

# THE INSTITUTE OF MATHEMATICAL SCIENCES

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## ANNUAL REPORT ( DETAILED )

Apr 2005 - Mar 2006

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# Foreword

I am pleased to present the progress made by the Institute during 2005-2006 in its many sub-disciplines and note the distinctive achievements of its members.

I am very happy to note that three of the Institute members were honoured for their distinctive contributions. Prof. R. Balasubramanian was conferred the ‘Padma Shri’ by the Govt. of India, Prof. Kapil Paranjape received the ‘Shanti Swarup Bhatnagar Award’ for 2005 from the CSIR and Dr. Gautam Menon was awarded the ‘Swarna Jayanti Fellowship’ by the DST.

As usual, 2005-2006 was an academically productive year in terms of scientific publications and scientific meetings.

This year the Institute organized and hosted “the 6<sup>th</sup> National Conference on Commutative Algebra and Algebraic Geometry”, “Perspectives in Mathematics”, the month long “The IMSc Complex Systems School” and the “Indian Neutrino Observatory Interaction Meeting”.

IMSc also co-sponsored “Indo-Israeli workshop on Condensed Matter Physics”, “25th Conference on Foundations of Software Technology and Theoretical Computer Science (FST&TCS)”, “International Workshop on Noncommutative Geometry and Quantum Physics” and “National Conference on Non-linear Systems and Dynamics”.

The Subhashis Nag Memorial Lecture and The Institute Seminar Week are an annual feature of our activities. This year’s Nag Memorial Lecture was delivered by Prof. Bernard De Wit, Institute for Theoretical Physics and Spinoza Institute, Utrecht University, The Netherlands.

The Institute has also participated in several national and international collaborative projects the details of which are given inside the report.

This report has been compiled through the efforts of a committee consisting of Drs. G. Date, Gautam Menon, R. Rajesh, V. S. Sunder, C. R. Subramanian, and Dr. Paul Pandian (Librarian) together with secretarial assistance from Ms. Usha Devi. Mr. Manja (Registrar) assisted with the photographs as well as with the preparation of the summary version of this detailed report. I owe my gratitude to all of them.

I look forward to another year full of distinctive achievements for the Institute.

April, 2006

**R. Balasubramanian**



# Contents

<b>Foreword</b>	<b>iii</b>
<b>1 The Institute</b>	<b>1</b>
1.1 Board . . . . .	1
1.2 Executive Council . . . . .	3
1.3 Faculty . . . . .	4
1.4 Scientific Staff . . . . .	5
1.5 Technical Staff . . . . .	5
1.6 Project Scientists . . . . .	6
1.7 Project Staff . . . . .	6
1.8 Post-Doctoral Fellows . . . . .	7
1.9 Ph.D. Students . . . . .	8
1.10 Administrative Staff . . . . .	10
<b>2 Research and Teaching</b>	<b>11</b>
2.1 Mathematics . . . . .	11
2.1.1 Research Summary . . . . .	11
2.1.2 List of Publications . . . . .	14
2.2 Physics . . . . .	20
2.2.1 Research Summary . . . . .	20
2.2.2 List of Publications . . . . .	27
2.3 Theoretical Computer Science . . . . .	37
2.3.1 Research Summary . . . . .	37
2.3.2 List of Publications . . . . .	39
2.4 Student Programmes . . . . .	43

2.4.1	Degrees Awarded . . . . .	43
2.4.2	Lecture Courses During 2005 – 2006. . . . .	45
2.4.3	Summer Students . . . . .	47
2.4.4	Other Students . . . . .	47
2.4.5	Apalat Fellowship . . . . .	48
2.5	Honours and Awards . . . . .	49
<b>3</b>	<b>Other Professional Activities</b>	<b>51</b>
<b>4</b>	<b>Colloquia</b>	<b>57</b>
4.1	Conferences/Workshops Held at IMSc . . . . .	57
4.1.1	CAAG-VI . . . . .	57
4.1.2	Perspectives in Mathematics . . . . .	58
4.1.3	Subhashis Nag Memorial Endowment Lecture . . . . .	59
4.1.4	The IMSc Complex Systems School . . . . .	59
4.1.5	INO Interaction Meeting . . . . .	61
4.1.6	Institute Seminar Week 2006 . . . . .	61
4.1.7	National Science Day . . . . .	63
4.2	Other Conferences/Workshops Organized by IMSc . . . . .	64
4.2.1	Indo-Israeli Workshop on Condensed Matter Physics . . . . .	64
4.2.2	25 <sup>th</sup> Conference on Foundations of Software Technology and Theoretical Computer Science . . . . .	64
4.2.3	International Workshop on Noncommutative geometry and quantum Physics . . . . .	64
4.2.4	National Conference on Nonlinear Systems and Dynamics . . . . .	65
4.3	Seminars . . . . .	66
<b>5</b>	<b>External Interactions</b>	<b>81</b>
5.1	Collaborative Projects with Other Institutions . . . . .	81
5.1.1	Classical and Quantum Complexity of Graph Isomorphism and Related Problems . . . . .	81
5.1.2	India-based Neutrino Observatory . . . . .	81
5.1.3	JST CREST Project, Japan . . . . .	81

5.1.4	Wave Propagation in disordered excitable media and simulated cardiac tissue . . . . .	82
5.2	Institute Associateships . . . . .	83
5.3	Conference Participation and Visits to Other Institutions . . . . .	84
5.4	Visitors from Other Institutions . . . . .	100
<b>6</b>	<b>Infrastructure</b>	<b>111</b>
6.1	Computer Facilities . . . . .	111
6.2	The Library . . . . .	112





# Chapter 1

## The Institute

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Prasad, Amritanshu	amri	213	2448 3207
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Baskaran, G.	baskaran	233	2451 0504
Basu, Rahul	rahul	284	2245 4794, 2245 3297
Date, G.	shyam	280	2245 0203
Digal, Sanatan	digal	-	-
Govindarajan, Thupil R.	trg	281	2442 2715
Hari Dass, N. D.	dass	275	2442 2767
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Jagannathan, R.	jagan	219	2263 1638
Jayaraman, T.	jayaram	248	2492 9527
Kaul, R.	kaul	279	2445 3508
Menon, Gautam I.	menon	292	2621 3024, 5546 8834
Mishra, Ashok K.	mishra	283	2258 3867
Murthy, M. V. N.	murthy	227	2257 0652, 2257 9342
Parthasarathy, R.	sarathy	214	2223 2021
Rajesh, Ravindran	rrajesh	249	2257 6075
Rama, S. Kalyana	krama	293	2448 2696
Ray, Purusattam	ray	231	5215 8773
Sathiapalan, Balachandran	bala	278	5215 8742
Shankar, R.	shankar	235	2448 1914
Sharatchandra, H. S.	sharat	276	3091 5916
Siddharthan, Rahul	rsidd	215	-
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Vempati, Sudhir Kumar	vempati	-	-

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Subramanian, C.R.	crs	282	2454 3732

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Arangarajan, R.	arajan	297	2440 4795
Mohan, S.	mohan	300	2276 2805
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<b>Eswarakumar, P.</b>	eswar	326	2448 3274
<b>Ghosh, Antina</b>	antina	-	-
<b>Kausalya, Ramaswamy</b>	kausalya	326	-
<b>Nagaprasadu, S.</b>	-	-	-
<b>Pandey, Mangal</b>	mangal	335	-
<b>Raina, P. M.</b>	-	-	-
<b>Ramakrishna, D. V.</b>	dvrkrishna	367	-
<b>Sridhar, M.</b>	-	-	-

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Baoulina, Ioulia	baoulina	324	-
Kennedy Joseph A.	kennedy	246	-
Mukhopadhyaya, Anirban	anirban	296	-
Sridharan, Shrihari	shrihari	258	-
Srinivasan, R.	vasanth	-	-
<b>Physics</b>			
Biswas, Anindya	anindyab	295	-
Das, Chittaranjan	crdas	226	-
Das, Prasanta K.	dasp	258	-
De, Baskar	baskar	207	-
Gupta, Nayantara	nayan	328	-
Joseph, Toby	toby	246	-
Matlock, Peter William	pwm	365	-
Ratabole, Raghunath	raghu	327	-
Saha, Jyoti Prasad	joyti	295	-
Sunil Kumar, V.	sunil	207	-
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Gautam, Sachin	sachin	223	-
George, Scaria	george	287	-
Gupta, Ved Prakash	vpgupta	224	-
Kanhere, Aaloka	aaloka	289	-
Krishna, K.S.	krishna	223	-
Muthukumar, T.	tmk	287	-
Pal, Sarbeswar	spal	209	-
Pandey, Prem Prakash	premsmg	223	-
Patnaik, Sasmita	sasmita	294	-
Samuel, Preena	preena	287	-
Sarkar, Swagata	swagata	363	-
Sen, Debasis	debasis	-	-
Singla, Pooja	pooja	294	-
Sundar, S.	ssundar	382	-
Thakur, Ajay Singh	thakur	382	-
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Basak, Soumen	soumen	344	2254 2050
Bhattacharjee, Amit Kumar	amit	348	-
Bhowmick, Samrat	samr	373	-
Chakravarty, Gaurav	gaurav	373	-
Ezhuthachan, Bobby V. K.	bobby	334	2254 2050
Gopala Krishna, K.	gkrishna	363	-
Goyal, Sandeep K.	goyal	374	-
Hossain, Golam Mortuza	golam	334	2254 2050
Kapoor, Varun	kapoor	334	-
Karthik, G. V. S.	karthik	287	-
Kumar, Alok	alok	272	-
Laddha, Alok	alokl	363	-
Lukose, Vinu	vinu	259	-
Mandal, Saptarshi	saptarshi	344	-
Misra, Basudha	basudha	363	-
Mitra, Mithun Kumar	mithun	211	-

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Saket, Abhinav	abhinav	348	-
Sarkar, Swarnendu	swarnen	209	2254 2050
Sharma, Chandradev	sharma	344	-
Sircar, Nilanjan	nilanjan	289	-
Solomon, Ivan J.	solomon	289	-
Syed Mohammed Kamil	kamil	373	-
Vallan, Bruno Cruz A.	bruno	373	-

### Theoretical Computer Science

Amaldev, Manuel	amal	373	-
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Das, Bireswar	bireswar	211	-
Easaw Simon, Sunil	ssimon	224	-
Joglekar, Shripad Pushkar	pushkar	374	-
Kurur, Piyush P.	ppk	287	-
Limaye, Nutan P.	nutan	334	-
Mukhopadhyay, Partha	partham	374	-
Muthu, Rahul	rahulm	272	2233 5558
Narayanan, N.	narayan	259	-
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Rao, Raghavendra B.	bvrr	347	-
Saurabh, Saket	saket	382	-
Sharma, Jayalal	-	224	-
Sheerazuddin, S.	sheeraz	373	-
Sikdar, Somnath	somnath	272	-
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# Chapter 2

## Research and Teaching

### 2.1 Mathematics

#### 2.1.1 Research Summary

##### Algebraic Geometry

Consider the diagonal action of the special orthogonal group on several copies of a vector space endowed with a non-degenerate symmetric bilinear form (characteristic of the underlying field is assumed to be not 2). An approach via standard monomial theory to the first and second fundamental theorems of invariant theory is worked out. An explicit basis for the ring of polynomial invariants as a vector space over the underlying field is given. The Cohen-Macaulayness of this ring of polynomial invariants is deduced. As a corollary, the Cohen-Macaulayness of the moduli space of semi-stable vector bundles of rank two and degree zero over a smooth projective curve is obtained [R2].

In the flag variety of a general linear group over a finite length local ring, new types of varieties, more general than Schubert varieties, have been discovered. While Schubert varieties are associated to permutation matrices, these varieties can be associated to matrices with non-negative integer entries whose rows and columns add up to the length of the local ring.

##### Analytic Number Theory

Some work has been done to obtain zero-density estimates for a general Dirichlet series. Interestingly, this general result improves the existing results in certain cases, while in some cases it gives the same estimates as known earlier. The role played by *mean-square* estimates in this kind of results have also been highlighted [Sri].

For any finite abelian group, Davenport's constant  $D$  is defined to be the minimum  $s$  such that, given a sequence of  $s$  (not necessarily distinct) elements of  $G$ , there is a sub-sum which adds up to zero. It is conjectured that  $D \leq \frac{|G|}{k} + (k - 1)$  for all  $k$ , with only finitely many exceptional families which can be explicitly written. This is proved for  $k = 5$  [B1].

The results of Bohr are extended to the Dirichlet series setting. In particular, it is proved that if  $\sum_{n=1}^{\alpha} \frac{a_n}{n^s}$  is convergent and bounded by 1 in  $\sigma > 0$ , then  $\sum \frac{|a_n|}{n^2} \leq 1$  and  $\sum \frac{|a_n|}{n^{1/2}}$  is convergent [B2].

The equivalence of the functional equation for Riemann Zeta Function with other functional equations, such as the functional equation for Hurwitz Zeta function, is the central theme in [B3].

Let  $G$  be a finite abelian group.  $A$  is a sum-free set in  $G$  if  $a + b = c$  has no solution in  $a, b, c \in A$ . The problem of improving the known asymptotic formula for the number in sum-free sets is attacked here, particularly for the case when all the prime factors of the order of  $G$  are  $1 \pmod{3}$  [B5].

## Differential Equations

The numerical approximation of the generalized von Kármán equations, which model the buckling of thin elastic plates, was studied and the convergence of a finite element approximation was proved [Ke4].

A complete and satisfactory description of the limit problem in the homogenization of an optimal control problem wherein the control is in the positive cone of  $L^2(\Omega)$  and the cost functional involves the  $L^2$ -norm of the state variable was obtained. It was shown that the limit problem could be posed as an optimal control problem with the control in the positive cone of  $H^{-1}(\Omega)$ .

An optimality system whose right hand side only converges weakly in  $H^{-1}(\Omega)$  was successfully homogenized in certain cases and this leads to some partial results on the homogenization of a low cost optimal control problem with the cost functional involving a Dirichlet type of energy functional.

The study of the nonlinear eigenvalue problem for the  $p$ -Laplacian has been initiated. It has been shown that the first eigenvalue is minimal for the spherical domain, amongst all domains of equal measure and that the minimal configuration is unique.

## Financial Mathematics

Using data from the NSE and the NYSE a relation was obtained between stock price volatility and volumes traded over 15 minute intervals. This relation can be used to modify the standard Black-Scholes formula for pricing options, where the risk neutral volatility is obtained in terms of volumes.

## Harmonic Analysis

Using the atomic decomposition of Hardy spaces, Hardy-type inequalities for Fourier-Hermite coefficients of functions on  $H^p(R)$ ,  $0 < p < 1$  are proved [B5]. In this paper, the problem of finding a solution of a tridiagonal operator equation through its finite dimensional function is discussed [B4].

## Mathematical Physics

A large deviation result for the periodic points of a hyperbolic rational map defined on the Riemann sphere is proved. This extends the well-known equi-distribution result of Lyubich in this setting. Convergence results for more general weighted averages of orbital measures with respect to Hölder continuous functions are also considered [Sr1].

Almost sure invariance principles on the natural extensions of Julia sets for the function  $-\log |T'|$  are established, where  $T$  is a hyperbolic rational map. This implies a number of well-known corollaries including the weak invariance principles and law of iterated logarithms [Sr2].

The family of hyperbolic quadratic polynomials  $P_c(z) = z^2 + c$ ;  $c \in [0, 1/4)$  was considered and its Lyapunov characteristic exponents discussed. The structural stability of this family was used to show that the results of Manning on Lyapunov exponents for Julia sets do not generalise to other Bernoulli measures [Sr3].

## Operator Algebras

Work was completed [Ko3] on the project of obtaining Kuperberg's quantum invariant of 3-manifolds from planar algebraic considerations. This required a re-working of various points of the theory in the context where the ground field was an arbitrary field, and where no \*-structure was demanded of planar algebras. All these details were satisfactorily worked out in [Ko2].

An expository account on *von Neumann algebras* was written up at the request of the editors of a forthcoming encyclopedia on Mathematical Physics [Su].

Work is in progress toward the determination of the planar algebra of the asymptotic inclusion of the sub-factor associated to an outer action of a finite-dimensional Kac algebra on the hyper-finite  $II_1$  factor. We have, for example, found that this is a sub-planar algebra of the planar algebra of the sub-factor associated to an outer action of the opposite Kac algebra on the hyper-finite  $II_1$  factor.

An intriguing connection between Temperley-Lieb algebras and non-crossing partitions has been noticed, whose consequences are currently being investigated.

The notion of minimality for an equivariant spectral triple was explained and the triple for the quantum  $SU(2)$  group constructed earlier was shown to be minimal. A decomposition, in terms of minimal triples, of the spectral triple constructed by Dabrowski et al was also obtained [C].

## Representation Theory

Although the representation theory of general linear groups over finite or local fields is well-understood, the same cannot be said of general linear groups over local rings. For example, the representation theory of  $GL_n(\mathbf{Z}_p)$  is only understood for  $n \leq 2$ , through the work of Alexandre Nobs in the 1970's. Every continuous representation of the compact group  $GL_n(\mathbf{Z}_p)$  can be thought of as a representation of  $GL_n(\mathbf{Z}/p^k\mathbf{Z})$  for sufficiently large  $k$ . Therefore the representation theory of the former can be recovered by coherent analysis

of the representation theory of the latter groups. It is hoped that a Hecke algebra approach, analogous to that over finite or local fields will provide a partial solution to this problem. At the same time, attempts are being made to solve the dual problem of classifying the conjugacy classes in these groups, and more generally the similarity classes of matrices with entries in local rings.

## 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.

[B1]

**R. Balasubramanian and Gautami Bhowmik\***.

Upper bounds for Davenport's constant.

*Integers*, 2006.

(To be published).

[B2]

**R. Balasubramanian, B. Calado\***, and **H. Queffelec\***.

L'inégalité de Bohr pour les series de Dirichlet.

*C.R.Acad .Paris*, **342**, 7, 2006.

[B3]

**R. Balasubramanian, L. Ding\***, **S. Kanemitsu\***, and **Y. Tanigawa\***.

On the partial fraction expansion of the cotangent like function.

2006.

(Preprint).

[B4]

**R. Balasubramanian, S.H Kulkarni\***, and **R. Radha\***.

Solution of a tridiagonal operator equation.

*Linear Algebra and its Applications*, **414**, 389, 2006.

[B5]

**R. Balasubramanian and R. Radha\***.

Hardy type inequalities for Hermite expansion.

*JIPAM*, **6(2005)**, 1, 2005.

[B6]

**R. Balasubramanian and C.R. Subramanian.**

On sampling colorings of bipartite graphs.

*Disc math theor. comp. sci.* **17**, **8(2006)**, 17, 2006.

[Ba1]

**Ioulia Baoulina.**

On some equations over finite fields.

*Journal de Théorie des Nombres de Bordeaux*, **17(1)**, 45, 2005.

[Ba2]

**Ioulia Baoulina.**

Generalizations of the Markoff-Hurwitz equations over finite fields.

*Journal of Number Theory*, 2005.

(To be published).

[Ba3]

**Ioulia Baoulina.**

On a problem of Carlitz.

*International Journal of Number Theory*, **1(2)**, 293, 2005.

[Ba4]

**Ioulia Baoulina.**

On the equation  $x_1^{m_1} + \dots + x_n^{m_n} = ax_1 \cdots x_n$  over a finite field.

*Finite Fields and Their Applications*, 2005.

(Submitted).

[Ba5]

**Ioulia Baoulina.**

On the number of solutions of the equation  $(x_1 + \dots + x_n)^m = ax_1 \cdots x_n$  over the finite field  $F_q$  for  $\gcd(m - n, q - 1) = 7$  and  $\gcd(m - n, q - 1) = 14$ .

*The Ramanujan Journal*, 2005.

(Submitted).

[Ba6]

**Ioulia Baoulina.**

On the equation  $(x_1^{m_1} + \dots + x_n^{m_n})^k = ax_1 \cdots x_n$  over a finite field.

*International Journal of Number Theory*, 2006.

(To be published).

[C]

**P. S. Chakraborty and A. Pal\***

On equivariant Dirac operators for  $su_q(2)$ .

*Proc. of I.A.Sc.*, 2006.

(To be published).

[D]

**Paramita Das and Vijay Kodiyalam.**

Planar algebras and the Ocneanu-Szymanski theorem.

*Proceedings of the American Mathematical Society*, **133(9)**, 2751, 2005.

[I1]

**Jaya N. Iyer.**

Chern invariants of some flat bundles in the arithmetic Deligne cohomology.  
2005.  
(Submitted).

[I2]

**Jaya N. Iyer and Indranil Biswas\***.

Holomorphic connections on some complex manifolds.  
2006.  
(Submitted).

[I3]

**Jaya N. Iyer and Carlos T. Simpson\***.

A relation between the parabolic Chern characters of the de Rham bundles.  
2006.  
(Preprint).

[K]

**Joseph A. Kennedy.**

Class partition algebras as centralizer algebras of wreath products.  
*Communications in Algebra*, 2006.  
(To be published).

[Ke1]

**Cherif Amrouche\*, Philippe G. Ciarlet\*, L. Gratie\*, and S. Kesavan.**

On Saint Venant's compatibility conditions and Poincaré's lemma.  
*C. R. Acad. Sc., Paris*, 2006.  
(To be published).

[Ke2]

**Cherif Amrouche\*, Philippe G. Ciarlet\*, L. Gratie\*, and S. Kesavan.**

New formulations of linearized elasticity problems, based on extensions of Donati's theorem.  
*C. R. Acad. Sc., Paris*, 2006.  
(To be published).

[Ke3]

**Cherif Amrouche\*, Philippe G. Ciarlet\*, Liliana Gratie\*, and S. Kesavan.**

On the characterizations of matrix fields as linearized strain tensor fields.  
*Journal de Mathématiques Pures et Appliquées*, 2006.  
(To be published).

[Ke4]

**Philippe G. Ciarlet\*, Liliana Gratie\*, and S. Kesavan.**

Numerical analysis of the generalized von Kármán equations.  
*C. R. Acad. Sci., Paris, Ser. I*, **341**, 695, 2005.



[Ke5]

**Philippe G. Ciarlet\***, **Liliana Gratie\***, and **S. Kesavan**.

On the generalized von Kármán equations and their approximation.

*Math. Models and Meth. in App. Sciences*, 2005.

(Submitted).

[Ko1]

**Vijay Kodiyalam**, **Vishwambhar Pati\***, and **V.S. Sunder**.

Subfactors and 1+1-dimensional TQFTs.

*Internat. J. of Math.*, 2006.

(To be published).

[Ko2]

**Vijay Kodiyalam** and **V. S. Sunder**.

The planar algebra of a semisimple and cosemisimple Hopf algebra.

*Proc. (Math. Sci.) of the Indian Academy of Sciences*, 2005.

e-print arXiv math.QA/0506153

(To be published).

[Ko3]

**Vijay Kodiyalam** and **V. S. Sunder**.

Graphs, planar algebras and Kuperberg's invariant.

2005.

(Submitted).

[Kr]

**P D Hislop\***, **W. Kirsch\***, and **M. Krishna**.

Spectral and dynamical properties of random models with nonlocal singular interaction.

*Mathematische Nachrichten*, **278(6)**, 627, 2005.

[N1]

**V. Balaji\***, **I. Biswas\***, **D. S. Nagaraj**, and **P. Newstead\***.

Universal families on moduli space of bundles on curves.

*International Mathematics Research Notices*, 2006.

(To be published).

[N2]

**V. Balaji\***, **I. Biswas\***, **D. S. Nagaraj**, and **A. J. Parameswaran\***.

Krull-Schmidt reduction of principal bundles in positive characteristic.

*Expos. Math.*, 2005.

(To be published).

[N3]

**I. Biswas\*** and **D. S. Nagaraj**.

Classification of real algebraic vector bundles over the real anisotropic conic.

*International Journal of Mathematics*, **16(10)**, 1, 2005.

[N4]

**L. Gruson\***, **F. Laytimi\***, and **D. S. Nagaraj**.

On prime Fano threefolds of genus 9.

*International Journal of Mathematics*, 2006.

(To be published).

[P1]

**Uri Onn\***, **Amritanshu Prasad**, and **Leonid Vaserstein\***.

A note on Bruhat decomposition of  $GL(n)$  over local principal ideal rings.

*Communications in Algebra*, 2005.

(To be published).

[P2]

**Amritanshu Prasad**.

On Bernstein's presentation of Iwahori-Hecke algebras and representations of split reductive groups over non-Archimedean local fields.

*Bulletin of Kerala Mathematics Association (a special issue on harmonic analysis and quantum groups)*, , 31, 2005.

[R1]

**V. Lakshmibai\***, **K. N. Raghavan**, and **Parameswaran Sankaran**.

Equivariant Giambelli and determinantal restriction formulas for the Grassmannian.

*Pure and Applied Mathematics Quarterly Journal (special volume in honor of Macpherson)*, 2005.

math/0506015

(To be published).

[R2]

**V. Lakshmibai\***, **K. N. Raghavan**, **Parameswaran Sankaran**, and **Pradeep Shukla\***.

Standard monomial bases, moduli spaces of vector bundles & invariant theory.

*Transformation Groups*, 2005.

(Submitted).

[S]

**P. Sankaran**.

Notes on toric varieties (chapter 2).

In Goutam Mukherjee, editor, *Transformation groups*. Hindustan Book Agency, New Delhi,, 2005.

[Sr1]

**Mark Pollicott\*** and **Shrihari Sridharan**.

Large deviations of periodic points of a rational map.

2006.

(Submitted).

[Sr2]

**Shrihari Sridharan.**

Statistical properties for hyperbolic Julia sets.

2005.

(Submitted).

[Sr3]

**Shrihari Sridharan.**

Non-vanishing derivatives of Lyapunov exponents and the pressure function.

2005.

(Submitted).

[Sri]

**Srinivas Kotyada and Anirban Mukhopadhyay\***

A zero-density estimate for the Selberg class.

*International Journal of Number Theory*, 843313, 2005.

(Submitted).

[Su]

**V.S. Sunder.**

von Neumann algebras: Introduction, modular theory and classification theory.

In G.L. Naber, J.-P. Francoise and Tsou S.T., editors, *Encyclopedia of Math. Physics*, vol. 5, page 379. Oxford: Elsevier, 2006.

(To be published).

## Books/Monographs Authored/Edited

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

[K]

**S. Kesavan.**

*Symmetrization and Applications*, volume 3 of *Series in Analysis*.

World Scientific, Singapore, 2006.

(To be published).

## 2.2 Physics

### 2.2.1 Research Summary

#### Biological Physics

A model proposed by P. Ranjith et al. (PRL, 2005) for the loop formation probability in models for short double-stranded DNA molecules was studied further, with a view to understanding whether the sequence dependence of this quantity could be determined theoretically. A model for pattern formation in motor-micro-tubule mixtures, proposed initially to understand some features of in-vitro experiments in a quasi-two-dimensional geometry, is currently being generalized to three dimensions, as well as to understanding pattern formation in a periodic array of seeds [Me2].

In certain situations – for example, in people suffering from an ischemic heart – the normal periodic activity of the heart can be hampered by arrhythmias, i.e., disturbances in the heart’s natural rhythmic activity. A potentially fatal arrhythmia occurring in the ventricles is Ventricular Tachycardia (VT), an abnormally fast excitation during which the heart can be activated as rapidly as 300 times per minute. For people in chronic risk of VT, the most common treatment is implanting an ICD, a device capable of detecting the onset of VT and giving a periodic sequence of low-amplitude electrical stimuli (pacing). However, the underlying mechanisms of the success and failure of pacing termination are poorly understood and the algorithms currently used in such devices are often based on purely heuristic principles. To address this problem, a model of VT in a quasi-1D geometry that reproduces all the relevant features of clinical VT and is convenient to study computationally has been investigated. The results show that conduction inhomogeneities can be generated through the nonlinear dynamics of excitation wave propagation in otherwise homogeneous cardiac tissue, and that these inhomogeneities play a crucial role in the successful termination of VT by pacing. The results further imply that the dynamical generation of transient heterogeneity could be a principal mechanism by which ICDs terminate VT [Sinh1].

Problems in regulatory genomics, phylogeny, algorithms in motif detection and multiple sequence alignment have been studied. The study of various cellular phenomena at the molecular and membrane levels has been initiated, together with a collaborative study of the immune-response network.

#### Classical and Quantum Gravity, Black Holes, Cosmology

Cosmological models, quantized using loop quantization methods, have uncovered interesting features of loop quantization such as singularity resolution and phenomenological implications such as inflation. These have been analyzed: (a) at the fundamental quantum level and (b) at the classical level with dominant quantum corrections incorporated. The work [Ba] elaborates the method of effective Hamiltonians in the context of isotropic models and explicitly identifies the modifications due to the underlying discreteness of the quantum theory. These features are also shown to arise in the more general anisotropic models, notably the vacuum Bianchi I model. Here the discreteness corrections replace the exact, singular Kasner solution by an exact *non-singular* one [Da1]. The vacuum Bianchi I model is also

analyzed at the quantum level and shown to admit separable solutions among which are the so called *pre-classical* solutions relevant for a semi-classical behaviour [Da2].

A model of a dynamical two-brane in a four-dimensional black hole background with scalar hair was studied. At high temperatures, this black hole goes through a phase transition by radiating away the scalar. The end phase is a topological AdS-Schwarzschild black hole. It is argued that for a sufficiently low temperature, the brane motion in this geometry is non-singular. This results in a universe which passes over from a contracting phase to an expanding one without reaching a singularity [Bi].

## Condensed Matter Physics

A detailed theory of surface melting in the mixed phase of type-II superconductors has been developed. The main features of the results are as follows: the surface transition typically occurs via the formation of a melted layer at the sample surface. The density profile of this melted layer and its depinning transition have been characterized fully. The results here account for the observation of asymmetric hysteresis loops across the melting transition in the high- $T_c$  superconductor BSCCO. The techniques used to study surface melting are generalizations of a technique termed as the “DFT + substrate” model. This approach provides very accurate fits to the simulation data [Me4].

Despite the importance of elasticity theory and hydrodynamics to frontier areas of basic and applied science, these fields are rarely taught as part of the physics curriculum at the undergraduate or post-graduate level in most universities in India. The general pedagogic value of the concepts introduced in these fields is stressed: The nature of the subject lends itself easily to classroom demonstrations and everyday experience and such exposure is key to attracting and retaining young minds to science. Based on experience with a similar course, a curriculum for a one-semester course in this area at the undergraduate level is suggested. The exclusion of these fields from the syllabus in the past creates a catch-22 situation because few teachers would consider themselves qualified or able to teach them. Ways in which this problem can be addressed are discussed [Me1].

In collaboration with the groups of S.L. Lee (Edinburgh), E.M. Forgan (Birmingham) and J. Mesot (Villigen), flux-line structure was studied through the tools of neutron scattering and muon-spin rotation, coupled with analytic calculations and numerical simulations. Highlights of this work include the observation of a square-triangular transition in the flux-line lattice, the first observation of the vortex line glass phase and the first theoretical understanding of the change in sign of the third moment of the field distribution function in the vortex glass state [M, Me5].

The equivalence of thermodynamics of independent orthofermions to the infinite U Hubbard model has been shown for the finite system of two lattice sites and for one-dimensional infinite lattice. Regarding the algebra of orthofermions, the algebraic expressions for the number operator for a given spin as well as the spin raising (lowering) operators at any lattice site  $i$  have been obtained as a function of orthofermi creation and annihilation operators [Mi2].

A detailed analysis of the electron transfer kinetics has been carried out in the solution phase using standard redox species, and as bridge mediated systems with the redox species tethered to the carboxylate functional groups of thiols acting as anchors. The difference in electron transfer kinetics observed in the case of solution phase electron transfer and bridge mediated electron transfer is clearly demonstrated in the case of Au—MUA electrode. The results present the scope of using the carboxylic terminated thiols for further functionalisation leading to different applications like molecular rectifiers and sensors [Mi1].

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

The sensitivity of neutrino oscillation probabilities to the fundamental neutrino parameters and their possible determination through experiments was studied. The first part of the paper was devoted to the broad theme of isolating regions in the neutrino (and anti-neutrino) energy and propagation length that are sensitive to the oscillation parameters. Such a study is relevant to neutrinos both from the Earth's atmosphere or from a neutrino factory. For completeness the sensitivity, however small, to the parameters involved in a three-generation framework, and to the Earth matter density profile were discussed. Processes relevant to atmospheric neutrinos which are sensitive to and allow precision measurements of the mixing angle  $\theta_{23}$  and mass-squared difference  $\delta_{32}$  apart from the mixing angle  $\theta_{13}$  were then studied. Crucial to this analysis is charge identification; detectors having this capability can isolate these matter effects. In particular, the issue of using matter effects to determine whether the mixing angle  $\theta_{23}$  is maximal, and, if not, to explore how well its octant can be determined, was studied for a magnetized iron calorimeter. When realistic detector resolutions are included, deviations of about 15% (20%) from a maximal value of  $\sin^2 \theta_{23} = 1/2$  can be measured at 95% (99%) confidence level provided  $\theta_{13}$  is non-zero,  $\sin^2 \theta_{13} \geq 0.015$ , and the neutrino mass ordering is normal, with fairly large exposures of 1000 kton-years [I2].

Motivated by a hexagonal unification  $SU(3)^6$  an additional  $SU(2)$  is envisaged in the Standard Model, to distinguish the quarks and leptons. This implies small deviations from quark-lepton universality at the TeV scale, as allowed by neutron-decay data. The discovery potential for the new W boson of such a theory at the Tevatron and the LHC is analysed [R1].

An  $SO(10)$  grand unified theory proposed earlier, with minimum Higgs (210 and 16 only) is analysed further. All the fermion masses arise from one-loop corrections and are of the see-saw type. The RG evolution is studied in detail and the unification scale as well as the left-right symmetry scale are determined. The Yukawa sector in this model is completely different from most of the standard grand unified models and its structure in different phases is explicitly shown. Baryon number asymmetry arising through leptogenesis in the model is calculated [D].

A technique is proposed to measure the Cabibbo-Kobayashi-Maskawa parameter  $2\beta + \gamma$  using  $B^0$  decays involving several intermediate states, and a general formalism that applies to a broad class of decays described. The main advantage of this method is that the ratios between the interfering amplitudes can be measured without requiring external input. In addition, discrete ambiguities are resolved. The method is sensitive to  $2\beta + \gamma$  using only first order terms in the ratios  $a_m/A_n$  between the  $b \rightarrow u$  and  $b \rightarrow c$  amplitudes. By contrast, in  $B \rightarrow D^{(*)-}\pi^+$ , or in the analysis of other decay modes that ignores the contribution of

multiple intermediate states, one needs to extract  $r = a_1/A_1$  from  $\mathcal{O}(1 - r^2)$  terms, or rely on external measurements and incur a large theoretical uncertainty [Sin2].

## Mathematical Physics

Some asymptotic number theoretical results on the partitioning of an integer were derived earlier by exploiting its connection to the quantum density of states of a many-particle system. These results have now been generalised to obtain an asymptotic formula for the restricted or coloured partitions  $p_k^s(n)$ , which are the number of partitions of an integer  $n$  into the summand of  $s^{\text{th}}$  powers of integers such that each power of a given integer may occur at most  $k$  times. The generating function for these restricted partitions is precisely the partition function of the Gentile statistics. The method reproduces the well known asymptotic results for  $s = 1$  apart from yielding more general results for arbitrary values of  $s$  [Mu].

A method is provided to embed a  $q$ -series in a  $(p, q)$ -series and derive the corresponding  $(p, q)$ -extensions of the known  $q$ -identities. The  $(p, q)$ -hyper-geometric series, or twin-basic hyper-geometric series (different from the usual Bi-basic hyper-geometric series) is based on the concept of a twin-basic number  $[n]_{p,q} = (p^n - q^n)/(p - q)$ . The twin-basic number occurs in the theory of two-parameter quantum algebras and has been introduced independently in combinatorics. The  $(p, q)$ -identities thus derived, with doubling of the number of parameters, offer more choices for manipulations; for example, results that can be obtained via the limiting process of confluence in the usual  $q$ -series framework can be obtained by simpler substitutions. The  $q$ -results are of course special cases of the  $(p, q)$ -results corresponding to choosing  $p = 1$ . This also provides new insights into the  $q$ -identities [Ja].

## Nonlinear Dynamics, Solitons and Chaos

The geometric phase associated with the time evolution of the wave function of a Bose-Einstein condensate in a double well trap is calculated using a tunnelling model and expressed in terms of the population difference and phase difference between the condensates in the two wells. Both cyclic and noncyclic evolutions are considered [B2].

The phenomenon of anholonomy that gets associated with a static and a moving curve is reviewed. The expressions for the geometric phases in these two cases are derived and interpreted. Two examples in physics are presented to show the close connection between anholonomy and nonlinearity [B1].

In the Kirchhoff model of a bio-polymer, conformation dynamics can be described in terms of solitary (nonlinear) waves. An electron on the polymer would experience a quantum effective potential induced by the spatially localized bends and twists of the polymer. It is shown that this enables the formalization and quantification of the concept of a *conformon* hypothesized in biology. (This paper is in the ‘‘IOP select’’ list of papers published in various journals, due to its ‘‘novelty, significant breakthrough and potential impact on future research’’) [B3].

A class of very simple systems yielding multi-scroll chaotic attractors was proposed. These were given by a single autonomous third order ordinary differential equation of the form:  $x''' = ax'' + bx' + cx + G(x)$ , where the *only* nonlinearity  $G(x)$  was simply the variable  $x$ , thresholded by an upper cut-off and lower cut-off. Such systems permit easy electronic im-

plementation and exhibit a wide variety of dynamical behaviour and attractor sizes. Further one can increase the number of scrolls in the attractor by a simple manipulation of thresholds. So here, increasing the number of scrolls does not entail increasing the dimensionality of the system [Sinha2].

A class of models incorporating threshold-activated coupling on a lattice of chaotic elements was studied. In such systems, the relaxation time allowed between chaotic updates determines the intrinsic driving rate due to the local chaos, and it was shown that an inverse cascade from fixed spatial profiles to spatio-temporal chaos exists as the relaxation time grows shorter. This spectrum of spatio-temporal transitions is shown to arise from the competing timescales of the local chaos and the propagation of coupling [Sinha3].

The transition to phase synchronization in a model for the spread of infection defined on a small world network was studied. It had been shown previously that the synchronization transition occurred at a finite degree of disorder  $p$ , unlike equilibrium models where systems behave as random networks even at infinitesimal  $p$  in the infinite size limit. Under variation of a parameter determining the driving rate it was shown that the transition point decreased as the system was driven more slowly. Thus it appears that the transition moves to  $p=0$  in the very slow driving limit, just as in the equilibrium case [Sinha1].

A long-standing controversy in the study of complex systems is whether increasing the diversity of a network (in terms of its size, connectivity and strength of connections) alters its robustness against perturbations. Linear stability analysis seems to suggest that increasing complexity decreases stability, while empirical results in many fields seem to indicate the opposite. To answer many critics of the existing theoretical argument, a random network of nonlinear maps exhibiting a wide range of local dynamics was studied, in which the links had a normally distributed interaction strengths [Sinh6]. Starting from a knowledge of the micro-level behaviour at each node, a macroscopic description of the system was developed in terms of the statistical features of the subnetwork of active nodes. The asymptotic characteristics of this subnetwork was found to be remarkably robust: the size of the active set is independent of the total number of nodes in the network, and the average degree of the active nodes is independent of both the network size and its connectivity. These results suggest that very different networks evolve to active subnetworks with the same characteristic features. This has strong implications for dynamical networks observed in the natural world, notably for the existence of a characteristic range of links per species across ecological systems.

## **QFT, Topological QFT, Conformal Field Theory**

Using the Zumino identities it is shown that in a class of non-local gauges, massless  $QED_3$  has an infrared behaviour of a conformal field theory with a continuously varying anomalous dimension of the fermion. In the usual Lorentz gauge, the fermion propagator falls off exponentially for a large separation, but this apparent fermion mass is a gauge artifact. The infrared behaviour of the gauge-invariant dressed fermion propagator in massless  $QED_3$  is discussed for three choices of dressing. It is found that only the propagator with the isotropic (in three Euclidean dimensions) choice of dressing is acceptable as the physical fermion propagator. The negative anomalous dimension of this physical fermion does not contradict any field-theoretical requirement. Instability in the scalar channel of the fermion-antifermion scattering amplitude in massless  $QED_3$  for number of flavours less than the critical value



$128/3\pi^2$  is demonstrated. The anomalous dimensions of gauge-invariant composite operators are determined to  $O(1/N)$ . The exponentiation of the  $O(1/N)$  infrared logarithm is explicitly demonstrated by evaluating the contribution of the ladder diagrams [**Mit1**, **Mit2**, **Mit3**].

Studies in non-commutative geometry and quantum physics were performed. The unitarity of theories with space-time non-commutativity [**G2**] was proved. Interesting new developments like twisted symmetries being realised in such space-times were considered. 2D gravity in NC space was studied and realizations of diffeomorphisms through twisting were described [**G1**]. The issue of regularising quantum field theories in a novel scheme known as nonlocal regularization was studied. It was shown that IR/UV mixing could be avoided in an interesting way [**G3**].

## Statistical Mechanics

When a substance is brought below its equilibrium freezing temperature and yet maintained in the liquid state, it is referred to as a super-cooled liquid. The understanding of the role of the unstable region in the phase diagram demarcated by the liquid-gas and gas-liquid spinodals is a necessary component of a comprehensive picture of the glassy state. In previous work which used computer simulations and the energy landscape approach, it was found that the glass transition line and the liquid-gas spinodal intersect at a finite temperature, thus predicting a glass-gas limit of mechanical stability at lower temperatures. An analysis of these limiting lines has been performed for a realistic glass former which uses (i) accurate liquid state theoretical methods to calculate the equation of state of the system, and thus the liquid-gas spinodal, coupled with, (ii) a first-principles approach to the glass transition proposed by Mezard and Parisi to evaluate the glass transition line. The calculations, which are quantitatively in reasonable agreement with the previous study, also obtain an intersection of the glass transition line and the liquid-gas spinodal at a finite temperature, thus providing strong support for the proposal that such an intersection of these limiting lines is generic to the liquid state [**Me3**].

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, groups, companies or nations. A fruitful area for seeking such patterns is the evolution of collective choice from individual behavior, e.g., the sudden popularity or “success” of certain ideas or products, compared to their numerous (often very similar) competitors. Empirical investigation of such popularity distributions may shed light on this issue. To this end, the popularity of movies has been examined by estimating the distributions of their gross earnings (opening and total) and the time-evolution of the income over the time that a movie is being shown at theaters [**Sinh4**]. The results show that the income distribution fits a log-normal distribution, suggesting that a multiplicative stochastic process is the basis for emergence of popular products. An inverse power-law decay over time of the income per theater for movies is observed. It is interesting that both these features of movie popularity are quantitatively identical to those reported for the popularity of scientific papers, as measured by the number of citations to them. This suggests the existence of universalities hitherto unsuspected in social phenomena.

The analysis of movie income can also be seen as part of a broad investigation into the general features of income and wealth distributions in society. A well-known scaling relation in economics known as the Pareto Law asserts that the distribution of income (as well as wealth) across different societies has a power-law tail with a characteristic exponent  $\alpha$  and 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  $\alpha$  for different national economies. An analysis of publicly available data on income and wealth distribution in India has been performed [**Sinh3**]. The result shows a power-law tail for both distributions, with the exponent for the income distribution being very close to 1.5, as is true for advanced industrial economies such as USA or Japan. A very simple model to explain the observed universal features of income and wealth distributions, using the framework of kinetic theory of colliding particles has been proposed [**Sinh2**]. Assuming that many agents (each starting with some fixed amount of assets) are interacting among each other, such that two randomly chosen agents perform a trade at every time instant where a certain fraction of their combined assets are exchanged from one to the other, and also assuming that the total amount of assets is conserved, two classes of models can be studied: the random exchange class and the minimum exchange class. The former shows an exponential distribution, while the latter exhibits condensation in the asymptotic limit. By assuming that a fraction of agents perform random exchange, while the remaining do minimum exchange, it is shown that the resulting asset distribution shows all the general features observed in empirical wealth or income distribution, in particular, a power-law tail with characteristic exponent  $\alpha$ . A quantitatively accurate  $\alpha = 1.5$  for a special case of the model has been obtained.

Another observed feature of many socio-economic distributions that deviates significantly from a Gaussian nature is their bimodal character, whereby most of the instances occur at extreme ends of the distribution while its centre is remarkably under-represented. Most notably, such a feature has been observed in stock markets, movie income and vote fraction received by a particular political party. An agent-interaction model has been formulated that shows how the distribution of collective choice can show a transition from unimodal to bimodal for a broad range of parameters [**Sinh5**]. The model is based on nearest neighbour interactions among binary spin variables, with a random local field at each site. The local field is also evolving with time as a function of the spin orientation at that site and the overall magnetization (which is analogous to the collective choice). This has a natural interpretation as the agent learning from its knowledge about how its previous actions accorded with those of the majority. The model also exhibits spontaneous pattern formation.

The Kolmogorov laws for fully developed turbulence have been studied in the context of models of aggregation. Using renormalization group techniques, the breakdown of Kolmogorov self similar scaling is explicitly demonstrated for a simple model of diffusing aggregating particles with input [**Ra1**, **Ra2**].

Interacting particle systems in low dimensions exhibit nontrivial non mean field behaviour. Multi point correlation functions for annihilating or coagulating particles are calculated using the renormalization group technique. Rigorous results are obtained when the dimension is one [**Ra4**, **Ra3**].

## String Theory

The gauge invariant loop variable formalism and old covariant formalism for bosonic open string theory were compared. It is expected that for the free theory, after gauge fixing, the loop variable fields can be mapped to those of the old covariant formalism in bosonic string theory, level by level. This was verified explicitly for the first two massive levels. It was shown that (in the critical dimension) the fields, constraints and gauge transformations can all be mapped from one to the other. Assuming this continues at all levels one can give general arguments that the tree S-matrix (integrated correlation functions for on-shell physical fields) is the same in both formalisms and therefore they describe the same physical theory (at tree level) [Sa].

It was shown in an earlier work, in the context of bosonic theory, that the infra-red singular terms that arise as a result of integrating out high momentum modes in non-planar diagrams of non-commutative gauge theory can be recovered from low lying tree-level closed string exchanges. This follows as a natural consequence of world-sheet open-closed string duality. Here using the same setup we study the phenomenon for non-commutative  $\mathcal{N} = 2$  gauge theory realised on a  $D_3$  fractional brane localised at the fixed point of  $C^2/Z_2$ . The infra-red singularities from the massless closed string exchanges are exactly equal to those coming from one-loop gauge theory. This is as a result of cancellation of all contributions from the massive modes[S].

### 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.**

Space curves, anholonomy and nonlinearity.

*Pramana*, **64**, 607, 2005.

[B2]

**Radha Balakrishnan and Mitaxi Mehta\***.

Geometric phase in a Bose-Einstein Josephson junction.

*Euro. Phys. Jour. D*, **33**, 437, 2005.

[B3]

**Rossen Dandoloff\* and Radha Balakrishnan.**

Quantum effective potential, electron transport and comformons in biopolymers.

*J. Phys. A: Math. Gen.*, **38**, 6121, 2005.

[Ba]

**Kinjal Banerjee and Ghanashyam Date.**

Discreteness corrections to the effective Hamiltonian of isotropic loop quantum cosmology.  
*Class. Quantum Grav.*, **22**, 2017, 2005.

[Bi]

**Anindya Biswas and Sudipta Mukherji\*.**

Bouncing cosmology in three dimensions.

*J. Cosmol. Astropart. Phys.*, **JCAP02(2006)**, 002, 2006.

[D]

**Kaushik Bhattacharya\*, C. R. Das, Bipin R. Desai\*, G. Rajasekaran, and Utpal Sarkar\*.**

Sea-saw fermion masses in an SO(10) GUT.

*Physical Review*, 2006.

hep-ph/0601170

(Submitted).

[Da1]

**Ghanashyam Date.**

Absence of the Kasner singularity in the effective dynamics from loop quantum cosmology.

*Phys. Rev. D*, **71**, 127502, 2005.

[Da2]

**Ghanashyam Date.**

Pre-classical solutions of the vacuum Bianchi I loop quantum cosmology.

*Phys. Rev. D*, **72**, 067301, 2005.

[G1]

**A. P. Balachandran\*, T. R. Govindarajan, K. S. Gupta\*, and S. Kurcuoglu\*.**

Noncommutative two dimensional gravities.

2006.

(Preprint: hep-th/0602265).

[G2]

**A. P. Balachandran\*, T. R. Govindarajan, A. G. Martins\*, C. Molina\*, and P. Teotonio Sobrinho\*.**

Unitary quantum physics with time-space non-commutativity.

*J.Phys.Conf.Ser.*, **24**, 179, 2005.

[G3]

**T. R. Govindarajan, S. Kurcuoglu\*, and M. Panero\*.**

Nonlocal regularisation of noncommutative field theories.

2006.

(Preprint: hep-th/0604061).

[H1]

**Golam Mortuza Hossain.**

Primordial density perturbation in effective loop quantum cosmology.

*Class. Quant. Grav.*, **22**, 2511, 2005.

[H2]

**Golam Mortuza Hossain.**

On energy conditions and stability in effective loop quantum cosmology.

*Class. Quant. Grav.*, **22(13)**, 2653, 2005.

[H3]

**Golam Mortuza Hossain.**

Large volume quantum correction in loop quantum cosmology: Graviton illusion?  
2005.

IMSc/2005/04/10

(Submitted).

[I1]

**D. Indumathi.**

India-based neutrino observatory (INO).

In *Proceedings of the 29th International Cosmic Ray Conference*, pages 10–199, Aug 2005.

[I2]

**D. Indumathi, M.V.N. Murthy, G. Rajasekaran, and Nita Sinha.**

Neutrino oscillation probabilities: Sensitivity to parameters.

2006.

hep-ph/0603264, IMSc/2006/03/09

(Submitted).

[Iv]

**J. S. Ivan, N. Mukunda\*, and R. Simon.**

Generation of NPT entanglement from nonclassical photon statistics.

2006.

(Preprint: quant-ph/0603255).

[J]

**Ramaswamy Jaganathan and Sudeshna Sinha.**

A  $q$ -deformed nonlinear map.

*Phys. Lett. A*, **338(3-5)**, 277, 2005.

[Ja]

**R. Jagannathan and K. Srinivasa Rao\*.**

Two-parameter quantum algebras, twin-basic numbers, and associated generalized hypergeometric series.

In *Proceedings of the International Conference on Number Theory and Mathematical Physics*,  
Dec 2005.  
math.NT/0602613  
(To be published).

[K]

**R. K. Kaul, T. R. Govindarajan, and P. Ramadevi\***.

Schwarz type topological quantum field theories.

In *Encyclopedia of Mathematical Physics*. Elsevier, 2005.

(Preprint: hep-th/0504100).

[M]

**Joel Mesot\*, J. Chang\*, J. Kohlbrecher\*, R. Gilardi\*, A. J. Drew\*, U. Divakar\*,  
D. O. Heron\*, S. J. Lister\*, S. L. Lee\*, S. P. Brown\*, D. Charalambous\*, E. M.  
Forgan\*, F. Y. Ogrin\*, G. I. Menon, C. D. Dewhurst\*, R. Cubbit\*, R. Baines\*,  
N. Momono\*, M. Oda\*, T. Uefuji\*, and K. Yamada\***.

Combined neutron scattering and muon-spin rotation investigations of the Abrikosov state  
of high-temperature superconductors.

In Ivan Bozovic and Davor Pavuna, editors, *Strongly Correlated Electron Materials: Physics  
and Nanoengineering*, page 350. SPIE, Aug 2005.

[Me1]

**Gautam I. Menon and R. Shankar.**

Introducing hydrodynamics and elasticity theory into the undergraduate curriculum.

In P. Jolly, editor, *Proceedings of the International Conference on Physics Education (ICPE  
2005)*. World Scientific, Oct 2005.

(Submitted).

[Me2]

**Gautam I. Menon.**

Collective effects in models for interacting molecular motors and motor-microtubule mix-  
tures.

In *Proceedings of "Common Trends in Traffic Systems: Physical and Computational Mod-  
els in Transportation Engineering and Biological Sciences"*, IITK, Kanpur, India (2006).

Physica A, Mar 2006.

cond-mat/0604013

(Submitted).

[Me3]

**S. S. Ashwin\*, Gautam I. Menon, and Srikanth Sastry\***.

The glass transition and liquid-gas spinodal boundaries of metastable liquids.  
2005.

cond-mat/0512728

(Submitted).

[Me4]

**Alvise de Col\***, **Gautam I. Menon**, **V. Geshkenbein\***, and **G. Blatter**.

Surface melting of the vortex lattice.

*Physical Review Letters*, 2005.

cond-mat/0511046

(Submitted).

[Me5]

**Gautam I. Menon**, **Alan Drew\***, **U. K. Divakar\***, **S. L. Lee\***, **R. Gilardi\***, **J. Mesot\***,  
**F. Y. Ogrin\***, **D. Charalambous\***, **E. M. Forgan\***, **N. Momono\***, **M. Oda\***,  
**C. Dewhurst\***, and **C. Baines\***.

Muons as local probes of many particle correlations.

2005.

(Submitted).

[Me6]

**Ankush Sengupta\***, **Surajit Sengupta\***, and **Gautam I. Menon**.

Probing disordered substrates by imaging the adsorbate in its fluid phase.

*Europhysics Letters*, **70(5)**, 635, 2005.

[Mi1]

**Sheela Berchman\***, **R. G. Nirmal\***, **G. Prabakaran\***, **Ashok K. Mishra**, and  
**V. Yegnaraman\***.

Solution phase electron transfer versus bridge mediated electron transfer across carboxylic acid terminated thiols.

*J Solid State Electrochemistry*.

(To be published).

[Mi2]

**Ram Kishore\*** and **Ashok K. Mishra**.

Algebra of orthofermions and equivalence of their thermodynamics to the infinite U Hubbard model.

*Physica B*.

(To be published).

[Mi3]

**Ram Kishore\*** and **Ashok K. Mishra**.

On the solution of infinite U Hubbard model through orthofermions.

2006.

(Preprint: IMSc/2006/3/5).

[Mi4]

**Ram Kishore\*** and **Ashok K. Mishra**.

Theory of second quantization of orthofermions.

2006.

(Preprint: IMSc/2006/3/6).

[Mit1]

**Indrajit Mitra, Raghunath Ratabole, and H.S. Sharatchandra.**

Gauge dependence of the infrared behaviour of massless  $QED_3$ .

*Phys.Lett. B*, **634**, 557, 2006.

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**Indrajit Mitra, Raghunath Ratabole, and H.S. Sharatchandra.**

Gauge-invariant dressed fermion propagator in massless  $QED_3$ .

*Phys.Lett. B*, 2006.

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[Mit3]

**Indrajit Mitra, Raghunath Ratabole, and H.S. Sharatchandra.**

Instability in scalar channel of fermion-antifermion scattering amplitude in massless  $qed_3$  and anomalous dimensions of composite operators.

2006.

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[Mu]

**C.S. Srivatsan\*, M.V.N. Murthy, and R.K. Bhaduri\*.**

Gentile statistics and restricted partitions.

*Pramana*, **66(3)**, 485, 2006.

[R1]

**Oing-Hong Cao\*, Shao-Long Chen\*, Ernest Ma\*, and G. Rajasekaran.**

Hexagonal  $SU(3)$  unification and its manifestation at the TeV scale.

*Physical Review*, **D 73**, 015009, 2005.

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**R. Mohapatra\*, M. Parida\*, and G. Rajasekaran.**

Radiative magnification of neutrino mixings in split supersymmetry.

*Physical Review*, **D 72**, 013002, 2005.

[R3]

**G. Rajasekaran.**

From atoms to quarks and beyond: A historical panorama.

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physics/0602131

(Submitted).

[Ra1]

**C. Connaughton\*, R. Rajesh, and O. Zaboronski\*.**

Breakdown of Kolmogorov scaling in models of cluster aggregation.

*Physical Review Letters*, **94**, 194503, 2005.



[Ra2]

**C. Connaughton\***, **R. Rajesh**, and **O. Zaboronski\***.

Cluster-cluster aggregation as an analogue of a turbulent cascade : Kolmogorov phenomenology, scaling laws and the breakdown of self-similarity.

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cond-mat/0510389

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Multi-scaling of the n-point density function for coalescing Brownian motions.

2005.

math.PR/0512179

(Submitted).

[Ra4]

**R. Munasinghe\***, **R. Rajesh**, and **O. Zaboronski\***.

Multi-scaling of correlation functions in single species reaction-diffusion systems.

2005.

cond-mat/0506398

(Submitted).

[S]

**Swarnendu Sarkar** and **Balachandran Sathiapalan**.

Aspects of open-closed duality in a background B-field II.

*JHEP*, **0511**, 002, 2005.

[Sa]

**Balachandran Sathiapalan**.

Connection between the loop variable formalism and the old covariant formalism for the open bosonic string.

*Mod Phys Lett A*, 2006.

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(To be published).

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**Chandradew Sharma** and **Rahul Sinha**.

Angular analysis of B decaying into  $J/\psi$  Tensor,  $J/\psi$  Vector and  $J/\psi$  Scalar modes.

*Physical Review D.*, **73**, 014016, 2006.

[Si1]

**Martin Ligr\***, **Rahul Siddharthan**, **Frederick Cross\***, and **Eric Siggia\***.

Gene expression from random libraries of yeast promoters.

*Genetics*, 2006.

PMID 16415362

(To be published).

[Si2]

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Sigma: multiple alignment of weakly-conserved non-coding DNA sequence.  
*BMC Bioinformatics*, **7**, 143, 2006.

[Si3]

**Rahul Siddharthan, Eric D. Siggia\***, and **Erik van Nimwegen\***.

Phylogibbs: A Gibbs sampling motif finder that incorporates phylogeny.  
*PLoS Computational Biology*, **1(7)**, e67, 2005.

[Sim1]

**Arvind\***, **S. Chaturvedi\***, **N. Mukunda\***, and **R. Simon.**

The sampling theorem and coherent state systems in quantum theory.  
2006.  
(Preprint: quant-ph/0601059).

[Sim2]

**S. Chaturvedi\***, **G. Marmo\***, **N. Mukunda\***, **R. Simon**, and **A. Zampini\***.

The Schwinger representation of a group: Concept and applications.  
2005.  
(Preprint: quant-ph/0505012).

[Sim3]

**M. Mukunda\***, **G. Marmo\***, **A. Zampini\***, **S. Chaturvedi\***, and **R. Simon.**

Wigner-Weyl correspondence in quantum mechanics for continuous and discrete systems –  
a Dirac inspired view.  
*Jour. Phys. A: Math. Gen.*, **39**, 1405–1423, 2006.

[Sim4]

**N. Mukunda\***, **S. Chaturvedi\***, and **R. Simon.**

The Einstein-Podolsky-Rosen paper – an important event in the history of quantum mechanics.  
*Resonance*, **11(3)**, 6–24, 2006.

[Sim5]

**N. Mukunda\***, **G. Marmo\***, **A. Zampini\***, **S. Chaturvedi\***, and **R. Simon.**

Wigner distributions for finite dimensional quantum systems: An algebraic approach.  
*Pramana – Jour. Phys.*, **65(12)**, 981–993, 2005.

[Sim6]

**R. Simon**, **S. Chaturvedi\***, **V. Srinivasan\***, and **N. Mukunda\***.

Hamilton's turns for the Lorentz group.  
2006.  
(Preprint: quant-ph/0601060).

[Sin1]

**Alakabha Datta\***, **Maxime Imbeault\***, **London David\***, **Veronique Page\***, **Nita Sinha**, and **Rahul Sinha**.

Methods for measuring new-physics parameters in B decays.

*Physical Review D*, **71**, 096002, 2005.

[Sin2]

**Nita Sinha**, **Rahul Sinha**, and **Abner Soffer\***.

Improved measurement of  $2\beta + \gamma$ .

*Physical Review D*, **72**, 071302(R), 2005.

[Sinh1]

**Johannes Breuer\*** and **Sitabhra Sinha**.

Death, dynamics and disorder: Terminating reentry in excitable media by dynamically induced inhomogeneities.

*Pramana*, **64(4)**, 553, 2005.

[Sinh2]

**Sitabhra Sinha**.

The rich are different!: Pareto law from asymmetric interactions in asset exchange models.

In S. Yarlagadda A. Chatterjee and B. K. Chakrabarti, editors, *Econophysics of Wealth Distributions*, page 177. Springer, 2005.

[Sinh3]

**Sitabhra Sinha**.

Evidence for power-law tail of the wealth distribution in india.

*Physica A*, **359(1)**, 555, 2006.

[Sinh4]

**Sitabhra Sinha** and **Raj K. Pan**.

Blockbusters, bombs and sleepers: The income distribution of movies.

In S. Yarlagadda A. Chatterjee and B. K. Chakrabarti, editors, *Econophysics of Wealth Distributions*, page 43. Springer, 2005.

[Sinh5]

**Sitabhra Sinha** and **Srinivasa Raghavendra\***.

Emergence of two-phase behavior in markets through interaction and learning in agents with bounded rationality.

In H. Takayasu, editor, *Practical Fruits of Econophysics : Proceedings of The Third Nikkei Econophysics Symposium*, page 200. Springer, 2006.

[Sinh6]

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**P. M. Gade\*** and **Sudeshna Sinha**.

Dynamic transitions in small world networks: Approach to equilibrium.

*Physical Review E*, **72**, 052903, 2005.

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**J. Lu\***, **K. Murali\***, **Sudeshna Sinha**, and **H. Leung\***.

Generating multi-scroll chaotic attractors via threshold control.

*IEEE Trans. of Circuits and Systems*, 2006.

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[Sinha3]

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Spatiotemporal consequences of relaxation timescales in threshold coupled systems.

*Physical Review E*, **73**, 026215, 2006.

[Sinha4]

**K. Murali\***, **Sudeshna Sinha**, **W. L. Ditto\***, **H. Leung\***, and **E. Lindberg\***.

Dynamic nor/nand logic gates using a chaotic circuit.

*IEEE Trans. of Circuits and Systems (Express)*, 2006.

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## 2.3 Theoretical Computer Science

### 2.3.1 Research Summary

#### Algorithms and Data Structures

Given a bipartite graph  $G = (X \dot{\cup} D, E \subseteq X \times D)$ , an  $X$ -perfect matching is a matching in  $G$  that covers every node in  $X$ . The following generalisation of the  $X$ -perfect matching problem has applications in constraint programming: Given a bipartite graph as above and a collection  $\mathcal{F} \subseteq 2^X$  of  $k$  subsets of  $X$ , find a subset  $M \subseteq E$  of the edges such that for each  $C \in \mathcal{F}$ , the edge set  $M \cap (C \times D)$  is a  $C$ -perfect matching in  $G$  (or report that no such set exists). In [M1] it is shown that the decision problem is NP-complete and that the corresponding optimisation problem is in APX when  $k = O(1)$  and even APX-complete already for  $k = 2$ . On the positive side, it is shown that a  $2/(k + 1)$ -approximation can be found in  $2^k \text{poly}(k, |X \cup D|)$  time.

In [Ra3], substantially improved exact exponential algorithms for a number of NP-hard problems are obtained. These algorithms are obtained through a variety of techniques. These techniques include: (1) obtaining exact algorithms by enumerating maximal independent sets in a graph, (2) obtaining exact algorithms from parameterized algorithms, and (3) a variant of the usual branch-and-bound technique which can be referred to as the ‘colored’ branch-and-bound technique.

These techniques are simple in that they avoid detailed case analyses and yield algorithms that can be easily implemented. These techniques are illustrated by applying them on several NP-hard problems and obtaining improved upper bounds. The specific problems that are tackled are: (1) the ODD CYCLE TRANSVERSAL problem in general undirected graphs, (2) the FEEDBACK VERTEX SET problem in undirected and directed graphs of maximum degree 4, (3) the FEEDBACK ARC SET problem in tournaments, (4) the 4-HITTING SET problem, (5) the MINIMUM MAXIMAL MATCHING and EDGE DOMINATING SET problems. The algorithms presented for these problems are the best known and provide substantial improvement. For example, for the ODD CYCLE TRANSVERSAL problem, the algorithm obtained has a runtime of  $O(1.62^n \cdot n^{O(1)})$  which improves the previous time bound of  $O(1.7724^n \cdot n^{O(1)})$ .

Several parameterized problems that are hard on general graphs are shown to be fixed parameter tractable on graphs with no small cycles in [Ra1]. More specifically, it is shown that each of the following problems of finding a  $k$ -vertex (1) DOMINATING SET, (2)  $t$ -VERTEX COVER (where one needs to cover at least  $t$  edges) and (3) Independent set admits efficient fixed parameter algorithms provided we assume that the input graph has no cycles of length 3 or 4 or both. Each of these is known to be  $W$ -hard on general graphs. It is also shown that the Dominating Set problem is  $W$ -hard in bipartite graphs and hence on triangle free graphs. Also, it is shown that the DENSE SUBGRAPH problem (related to the CLIQUE problem) is  $W$ -hard on graphs with no cycles of length at most 5.

#### Automata, Logic and Concurrency

Logics for security protocols are difficult to design since the logical need for abstraction needs to be reconciled with the details (parallel sessions, freshness of nonces and keys, encryption

algorithms etc) of security. In [R], we suggest propositional logics of knowledge as suitable candidates for reasoning about a range of security properties. We define a specification logic which limits knowledge of agents to only that data which they can explicitly construct from their initial knowledge (of terms and keys) using communications. We also study a richer protocol logic where we can reason about how a protocol achieves (or fails to achieve) security requirements. We show a way of restricting the expressiveness of the logics so as to ensure decidability of the verification problem, over the subclass of tagged protocols using a fixed finite set of nonces, even when the number of sessions is unbounded.

Various algebraic structures have been proposed for the treatment of concurrency, beginning with early process calculi like CCS in 1980, TCSP in 1981 and ACP in 1982. A common framework is the generalization of process behaviour from a semi-ring of formal languages to an idempotent grove of tree unfoldings of transition systems up to bisimulation. Restricting to finite state behaviour, the generalization is from starred semi-rings or  $\mu$ -semi-rings of regular languages to idempotent  $\mu$ -groves of tree unfoldings of finite state transition systems up to bisimulation. However there are several open questions relating to: axiomatization of rational trace languages, strongly guarded  $\mu$ -expressions with shuffle, axiomatization of concurrent bisimulation and recognizable labelled event structures These are discussed in [Lo].

## Computational Complexity

In [L], the complexity of evaluating monotone planar circuits MPCVP is revisited, with special attention to circuits with cylindrical embeddings. MPCVP is known to be in  $NC^3$ , and for the special case of upward stratified circuits, it is known to be in LogDCFL. Also, in [L], the topological notion of cylindricality, which is stronger than planarity but strictly generalizes upward planarity, is characterized combinatorially, and the characterization is made partially constructive. Using this construction, and four key reduction lemmas, several improvements are obtained. It is shown that stratified cylindrical monotone circuits can be evaluated in LogDCFL, arbitrary cylindrical monotone circuits can be evaluated in  $AC^1(\text{LogDCFL})$ , while monotone circuits with one-input-face planar embeddings can be evaluated in LogCFL. For monotone circuits with focused embeddings, an upper bound of  $AC^1(\text{LogDCFL})$  is obtained. The  $NC^3$  algorithm for general MPCVP is reexamined and placed in  $AC^1(\text{LogCFL}) = SAC^2$ . Finally, it is shown that monotone circuits with toroidal embeddings can, given such an embedding, be evaluated in NC. Also, it is shown that special kinds of arbitrary genus circuits can also be evaluated in NC.

In [Ar2], it is shown that several algorithmic problems in group theory, known to be in  $AM \cap coAM$ , in fact have either perfect zero-knowledge proofs or statistical zero-knowledge proofs.

In [Ar3], there is a description of quantum polynomial-time algorithms for several problems over black-box rings, where the ring operations are performed by an oracle.

## Graph Theory and Combinatorics

A *proper* colouring of the edges of a graph is called *acyclic* if there is no two-coloured cycle in  $G$ . The *acyclic chromatic index* of  $G$ , denoted  $a'(G)$ , is the least number of colours required

for an acyclic edge colouring of  $G$ . No exact estimate of  $a'(G)$  is known even for very special classes of graphs. In [Mu], the values of the acyclic chromatic index of a class of graphs referred to as *d-dimensional partial tori* are determined. These are graphs which can be expressed as the Cartesian product of  $d$  graphs each of which is an induced path or cycle. This class includes some known classes of graphs like  $d$ -dimensional meshes, hypercubes, tori, etc. These estimates are exact except when the graph is a product of a path and a number of odd cycles, in which case the estimates differ by an additive factor of at most 1. These results are also constructive and provide an optimal (or almost optimal) acyclic edge colouring in polynomial time.

It is known from existential arguments that any graph  $G$  can be acyclically edge coloured using at most  $16\Delta(G)$  colours where  $\Delta(G)$  denotes the maximum degree  $G$ . However, no non-trivial constructive bound (which works for all graphs) is known except for the straightforward distance 2 colouring which requires  $\Delta^2$  colours. In [S2], a simple  $O(mn\Delta^2(\log \Delta)^2)$  time greedy heuristic is analyzed and it is shown that it uses at most  $5\Delta(\log \Delta + 2)$  colours on any graph.

Let  $D$  denote a simple random digraph obtained by choosing each undirected edge with probability  $2p$  and then orienting it in either direction with probability  $1/2$ . The choices are independent for different undirected edges. In [S1], very tight concentration results on the maximum size (denoted  $mas(D)$ ) of an induced acyclic subgraph in  $D$  are obtained. Precisely, it is shown that (for  $p$  satisfying  $np = \omega(1)$ ), almost surely  $mas(D)$  is  $2p^{-1}(\ln np)$  up to an asymptotically small additive term. This partially confirms a conjecture stated in an earlier work. These results are also valid for the random digraph obtained by choosing each of the  $n(n-1)$  directed edges independently with probability  $p$ .

### 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.

[A]

**V. Arvind, Piyush P Kurur, and T.C. Vijayaraghavan.**

Bounded color multiplicity graph isomorphism is in the #L hierarchy.

In *Proceedings of the 20th IEEE Conference on Computational Complexity (CCC-2005)*, pages 13–27. IEEE Computer Society, Jun 2005.

[Ar1]

**Vikraman Arvind and Johannes Koebler\***

On hypergraph and graph isomorphism with bounded color classes.

In Bruno Durand and Wolfgang Thomas, editors, *Proceedings of 23rd Annual Symposium on Theoretical Aspects of Computer Science (STACS-06)*, pages 384–395. Springer Lecture Notes in Computer Science volume 3884, Feb 2006.

[Ar2]

**Vikraman Arvind and Bireswar Das.**

SZK proofs for black-box group problems.

In Dima Grigoriev, editor, *Proceedings of the First International Computer Science Symposium in Russia (CSR-2006)*. Springer Verlag, Mar 2006.

(To be published).

[Ar3]

**Vikraman Arvind, Bireswar Das, and Partha Mukhopadhyay.**

The complexity of black-box ring problems.

In Danny Z. Chen and D.T. Lee, editors, *Proceedings of the Twelfth Annual International Computing and Combinatorics Conference*. Springer Verlag, Mar 2006.

(To be published).

[Ar4]

**Vikraman Arvind and Jacobo Toran\***.

Isomorphism testing: Perspective and open problems.

In Jacobo Toran, editor, *Bulletin of the European Association for Theoretical Computer Science, Computational Complexity Column*. European Association for Theoretical Computer Science, 2005.

[B]

**R. Balasubramanian and C. R. Subramanian.**

On sampling colorings of bipartite graphs.

*Discrete Mathematics and Theoretical Computer Science*, **8(1)**, 17–30, 2006.

[L]

**Nutan P. Limaye, Meena B. Mahajan, and Jayalal Sarma M N.**

Evaluating monotone circuits on cylinders, planes and tori.

In Bruno Durand and Wolfgang Thomas, editors, *Proceedings of 23rd Symposium on Theoretical Aspects of Computer Science (STACS-06)*, pages 660–671. Springer Lecture Notes in Computer Science volume 3884, Feb 2006.

[Lo]

**Kamal Lodaya.**

Looking back at process algebra.

In Z. Ésik and Z. Fülöp, editors, *Automata and formal languages: proceedings of AFL 2005*, pages 39–46. Inst of Informatics, Univ of Szeged, May 2005.

[M1]

**Khaled Elbassioni\*, Irit Katriel\*, Martin Kutz\*, and Meena Mahajan.**

Simultaneous matchings.

In Xiaotie Deng and Dinghzu Du, editors, *Proceedings of the 16th Annual International Symposium on Algorithms and Computation (ISAAC-2005)*, pages 106–115. Springer Lecture Notes in Computer Science volume 3827, Dec 2005.



[M2]

**Meena Mahajan, R. Rama\*, and S. Vijayakumar\*.**

On sorting by 3-bounded transpositions.

*Discrete Mathematics*, 2005.

(To be published).

[Mu]

**Rahul Muthu, N. Narayanan, and C. R. Subramanian.**

Optimal acyclic edge colouring of grid like graphs.

2005.

(Submitted).

[R]

**R. Ramanujam and S.P. Suresh\*.**

Deciding knowledge properties of security protocols.

In Ron von der Meyden, editor, *Proceedings of Theoretical Aspects of Rationality and Knowledge*, pages 219–235. Morgan Kaufmann, Jun 2005.

[Ra1]

**Venkatesh Raman and Saket Saurabh.**

Triangles, 4-cycles and parameterized (in)-tractability.

In *Proceedings of the Scandinavian Workshop on Algorithm Theory (SWAT-2006)*. Springer Verlag, Mar 2006.

(To be published).

[Ra2]

**Venkatesh Raman and Saket Saurabh.**

Parameterized algorithms for feedback set problems and their duals in tournaments.

*Theoretical Computer Science*, **351(3)**, 446–458, 2006.

[Ra3]

**Venkatesh Raman, Saket Saurabh, and Somnath Sikdar.**

Efficient exact algorithms through enumerating maximal independent sets and other techniques.

*Theory of Computing Systems*, 2006.

(To be published).

Preliminary version appears in the Proceedings of 9th Italian Conference on Theoretical Computer Science (ICTCS 2005), Siena, Italy, October 12-14, 2005, Springer Lecture Notes in Computer Science volume 3701.

[Ra4]

**Venkatesh Raman, Saket Saurabh, and C. R. Subramanian.**

Faster fixed parameter tractable algorithms for finding feedback vertex sets.

*ACM Transactions on Algorithms*, 2006.

(To be published).

Parts of this work appear in the Proceedings of 2nd Brazilian Symposium on Graphs, Al-

gorithms and Combinatorics (GRACO 2005), Electronic Notes in Discrete Mathematics, 19(2005), 273-279, Elsevier, 2005.

[S1]

**Joel Spencer\* and C. R. Subramanian.**

On the size of induced acyclic subgraphs in random digraphs.

2006.

(Submitted).

[S2]

**C. R. Subramanian.**

Analysis of a heuristic for acyclic edge colouring.

2006.

(Submitted).

## 2.4 Student Programmes

### 2.4.1 Degrees Awarded

#### Doctoral Theses Submitted during 2005 – 2006

##### Mathematics

Name: **Prakash, Gyan**

Thesis Title: On some problems in additive Number theory

Thesis Advisor: Balasubramanian, R.

University: ISI Kolkatta

##### Theoretical Computer Science

Name: **Kurur, Piyush P.**

Thesis Title: Complexity upper bounds using permutation group theory

Thesis Advisor: Arvind, V.

University: Madras University

#### Masters Theses during 2005 – 2006

##### Mathematics

Name: **Gautam, Sachin**

Thesis Title: Kazhdan-Lusztig Conjectures

Thesis Advisor: Raghavan, K. N.

University: Anna University

##### Physics

Name: **Cruz, Vallan B.**

Thesis Title: Quantum Algorithms and Error Correction

Thesis Advisor: Simon, R.

University: Anna university

Name: **Gopalakrishna, K. V. S. N. S.**

Thesis Title: Superscattering Approach to Black Hole Evaporation

Thesis Advisor: Rama, S. Kalyana

University: Anna university

## Theoretical Computer Science

Name: **Sheerazuddin, S.**

Thesis Title: A logic for pointers

Thesis Advisor: Ramanujam, R.

University: Anna University

Name: **Limaye, Nutan**

Thesis Title: Parallel Complexity Classes centred around LogCFL

Thesis Advisor: Mahajan, Meena B.

University: Anna University

## 2.4.2 Lecture Courses During 2005 – 2006.

The following **lecture courses** were offered during 2005 – 2006.

Course Title	Period	Lecturer
<b>Mathematics</b>		
Harmonic Analysis	Sep - Mar 2005	Prasad, Amritanshu
Complex Analysis	Jan - Apr 2005	Srinivas, K.
Differential Equations	Jan - Apr 2005	Krishna, M.
Functional Analysis	Jan - Apr 2005	Kesavan, S.
Topology-II	Jan - Apr 2005	Sankaran, P.
$GL_2(\mathbf{F}_p)$	Jun - Jun 2005	Prasad, Amritanshu
Algebra II	Aug- Nov 2005	Iyer, Jaya N.
Algebra I	Aug- Nov 2005	Raghavan, K. N.
Real Analysis	Aug- Nov 2005	Sunder, V. S.
Algebraic Number Theory	Jan - Apr 2006	Balasubramanian, R.
Complex Analysis	Jan - Apr 2006	Srinivas, K.
Differential Equations	Jan - Feb 2006	Krishna, M.
Elliptic Curves and Modular forms	Jan - Jan 2006	Balasubramanian, R.
Functional Analysis	Jan - Apr 2006	Kesavan, S.
Topology	Jan -May 2006	Kodiyalam, Vijay
Ergodic Theory	Mar- Apr 2006	Sridharan, Shrihari
<b>Physics</b>		
Condensed Matter Physics	Jan - Apr 2005	Siddharthan, Rahul
Particle Physics.	Jan - Apr 2005	Parthasarathy, R.
Advanced Condensed Matter Physics	Aug- Dec 2005	Menon, Gautam I.
Classical Mechanics	Aug- Dec 2005	Date, G.
Methods of Mathematical Physics	Aug- Dec 2005	Mani, Harihara S.
Quantum Mechanics	Aug- Dec 2005	Simon, R.
Advanced Statistical Mechanics	Sep - Oct 2005	Sinha, Sitabhra
String theory	Nov -Mar 2006	Sathiapalan, B.
Advanced Condensed Matter Physics	Dec - Dec 2005	Siddharthan, Rahul
Condensed Matter Physics	Jan - Apr 2006	Menon, Gautam I.
Quantum Field Theory I	Jan - Apr 2006	Basu, Rahul
<b>Theoretical Computer Science</b>		
Algebra and Computation	Jan - Apr 2005	Arvind, V.
Algorithmic Game Theory	Jan -May 2005	Ramanujam, R.
Concurrency theory	Jan - Apr 2005	Lodaya, Kamal
Mathematical Logic	Jan -May 2005	Ramanujam, R.
Algebra and Computation II	Aug- Nov 2005	Arvind, V.
Approximation Algorithms	Aug- Dec 2005	Raman, Venkatesh

Computational Geometry	Aug-Dec 2005	Mahajan, Meena B.
Discrete Mathematics	Aug-Dec 2005	Subramanian, C. R.
Programming languages	Aug-Dec 2005	Lodaya, Kamal
Theory of computation	Aug-Dec 2005	Ramanujam, R.
Automata and concurrency	Jan -Apr 2006	Lodaya, Kamal
Computational Complexity	Jan -Apr 2006	Arvind, V.
Mathematical Logic	Jan -Apr 2006	Ramanujam, R.
Randomized Algorithms	Jan -Feb 2006	Raman, Venkatesh
Randomized Algorithms	Feb -Apr 2006	Subramanian, C. R.

In addition, the following **lecture courses** were offered during 2005 – 2006 by IMSC faculty in the National Undergraduate programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer
<b>Mathematics</b>		
Analysis-II	Jan -Apr 2005	Sankaran, P.
Analysis I	Aug-Dec 2005	Prasad, Amritanshu
<b>Physics</b>		
Electromagnetic Theory II	Jan-Apr 2005	Mani, Harihara S.
Quantum Mechanics II	Jan-Apr 2005	Rajasekaran, G.
Computational Physics	Jan-Apr 2006	Siddharthan, Rahul
Gravitation and Cosmology	Jan-Apr 2006	Rajasekaran, G.
Quantum Mechanics II	Jan-Apr 2006	Mani, Harihara S.

### 2.4.3 Summer Students

Every summer, a small number of students from various institutes/universities come to our institute and work on some learning/research projects with some of the faculty members for a period of four to six weeks. The following students visited the institute during the period April 2005 - March 2006.

Student

Faculty

#### Physics

Menon, Deepikaa, Holyoke College, Boston  
Venkatesh, Prasanna, CMI  
Chatterji, Arindam, CMI  
Srivatsan, C. S., IIT, Kanpur  
Sharma, Auditya, IIT Madras  
Suri, Baladitya, IIT Madras  
Aditya, Y. G., Delhi University  
John, Yohan J., IIT, Mumbai  
Sengupta, Shiladitya, IIT, Kharagpur

Basu, Rahul  
Jagannathan, R.  
Jagannathan, R.  
Murthy, M.V.N.  
Siddharthan, Rahul  
Siddharthan, Rahul  
Simon, R.  
Sinha, Sitabhra  
Sinha, Sitabhra

#### Theoretical Computer Science

Krishna, Gopal, IIT, Kanpur  
Mukherjee, Indraneel, CMI  
Chakraborty, Tanmoy, CMI  
Malhotra, Riti, IIT, Kharagpur  
Sundar, Aparna, BITS, Pilani

Arvind, V.  
Mahajan, Meena B.  
Mahajan, Meena B.  
Ramanujam, R.  
Ramanujam, R.

### 2.4.4 Other Students

Students also do their projects under the supervision of our faculty members during the academic year. The following students visited the institute during April 2005 - March 2006.

Student

Faculty

#### Mathematics

Sekhar, Gautham, BITS, Pilani

Srinivas, K.

#### Physics

Sunitha, Auxilia, Stella Maris College, Chennai  
Salve, Saritha, Stella Maris College, Chennai  
Salve, Sangeetha, Stella Maris College, Chennai  
J, Meenupriya, Stella Maris College, Chennai  
Khan, Mayukh N., IIT, Kharagpur

Siddharthan, Rahul  
Siddharthan, Rahul  
Siddharthan, Rahul  
Siddharthan, Rahul  
Simon, R.

### 2.4.5 Apalat Fellowship

In order to encourage bright B.Sc. students to take up Physics or Mathematics for their higher studies, the Institute is offering two fellowships, one in Mathematics and another in Physics for students studying in and around Chennai. This goes under the name of APALAT-IMSc scholarship. The scholarship amount is Rs.1000 per month for 10 months of the academic year and is paid during their M.Sc. programme. Each student is expected to work under the guidance of a faculty member in the respective discipline of the Institute.

Heads of the Departments in Physics and Mathematics of various colleges in the city are contacted to suggest five bright students of B.Sc (third year) who are likely to join M.Sc programme in an institution in Chennai. Out of them, one student in each subject is selected through a written test followed by an interview. The successful students are encouraged to attend seminars in the Institute and to work under the supervision of a faculty member at IMSc, during the summer vacation. They are expected to show their progress in their regular M.Sc course and if satisfied, the scholarship is extended to the second year of their M.Sc course.

During this academic year, the fellowship was awarded to Ms. Aarti Raghuraman of Madras Christian College, Chennai in Physics and Mr. Jishnu Jagannathan of Indian Institute of Technology, Chennai in Mathematics.



## 2.5 Honours and Awards

**Balasubramanian, R.** was awarded **PADMA SHRI**, for 2006, by the Government of India.

**Balakrishnan, Radha** was awarded Professor Darshan Ranganathan Memorial Lecture Award, for 2005, by the Indian National Science Academy, New Delhi for her original and pioneering contributions in Nonlinear Dynamics.

**Balasubramanian, R** was awarded A.C. Banerjee Memorial lecture, for 2005, by the National Academy of Sciences, India, Allahabad.

**Paranjape, Kapil H.** was awarded Shanti Swarup Bhatnagar Award, for 2005, by the CSIR for outstanding contributions in the field of algebraic geometry, especially the theory of algebraic cycles.

**Menon, Gautam I** was awarded Swarnajayanti Fellowship, for 2005, by the DST, India.

**Prasad, Amritanshu** was awarded an Associateship, for 2005, by The Indian Academy of Sciences.

**Siddharthan, Rahul** was awarded Associateship, for 2005, by the Indian Academy of Sciences.



# 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 Program Committee, for the conference on Computational Complexity, 2006.

### **Balakrishnan, Radha**

Member of Panel of Experts of University of Madras, Chennai during Sep, 2005.

Member of Local Organising Committee for National Conference on Nonlinear Systems and Dynamics held at Ramanujan Institute for Advanced Study in Mathematics, Chennai during Feb 6 – Feb 8, 2006.

### **Balasubramanian, R.**

President, Sectional Committee, of the Physical Science Section , NASI during Dec, 2005.

### **Baoulina, Ioulia**

Reviewer of Mathematical Reviews, AMS during Jul 2003 – Mar 2006.

### **Baskaran, G.**

Member of Board of Trustees of K S Krishnan Memorial Trust during Aug 2002 – Jul 2005.

Council Member of International Center for Condensed Matter Physics, Brasilia, Brazil during Nov 2002 – Jul 2005.

Member of Scientific Advisory Committee (SAC), National Brain Research Centre, Manesar, Gurgaon, Haryana during Jun 2003 – Jun 2005.

Member of RSC, CSIR, New Delhi during Mar 2004 – Jul 2005.

Member of S S Bhatnagar Award Committee, CSIR, New Delhi during Mar 2004 – Jul 2005.

Member of Program Advisory Committee, Department of Science and Technology, New Delhi during Jun 2004 – Jul 2005.

Member of Japanese Science and Technology (JEST), Fukuyama Project, CREST during Jun 2004 – Jul 2005.

Member of Physics Selection Committee, Central University of Hyderabad during Jul 2004 – Jun 2005.

### **Basu, Rahul**

Member of National Organising Committee of LCWS06 during Nov 2005 – Mar 2006.

### **Date, G.**

Member of The Council of the Indian Association for General Relativity and Gravitation. during Apr 2005 – Feb 2006.

Secretary of The Indian Association for General Relativity and Gravitation. during Mar, 2006.

### **Govindarajan, T. R.**

Member of Board of studies, Physics, Vivekananda college.

Member of Board of studies, Physics, Stella Maris College.

Member of National Organising Committee for International Workshop on Non-commutative geometry and quantum Physics held at S. N. Bose Center, Kolkata during Jan 4 – Jan 10, 2006.

### **Hari Dass, N. D.**

External Expert of School Board of the Northeast Hill University, Shillong during Oct 2004 – Jul 2005.

### **Kesavan, S.**

Member of National Board for Higher Mathematics.

Member of Editorial Board, Journal of Analysis and Applications.

Member of Apex Committee, National Undergraduate Programme, Chennai Mathematical Institute.

Professor-in-charge of all teaching programs, National Undergraduate Programme, Chennai Mathematical Institute.

Reviewer of Mathematical Reviews.

Fellow of Forum d' Analyses.

Member of Editorial Board, Journal of the Kerala Mathematical Association.

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

Member of Board of Studies in Engineering Sciences, Homi Bhabha National Institute.

Visitor's Nominee of Selection Committee, School of Sciences, Indira Gandhi National Open University (IGNOU), New Delhi.

Convener of Local Organising Committee for Perspectives in Mathematics held at IMSc during Sep 30 – Oct 1, 2005.

### **Kodiyalam, Vijay**

Reviewer of Mathematical Reviews.

### **Krishna, M.**

Gave a talk on "Probability in the Stock Markets" at National Science Day Program, on Feb 28, 2006, at IMSc.

### **Lodaya, Kamal**

Member of Programme Committee, 25th FSTTCS Conference during Jan – Dec, 2005.

### **Mani, Harihara S.**

Member of Local Organising Committee for WHEPP held at Bhubaneswar during Jan 9 – Jan 14, 2006.

### **Menon, Gautam I.**

Member of Board of Studies for Physical Sciences, and Balancing Member on the Board of Studies for Biological Sciences, Homi Bhabha National Institute during Apr 2005 – Mar 2006.

Member of National Organising Committee for Indo-Israeli Workshop on Condensed Matter Physics held at Toshali Sands, Puri during Apr 18 – Apr 21, 2005.

**Murthy, M.V.N.**

Convener of Local Organising Committee for INO Interaction Meeting held at IMSc during Feb 22 – Feb 24, 2006.

**Rajasekaran, G.**

Member of the Council and the Governing Board of IUCAA, Pune.

Wrote a science education article, “Hans Bethe, the Sun and the Neutrinos”, published in *Resonance*, volume 10, page 49, October 2005.

Gave a Popular Science Lecture on “Einstein and a Century of Physics” at Srimad Andavan Arts and Science College, Srirangam on Dec 26, 2005.

Gave a lecture on “Einstein and a Century of Physics” during Science Day at Central School, Kalpakkam on Feb 28, 2006.

Gave a lecture on “Einstein and a Century of Physics” during One-day Symposium at Sri Sai Ram Engineering College, West Tambaram on Mar 22, 2006.

**Raman, Venkatesh**

Member of Steering Committee of the International Workshop on Parameterized and Exact Computation during Jul 2005 – Mar 2006.

Member of Program Committee of the Second International Workshop on Parameterized and Exact Computation during Nov 2005 – Mar 2006.

Member of Program Committee of the International Conference on Discrete Mathematics during Jan – Mar, 2006.

**Ramanujam, R.**

Member of Program committee of TARK XI (Reasoning about Theoretical Aspects of Rationality and Knowledge) during Aug 2004 – Jun 2005.

Convener of International Organising Committee for 25<sup>th</sup> Conference on Foundations of Software Technology and Theoretical Computer Science held at International Institute of Information Technology, Hyderabad during Dec 15 – Dec 18, 2005.

Convener of Local Organising Committee for Institute Seminar Week 2006 held at IMSc during Feb 13 – Feb 17, 2006.

**Sankaran, Parameswaran**

External Member of Technical Advisory Committee, Indian Statistical Institute during Nov 2005 – Mar 2006.

**Sinha, Nita**

Working group co-ordinator of WG3 (Flavor Physics and Model Building) of WHEPP-9 held at Institute of Physics Bhubaneswar.

**Sinha, Sitabhra**

Convener of Local Organising Committee for The IMSc Complex Systems School held at IMSc during Jan 2 – Jan 27, 2006.

**Sinha, Sudeshna**

Editor of AIP Journal “Chaos” during Oct 2005 – Mar 2006.

Member of Local Organising Committee for National Conference on Nonlinear Systems and Dynamics held at RIASM, Chennai during Feb 6 – Feb 8, 2006.

**Sunder, V. S.**

Member of Editorial Board of the Proceedings of the Indian Academy of Sciences (Math. Sci.) during Aug 2001 – Mar 2006.

Member of Editorial Board of the ‘Texts and Readings in Mathematics’ (TRIM) series published by the Hindustan Book Agency during Aug 2001 – Mar 2006.

Member of Council of the Indian Academy of Sciences during Jan 2004 – Mar 2006.

Member of Sectional Committee for Mathematical Sciences, Indian National Science Academy during Jan 2005 – Mar 2006.

Convener of Board of Studies for Math. Sciences, HBNI during May 2005 – Mar 2006.

Member of S.S. Bhatnagar Award Committee during Jun 2005 – Mar 2006.

Subject Expert for Math. Sci. of DST FITS Committee during Jun 2005 – Mar 2006.





# Chapter 4

## Colloquia

### 4.1 Conferences/Workshops Held at IMSc

#### 4.1.1 CAAG-VI

The National Conferences on Commutative Algebra and Algebraic Geometry (CAAG) are held every 18 months or so in various centres across India. The sixth such conference was held in IMSc, Chennai in the first week of August 2005. The conference was organised by D. S. Nagaraj with V. Balaji of CMI and Kapil Paranjape.

There were about 40 participants from across India and some speakers from abroad as well. The speakers and their talks were as follows:

- **R. Sujatha**  
*Fine Selmer groups for elliptic curves*
- **Jaya Iyer**  
*Chern classes of flat bundles*
- **R. Parthasarathi**  
*Donaldson Uhlenbeck compactification of parabolic bundles*
- **Manoj Kumar Keshari**  
*A note on projective modules over real affine algebras.*
- **Pooja Singla**  
*The regularity of power products of graded ideals and minimal monomial reduction ideal*
- **R. V. Gurjar**  
*The depth of  $\Omega^1$  for certain local rings*
- **G. Kemper**  
*Depth of invariant rings and wild ramification*
- **P. Russell**  
*Some results on affine rational surfaces*

- **V. B. Mehta**  
*Fundamental Group Scheme in char  $p$*
- **Alok K. Maloo**  
*Maximally differential ideals in positive characteristic*
- **Shyamashree Upadhyay**  
*Hilbert Functions of points on Schubert varieties in the Orthogonal Grassmannian*
- **P. Tony Joseph**  
*On a filtration of the canonical module*
- **Vijayalaxmi Trivedi**  
*Hilbert-Knuz multiplicities and vector bundles on curves*
- **R. Parimala**  
*Division algebras of prime degree over function fields of surfaces*
- **C. S. Dalawat**  
*Good reduction, bad reduction*
- **Vinay Wagh**  
*Some results on the modules of derivations of certain local rings*
- **Jose Selby**  
*The unimodular vector quotient is nilpotent*
- **S. Ramanan**  
*Fano Varieties*
- **Avinash Sathaye**  
*Globalization of an old Theorem of Zariski*
- **V. Balaji**  
*Principal bundles on algebraic surfaces*
- **T. E. Venkata Balaji**  
*The Witt-Invariant Classifies Ternary Quadratic Bundles*
- **J. K. Verma**  
*Hilbert coefficients and depth of fiber cones of ideals*

#### 4.1.2 Perspectives in Mathematics

A Workshop for College Teachers and Research Scholars was conducted at the Institute on Friday, September 30 and Saturday, October 1, 2005 on the occasion of the Platinum Jubilee of the National Academy of Sciences, Allahabad.

The programme consisted of six lectures, each of an hour's duration, wherein, starting from the basics, a survey of a mathematical topic was presented. Each lecture concluded with

a glimpse of the frontiers of current research and conveyed the excitement and richness of mathematical research in general and the chosen topic in particular. The talks were aimed at an audience with a general mathematical maturity and no expertise in any topic was assumed.

The list of speakers and the titles of their talks are given below:

- **V. S. Sunder, IMSc.**  
*The problem of knot equivalence.*
- **M. Krishna, IMSc.**  
*The beauty of Schrödinger operators.*
- **V. Balaji, CMI**  
*Topology and Bi-rational geometry.*
- **K. Parthasarathy, Ramanujan Institute, University of Madras**  
*Harmonic analysis - some glimpses.*
- **Bala Sathiapalan, IMSc.**  
*String Theory.*
- **Madhavan Mukund, CMI**  
*Automata, logic and verifying computer programmes.*

#### 4.1.3 Subhashis Nag Memorial Endowment Lecture

The fourth Subhashis Nag Memorial Endowment Lecture for the year 2005-2006 was delivered by Professor Bernard De Wit, Institute for Theoretical Physics and Spinoza Institute, Utrecht University, The Netherlands. Professor De Wit visited the Institute during Dec 9 – Dec 15, 2005. Besides his Endowment Lecture on “Black Hole Entropy from M-theory and Supergravity”, he also gave two seminars on “Magnetic Charges in Local Field Theory - Lessons learnt from Gauging Supergravity” and on “Black Hole Partition Functions and Duality”.

#### 4.1.4 The IMSc Complex Systems School

This intensive four-week school during Jan 2 – Jan 27, 2006, organized in cooperation with the Santa Fe Institute, Santa Fe, USA, was meant to introduce advanced masters students, graduate students and postdocs in various academic disciplines to research on complex phenomena in physical, biological and social systems. 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 31 participants, including 3 from abroad, and the last 2 days of the School were given over to project presentations by all of them.

The list of speakers at the School were as follows:

- **Sanjay Jain**, Delhi University  
*Networks in complex systems: structure, dynamics and evolution*
- **V. Balakrishnan**, IIT Madras  
*Introduction to Nonlinear Dynamics*
- **Jose Lobo**, Arizona State University, Tempe  
*Cities: Economic Growth, Innovation and Scaling*
- **Gautam Menon**, IMSc, Chennai  
*Statistical Mechanics and Applications*
- **Eric Smith**, Santa Fe Institute, Santa Fe  
*Understanding the origin and order of biochemistry*
- **Suresh Naidu**, University of California, Berkeley  
*Evolutionary Dynamics of Institutions*
- **Somdatta Sinha**, CCMB, Hyderabad  
*Pattern Formation in Biological Systems*
- **Kanury V. S. Rao**, ICGEB, New Delhi  
*The Immune System*
- **Ram Ramaswamy**, JNU, New Delhi  
*Introduction to Computational Biology and Genome Organization*
- **Rahul Siddharthan**, IMSc, Chennai  
*Introduction to Regulatory Genomics*
- **Lauren Buckley**, Santa Fe Institute, Santa Fe  
*Spatial Ecology*
- **Jukka-Pekka Onnela**, Helsinki University of Technology, Helsinki  
*Financial and Social Networks*
- **Bikas K Chakrabarti**, SINP, Kolkata  
*Models of earthquakes and wealth distribution*
- **R. Ramanujam**, IMSc, Chennai  
*Invitation to Game Theory*
- **Sudeshna Sinha**, IMSc, Chennai  
*Models of Spatiotemporal Chaos*
- **Sitabhra Sinha**, IMSc, Chennai  
*Introduction to Econophysics*
- **Chandan Dasgupta**, IISc, Bangalore  
*Complex behaviour of “glassy” systems*
- **Van Savage**, Harvard University, Cambridge  
*Biological Scaling*
- **Geoffrey West**, Santa Fe Institute, Santa Fe  
*Biological Scaling*

### 4.1.5 INO Interaction Meeting

An INO interaction meeting was held at IMSc for three days in February. The participants included the members of the Programme Management Committee, Scientific Advisors and various group coordinators apart from active workers. The program on day one focussed on the Human Resource Generation for INO and the preparation of Detailed Project Report. On day two the focus was on the detector research and development and results from simulations. The program on the last day included a general colloquium and interaction with the engineers and geologists from IGCAR, TNEB and GSI leading to the formation of an engineering task force for INO.

### 4.1.6 Institute Seminar Week 2006

The **Institute Seminar Week** was held from February 10 to 17, 2006, from 10 AM to 1 PM on each day. The seminar coordinators were Amritanshu Prasad (Mathematics), Kalyana Rama (Theoretical Physics) and R. Ramanujam (Theoretical Computer Science). There were 30 talks, of 25 minutes duration each. Speakers presented their work and described problems of current research interest.

#### List of Seminars at ISW 2006

- **Radha Balakrishnan**  
*Conformons in Biopolymers*
- **R. Balasubramanian**  
*Sumfree sets in finite abelian groups*
- **Ioulia Baoulina**  
*On diagonal equations over finite fields*
- **Partha Sarathy Chakraborty**  
*Noncommutative Geometry of Quantum Groups and their Homogeneous Spaces*
- **Chitta Ranjan Das**  
*Phase Transition in the Higgs Model of Scalar Dyons*
- **Prasanta Kumar Das**  
*Muon anomaly: a probe to higgs-radion mixing in the Randall-Sundrum model!*
- **N.D. Hari Dass**  
*Kabru reveals the QCD-string*
- **R. Jagannathan**  
 *$(q, p)$ -Bosons and their applications*
- **Joseph Kennedy**  
*RSK correspondence and some consequences*
- **Kamal Lodaya**  
*Petri nets and process algebra*

- **Krishna Maddaly**  
*A possible law in the stock markets*
- **H.S. Mani**  
*High energy Neutrino detection and the study of their properties*
- **Peter Matlock**  
*T-duality in flat and curved backgrounds*
- **Antoine Meyer**  
*Infinite graphs in computer science*
- **Partha Mukhopadhyay**  
*Testing if a given finite ring is a field*
- **Amritanshu Prasad**  
*Reduction of matrices with entries in a local ring*
- **K.N. Raghavan**  
*On a certain ring of invariants*
- **G. Rajasekaran**  
*The Family Problem*
- **R. Rajesh**  
*Statistics of “Turbulent Systems”*
- **R. Ramanujam**  
*Security protocols: the logical quagmire*
- **Parameswaran Sankaran**  
*Rational homotopy and formality*
- **Jayalal Sarma**  
*Evaluating Monotone Circuits*
- **George Scaria**  
*Dirichlet’s theorem on arithmetic progressions*
- **R. Shankar**  
*The source region of the 2004 Indian Ocean tsunami*
- **S. Shrihari**  
*Lyapunov Exponents for polynomial maps of degree 2*
- **Somnath Sikdar**  
*Exact Algorithms for NP-hard problems*
- **R. Simon**  
*Entanglement in Continuous Variable Canonical Systems*
- **Sunil Simon**  
*Composite strategies for finite game graphs*
- **V.S. Sunder**  
*An overdose of Weyl commutation relations*

### 4.1.7 National Science Day

February 28th of each year is celebrated as National Science Day, to commemorate the discovery of the Raman Effect. This year the activities of the day were coordinated by Parameswaran Sankaran. Over a hundred students from various city colleges besides members of our Institute participated in the activities.

The day began with a screening test for the quiz programme. There were three popular lectures, one in each of the three major groups: Mathematics, Theoretical Computer Science and Physics. The day ended with the quiz programme and prize distribution.

The speakers and the titles of talks given, are listed below.

- **Meena Mahajan**, IMSc  
*How many cameras does the Big Brother need?*
- **G. Baskaran**, IMSc  
*Science hidden in a logo*
- **M. Krishna**, IMSc  
*Probabilities in financial market*

## 4.2 Other Conferences/Workshops Organized by IMSc

### 4.2.1 Indo-Israeli Workshop on Condensed Matter Physics

The series of *Indo-Israel meetings in condensed matter physics* was started in 1999 under the auspices of the Indian National Science Academy (INSA) and the Israeli Academy for Science and Humanities to promote a forum for collaboration and dialog amongst Indian and Israeli condensed matter physicists. The first was held in Delhi during January 1999 and the second in Jerusalem during January 2002. This third meeting was held in Puri during April 17-21, 2005 and was funded principally by SNBNCBS, Kolkata and IOP, Bhubaneswar with support from IMSc.

The meeting was held at the Toshali sands resort. The talks were spread over 14 sessions. The topics of special interest were: Correlated Electron and Mesoscopic Systems, Biological Physics and Soft Matter and Statistical Mechanics and Materials. The talks covered a wide range of very interesting phenomena related to thermal, acoustic, electronic, magnetic and mechanical properties of nano structures, exotic optical materials with negative refractive index, quantum control and chaos, chemotaxis, conduction of electro-chemical signals in nerve cells, physical properties of DNA, protein aggregation diseases, dynamics of bacterial colonies, dynamics of the human heart, colossal magneto-resistance and high  $T_c$  superconductivity, quantum Hall effect etc.

Several collaborative projects were discussed and the stage was set for further such meetings in the future.

### 4.2.2 25<sup>th</sup> Conference on Foundations of Software Technology and Theoretical Computer Science

FST&TCS is an annual international conference on theoretical computer science held in India. The *Silver Jubilee* edition of FST&TCS was held at IIIT, Hyderabad during Dec 13 – 18, 2005. It was a four day conference with 7 invited talks and 38 contributed papers, which were selected by the international program committee from among 167 submissions with authors from 29 countries. The program committee was co-chaired by R. Ramanujam (IMSc) and Sandeep Sen (IIT-Kharagpur). FST&TCS included two pre-conference workshops: one on *Algorithms in Networking* coordinated by Amit Kumar (IIT Delhi) and Aravind Srinivasan (University of Maryland), and another on *Software Verification* coordinated by P. Madhusudan (University of Illinois at Urbana Champaign) and Sriram Rajamani (Microsoft Research). The proceedings was published by Springer Verlag as Lecture Notes in Computer Science, volume 3821.

### 4.2.3 International Workshop on Noncommutative geometry and quantum Physics

The International Workshop was organised by S N Bose Centre and sponsored by IMSc during January 4-6, 2006 to discuss recent developments in noncommutative geometry and quantum physics with applications to gravity, particle physics and condensed matter systems.



It was attended by 50 participants. About 35 talks were presented on Noncommutative geometry and quantum physics.

#### **4.2.4 National Conference on Nonlinear Systems and Dynamics**

The primary objective of the National Conference on Nonlinear Systems and Dynamics (NC-NSD) was to provide a forum for bringing the various research groups working in the area of Nonlinear Systems and Dynamics on a single platform for reporting research findings and discussing their investigations. Topics ranging from Integrable systems and solitons, Hamiltonian and quantum chaos to Control of chaos and synchronization, Spatio-temporal pattern formation and turbulence were covered. Also multi-disciplinary fields such as nonlinear optics, magneto-hydrodynamics, plasma physics, nonlinear phenomena in engineering and biological sciences found place in this meeting.

## 4.3 Seminars

Date	Speaker Affiliation	Title
01-04-2005	Indranil Mitra SINP Kolkata	Mathematical Modelling of Cognitive functions - A proposal
04-04-2005	Biswajit Chakraborty S.N.Bose Centre Kolkata	Dual Families of Non-commutative Quantum Systems
05-04-2005	Narendra Sahu IIT Mumbai	Baryogenesis: An interface of Particle physics and Cosmology
05-04-2005	Pragya Shukla IIT Kharagpur	Level-Statistics of Disordered Systems
06-04-2005	Lakshmi Subramaniam, Centre for Studies in Social Sciences, Kolkata	Towards a Unitary Trading Network? The Case of the Indian Ocean in Historiographical Perspective
07-04-2005	Christopher R. Vinroot TIFR Mumbai	Character degree sums of finite groups of Lie type
08-04-2005	Murali Vemuri CMI	Kahler geometry
08-04-2005	Lakshmi Subramaniam Centre for Studies in Social Sciences, Kolkata	Merchants in Transit: Risk Sharing Strategies in the Indian Ocean
13-04-2005	Jessica Flack	Management and network structure: A robust primate social niche emerges from conflict
13-04-2005	J. Maharana IOP Bhubaneswar	Aspects of String Cosmology
13-04-2005	S. Larsen Santa Fe Institute, USA	Complex Systems Research in Santa Fe Institute, USA
13-04-2005	O. Peters Santa Fe Institute, USA	Rainfall in a Critical Atmosphere

15-04-2005	Arti Garg TIFR Mumbai	Metals, Insulators and Superconductors: A dynamical Mean Field theory perspective
20-04-2005	Sujata Ghosh Viswabharati, Santiniketan	A Logic of Inconsistency
21-04-2005	Preena Samuel IMSc	Connectedness theorem by Hartshorne
21-04-2005	Sarbeswar Pal IMSc	Dedekind domains and discrete valuation rings
21-04-2005	Sachin Gautam IMSc	On the notion of “etaleness”
22-04-2005	N. Deiva Sundaram Director, Linguistics Studies Unit, Department of Tamil Language, University of Madras	Chomsky’s Universal Grammar
22-04-2005	Ravi Chinnappan, IMSc	First Principles Study of Aluminium Alloy Thermodynamics
25-04-2005	L. Devaki Central Institute of Indian Languages, Mysore	Language as a complex dynamical system
27-04-2005	B. Sathiapalan IMSc	Independence in String Theory: Loop Variables and the Problem of Background
28-04-2005	Ioulia Baoulina IMSc	On some special equations over finite fields
29-04-2005	Tara Thiagarajan National Institute of Mental Health, Bethesda MD, USA	Initiation and Propagation of Activity in Cortical Networks
04-05-2005	H. Chakrabarti, Bidhannagar College, Kolkata	Glass Transitions in a Strongly Correlated 2D liquid System
16-05-2005	Adimurthy TIFR Bangalore	Hardy Sobolev inequality

18-05-2005	N.S.N. Sastry ISI Bangalore	Non-abelian representations of Finite Geometries
18-05-2005	N.S.N. Sastry ISI Bangalore	On Finite Simple Groups
20-05-2005	H. Mweene University of Zambia, Lusaka, Zambia	Diagonalization of Certain Families of Matrices
25-05-2005	P.N. Pandita North-Eastern Hill University, Shillong	Squark and Slepton mass relations as Probes of Supersymmetric Unification
26-05-2005	M. Sivakumar University of Hyderabad	Vasiliev's Approach to Higher Spin Fields
06-06-2005	J. Maharana IOP Bhubaneswar	String Compactification and Cosmological Constant Problem
07-06-2005	P. Murugan Tohoku University, Sendai, Japan	Growth, Bonding and Magnetism in $Mo_xS_y$ Clusters
09-06-2005	G. Baskaran IMSc	A New theory of Supersolid He4
10-06-2005	K. Varadarajan University of Calgary, Canada	Exchange Rings and Clean Rings
14-06-2005	Y. Sudhakar SINP Kolkata	Many polaron effects in the Holstein Model
15-06-2005	Raghavan Narasimhan	$L^2$ Vanishing Theorems and Geometric Applications
16-06-2005	Malabika Pramanik Caltech	Some Applications of an Inequality of Wolff
17-06-2005	Karthik Ramaseshan	Linearized Attenuated Radon Transform
22-06-2005	Kaushal Verma IISc	Boundary regularity of proper holomorphic mappings

22-06-2005	N.D. Hari Dass IMSc	String Formation in Gauge Theories – First results from KABRU
28-06-2005	K. Narayan TIFR Mumbai	Closed string Tachyons, Topology change and Duality
28-06-2005	K.R. Parthasarathy ISI	Quantum information theory
29-06-2005	Gautam I. Menon IMSc	Machines at the Molecular Scale
30-06-2005	Harish Parthasarathy NSIT New Delhi	Finite element methods in mechanics and electrodynamics
30-06-2005	N. Sukumar Renesslar Polytechnic Institute, USA	Machine Learning with High-Throughput Electron Density-Derived Molecular Descriptors: From Drug Discovery to Bioinformatics
30-06-2005	K.R. Parthasarathy ISI	Quantum information theory
30-06-2005	Mohua Banerjee IIT Kanpur	Some logics based on S5
01-07-2005	K. Srinivasan S.N.Bose Centre Kolkata	Optics: A Paradigm to Learn Physics
01-07-2005	J.V. Narlikar	Revolutions in Physics
06-07-2005	P. Ray IMSc	Physics of Material Breakdown
11-07-2005	Nutan P. Limaye IMSc	Parallel Complexity Classes centred around LogCFL
13-07-2005	G. Date IMSc	Quantum Theory of the Cosmological Sector
14-07-2005	Sheerazuddin IMSc	A Logic for Pointers

15-07-2005	Maria J. Esteban	A General method to find Eigenvalues in gaps of the continuous spectrum and applications
15-07-2005	S.N. Biswas	Two Aspects of Computer Vision
18-07-2005	Sumathi Rao H.R.I. Allahabad	Correlation effects on Transport through Junctions of Quantum wires
18-07-2005	Marco Panero DIAS, Ireland	Numerical Simulations on the Fuzzy sphere
20-07-2005	K.S. Kavikumar Madras School of Economics	Towards a formal framework of vulnerability to climate change
21-07-2005	T.R. Govindarajan IMSc	Quantum Physics with Space-time Noncommutativity I
22-07-2005	A.P. Balachandran Syracuse University, USA	Quantum Physics with Space-time Noncommutativity II
25-07-2005	Seckin Kurcuoglu DIAS, Ireland	Diffeomorphism in Non commutative Space and Gravity
27-07-2005	G.S. Iroshnikov Moscow Institute of Physics and Technology	Instanton contributions to tunnelling splitting of excited energy levels of Quantum Systems
27-07-2005	Abhijnan Rej Boston University, USA	Quantum Groups I: Mathematical Aspects
28-07-2005	R. Srinivasan University of Tokyo	Generalised CCR-Flows
28-07-2005	R. Jagannathan IMSc	Quantum Groups II: Physical Aspects
29-07-2005	Sachin Vaidya CHEP, IISc Bangalore	UV/IR divergence: to be or not to be
04-08-2005	R. Srinivasan University of Tokyo	Stochastic Integration with respect to Quasi-Exponential Product Systems

10-08-2005	G.S. Iroshnikov Moscow Institute of Physics and Technology	Strings and Large-N QCD
11-08-2005	R. Adhikari University of Edinburgh	Arrested coarsening in Binary fluid mixtures: Shear flow and Nano-colloidal Additives
11-08-2005	Atish Das Sarma IIT Mumbai	Robust Incremental k-Median Clustering
12-08-2005	Ujjwal Sen ICFO - Institut de Ciencies Fotoniques, Barcelona, Spain	Classical Information Transfer by Quantum States
12-08-2005	Rajaram Bhat ISI Bangalore	Dilations of Stable Semigroups
17-08-2005	Takao Morinari Yukawa Institute for Theoretical Physics, Kyoto University	Half-skyrmion Spin texture in Single-hole-doped High-Tc Cuprate
18-08-2005	Sitabhra Sinha IMSc	The (Statistical) Mechanics of Popularity and the Emergence of “Blockbusters”
18-08-2005	V.S. Lakshmanan University of British Columbia, Canada	To Give or not to Give: Just How Safe is Your Data?
18-08-2005	T.E. Venkata Balaji Mathematics Institute at Goettingen	Vector Bundles without Azumaya Structures and Good Quadratic Forms
22-08-2005	Aravind Srinivasan University of Maryland, USA	Constructing nice distributions using Linear algebra and Randomness
23-08-2005	Fethi Madouri University of Tunis, Tunisia	$Z_3$ -graded Grassmann Variables, Parafermions and their Coherent States
24-08-2005	M.V.N. Murthy IMSc	A Question of Hierarchy: matter effects with Atmospheric Neutrinos

25-08-2005	Benjamin Miller UCLA	Borel Automorphisms of Polish Spaces
29-08-2005	Prabhu Manyem University of Ballarat, Australia	Syntactic Characterisations of Polynomial-Time Optimisation Classes
30-08-2005	S.M. Srivastava ISI Kolkata	A Measurable marriage problem
02-09-2005	C. Pandu Rangan IIT Madras	On Proactive Perfectly Secure Message Transmission
07-09-2005	Rajarshi Ray SINP Kolkata	Phase Transitions and QCD
09-09-2005	Samir Datta CMI	The Directed Planar Reachability Problem
15-09-2005	J. Katriel Technion, Israel	Representation Theory of the Symmetric Group in terms of a set of Commuting Operators
16-09-2005	Alexander Fell RWTH, Aachen	A feasibility study to improve results of search engines
16-09-2005	Vani Vemparala Center for Molecular Modelling, University of Pennsylvania, USA	Computational studies of chemical and biological systems: a molecular dynamics perspective
19-09-2005	K.G. Guruharsha	Gene regulation during animal development—insights from <i>Drosophila</i> Myogenesis
22-09-2005	Sujit Sarkar TIFR Mumbai	Fractionally Quantized Magnetization Plateaus of Low-Dimensional Spin Disorder Systems under a Magnetic Field
22-09-2005	V.M. Datar TIFR Mumbai	Gamma ray signals from dumbbell shaped $^8\text{Be}$
23-09-2005	Nilmani Mathur Kentucky University, USA	Hadronic Physics from Lattice



23-09-2005	Meena Mahajan IMSc	Simultaneous Matchings
26-09-2005	N. Aizawa Osaka Prefecture University, Japan	Noncommutative Spaces of Quantum Groups and Supersymmetric Extension
27-09-2005	Abhishek Dhar RRI Bangalore	Nonequilibrium Green's function formalism and the problem of bound states
29-09-2005	M.G. Nadkarni University of Mumbai	Glimm-Effros theorem
29-09-2005	Tarun Souradeep IUCAA Pune	Mining the CMB anisotropy for Early Universe physics
30-09-2005	Tarun Souradeep IUCAA Pune	Cosmological Frontiers with CMB Anisotropy
04-10-2005	S. Sundar IMSc	Proof of Brouwer's fixed point theorem
12-10-2005	Thakur Ajay Singh IMSc	van-Kampen theorems
13-10-2005	V.S. Sunder IMSc	Matrices of small norm
14-10-2005	Deepak D'Souza IISc Bangalore	A Unification-based Decision procedure for Cryptographic Protocol analysis
14-10-2005	George Scaria IMSc	Eisenstein's description of trigonometric functions
18-10-2005	Umesh Venkatesh Dubey IMSc	Hopf fibration
19-10-2005	Rahul Sinha IMSc	B mesons and signals of New Physics
21-10-2005	Rahul Basu IMSc	The Rhythm of Time: the Evolution of the Calendar through the Ages

24-10-2005	R. Simon IMSc	Physics Nobel 2005
25-10-2005	J. Chakrabarti	Long Range Interaction between two Solute Particles in a Subcritical Liquid Solvent
25-10-2005	K.S. Krishna IMSc	The Stone-Weierstrass theorem
02-11-2005	Pooja Singla IMSc	Classical groups are Lie groups
09-11-2005	Rajesh Narayanan Institute for Nanotechnology, Forschungszentrum, Karlsruhe	Quantum Critical Behavior in Itinerant Magnets
11-11-2005	Sriram K. Rajamani Microsoft Research	Counterexample driven refinement for abstract interpretation
15-11-2005	Vijay Kumar AIST, Tsukuba, Japan	Designing novel nanosystems: Silicon fullerenes, nanowires, nanotubes, and cubes of magnetic Rh
15-11-2005	Sasmita Patnaik IMSc	On the existence of partitions of unity
17-11-2005	S. Shrihari IMSc	A counting result on hyperbolic Julia sets
18-11-2005	Dibyendu Das IIT Mumbai	Dynamics in the presence of a quenched random velocity field
18-11-2005	Rahul Roy ISI New Delhi	Random Directed Tree
18-11-2005	Prem Prakash Pandey IMSc	The Shauder-Tychonoff theorem
22-11-2005	L.V. Laperashvili ITEP, Moscow	Dual Symmetry of Gauge Theories, Monopoles and Dyons (Part I: Abelian theory)

23-11-2005	P.P. Biswas Institute for Theoretical Physics, University of Leipzig, Germany	Novel methods for first principles modeling and electronic structure of amorphous materials
24-11-2005	R. Radha IIT Madras	Multipliers for Sobolev spaces
24-11-2005	R.S. Raghavan Virginia Tech, USA	Neutrino Luminosity of the Sun: LENS
25-11-2005	S. Balasubramanian University of Missouri-Columbia, USA	Light Waves and Semiconductors : The Optical Detection and Tracking of Skin Cancer Tumors
25-11-2005	Alladi Sitaram ISI Bangalore	Some generalizations of the Wiener Tauberian theorem to $R(n)$ and symmetric spaces
30-11-2005	Mukunda P. Das The Australian National University	How Relevant is Occam's Razor in the Realm of Mesoscopic Electron Transport?
01-12-2005	Antoine Meyer IMSc	Finitely presented infinite graphs
02-12-2005	G. Ananthakrishna MRC, IISc Bangalore	Dynamics of the peel front and the associated acoustic emission during peeling of an adhesive tape
06-12-2005	Thomas R. Powers Brown University, USA	Mechanics of bacterial flagella
07-12-2005	Vikram Soni	Biodiversity begets Stability from a model for an Ecoweb
07-12-2005	Dietmar Berwanger LaBRI, Bordeaux	How to win when not competing
08-12-2005	Anindya Biswas IMSc	Bubble Space-Time from Black Hole and Strings
09-12-2005	B. de Wit Institute for Theoretical Physics and Spinoza Institute, Utrecht University, The Netherlands	Black hole entropy from M-theory and supergravity

09-12-2005	Pushkar Joglekar IMSc	Factorization of Polynomials over Finite Fields in subexponential time assuming GRH
09-12-2005	V. Srinivas TIFR Mumbai	Lefschetz theorems for the divisor class group
12-12-2005	B. de Wit Institute for Theoretical Physics and Spinoza Institute, Utrecht University, The Netherlands	Magnetic charges in local field theory – Lessons learnt from gauging supergravity
12-12-2005	M. Bojowald AEI, Max Planck Institute for Gravitational Physics, Germany	Quantum Geometry and Black Holes
13-12-2005	B. de Wit Institute for Theoretical Physics and Spinoza Institute, Utrecht University, The Netherlands	Black hole partition functions and duality
13-12-2005	P. van Nieuwenhuizen YITP, Stony Brook, USA	Surface terms and New Anomalies in SUSY gauge theories and Supergravity
15-12-2005	Partha Sarathi Chakraborty ISI New Delhi	Non-commutative geometry of quantum $SU(2)$ .
19-12-2005	Manindra Agrawal IIT Kanpur	Automorphisms of Finite Rings and Applications to Complexity of Problems
21-12-2005	Raghavendra Rao IMSc	Complexity of Feasible Systems of Linear Equations
22-12-2005	Joel Spencer Courant Institute of Mathematical Sciences, New York	Paul Erdős and His Magic
23-12-2005	Joel Spencer Courant Institute of Mathematical Sciences, New York	Counting Connected Graphs

28-12-2005	N.D. Hari Dass IMSc	Einstein and the bizarre world of quantum mechanics
29-12-2005	Manjul Bhargava Princeton University	Parameterization of rings of low rank
30-12-2005	N.R. Aravind IMSc	There are infinitely many Carmichael numbers
12-01-2006	Iftikhar Burhanuddin USC	Some computational problems motivated by the BSD conjecture
25-01-2006	Saradha TIFR	Some generalised Ramanujan-Nagell Equations
27-01-2006	Nutan P. Limaye IMSc	Evaluating Monotone Circuits on Cylinders, Planes and Tori
09-02-2006	Sanjay Puri JNU, New Delhi	Phase Ordering Kinetics and the Complex Ginzburg-Landau Equation
09-02-2006	S. Ramanan IMSc	Remembering Raoul Bott
10-02-2006	Shrisha Rao University of Iowa	The $n$ -Queens Problem In Higher Dimensions
15-02-2006	S. Sabhapandit LPTMS	Functionals of the Paths of a Particle Diffusing in one-dimensional Random Potential
20-02-2006	M. Marsil ICTP, Trieste, Italy	Dynamic instability in a Phenomenological model of Correlated Assets
21-02-2006	E. Laenen NIKHEF and ITP, University of Utrecht, The Netherlands	Resummation and High Energy Scattering
22-02-2006	J. Pringle Cambridge University	Spinning black holes - which way do they point?

23-02-2006	J.H. Bakke Norwegian University of Science and Technology, Trondheim, Norway	Self-affinity of fracture surfaces
01-03-2006	Bhabani P. Sinha ISI Kolkata	An Improved Sorting Technique using Parallel Multi-way Merge
01-03-2006	G.von Gehlen Physikalisches Institut, Universitat Bonn, Germany	Construction of 3-dimensional Integrable Lattice Spin Models
02-03-2006	J. Pasupathy CTS Bangalore	The Derivative of the Topological Susceptibility at Zero momentum and $\eta'$ mass in the Chiral limit
03-03-2006	S. Bandhyopadhyay University of Calgary, Canada	Monogamy of quantum entanglement
06-03-2006	S. Kumaresan University of Mumbai	Expository talk on Differential Geometry
08-03-2006	N. Iizuka TIFR Mumbai	A Stringy Small Black Ring
08-03-2006	T.K. Ghosh Okayama University, Japan	Sound propagation in a Fermi superfluid along the BEC-BCS cross-over
09-03-2006	J. Maharana IOP Bhubaneswar	Aspects of String Cosmology
09-03-2006	J. Haynes IoP Publishing, UK	Current Activities in India of Institute of Physics Publishing, UK and global physics challenges & issues
15-03-2006	A. D'Adda INFN, Torino	Supersymmetry on Lattice
16-03-2006	P. Sankaran IMSc	Convex polytopes, Torus actions and K-theory
20-03-2006	N. Kawamoto Hokkaido University, Japan	Introduction to twisted Supersymmetry on a Lattice

22-03-2006	N. Kawamoto Hokkaido University, Japan	Twisted Supersymmetric Yang-Mills theory on a lattice
24-03-2006	A. D'Adda INFN, Torino	A new Phase transition in d=2 Yang-Mills Theory
29-03-2006	U. Waghmare JNCASR Bangalore	Geometric Phases, Wannier Functions and Bonding in Materials
31-03-2006	S. Narasimhan JNCASR Bangalore	Stiffness and Thermal Stability of very Small Objects





# Chapter 5

## External Interactions

### 5.1 Collaborative Projects with Other Institutions

#### 5.1.1 Classical and Quantum Complexity of Graph Isomorphism and Related Problems

This is a joint Indo-German project funded by the DST and the DAAD to support exchange visits during the period June 2004 to June 2006. The broad aim is a study of algorithmic and complexity-theoretic aspects of the Graph Isomorphism problem and related questions. The IMSc members are: V. Arvind, Piyush Kurur, T. C. Vijayaraghavan and Bireswar Das.

#### 5.1.2 India-based Neutrino Observatory

This is an on-going feasibility study, exploring the possibility of constructing an India-based neutrino laboratory. The initial focus is expected to be the study of neutrino oscillation parameters using atmospheric neutrinos detected in a magnetised iron calorimeter (ICAL), with the possibility of doing long-baseline neutrino physics using beams from neutrino factories in the future. The feasibility study for INO is now complete and the feasibility reports have been submitted to the DAE, which funded the study entirely, and also to DST and UGC. The project is now geared for a push to the next level. Steps are being taken now to form the INO task force, scientific and engineering, to prepare detailed project reports (DPR) for the site as well as the main detector. Simultaneously, at IMSc physics and simulation studies are in progress. The Site survey group is formed to find a suitable underground location for INO. The IMSc Members of this study are: D. Indumathi, H. S. Mani, M. V. N. Murthy, G. Rajasekaran and D. V. Ramakrishna. Details of the study are available in the *Proceedings of the 29th International Cosmic Ray Conference*, pages 10 – 119, August 2005.

#### 5.1.3 JST CREST Project, Japan

This project deals with control and application of Nano-Structured Materials for Advanced Data Processing and communications. The Collaboration involves Prof. G. Baskaran, IMSc,

Prof. H. Fukuyama of Tohoku University, Sendai and Prof. N. Nagaosa of Tokyo University, Tokyo, Japan. Work on problems of strongly correlated electronics and nanoscience, is in progress.

#### **5.1.4 Wave Propagation in disordered excitable media and simulated cardiac tissue**

This is an IFCPAR project (no. 3404-4) funded by the Indo-French Centre for the Promotion of Advanced Research, being carried out by Dr. Sitabhra Sinha in collaboration with Prof. Alain Pumir of INLN, Sophia-Antipolis, France.

## 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 01.04.05 to 31.03.06 are :

### **Mohua Banerjee**

Dept. of Mathematics & Statistics, Indian Institute of Technology., Kanpur  
13.06.2005 to 08.07.2005

### **M.K. Parida**

Dept. of Physics, Tezpur University, Tezpur - 784028  
06.02.2006 to 01.03.2006

## 5.3 Conference Participation and Visits to Other Institutions

### Balakrishnan, Radha

Visited S. N. Bose National Centre for Basic Sciences, Kolkata during Apr 4 – Apr 6, 2005. Gave a colloquium on Geometry and Nonlinearity: Some Applications in Physics.

Visited George Mason University, Fairfax, Virginia, USA during May 9 – Jun 9, 2005. Research Collaboration.

Visited Limburgs Universitair Centrum, Diepenbeek; Free University, Brussels; University of Antwerp, Antwerp, Belgium during Jul 1 – Jul 20, 2005. Invited talk on my recent research work at Dept. of Physics, University of Antwerp, Belgium, at an inter-university discussion meeting.

Visited Centre for Nonlinear Dynamics, Bharathidasan University, Tiruchirapalli on Aug 23, 2005 for Thesis Viva and discussions.

Participated in *International Conference on Statistical Mechanics of Plasticity and Related Instabilities* held at IISc, Bangalore during Aug 29 – Sep 2, 2005. Gave an invited talk on “Geometric Phase and localization in dynamical systems”.

Visited Department of Physics, IIT Madras, Chennai on Sep 21, 2005. Seminar on Geometry of phase trajectories in dynamical systems.

Visited Department of Physics, IIT Madras, Chennai on Oct 26, 2005. Professor Darshan Ranganathan Memorial Lecture titled “Geometry and Nonlinearity: Some applications in physics”.

Participated in *National conference on exciting physics of this decade* held at Department of Theoretical Physics, University of Madras, Chennai during Dec 2 – Dec 3, 2005. Gave an Invited talk titled “Anholonomy of phase trajectories in nonlinear systems”.

Participated in *DST-SERC School on Nonlinear Dynamics* held at Department of Mathematics, Pondicherry University, Pondicherry during Jan 4 – Jan 24, 2006. Special Lecture on Connections between Nonlinearity and Geometry.

Participated in *XIII Ramanujan Symposium on Nonlinear Differential Equations* held at Ramanujan Institute for Advanced Study in Mathematics, University of Madras, Chennai during Feb 8 – Feb 10, 2006. Invited lecture titled “New links between geometry of moving curves and nonlinear partial differential equations”.

**Balasubramanian, R.**

Visited University of Lille during Sep 5 – Oct 5, 2005.

Participated in *Conference on Number Theory and Discrete Geometry* held at Centre for Advanced Study in Mathematics, Panjab University Chandigarh during Nov 30 – Dec 3, 2005.

Participated in *International Conference on “Diophantine Equations”* held at TIFR Mumbai during Dec 16 – Dec 20, 2005.

**Baoulina, Ioulia**

Visited Indian Statistical Institute, New Delhi during Nov 27 – Dec 2, 2005.

Participated in *International Conference on Diophantine Equations in honour of Professor T.N. Shorey on his 60th Birthday* held at TIFR, Mumbai during Dec 16 – Dec 20, 2005.

Participated in *Workshop on Number Theory and Cryptography* held at IISc, Bangalore during Jan 23 – Feb 11, 2006.

Visited University of Pune during Feb 28 – Mar 14, 2006. Gave two lectures.

**Basu, Rahul**

Participated in *Supercomputing Relativistic Heavy-Ion Collision Physics (SRHIC)* held at TIFR, Mumbai during Dec 5 – Dec 9, 2005.

Participated in *WHEPP 9* held at Institute of Physics, Bhubaneswar during Jan 3 – Jan 14, 2006.

Participated in *Linear Collider Workshop 2006 (LCWS06)* held at IISc, Bangalore during Mar 9 – Mar 13, 2006.

**Biswas, Anindya**

Participated in *Workshop on Einstein’s Legacy in the new Millennium* held at Toshali Sands, Puri, India during Dec 15 – Dec 22, 2005. An international conference on “Einstein’s Legacy in the New Millennium”.

Visited Institute of Physics, Bhubaneswar, India during Dec 23 – Dec 28, 2005. for Collaboration work.

**Date, G.**

Participated in *A. K. Raychoudhuri School on Cosmology* held at Inter University Centre for Astronomy and Astrophysics, Pune during Dec 26 – Dec 30, 2005. Gave a lecture on “Anisotropic Models in Loop Quantum Cosmology”.

**Govindarajan, T. R.**

Visited Dublin Institute of Advanced Studies, Dublin during Aug 25 – Dec 13, 2005. Research collaborations.

Visited Edinburgh University, Scotland during Oct 25 – Oct 26, 2005 and gave a seminar.

Visited Queens college, London during Oct 27 – Oct 28, 2005 and gave a seminar.

Participated in *Noncommutative geometry and Quantum Physics* held at S N Bose Centre, Kolkata during Jan 4 – Jan 10, 2006 as an Invited speaker.

Visited University of Sao Paulo, Sao Paulo during Jan 25 – Feb 25, 2006 for Research Collaboration and gave a seminar.

Visited Albert Einstein Institute for Gravitational Physics, Potsdam, Germany during Feb 26 – Mar 31, 2006 for Research Collaboration.

Visited University of Rome, Rome during Mar 10 – Mar 11, 2006 and gave a seminar.

Visited ASICTP, Trieste, Italy during Mar 12 – Mar 15, 2006 and gave a seminar.

**Hossain, Golam Mortuza**

Visited Jadavpur University, Kolkata during Jul 24 – Jul 29, 2005. Gave a series of five talks on “Introduction to Loop Quantum Cosmology”.

Visited Saha Institute of Nuclear Physics, Kolkata on Jul 25, 2005. Gave a talk on “On energy conditions in effective Loop Quantum Cosmology”.

Participated in *Einstein’s Legacy in New Millennium* held at Toshali Sands, Puri, India during Dec 15 – Dec 22, 2005. Gave a short talk on “Primordial density perturbation in effective loop quantum cosmology”.

Participated in *A.K. Raychaudhuri Memorial School on Cosmology and the Very Early Universe* held at IUCAA, Pune, India during Dec 25 – Dec 30, 2005. Gave a talk on “On energy conditions in effective loop quantum cosmology”.

Visited Perimeter Institute for Theoretical Physics, Waterloo, Canada during Mar 7 – Mar

15, 2006. Gave a talk on “Effective description of loop quantum cosmology”.

Visited Raman Research Institute, Bangalore during Mar 19 – Mar 21, 2006. Gave a talk on “Effective description of loop quantum cosmology”.

### **Indumathi, D.**

Participated in *29th International Cosmic Ray Conference* held at IUCAA, Pune during Aug 3 – Aug 10, 2005. Gave an invited “highlight” talk.

### **Ivan, Solomon J.**

Participated in *Refresher Course in Theoretical Physics* held at S.B. College, Changanacherry, Kerala during Sep 19 – Sep 30, 2005.

### **Jagannathan, R.**

Participated in *International Conference on Number Theory and Mathematical Physics* held at Srinivasa Ramanujan Center, SASTRA Deemed University, Kumbakonam during Dec 19 – Dec 22, 2005. Delivered an invited talk on “Two-parameter quantum algebras, twin-basic numbers, and associated generalized hypergeometric series”.

### **Joglekar, Pushkar S.**

Participated in *Workshop on Approximation Algorithms* held at IIT Delhi during Oct 8 – Oct 10, 2005.

### **Kesavan, S.**

Visited Université de Metz, Metz, France during May 1 – May 31, 2005. Visiting Professor. Delivered a seminar talk and a mini course of 3 lectures on “Schwarz Symmetrization”.

Visited IIT, Madras on Sep 5, 2005. Addressed the gathering as Chief Guest on Teachers’ Day.

Visited Madurai Kamaraj University, Madurai during Dec 1 – Dec 2, 2005. Delivered two lectures on “Isoperimetric Inequalities”.

Participated in *Seventy-Fifth Annual Session of the National Academy of Sciences, India* held at Pondicherry University, Pondicherry during Dec 8 – Dec 9, 2005. Delivered an invited talk.

Participated in *XIII Ramanujan Symposium on Nonlinear Differential Equations* held at

Ramanujan Institute for Advanced Research in Mathematics, University of Madras, Chennai during Feb 8 – Feb 10, 2006. Delivered an invited talk.

### **Kodiyalam, Vijay**

Visited Indian Statistical Institute, Bangalore during Apr 1 – Apr 30, 2005. Gave a talk on ‘Planar algebras and Kuperberg’s 3-manifold invariant’.

Participated in *Refresher course on Differential Geometry* held at Ramanujan Institute for Advanced Study in Mathematics during Nov 9 – Nov 29, 2005. Gave three lectures on “Differential geometry of space curves”.

Participated in *Recent advances in Operator Theory and Operator Algebras* held at IISc., Bangalore during Dec 19 – Dec 22, 2005. Gave a talk on “Planar algebras and Kuperberg’s 3-manifold invariant”.

Visited IIT, Madras on Feb 10, 2006. Gave a talk on “Planar algebras and Hopf algebras”.

Participated in *Workshop on Algebra* held at Periyar University, Salem during Feb 16 – Feb 18, 2006. Gave two lectures for graduate students.

### **Krishna, M.**

Participated in *Perspectives in Mathematics, NAS Platinum Jubilee* held at IMSc, during Sep 30 – Oct 1, 2005. Gave talk on “The beauty of Schrödinger Operators”.

Participated in *Simon Fest*, a conference on Mathematical Physics in Honour of Barry Simon on his 60th birthday, held at California Institute of Technology, Pasadena during Mar 27 – Mar 30, 2006.

### **Lodaya, Kamal**

Visited CAIR, Bangalore on Apr 4, 2005 and gave a talk on “Parsing as calculation”.

Visited LaBRI, Université Bordeaux-1 during May 9 – Jun 16, 2005. Gave a talk on “Looking back at process algebra”.

Participated in *Automata and formal languages (AFL 05)* held at Dobogókő, Hungary during May 17 – May 20, 2005. Gave an invited talk on “Looking back at process algebra”.

Participated in *4th Formal Methods Update* held at IIT Mumbai during Jul 18 – Jul 22, 2005. Gave two lectures on “Separation logic”.



Visited Dept of foundations of theoretical computer science, University of Szeged during Sep 11 – Sep 24, 2005.

Visited School of computer science, University of Birmingham during Sep 25 – Sep 29, 2005.

Participated in *25th FSTTCS* held at IIIT Hyderabad during Dec 13 – Dec 18, 2005. I was a Member of the programme committee.

Participated in *1st winter school on logic and its relationship to other disciplines* held at IIT Bombay during Jan 9 – Jan 14, 2006. Gave three lectures on “Reasoning about time: points and intervals”.

### **Mahajan, Meena B.**

Visited Max-Planck Institut für Informatik, Saarbrücken, Germany during Apr 1 – May 3, 2005. Gave a talk on “Block Sorting and Sorting with Transpositions”.

Visited Dept of Mathematics, IIT Madras on Sep 29, 2005. Gave two lectures on Complexity Theory in the QIP Short-Term training programme on Research Trends in Formal Languages and Automata Theory.

Participated in *Workshop on Approximation Algorithms* held at IIT Delhi during Oct 8 – Oct 11, 2005. Gave a talk titled “Simultaneous Matchings”

### **Majumdar, Kaushik K.**

Visited University of Memphis during May 1, 2005 – Jan 31, 2006. Research and teaching as a Fulbright Visiting Lecturer/Scholar.

Visited University of Oregon during Feb 1 – Mar 31, 2006. Research in Neuroinformatics Center.

### **Mani, Harihara S.**

Visited CMERI, Jamshedpur during May 10 – May 18, 2005. Six lectures on Special Theory of Relativity to high School students (organised by Indian Academy of Science).

Visited Institute of Astrophysics(Kodaikanal Observatory) during Jun 13 – Jun 19, 2005. Gave a series of four lectures on Cosmography and Cosmohistory.

Visited Harish-Chandra Research Institute, Allahabad during Nov 6 – Nov 13, 2005. Series of Lectures on Quantum Field Theory for preparatory SERC School.

Visited Institute of Physics, Bhubaneswar during Jan 9 – Jan 14, 2006. Attended the lectures and participated in some possible research problems in Neutrino Physics, especially regarding models which predict bi-maximal or tri-maximal mixing, which is being pursued.

### **Menon, Gautam I.**

Participated in *Indo-Israeli Workshop on Condensed Matter Physics* held at Toshali Sands, Puri during Apr 17 – Apr 21, 2005. Chaired a Session on “Biological Physics”.

Visited Cochin University of Science and Technology (CUSAT) on May 4, 2005. Gave a seminar on “Pattern Formation at the Cellular Scale”.

Visited Indian Institute of Science, Bangalore during May 29 – Jun 1, 2005. Gave a talk on “Local Structure in Vortex Glass Phases” at the Centre for Condensed Matter Theory.

Visited Institute of Physics, Bhubaneswar during Sep 10 – Sep 15, 2005. Gave an Institute Colloquium on “Machines at the Molecular Scale” and a seminar on “Local Structure in Vortex Glass Phases”. Also gave a seminar addressed to physics students at Utkal University on “Biological Physics”.

Participated in *IMSc-SFI Complex Systems School* held at IMSc, Chennai during Jan 2 – Jan 28, 2006. Gave a set of 6 lectures on “Statistical Mechanics for Complex Systems”.

Participated in *SERC School on Nanoscience and Nanotechnology* held at SINP, Kolkata during Jan 2 – Jan 31, 2006. Gave a series of 6 lectures on “Introduction to Statistical Mechanics” during Jan 10 – Jan 15, 2005.

Participated in *Workshop on “Common Trends in Traffic Systems: Physical and Computational Models in Transportation Engineering and Biological sciences”* held at IIT, Kanpur during Feb 8 – Feb 10, 2006. Gave an Invited Talk on “Collective effects and pattern formation in motor-microtubule mixtures”.

Participated in *Frontiers of Physics* held at St. Philomena’s College, Mysore during Feb 17 – Feb 18, 2006. Gave an invited talk on “Machines at the Nano-scale”.

Participated in *Indo-EU Thematic Workshop on Computational Materials Science* held at Solid State and Structural Chemistry Unit, Indian Institute of Science, Bangalore during Feb 20 – Feb 22, 2006. Gave an Invited Talk on “What lies beneath: Probing Disordered Substrates using Adsorbate Correlations”.

Visited Indian Institute of Science, Bangalore during Mar 13 – Mar 15, 2006. Gave a seminar at the Department of Inorganic and Physical Chemistry on “Loop formation Probabilities and Distribution Functions in a Model for Short double-stranded DNA Molecules”. Also visited the JNCASR and NCBS, Bangalore for collaborative work.

### **Meyer, Antoine**

Participated in *FSTTCS 2005* held at IIIT Hyderabad during Dec 15 – Dec 18, 2005.

### **Murthy, M.V.N.**

Visited Indira Gandhi Center for Atomic Research, Kalpakkam on Jun 20, 2005. Delivered a talk on “Introduction to INO”.

Visited Indian Institute of Technology, Madras on Oct 19, 2005. Delivered a seminar on “A Physicist’s view of number partitions”.

Visited University of Mysore, Mysore on Nov 18, 2005. Delivered a talk at the World Year of Physics Celebrations on “Fluctuations in finite Fermi and Bose systems”.

### **Muthu, Rahul**

Participated in *Workshop on Software Verification* held at Hyderabad Central University, Hyderabad during Dec 13 – Dec 14, 2005.

Participated in *Pre-conference Workshop on Algorithms in Networking* held at Hyderabad Central University, Hyderabad on Dec 14, 2005.

Participated in *FSTTCS 2005* held at IIIT Hyderabad during Dec 15 – Dec 18, 2005.

### **Natarajan, Aravind**

Participated in *Workshop on Approximation Algorithms* held at IIT Delhi during Oct 8 – Oct 10, 2005.

### **Prasad, Amritanshu**

Participated in *the 9th Discussion Meeting on Harmonic Analysis* held at the Harish-Chandra Research Institute, Allahabad during Oct 17 – Oct 19, 2005 and gave a talk.

Visited the University of Madras during Jan 1 – Jan 7, 2006. Delivered five lectures on “Cellular Algebras”.

Participated in *the Advanced School and Conference on Representation Theory and Related Topics* held at the International Centre for Theoretical Physics, Trieste, during Jan 9 – Jan 27, 2006.

## **Rajasekaran, G.**

Participated in *Summer Institute* held at Indira Gandhi Centre for Atomic Research, Kalpakkam during May 20 – Jun 5, 2005. Gave a lecture titled: “Is there a Final Theory?”

Participated in *Summer Institute* held at Science City, Chennai during May 30 – Jun 10, 2005. Gave two lectures on “Neutrinos and INO”.

Visited University of California, Riverside during Aug 1 – Aug 30, 2005. Pursued collaborative research with Faculty of Physics Department.

Visited Pondicherry University on Sep 23, 2005. Gave a lecture on “Einstein and a Century of Physics”.

Participated in *Exciting Physics of this Decade* held at University of Madras during Dec 2 – Dec 3, 2005. Gave a talk on “The Discovery of Neutrino Mass”.

Participated in *75th Annual Session of the National Academy of Sciences of India* held at Pondicherry University during Dec 8 – Dec 9, 2005. Gave a talk on “The Discovery of Neutrino Mass”.

Participated in *Einstein’s Legacy in the New Millennium* held at Toshali Sands, Puri during Dec 15 – Dec 22, 2005 and chaired a Session.

Visited IUCAA & NCRA, Pune during Dec 29 – Dec 30, 2005. Visited the GMRT and the new optical telescope of IUCAA.

Visited IGCAR, Kalpakkam on Feb 28, 2006. Gave a lecture on “Recent discoveries in Neutrino Physics and INO”.

## **Raman, Venkatesh**

Participated in *Annual Ramanujan Mathematical Society Conference* held at Calicut on Jul 3, 2005. Gave a talk on “Structural and Algorithmical results for cycle hitting set problems”.

Participated in *FST&TCS Conference* held at Hyderabad during Dec 16 – Dec 18, 2005 and chaired a session.

Participated in *IARCS refresher course on Data Structures and Algorithms* held at Selvam Arts and Science College Namakkal during Jan 7 – Jan 8, 2006. I was one of the resource persons.

Visited IIT Chennai on Jan 13, 2006. Gave a talk on “Probabilistic Method – Erdo’s magic”.

Participated in *National Workshop on Algorithms* held at St. Xavier’s College, Palayankottai, Tamil Nadu on Mar 4, 2006. I was one of the resource persons.

## **Ramanujam, R.**

Visited Tata Institute of Fundamental Research, Mumbai during Apr 26 – Apr 30, 2005. Gave a talk on “Verification of security protocols”.

Visited LaBri, Bordeaux, France during May 9 – Jun 6, 2005. Gave a lecture on “Logics for security protocols”.

Visited LSV, École Normale Supérieure de Cachan, France during May 30 – May 31, 2005. Gave a lecture on “Decidability issues in security protocols”.

Participated in *TARK XI (Reasoning about Theoretical Aspects of Rationality and Knowledge)* held at University of Singapore during Jun 11 – Jun 13, 2005 and presented paper.

Participated in *Update meeting on Formal Methods* held at IIT Mumbai during Jul 18 – Jul 22, 2005. Gave a tutorial on “Language based security”.

Participated in *FST&TCS Workshop on Software Verification* held at University of Hyderabad during Dec 13 – Dec 14, 2005. Gave a tutorial lecture on “Büchi’s theorem for Pushdown Systems”.

Participated in *Winter school on Logic and applications* held at IIT Mumbai during Jan 3 – Jan 18, 2006. Gave a set of five lectures on “The Logic - Automata connection”.

Visited Vysya Engineering College, Salem on Feb 28, 2006. Gave a talk on “Cryptographic protocols”.

Visited Sairam College of Engineering, Chennai on Mar 22, 2006. Gave a lecture on “Research in Theoretical Computer Science”.

## **Rao, Raghavendra B.**

Participated in *FST&TCS* held at IIIT, Hyderabad during Dec 15 – Dec 18, 2005.

## **Sankaran, Parameswaran**

Visited Indian Statistical Institute, Kolkata during Apr 25 – Apr 28, 2005. Gave a talk on “Equivariant Schubert Calculus”.

Participated in *Conference on geometry and topology, Ramanujan Mathematical Society Annual Meeting* held at University of Calicut, Kozhikodu during Jul 25 – Jul 30, 2005. Gave three lectures on “Some applications of algebraic topology”.

Participated in *Commutative Algebra and Algebraic Geometry* held at IMSc., during Aug 1 – Aug 5, 2005. Gave a talk on “On certain rings of invariants”.

Visited University of Hyderabad, Hyderabad during Aug 11 – Aug 12, 2005. Gave a talk on “Residual finiteness and chaos”.

Participated in *Refresher Course in Differential Geometry* held at Ramanujan Institute, University of Madras, Chennai during Nov 9 – Nov 29, 2005. Gave six lectures on “Length, area, isometry, and surfaces”.

Participated in *Advanced Instructional School in Algebraic and Differential Topology* held at Indian Statistical Institute, Kolkata during Dec 5 – Dec 31, 2005. Gave six lectures on “Characteristic Classes”.

### **Sathiapalan, Balachandran**

Participated in *String Workshop* held at IIT Kanpur during Oct 9 – Oct 16, 2005.

Visited Dublin Institute for Advanced Studies during Nov 15 – Nov 19, 2005. Gave Seminar on 17th .

Visited Institute of Physics, Bhubaneswar during Feb 21 – Feb 23, 2006. TPSC seminar on “Loop Variables: A proposal for a Background Independent Approach to String Theory”.

### **Saurabh, Saket**

Participated in *The 4th Annual Inter Research Institute Student Seminar in Computer Science* held at IIT, Kanpur during Apr 1 – Apr 2, 2005.

Visited Department of Informatics, University of Bergen, Norway during Feb 1 – Mar 1, 2006 for research discussions.

### **Sharma, Chandradew**

Participated in *IX Workshop on High Energy Physics Phenomenology* held at Institute of Physics, Bhubaneswar during Jan 3 – Jan 14, 2006.

Participated in *Linear Collider Workshop, 2006* held at Indian Institute of Science, Bangalore during Mar 9 – Mar 13, 2006.

### **Siddharthan, Rahul**

Visited NCBS, Bangalore during Jun 26 – Jul 2, 2005. Academic visit, mainly to the lab of K Vijay Raghavan.

Participated in *Meeting on Systems Biology* held at ICGB, Delhi on Oct 27, 2005.

Participated in *Annual meeting of the Indian Academy of Sciences* held at Bharathidasan University, Tiruchi during Nov 11 – Nov 13, 2005.

Participated in *Complex Systems School* held at IMSc, during Jan 2 – Jan 27, 2006. Gave three talks on “Regulatory Genomics”.

### **Sikdar, Somnath**

Participated in *9th Italian Conference on Theoretical Computer Science, ICTCS 2005* held at Siena, Italy during Oct 12 – Oct 14, 2005.

Participated in *The 5th Annual Inter Research Institute Student Seminar in Computer Science (IRISS 2006)* held at Department of Computer Science and Engineering, Indian Institute of Technology Madras, Chennai during Jan 19 – Jan 21, 2006.

### **Simon, R.**

Participated in *Refresher Course in Theoretical Physics*, sponsored by the Indian Academy of Sciences held at S.B. College, Changannacherry during Sep 19 – Sep 30, 2005. Gave a course of six lectures in “Group Theoretical Methods”.

Visited St. Pious College, Hyderabad during Oct 28 – Oct 29, 2005. Gave two talks on “Einstein and the Genesis of Quantum Theory” in a Lecture Programme sponsored by the Indian Academy of Sciences.

Participated in “*Foundations of the Quantum Theory*” held at Centre for Philosophy and Foundations of Science, New Delhi during Jan 9 – Jan 12, 2006. Gave a talk on “Some open problems in Quantum Information Theory”.

Participated in *International Conference on “Quantum Computation: Back Action”* held at IIT, Kanpur during Feb 6 – Feb 13, 2006. Gave a talk on “Positive Maps and Nondistillable Entanglement”.

Visited IGCAR, Kalpakkam during Feb 17 – Feb 18, 2006. Gave a talk on “Glauber, Sudarshan, and Physics Nobel 2005”.

### **Sinha, Nita**

Participated in *IX Workshop on High Energy Physics Phenomenology (WHEPP-9)* held at Institute of Physics, Bhubaneswar during Jan 3 – Jan 14, 2006. Co-ordinator for working group 3, at the workshop.

## **Sinha, Rahul**

Visited Institute of Physics, Yonsei University, Seoul, Korea during May 1 – May 21, 2005. Collaboration and delivered three talks entitled “Introduction to  $B \rightarrow VV$  decays”, “Measuring Weak Phases using  $B \rightarrow VV$ ” and “New Physics signals using  $B \rightarrow VV$ ”.

Participated in *IXth Workshop on High Energy Physics Phenomenology (WHEPP-9)* held at Institute of Physics, Bhubaneshwar during Jan 3 – Jan 14, 2006. I was a Member of the National Organization Committee.

## **Sinha, Sitabhra**

Participated in *Third Indo-Israeli Meeting in Condensed Matter Physics* held at Toshali Sands Resorts, Puri, India during Apr 17 – Apr 21, 2005. Talk on “The role of Structural and Dynamical Disorder in Wave Propagation through Active Media”.

Participated in *School and Workshop on Structure and Function of Complex Networks* held at International Centre for Theoretical Physics, Trieste, Italy during May 16 – May 27, 2005. Talk on “Are complex networks unstable?”

Participated in *DBT Meeting in Systems Biology* held at ICGEB, New Delhi, India on Oct 27, 2005. Invited Talk on “Network Biology”.

Visited Helsinki University of Technology, Helsinki, Finland during Nov 6 – Nov 18, 2005. Talks on “Physics of Cardiac Arrhythmias” and “The Emergence of Popularity: Statistical mechanics of movie income”.

Visited Christian-Albrechts-University, Kiel, Germany during Nov 21 – Nov 22, 2005. Talk on “Blockbusters, Bombs and Sleepers: The income distribution of movies”.

Visited Centre for Cellular and Molecular Biology, Hyderabad during Dec 21 – Dec 23, 2005. Talk on “Physics of Cardiac Arrhythmias”.

Participated in *International Workshop on Econophysics of Stock Markets and Minority Games* held at Saha Institute of Nuclear Physics, Kolkata during Feb 14 – Feb 17, 2006. Invited talks on “The Power (Law) of Indian Markets: Analysing NSE and BSE trading statistics” and “The Apparent *Madness of Crowds*: Irrational collective behavior as an emergent outcome of networked interactions among individually rational agents”.

Visited International Centre for Theoretical Physics, Trieste, Italy during Mar 23 – Mar 25, 2006. Talk on “The Emergence of Popularity: Statistical mechanics of movie income”.

Participated in *India-China-Europe Triangular Meeting on Scientific Research Policies* held at Institute for Scientific Interchange (ISI) Foundation, Turin, Italy during Mar 27 – Mar 28, 2006. Invited talk on “Complex Systems Research at IMSc”.



## **Sinha, Sudeshna**

Visited Biomedical Engineering Department, University of Florida, Gainesville during May 7 – May 25, 2005 for collaborative research.

Visited Physics Department, University of Missouri, St. Louis during May 26 – May 28, 2005 and delivered a lecture.

Visited Physics Department, University of Potsdam during Jun 1 – Jun 15, 2005. Collaborative Research and delivered a lecture.

Participated in *International Conference on Control and Synchronization of Dynamical Systems* held at Leon, Mexico during Oct 4 – Oct 7, 2005 as an invited speaker.

Participated in *National Conference on Nonlinear Systems and Dynamics* held at RIASM, Chennai during Feb 6 – Feb 8, 2006 as an invited speaker.

## **Sircar, Nilanjan**

Participated in *National Workshop on String Theory* held at IIT Kanpur during Oct 9 – Oct 16, 2005.

## **Sridharan, Shrihari**

Participated in *IV Workshop on Dynamical Systems* held at Universidad Catolica del Norte, San Pedro de Atacama, Chile during Aug 15 – Aug 19, 2005. Gave a talk titled “Asymptotic Behaviour of Closed Orbits on Hyperbolic Julia Sets”.

Visited Indian Statistical Institute, Kolkata during Sep 1 – Sep 15, 2005. Gave three talks titled “Large Deviation Results”, “A Counting Result on Hyperbolic Julia Sets” and “Non-vanishing Derivatives of Lyapunov Exponents”. Participated in discussions with Prof B.V. Rao.

Participated in *Perspectives in Mathematics* held at IMSc., during Sep 30 – Oct 1, 2005.

Participated in *IX Discussion Meeting on Harmonic Analysis* held at Harish-Chandra Research Institute, Allahabad during Oct 17 – Oct 19, 2005.

Participated in *Instructional Workshop on Recent Advances in Operator Theory and Operator Algebras III* held at Indian Statistical Institute, Bangalore during Dec 12 – Dec 17, 2005.

Participated in *International Conference on Operator Theory, Operator Algebras and Harmonic Analysis III* held at Indian Institute of Sciences, Bangalore during Dec 19 – Dec 22, 2005.

## **Srinivas, K.**

Visited Laboratoire AGAT, University of Lille, France during Sep 5 – Oct 6, 2005. Visited under CEFIPRA project to collaborate with Profs. G. Bhowmik, O.Ramare, H. Queffelec.

Participated in *Workshop in Number theory* held at Presidency College, Chennai on Nov 22, 2005. Delivered a talk on “Some Glimpses of Ramanujan’s work”.

Participated in *International Conference in Number Theory in honour of Professor R.P. Bambah’s 80th birth anniversary* held at Department of Mathematics, University of Chandigarh, Chandigarh during Nov 30 – Dec 3, 2005. Gave an invited talk on the “Zero-density estimates for Zeta-functions”.

Participated in *International Conference on Diophantine Equations in honour of Professor T.N. Shorey on his 60th Birthday* held at TIFR, Mumbai during Dec 16 – Dec 20, 2005. Delivered an invited talk on “Gap between Zeros of the Epstein’s Zeta-function”.

Participated in *XXXIII Annual Conference of Orissa Mathematical Society* held at Department of Mathematics and Statistics, University of Sambalpur, Orissa during Feb 4 – Feb 5, 2006. Delivered an invited talk on “Some problems in Analytic Number Theory”.

Participated in *Workshop on Scope and Prospects of Mathematics Education* held at G. M. College, Sambalpur, Orissa during Feb 6 – Feb 7, 2006. Delivered a talk.

Participated in *National Seminar on Number theory and its applications* held at Department of Mathematics, Providence college for women, Coonoor during Mar 1 – Mar 2, 2006. Delivered an invited talk on “Some Integer Factorization Techniques”.

Visited IIT, Chennai on Mar 17, 2006. Delivered a seminar talk on “Hardy’s theorem and the Zeros of Zeta-functions”.

## **Subramanian, C. R.**

Visited Selvam Arts and Science College, Namakkal, Tamil Nadu. Participated in the IARCS Refresher Course on Data Structures and Algorithms held during Jan 7 – Jan 8, 2006. I was one of the resource persons.

Visited St. Xavier’s College, Palayamkottai, Tamil Nadu. Participated in the *National Workshop on Algorithms* during Mar 2 – Mar 3, 2006. I was one of the resource persons. Gave two lectures on “Randomized Algorithms”.

## **Sunder, V. S.**

Participated in *Quality of Science Education & Research in Tamil Nadu University System - Challenges and Opportunities* held at Bharathidasan University, Tiruchirappalli on Jul 30,

2005. I was One of the invited panelists at a panel discussion held at this meeting

Visited Ethiraj College on Aug 19, 2005. Gave a lecture on “Braid groups”.

Participated in *Perspectives in Mathematics, conducted by IMSc on behalf of the National Academy of Sciences, Allahabad* during Sep 23 – Sep 24, 2005. Gave a lecture on “The Problem of Knot Theory”.

Participated in *9th Discussion Meeting on Harmonic Analysis* held at Harish-Chandra Research Institute during Oct 17 – Oct 19, 2005. Gave an invited lecture on “Quantum Tomography, Masas, and Complex Hadamard Matrices”.

Participated in *Analysis and Applications* held at Madurai Kamaraj University during Dec 1 – Dec 2, 2005. Gave two lectures on “von Neumann Algebras”.

Participated in *Discussion Meeting on Recent Advances in Operator Theory and Operator Algebras III* held at Indian Statistical Institute during Dec 16 – Dec 17, 2005. Gave two lectures on “Planar Algebras, Hopf algebras, and 3-Manifold Invariants”.

Participated in *International Conference on Mathematics in the Twentieth century in commemoration of the birth centenary of André Weil* held at The Mathematical Science Foundation, Delhi during Jan 2 – Jan 3, 2006. Gave a lecture on “Quantum Tomography and Masas”.

Participated in *Inaugural Symposium of Chennai Mathematical Institute* held at CMI, Siruseri, Chennai on Jan 18, 2006. Gave a lecture on “von Neumann algebras”.

Participated in *Instructional Workshop and Conference in Analysis and Applications* held at Indian Institute of Science, Bangalore during Mar 14 – Mar 23, 2006. Gave a course of 5 lectures on “von Neumann Algebras” at the workshop, and a lecture on “Temperley-Lieb Algebras and Non-crossing Partitions” at the conference.

### **Vijayaraghavan, T. C.**

Participated in *The 5th Annual Inter Research Institute Student Seminar in Computer Science (IRISS 2006)* held at Indian Institute of Technology, Chennai during Jan 19 – Jan 21, 2006.

## 5.4 Visitors from Other Institutions

Name	Affiliation	Period of Visit
Biswajit Chakraborty	S.N.Bose National Centre for Basic Science, Kolkata	04.04.05 – 06.04.05
Narendra Sahu	Indian Institute of Technology, Mumbai	04.04.05 – 08.04.05
Lakshmi Subramania	CSSSC, Kolkata	04.04.05 – 09.04.05
S.D.Rindani	Physical Research Laboratory, Ahmedabad	11.04.05 – 15.04.05
Parthasarathy Majumdar	SINP, Kolkata	06.04.05 – 15.04.05
Arti Garg	TIFR, Mumbai	13.04.05 – 17.04.05
Sujata Ghosh	Siksha Bhavana, Santiniketan	13.04.05 – 21.04.05
L.Devaki	Central Institute of Indian Languages	24.04.05 – 27.04.05
Haimanti Chakrabarti	Bidhannagar Govt. College, Kolkata	29.04.05 – 04.05.05
Gyan Prakash	HRI, Allahabad	22.03.05 – 21.04.05
Gyan Prakash	HRI, Allahabad	22.04.05 – 09.05.05
N.S.N.Sastry	ISI, Bangalore	17.05.05 – 19.05.05
G.Ravi Kumar	BARC, Mumbai	15.05.05 – 21.05.05

M.Sivakumar	Univ. of Hyderabad, Hyderabad	23.05.05 – 27.05.05
P.N.Pandita	North Eastern Hill Univ., Shillong	19.05.05 – 01.06.05
Chinnappan Ravi	Pennsylvania State Univ. USA	03.03.05 – 01.06.05
J.Maharana	Institute of Physics, Bhubaneswar	03.06.05 – 07.06.05
N.Mukunda	Indian Institute of Science, Bangalore	19.08.05 – 20.08.05
P.Murugan	Tohoku University, Japan	04.06.05 – 07.06.05
Y.Sudhakar	SINP, Kolkata	15.05.05 – 15.06.05
R.S.Milton	MCC, Chennai	02.06.05 – 14.06.05
K.Varadarajan	University of Calgary, Canada	08.06.05 – 17.06.05
Karthik Ramaseshan	University of Rochester, USA	16.06.05 – 19.06.05
Malabika Pramanik	California Inst. of Technology, USA	16.06.05 – 19.06.05
R.Ramachandran	Univ. of Pune, Pune	06.06.05 – 22.06.05
I.Suresh	National Inst. of Oceanography, Goa	17.06.05 – 23.06.05
Ramandeep S.Johal	Lyallpur Khalsa College, Jalandhar	20.05.05 – 24.06.05
Kaushal Verma	IISc, Bangalore	21.06.05 – 23.06.05
K.Narayan	TIFR, Mumbai	17.06.05 – 04.07.05

Lorenzo Ramero	Univ. of Bordeaux, France	06.06.05 – 07.07.05
C.Ryan Vinroot	TIFR, Mumbai	05.04.05 – 07.04.05
Indrajit Mitra	SINP, Kolkata	19.06.05 – 18.07.05
Rupjyoti Gogoi	University of Guwahati, Assam	01.07.05 – 20.07.05
K.V.S.Rao	ICGEB, New Delhi	14.07.05 – 14.07.05
Madhavan Varadarajan	Raman Research Institute, Bangalore	15.07.05 – 17.07.05
C.S.Srivatsan	IIT, Kanpur	09.06.05 – 15.07.05
Arghya Mondal	CMI, Chennai	22.07.05 – 31.07.05
K.R.Parthasarathy	ISI, New Delhi	19.06.05 – 31.07.05
Arjun Krishnan	Anna University, Chennai	06.07.05 – 01.08.05
Deepikaa Menon	Mt Holyoke College, USA	15.06.05 – 30.07.05
R.R.Simha	TIFR, Mumbai	17.07.05 – 04.08.05
Abhijnan Rej	Boston University, USA	06.06.05 – 05.08.05
R.Srinivasan	University of Tokyo, Japan	24.07.05 – 07.08.05
Goutam Mukherjee	ISI, Kolkata	01.08.05 – 07.08.05
A.R.Shastri	IIT, Mumbai	01.08.05 – 10.08.05

Sandeep Sen	IIT, Kharagpur	06.08.05 – 08.08.05
J.Meena Devi	Madurai Kamaraj Univ. Madurai	07.08.05 – 21.08.05
Iroshnikov Georgy	Moscow Institute of Physics and Tech., Russia	17.07.05 – 25.08.05
Takao Morinari	Kyoto University, Japan	14.08.05 – 19.08.05
Fethi Madouri	University of Tunis, Tunisia	13.08.05 – 26.08.05
K.Gowri Navada	Periyar University	22.08.05 – 28.08.05
S.M.Srivastava	ISI, Kolkata	19.08.05 – 01.09.05
A.Sankaranarayanan	TIFR, Mumbai	22.08.05 – 03.09.05
R.Thangadurai	HRI, Allahabad	01.09.05 – 03.09.05
Gyan Prakash	HRI, Allahabad	24.08.05 – 10.09.05
Benjamin David Miller	University of California	17.08.05 – 14.09.05
Jacob Katriel	Technion, Israel	14.09.05 – 18.09.05
Naruhiko Aizawa	Osaka Prefecture University, Japan	13.09.05 – 27.09.05
Alexander Fell	RWTH, Germany	02.04.05 – 01.10.05
Naveen Surendran	IISc, Bangalore	01.09.05 – 17.09.05
Sujit Sarkar	TIFR, Mumbai	20.09.05 – 24.09.05

Nilmani Mathur	Jefferson Nat Lab, USA	21.09.05 – 24.09.05
Ganesh Bagler	CCMB, Hyderabad	12.09.05 – 30.09.05
Arghya Mondal	CMI, Chennai	23.09.05 – 03.10.05
A.R.Usha Devi	Bangalore University, Bangalore	20.10.05 – 22.10.05
Dhiraj Kumar	ICGEB, New Delhi	17.10.05 – 24.10.05
Ayan Nandy	IIM, Calcutta	23.10.05 – 28.10.05
Sugata Mondal	Ramakrishnan Mission, Belurimath	06.10.05 – 03.11.05
Satyajit Mukherjee	St. Xavier's College, Kolkata	06.10.05 – 05.11.05
Surejit Sengupta	S.N.Bose National centre for Basic Science, Kolkata	25.10.05 – 28.10.05
Rajesh Narayanan	Institute for Nanotechnology, Germany	06.11.05 – 10.11.05
Ajay Patwardhan	St.Xavier's College, Mumbai	26.10.05 – 10.11.05
Vinobalan Durairaj	University of Kentucky, USA	07.11.05 – 09.11.05
A.K.Grover	TIFR, Mumbai	08.11.05 – 10.11.05
Siva Athreya	Indian Statistical Institute, Bangalore	14.11.05 – 23.11.05
Rahul Roy	Indian Statistical Institute, Bangalore	14.11.05 – 20.11.05



Dibyendu Das	IIT, Mumbai	17.11.05 – 19.11.05
Takao Korinari	Kyoto University, Japan	21.11.05 – 29.11.05
Parthasarthy Biswas	University of Leipzig, Germany	21.11.05 – 25.11.05
Sajjad Athar	AMU, Allahabad	23.11.05 – 27.11.05
R.S.Raghavan	Virginia Tech, Virginia	24.11.05 – 28.11.05
S.D.Rindani	PRL, Ahmedabad	28.11.05 – 04.12.05
M.P.Das	Australian National University, Australia	29.11.05 – 04.12.05
G.Ananthkrishnan	IISc, Bangalore	30.11.05 – 03.12.05
N.Mukunda	IISc, Bangalore	01.12.05 – 06.12.05
S.Chaturvedi	University of Hyderabad, Hyderabad	02.12.05 – 06.12.05
Vikram Soni	National Physical Laboratory, New Delhi	02.12.05 – 10.12.05
S.Srinivasa Rao	ITU, Denmark	06.12.05 – 09.12.05
Indrajit Mitra	SINP, Kolkata	13.11.05 – 13.12.05
Pradeep Kumar Mishra	University of Calgary, Canada	04.12.05 – 09.12.05
Alex Hansen	Norwegian University of Science & Technology, Norway	09.12.05 – 12.12.05

Ron Kerman	Broch University, Canada	14.12.05 – 18.12.05
Manidra Agrawal	IIT, Kanpur	19.12.05 – 21.12.05
Sounaka Mishra	IIT, Gawahati	05.12.05 – 23.12.05
A.P.Balachandran	Syracuse University, USA	18.12.05 – 24.12.05
Joel Spencer	New York University, USA	21.12.05 – 24.12.05
George W.S.Hou	National Taiwan University, Taiwan	02.01.06 – 05.01.06
Justin David	HRI, Allhabad	03.01.06 – 06.01.06
Golterman, Maarten	San Francisco State University, USA	28.12.05 – 11.01.06
Ajay	G.B.Pant University, Pant Nagar	06.01.06 – 11.01.06
Jan Smit	University of Amsterdam, Netherland	31.12.05 – 13.01.06
K.Varadarajan	University of Calgary, USA	01.01.06 – 11.01.06
S.Sankaranarayanan	ICTP, Italy	11.01.06 – 13.01.06
Sayed Akbar Jafari	Tohoko University, Japan	04.01.06 – 18.01.06
Rukmani Dey	HRI, Allahabad	11.01.06 – 13.01.06
Lukierski Jerzy	University of Wroclaw, Poland	10.01.06 – 17.01.06
K.S.Viswanathan	Simon Fraser University, Canada	15.12.05 – 16.01.06

V.Venkatesh Shenoi	Institute of Physics, Bhubaneshwar	16.01.06 – 17.01.06
Deshouillers Jean Marg	University Victor Segalen, Bordeaux	08.01.06 – 19.01.06
Kaori Tanaka	University of Saskatchewan, Canada	14.01.06 – 29.01.06
Blake Temple	UC Davis, USA	16.01.06 – 19.01.06
Jukka Pekka Onnela	Helsinki University of Technology, Finland	14.01.06 – 26.01.06
Pruisken	University of Amsterdam, Netherlands	16.01.06 – 27.01.06
Srutarshi Pradhan	NTNU, Norway	03.01.06 – 27.01.06
S.D.Adhikari	HRI, Allahabad	20.01.06 – 30.01.06
Saradha Natarajan	TIFR, Mumbai	16.01.06 – 04.02.06
Shrisha Rao	Bangalore	09.02.06 – 10.02.06
Sanjib Sabhapandit	University of Paris, France	13.02.06 – 18.02.06
Jan Oistein Haavig Bakke	Norwegian University of Science, Trondheim	30.01.06 – 26.02.06
Eric Laenen	NIKHEF, Netherland	16.02.06 – 25.02.06
Anuradha Misra	University of Mumbai, Mumbai	16.02.06 – 23.02.06
Jim Pringle	Cambridge University, UK	21.02.06 – 24.02.06

Gaganbarg	IISc, Bangalore	19.02.06 – 24.02.06
Bhaskar Saha	National Centre for Cell Science, Pune	23.02.06 – 23.02.06
Benny George K	TIFR, Mumbai	31.01.06 – 24.02.06
Rossen Dandloff	Univeristy de Cergy-Pontoise, France	02.02.06 – 01.03.06
Von Gehlen, Gunter	University of Bonn, Germany	26.02.06 – 02.03.06
Naveen Surendran	IISc, Bangalore	26.02.06 – 05.03.06
Bhabani P.Simia	ISI, Kolkata	28.02.06 – 01.03.06
Somshubhro Bandyopadhyay	University of Calgary, Canada	02.03.06 – 03.03.06
Pushan Pajumdar	Univ. of Muenster, Germany	01.03.06 – 05.03.06
S.Kumaresan	University of Mumbai, Mumbai	03.03.06 – 06.03.06
Tarun Kanti Ghosh	Okayama University, Japan	05.03.06 – 08.03.06
Norihiro Iizuka	TIFR, Mumbai	06.03.06 – 13.03.06
J.Pasupathy	IISc, Bangalore	02.03.06 – 06.03.06
M.K.Srivastava	IIT, Roorkee	28.02.06 – 11.03.06
Kamal Lochan Panigrahi	IIT, Gowahati	07.03.06 – 09.03.06

J.Maharana	Institute of Physics, Bhubaneswar	07.03.06 – 11.03.06
N.Mukunda	IISc, Bangalore	12.03.06 – 16.03.06
Alessandro Dadda	INFN, Torino	11.03.06 – 25.03.06
Noboru Kawamoto	Hokkaido University, Japan	11.03.06 – 25.03.06
Devanka Pathak	Tezpur University, Assam	05.01.06 – 31.03.06



# Chapter 6

## Infrastructure

### 6.1 Computer Facilities

#### Enhancement of Computer Facility during 2005-2006

As part of the Institute's commitment towards high quality computing environment, facilities were upgraded through Sun servers, laptops for general use, expanded WiFi facilities, extending of local area networking to Guest House Complex as well as creating additional computing facilities for visitors and new JRFs.

- Additional laser printers(3 Xerox Phaser 3450DN, 1 Phaser 3420 and 1 Color Phaser 6300DN) are added to enhance the printing facility.
- Existing old mail server(banyan) was replaced with new server(Acer Altos G710 @3GHz).
- One MacMini Apple system was installed with camera.
- Additional 6 laptops(1 Apple PowerBook, 1 Zenith Director, 2 Toshiba Tecra M3 and Thinkpad R51) were purchased to be issued to faculty on demand basis for maximum of 2months.
- The internet bandwidth was enhanced from 2Mbps to 8Mbps(1:4) with a different ISP since November 2005.
- A new policy procedure for accessing IMSc LAN from remote site was implemented.
- A single chassis 24 AMD Processor based Cray XD1 system was installed for the need of cluster computing requirements and 3 days training programme was conducted to run cluster jobs on Cray XD1(vindhya) system.
- Upgraded Maple version 10 was installed with single user license over network.
- Portable USB HDDs and Graphics Tablets were ordered for additional higher capacity storage and generating graphical presentations.
- One Technical Assistant was appointed to handle the system services.

## 6.2 The Library

The Institute Library holds a total collection of 56108 books and bound periodicals as on March 31, 2006. This includes an addition of 1924 volumes during the current year April 2005 - March 2006. The library subscribes to about 332 national and international journals in the subject areas of Theoretical Physics, Mathematics and Theoretical Computer Science including journals on exchange. The library has a well balanced collection on these subject areas and is a resource for research workers of the entire southern region.

The NBHM has recognized this Institute library as the Regional Library for Mathematics. There are about 5000 outside users from colleges, universities and research institutions from different parts of the country who made use of the library facilities for their academic and research information needs.

The library has access to over 2500+ 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, BioMedCentral & JSTOR Full digital archive. It has also perpetual online access to backfile collection of journals from Elsevier under DAE consortium, Annual Reviews Electronic Backvolume collection and SIAM Online.

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, 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 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 in the southern region.

Library is an institutional member of AMS, MALIBNET, CURRENT SCIENCE Association, and IAPT.

Library has added additional mobile racks to meet the growing needs of library space.



## Acknowledgement

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:

R. Balasubramanian, IMSc  
P. Sankaran, IMSc  
Gyan Prakash, IMSc  
Surya Ramana

Kamal Lodaya, IMSc  
Rahul Basu, IMSc  
Piyush P. Kurur, IMSc

M.C. Joshi

T. Krishnan

M.G. Nadkarni  
Michael Demuth  
B.C. Chatterjee  
V.K. Aswal

M.S. Narasimhan  
K. R. Parthasarathy  
S.H. Kulkarni

Complex Systems Project

INO Project

NBHM & DOOR Programme  
DFG, Germany  
Haested Methods Inc.,USA

ICTP, Italy