniBand*
Storage	:	*30 TB Luster File System*
Total core	:	*1024*
Total node	:	*128*
Scheduler	:	*PBS Pro 5.1*
Compiler	:	*Intel compiler suite*
Topology	:	*HyperCube 5D*

- 85 desktops were upgraded with Intel Core2 Duo CPU E8400@3GHz, 4GB RAM, 80% efficient APFC SMPS Capacity 500W Huntkey
- 5 Netbooks of makes Lenovo and MSI-Wind were added
- 4 Laptops of different makes(Apple/Sony) were issued to faculty as a long term loan.
- Additional switches(Dlink) were included in the network for the deployment of more nodes.
- 2 LCD projectors fixed in the lecture rooms.
- SMF batteries and AC/DC capacitors were replaced for the 30KVA MGE UPS
- 1 Multifunction laserjet printer and 5 laserjet printers with duplex printing capability(HP/Xerox) were added in the network to enhance the printing facility through CUPS.

- 1 high speed scanner with ADF facility(HP) added in the network.
- The Internet bandwith is upgraded to 12Mbps(Airtel) with a new Cisco router.
- Additional Access Points were deployed in the campus to maximise the WiFi coverage.
- National Knowledge Network(NKN) link is established at IMSc and become operational.

Software facility:

- WiFi access to IMSc-LAN was made through a portal based validation and authentication mechanism through the WiFiDog S/W customised for IMSc.
- Guest House booking was made through a portal page using php-residence customised for IMSc.
- McAfee AVS was made available to the laptop users.
- Adobe Acrobat professional 9 S/W is installed in the central place for general use.

Students are encouraged to use Institute laptops/netbooks while attending conferences and workshops.

6.2 The Library

The Institute Library holds a total collection of 63433 books and bound periodicals as on March 31, 2010. This includes an addition of 1691 volumes during the current year April 2009 - March 2010. The NBHM has recognized this Institute library as the Regional Library for Mathematics. An average of about 5000 outside users in a year from colleges, universities and research institutions from different parts of the country make use of the library facilities for their academic and research information needs.

The library has a well balanced collection both print and online on the major subject areas of research such as Theoretical Physics, Mathematics and Theoretical Computer Science. The library subscribes to over 350 national and international journals.

The library has access to over 3000+ online journals from major publishers such as Elsevier, American Mathematical Society, American Physical Society, Springer Verlag, World Scientific, Institute of Physics, Wiley, etc.

Library has also access to Nature online, Science Online, ACM Digital Library, SIAM Journals Archive, Duke Mathematical Journal, and JSTOR Full digital archive. It has also perpetual online access to backfile collection of journals from Elesevier under DAE consortium, Springer and Annual Reviews Electronic Backvolume collection. The library has added this year the online journal archives from Cambridge University Press, Institute of Physics Publishing, World Scientific, Turpion and deGruyter that provide perpetual access to journals from Volume 1.

Access to online journals is restricted to members of the Institute.

Services

Apart from developing the collection, the library offers reprographic and inter library loan services. Using Libsys software on a linux platform, the library catalogue has been computerized and made available online to the readers both within and outside the Institute Campus. Online request for acquisition of books and status of borrowings have also been enabled using Libsys. Library has implemented RFID based system for self check-in and checkout of library materials. The library also provides effective 24x7 access to its resources with the help of RFID enabled access control system, perhaps the only library of this kind in the country.

Library has a website dedicated to host all the electronic information resources and to provide information about the library and its services.

Library is a member of DAE Libraries Consortium that subscribes to SCIENCE DIRECT SERVICE of Elsevier.

Library is also coordinating the MathSciNet consortium which provides online access to MathSciNet for 8 participating institutions at a deeply discounted rate in the southern region.

Library is an institutional member of AMS, MALIBNET, CURRENT SCIENCE Association, and IAPT.

Acknowledgment

The Library gratefully acknowledges the donation of valuable books journals, and other reading materials received during the current year from the persons and organizations mentioned below:

Akshay Sundararaman, IMSc
Balasubramanian,R, IMSc
Bireswar Das, IMSc
Kamal Lodaya, IMSc
Nutan Limaye, IMSc
P.Sankaran, IMSc
Partha Mukopadhyay, IMSc
Prajakta Nimbhorkar, IMSc
Praveen,M, IMSc
K.N.Raghavan, IMSc
Rajkumar Pan, IMSc
Srikanth Srinivasan, IMSc
Sunil E Simon, IMSc

Adam Naumowicz
Bryan Wells
M.S.Raghunathan

BARC
DOOR Program

HRI
NBHM