

THE INSTITUTE OF MATHEMATICAL SCIENCES

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ANNUAL REPORT

Apr 2003 - Mar 2004

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Foreword

I am pleased to present the progress made by the Institute during 2003-2004 in its many sub-disciplines and note the distinctive achievements of the members of the Institute.

As usual, 2003-2004 was an academically productive year in terms of scientific publications and scientific meetings.

The Institute conducted the “Fifth SERC School on the Physics of Disordered Systems”; a two day meeting on “Operator Algebras” and the “third IMSc Update Meeting: Automata and Verification”.

The Institute co-sponsored the conference on “Geometry Inspired by Physics”; the “Conference in Analytic Number Theory”; the fifth “International Conference on General Relativity and Cosmology” held at Cochin and the discussion meeting on “Field-theoretic aspects of gravity-IV” held at Pelling, Sikkim. The Institute faculty participated in full strength in the AMS conference in Bangalore.

The NBHM Nurture Programme, The Subhashis Nag Memorial Lecture and The Institute Seminar Week have become an annual feature. This year’s Nag Memorial Lecture was delivered by Prof. Ashoke Sen from the Harish-Chandra Research Institute, Allahabad.

The Institute has also participated in several national and international collaborative projects: the project on “Automata and concurrency: Syntactic methods for verification”, the joint project of IMSc, C-DAC and DST to bring out CD-ROMS on “The life and works of Srinivasa Ramanujan”, the Xth plan project “Indian Lattice Gauge Theory Initiative (ILGTI)”, the “India-based neutrino observatory” project, the DRDO project on “Novel materials for applications in molecular electronics and energy storage devices” the DFG-INSA project on “The spectral theory of Schrödinger operators”, and the Indo-US project on “Studies in quantum statistics”. The cluster computer being built under the ILGTI project has already reached a performance of 539 GFlops with only 81 nodes and is expected to compete for a slot in the top 500 supercomputers in the world. (I am pleased to note that the full cluster posted a performance of 959 GFlops getting a world rank of 257 in June 2004.)

This report has been compiled through the efforts of a committee consisting of Drs. G. Date, Parameswaran Sankaran, C. R. Subramanian and Mr. Paul Pandian (Librarian) together with secretarial assistance from Ms. Usha Devi. The photographs have been contributed by administration and Drs. Rahul Basu, N. D. Hari Dass, Gautam Menon, M. V. N. Murthy. I owe my gratitude to all of them.

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

April, 2004

R. Balasubramanian

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Chapter 1

The Institute

1.1 Board

Hon'ble Shri **M. Thambidurai**, Minister for Education, Government of Tamil Nadu, Fort St. George, Chennai 600 009 (Up to June 2003)
(**Chairman**)

Hon'ble Shri **S. Semmalai**, Minister for Education, Government of Tamil Nadu, Fort St. George, Chennai 600 009 (From June 2003)
(**Chairman**)

Dr. **Anil Kakodkar**, Chairman, AEC & Secretary to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001 (From December 2000)
(**Vice-Chairman**)

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

Prof. **E. Balagurusamy**, Vice Chancellor, Anna University, Chennai 600 025.
(**Member**)

Prof. **Mustansir Barma**, Department of Physics, Tata Institute of Fundamental Research, Mumbai 400 005 (As on 31st March 2004)
(**Member**)

Prof. **Ravi Kulkarni**, Director, Harish Chandra Research Institute, Chhatnag Road, Jhansi, Allahabad 211 019
(**Member**)

Prof. **C. S. Seshadri**, Director, Chennai Mathematical Institute, 92, G.N. Chetty Road, T. Nagar, Chennai 600 017
(**Member**)

Prof. **S. S. Jha**, Department of Physics, Indian Institute of Technology, Bombay, Mumbai 400 076

(Member)

Smt. **Sudha Bhave**, I.A.S., Joint Secretary to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001

(Member)

Shri **Rahul Asthana**, I.A.S., Joint Secretary (Finance) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001 (As on 31st March 2004)

(Member)

Shri **K. Gnanadesikan**, I.A.S., Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St. George, Chennai 600 009(As on 31st March 2004)

(Member)

Prof. **R. Balasubramanian**, Director, The Institute of Mathematical Sciences, Chennai

(Member Secretary)

1.2 Executive Council

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

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

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

Prof. **C. S. Seshadri**, Director, Chennai Mathematical Institute, Chennai 600 017
(**Member**)

Smt. **Sudha Bhave**, I.A.S., Joint Secretary to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001
(**Member**)

Shri **Rahul Asthana**, I.A.S., Joint Secretary (Finance) to Government of India, Department of Atomic Energy, CSM Marg, Mumbai 400 001 (As on 31st March 2004)
(**Member**)

Shri **K. Gnanadesikan**, I.A.S., Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St. George, Chennai 600 009 (As on 31st March 2004)
(**Member**)

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

1.3 Faculty

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Mathematics			
Balasubramanian, R.	balu	201	2259 1626
Kesavan, S	kesh	273	2641 2839
Kodiyalam, Vijay	vijay	228	2490 2041
Krishna, M.	krishna	285	2449 1499
Nagaraj, D. S.	dsn	291	2442 1393
Paranjape, Kapil H.	kapil	218	2259 3192
Raghavan, K. N.	knr	255	2844 6319
Sankaran, P.	sankaran	221	2446 0909
Srinivas, K.	srini	244	2448 1256
Sunder, V. S.	sunder	206	2442 0082
Iyer, Jaya N. ¹	jniyer	375	-
Prasad, Amritanshu ²	amri	213	-
Physics			
Anishetty, R.	ramesha	229	2496 0325
Balakrishnan, Radha	radha	203	2257 0387
Baskaran, G.	baskaran	233	2448 3504
Basu, Rahul	rahul	284	2245 4794, 2245 3297
Chakraborty, T. ³	tapash	215	2492 5271
Date, G.	shyam	280	2445 0203
Govindarajan, Thupil R.	trg	281	2442 2715
Guruprasad Kar ⁴	-	-	-
Hari Dass, N. D.	dass	275	2442 2767
Indumathi, D.	indu	225	2492 8138
Jagannathan, R.	jagan	219	2263 1638
Jayaraman, T.	jayaram	248	2492 9527
Kaul, R.	kaul	279	2445 3508
Majumdar, Parthasarathi	partha	282	2448 0793
Menon, Gautam I.	menon	292	2619 4134, 2621 3024
Mishra, Ashok K.	mishra	283	2492 5444
Murthy, M. V. N.	murthy	227	2257 9342, 2257 0652
Parthasarathy, R.	sarathy	214	2223 2021
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	2252 1388
Siddharthan, Rahul ⁵	rsidd	215	-
Simon, R.	simon	232	2451 0280
Sinha, Rahul	sinha	290	2448 2190

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Sinha, Sudeshna	sudeshna	216	2259 1393
Sinha, Sitabhra	sitabhra	342	2448 1487
Sridhar, R. ⁶	sridhar	213	2441 9145
Theoretical Computer Science			
Arvind, V.	arvind	277	2235 2556
Lodaya, Kamal	kamal	286	2446 9846
Mahajan, Meena B.	meena	247	2440 4396, 2440 4395
Raman, Venkatesh	vraman	243	2259 0374
Ramanujam, R.	jam	288	2492 8138
Subramanian, C. R.	crs	282	2448 3732

1.4 Scientific Staff

Ravindra, Reddy	ravi	343	2492 7845
Subramoniam, G.	gsmoni	217	2246 0520

1.5 Technical Staff

Arangarajan, R.	arajan	297	-
Mohan, S.	mohan	300	-
Paul Pandian, M.	pandian	237	-
Usha Devi, P.	usha	321	-
Venkatesan, G.	gvenkat	240	-

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¹ From 01.09.2003

² From 22.12.2003

³ Until 31.10.2003

⁴ Until 21.05.2004

⁵ From 30.06.2003

⁶ Until 31.05.2003

1.6 Project Scientists

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Mani, H.S.	hsmani	363	2227 3131
Rajasekaran, G.	graj	230	2441 3395
Sinha, Nita	nita	246	-
Srinivasa Rao, K. ¹	rao	220	-

1.7 Project Staff

Abdul Salam	salam	-	-
Eswarakumar, P. ²	eswar	326	-
Gautam Dutta ³	-	-	-
Srinivas, Shyam	sshyam	326	-
Venkatesh, T ⁴	venky	326	-

1.8 Visiting Scientists

Debanand, Sa ⁵	debanand	326	-
Divakaran, P. P. ⁶	ppd	348	-
Nadkarni, M. G. ⁷	nadkarni	248	-
Sethuraman, J. ⁸	jsethu	249	-
Setlur, Girish ⁹	gsetlur	226	-

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¹ Until 15.01.2004

⁴ Until 18.07.2003

⁷ Until 16.12.2003

² From 01.09.2003

⁵ From 02.05.2003

⁸ From 31.08.2001

³ Until 30.06.2003

⁶ From 21.07.2003

⁹ Until 31.01.2004

1.9 Post-Doctoral Fellows

Mathematics

Gautam, Vishvajit V. ¹	vishvajit	296	2254 2372
Mukhopadhyaya, Anirban	anirban	296	-
Narasimhan, Anuradha	anuradha	258	-
Subramanian, Uma	usubrama	258	-

Physics

Bhattacharya, Sandip	sandip	324	-
Ganguly, Avijit K.	avijit	324	2254 2588
Ghosh, Sibashish	sibashish	207	-
Gupta, Nayantara	nayan	328	-
Gurappa, N. ²	guru	-	-
Harikumar, E. ³	hari	258	-
Mitra, Indrajit	indrajit	328	-
Roy, Anirban	anirb	207	-
Ratnadeep, Roy	ratnadeep	246	-
Sanjay, Siwach	sanjay	295	-
Ratabole, Raghunath	raghu	327	-
De, Baskar	baskar	365	-

Theoretical Computer Science

Narayanan, Vasumathi K.	vasumathi	295	2471 2676
Vijayakumar, S.	vjy	296	2235 1587

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¹ Until 26.12.2003

² Until 24.02.2004

³ Until 23.09.2003

1.10 Ph.D. Students

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Mathematics			
Das, Paramita	pdas	224	2254 2050
Dey, Arijit	arijit	209	2254 2050
Ghosh, Shamindra Kumar	shami	224	-
Gyan, Prakash	gyan	211	-
Kanhere, Aaloka	aaloka	289	-
Muthukumar, T.	tmk	287	-
Sengupta, Ritabrata ¹	ritabrata	272	2254 2050
Uma, V.	uma	224	2235 2556
Gautam, Sachin	sachin	373	-
Gupta, Ved Prakash	vpgupta	223	-
Sarkar, Swagata	swagata	373	-

Physics

Bagchi, Arjun	arjun	211	-
Banerjee, Kinjal	kinjal	209	-
Basak, Soumen	soumen	344	2254 2050
Biswas, Turbasu	turbasu	344	-
Ezhuthachan, Bobby V. K.	bobby	334	2254 2050
Hossain, Golam Mortuza	golam	334	2254 2050
Karthik, G. V. S.	karthik	287	-
Kumar, Alok	alok	272	-
Lukose, Vinu	vinu	344	-
Saptarishi, Mandal	saptarshi	344	-
Mitra, Mithun Kumar	mithun	211	-
Rajesh, V.	chinta	289	-
Sankararaman, Sumithra ²	sumithra	259	-
Santosh, Kumar K.	sant	272	2254 2050
Sarkar, Swarnendu	swarnen	209	2254 2050
Sharma, Chandradev	sharma	344	-
Solomon, Ivan J.	solomon	289	-
Misra, Basudha	basudha	223	-
Vallan, Bruno Cruz A.	bruno	223	-
Gopala Krishna, K.	gkrishna	294	-
Syed Mohammed Kamil	kamil	223	-
Pan, Raj Kumar	rajkp	223	-

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¹ Until 31.07.2003

² Until 31.07.2003

Theoretical Computer Science

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Kurur, Piyush P.	ppk	287	-
Muthu, Rahul	rahulm	272	2233 5558
Suresh, S.P. ¹	spsuresh	344	-
Vijayaraghavan, T. C	tcvijay	259	2466 0586
Sharma, Jayalal	-	-	-
Das, Bireswar	bireswar	373	-
Kesarwani, Dushyant ²	dushyant	-	-
Limaye P., Nutan	nutan	373	-
Narayanan, N.	narayan	259	-
Prasad Rao, Donthu	prasad	294	-
Sheerazuddin, S.	sheeraz	294	-
Sikdar, Somnath	somnath	373	-
Easaw Simon, Sunil	ssimon	294	-

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¹ Until 31.7.2003

² Deceased.

1.11 Administrative Staff

<u>Name</u>	<u>Userid</u>	<u>Tel. Ext.</u>	<u>Res. Phone No.</u>
Ramakrishna Manja <i>Registrar</i>	manja	208	2492 5297
Jayaraman, R. ¹ <i>Admn. Officer</i>	rjao	242	2371 9889
Vishnu Prasad, S. ² <i>Admn. Officer</i>	svishnu	242	2492 7832
Krishnan, S. ³ <i>Accounts Officer</i>	skao	241	-
Palani, V. ⁴ <i>Accounts Officer</i>	palani	241	-

Amulraj, D.	Padmanabhan, T.
Ashfack Ahmed	Parijatham, S.M.
Babu, B.	Parthiban, V.
Balakrishnan, A.R. ⁵	Prema, P.
Balakrishnan, J.	Radhakrishnan, M. G.
Elumalai, G.	Rajasekaran, N.
Ganapathi, R.	Rajendran, C.
Gayatri, E.	Ramesh, M.
Geetha, M.	Ravichandran, N.
Indra, R.	Ravindran, A.
Janakiraman, J.	Rizwan Shariff, H.
Jayanthi, S.	Sankaran, K.P.
Johnson, P. ⁶	Selvaraj, M.
Moorthy, E.	Tamil Mani, M.
Munuswami, M.	Usha, Otheeswaran
Munuswami, N.	Varadaraj, M.
Muthukrishnan, M.	Vasudevan, T.V.
Muthusigamani, S. ⁷	Venugopal, T.
Nityanandam, G.	

email: userid@imsc.res.in

¹ Until 31.08.2003

⁴ From 11.12.2003

⁷ Until 31.10.2003

² From 08.05.2003

⁵ Until 31.07.2003

³ Until 29.02.2004

⁶ From 12.01.2004

Chapter 2

Research and Teaching

2.1 Mathematics

2.1.1 Research Summary

Algebra

The Hilbert functions of points on Schubert varieties in the Lagrangian Grassmannian have been calculated. This is in the spirit of the work of Kreiman-Lakshmibai for Schubert varieties in the Grassmannian. As a special case results of Conca on Hilbert functions of symmetric determinantal varieties are recovered.

In continuation of earlier work, certain numerical invariants of tangent cones to Schubert varieties in certain generalized flag varieties are being investigated.

Algebraic Geometry

The earlier work on Krull-Schmitt for principal bundles has been extended to positive characteristics [Na4].

It has been shown that universal bundle exists on the moduli space of topologically trivial principal G bundles on a curve of genus greater or equal to three if and only if G is a adjoint group [Na3].

The category of motives: In a continuing effort to understand Nori's construction of the abelian category of motives, it was attempted to check whether the cycles over fields of transcendence degree one constructed earlier are detected by this theory. In the process one was able to better the result of Terasoma as follows: if V is the ℓ -adic representation of the Galois group of a finitely generated field that is associated with a certain motive over that field, then one can find an UN-ramified specialisation of this representation to the Galois group of a number field such that the image of the two Galois groups is the same. In particular, certain Ext^2 -groups for this *image* need not be trivial. However, the same Ext^2 groups are expected to be trivial when considered in the category of motives over a number field. This exhibits some of the difficulties in dealing with Ext^2 (and higher Ext^i)

in the category of motives. In particular, it follows that there are not likely to be enough projective or injective objects in the category of motives. An easier proof of this was found by proving that a Tannakian category has projectives (or injectives) only if it is semi-simple.

Computations with generic groups: The study of abelian groups of large order (which is the product of one or two primes) is of great importance in cryptographic applications. Buchmann et al. and P. Schnorr have extensively investigated “generic” algorithms to extract the structure of such groups. In particular, this includes the algorithms of Pollard and Shanks. The method of index calculus is said not to be such a generic algorithm. A version of index calculus has been formulated that is amenable to interpretation as a “generic” algorithm for groups with “structure”.

The groups that are actually used for cryptographic purpose, are actually modules over a certain ring of semi-simple operators. It does appear that it is this structure that is exploited by Manindra Aggrawal and others in their recent breakthrough algorithm that achieves primality testing in polynomial time. The possibility of using this additional structure in other ways is being explored.

The structure of block ciphers: A detailed study of block ciphers was made with a view to finding techniques for cryptanalysis. While no publicly available techniques are known for completely cracking the ciphers that are currently in use (such as Rijndael, Serpent and Blowfish), one can still explore techniques that can be used to make some of the bits of the cipher text susceptible. Additionally, one can explore the vulnerabilities of certain sub-rounds. This study should lead to the setting up of a computer system that can perform such analysis on a large number of candidate block ciphers which can aid the selection the cipher that is least susceptible. The emphasis was on “generic” techniques rather than techniques that are specific to the block cipher employed.

More Calabi-Yau varieties representing Modular forms: The possibility of representing modular forms by Calabi-Yau varieties is being explored. This goes beyond existing conjectures on the relations between motives and modular forms. It was shown that this relationship can be exhibited for a large class of modular forms of different levels and weights. In addition, this was demonstrated for modular forms that are higher symmetric powers of level 2 forms which have complex multiplication.

A study of linear systems on a projective variety is a classical subject in Algebraic geometry. In particular, the syzygy-property of Abelian varieties has been studied [I1].

The parameter spaces or the moduli spaces carry lot of information on geometry and are usually better understood. A focus of study is to find interesting algebraic cycles/relations on them.

From the explicit zeta functions obtained for the projective non-singular curves $aY^e = bX^e + cZ^e$ ($e = l, 2l$, l an odd prime) defined over certain class of finite fields, the class numbers for the function fields of these curves are explicitly determined. When the field of definition of the curve(s) is fixed, these results provide concrete information on the growth of class numbers for constant field extensions of the function field of the curve(s) [A1].

The exact form of the zeta functions of the Jacobian variety of any maximal and minimal curve, of genus $g \geq 1$, defined over a finite field, is obtained. The zeta functions are seen to

satisfy, and thus corroborate, the Weil conjectures (proven in generality) in these concrete instances of higher-dimensional (dimension $g \geq 1$) varieties [A2].

Analytic Number Theory

The gaps between zeros of the zeta-function associated to an Ideal class of a real quadratic number field on the critical line has been studied [Sri].

Differential Equations

The study of homogenization of various classes of optimal control problems was continued. The non-coercivity of a functional occurring in the study of a class of low cost problems was proved. The homogenization of an optimal control problem in which the set of controls depends on the solution of the equation of state was studied and the limit problem was identified.

Mathematical Physics

A new criterion involving wavelet transform is developed for detecting components of measures a la Lebesgue decomposition. In addition work is ongoing to exhibit absolutely continuous spectrum in a class of models with decaying randomness.

Operator Algebras

It has been known for a while that ‘finite-depth subfactors’ can be used to construct 2+1-dimensional Topological Quantum Field Theories (TQFTs). It has also been known that 1+1-dimensional TQFTs, defined on the category $2Cob$ are in bijection with ‘commutative Frobenius algebras’. It has recently been shown, here, that 1+1-dimensional TQFTs on a certain category - which is a suitably ‘decorated’ variant of $2Cob$ - are closely connected to finite index subfactors, and that in fact, they are essentially in bijective correspondence with the so-called ‘planar algebras’ associated by Jones to finite-index extremal subfactors.

The irreducible representations of the ‘annular category over the planar algebra associated to a finite group’ have been classified. (The only planar algebra for which this had been done earlier was the one associated to the Temperley-Lieb algebra, and this was done a few years ago by V. Jones.)

Topology

A criterion for a real line bundle over an arbitrary topological space X to be stably trivial has been obtained using certain universal property of projective Stiefel manifolds. As an application, it is shown that no multiple nor tensor power of the tangent bundle of Alexandroff’s long line (with respect to any differentiable structure) admits a nowhere vanishing section [Sa1].

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.

[A1]

N. Anuradha.

Zeta function of the projective curve $aY^{2l} = bX^{2l} + cZ^{2l}$ over a class of finite fields, for odd primes l .

Proceedings (Mathematical Sciences), Indian Academy of Sciences, 2003.

(Submitted).

[A2]

N. Anuradha.

Maximal and minimal curves.

Journal of Ramanujan Mathematical Society, 2003.

(Submitted).

[B1]

R. Balasubramanian, S. Kanemitsu*, and K. Ramachandra*.

On ideal-function-like functions. proceedings of the international conference on special function and their applications.

J. Comput. Appl. Math., **No.1-2**, 27, 2003.

[B2]

R. Balasubramanian and Gyan Prakash.

On an additive representation function.

J. Number Theory, **No.2**, 327, 2004.

[B3]

R. Balasubramanian, Venkatesh Raman, and V. Yegnanarayanan*.

On the pseudoachromatic number of join of graphs.

Int. J. Comput. Math., **9**, 1131, 2003.

[D]

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2.2 Physics

2.2.1 Research Summary

Astro-particle Physics

The directional correlation of astrophysical objects which emit TeV energy gamma-rays with the ultra-high energy cosmic ray events observed by Akeno Giant Air Shower Array (AGASA) experiment has been studied in detail. The high energy gamma-ray sources from the third EGRET catalog which are correlated in direction with the ultra-high energy events observed by AGASA above energy $4 \times 10^{19} eV$ have been selected. Assuming Lorentz invariance is violated slightly in nature above the energy $4 \times 10^{19} eV$, which is nearly the Greisen-Zatsepin-Kuzmin (GZK) cut-off, the expected number of neutron events from these EGRET sources has been calculated in AGASA above this energy. In the presence of slight violation in Lorentz invariance, the minimum number of events AGASA and AUGER experiments would see in future from these sources have been predicted [Gu].

Biological Physics

Molecular motors are protein molecules which move on the filaments which constitute the cytoskeleton of the cell. A detailed study of pattern formation in mixtures of molecular motors and micro-tubules has been carried out [S1, Me3]. This study proceeds via the numerical solution of coarse-grained hydro-dynamical equations of motion for fields governing the local micro-tubule orientation as well as density fields for bound and free motors. It is capable of generating *all* the disordered and relatively ordered states such as lattice of vortices, lattices of asters and aster vortex mixtures which are seen in experiments *in vitro*. A study of mitotic spindle formation using these equations supplemented by appropriate boundary conditions has also been attempted and shown to reproduce some of the features of the mitotic spindle [S2]. A detailed phase diagram containing these phases has been worked out. The calculations illustrate how such a phase diagram can be used to rationalize the difference in the patterns formed by more processive (e.g. Kinesin) molecular motors and less processive ones (such as NCD).

Work is in progress concerning some aspects of the force-extension relationship for semi-flexible polymers, particularly in the large persistence length limit. The calculations are based on a novel use of transfer matrix techniques, analytic results in certain limits and Monte Carlo simulations both of semi-flexible polymers directly and the associated spin chain models. Unlike earlier calculations, these calculations span the entire regime of L/L_p where L is the length of the chain and L_p the persistence length. Properties of heterogeneous chains are also computed and some subtle issues of the equivalence of fixed extension and fixed force ensembles are addressed.

Ventricular fibrillation (VF), the major reason behind sudden cardiac death, is turbulent electrical activity in the ventricles (the two lower chambers of the heart). During VF, rapid irregular disturbances in the spatiotemporal electrical activation of heart makes it incapable of any concerted pumping action. A detailed study of the initiation of VF and its termination by small amplitude electrical pulses was undertaken. This study involves numerical solution

of partial differential equations describing the time course of activation of ventricular cells coupled to each other by gap junctions. Both, simplified excitable media models, as well as more biologically realistic models containing detailed ion channel kinetics are used in this study. Using these models, the effects of a conduction inhomogeneity (corresponding to ischemic regions in the heart) on the initiation of spiral turbulence in cardiac tissue was investigated. The size of the inhomogeneity was found to be a key determinant in the transition from a spatiotemporally chaotic state (corresponding to VF) to a rigidly rotating wave anchored to the inhomogeneity (This is clinically manifested as ventricular tachycardia, abnormal rapid heartbeat) [Sinh1]. Since, an aging heart contains inhomogeneities of various sizes, this implies a possible crucial role of large ischemic regions in the initiation of VF.

Computational and probabilistic DNA sequence analysis has been carried out (at the Rockefeller University, New York) focusing on gene regulation and detection of regulatory sites and motifs in cis-regulatory regions of genes. The evolution of regulatory sites is studied with phylogenetic information incorporated into motif detection [Si].

Classical and Quantum Gravity, Black Holes, Cosmology

In general, in loop quantum gravity, one expects the dynamical equation to be a difference equation. This however is *not* a discretization of a differential equation as done in numerical analysis. Rather, the difference equation is fundamentally specified by the quantization procedure. Such an equation has to admit a good *continuum approximation*. The analysis of this requirement also leads to a notion of *local stability*. These conditions are formulated and shown to be quite restrictive. This provides a means for resolving ambiguities inherent in quantization. The quantization of general homogeneous as well as isotropic cosmological models is shown to satisfy these conditions [Da1].

When the methods of Loop Quantum Cosmology are extended to anisotropic models with intrinsic curvature, the spin-connection has to be treated with care. Since the connection with the full theory is lost, guidance is sought from the criteria of admissible quantizations discussed in [Da1]. A general quantization of all diagonal, vacuum, Bianchi class A models has been presented in [Da3].

The Bianchi IX model plays a key role in elucidating the nature of the cosmological singularity as summarized in the Belinski-Khalatnikov-Lifschitz scenario. It is shown that the chaotic oscillatory behaviour implied by the classical relativity is modified when quantum gravity effects are incorporated [Da2].

Condensed Matter Physics

The problem of an electron on a cylinder with a uniform radial magnetic field is analysed taking two different approaches. The first one takes quantum realization of symmetries as primary concern and uses the theory of projective representations of the symmetry group of the cylinder. The second approach takes the Hamiltonian as the primary object and looks for possible admissible symmetries at the quantum level. Both approaches give the same result, namely, contrary to the naive expectation, the (classically indicated) symmetry group of the cylinder is *not* realised at the quantum level. In particular only a discrete subgroup of the translations along the axial direction is realised. The size of the discrete translation step is

controlled by the magnetic flux per slice of the cylinder [D].

In a detailed analysis of experimental data obtained from muon-spin rotation, neutron scattering and magnetization experiments, it has been shown that the high-field state of underdoped LSCO is best described in terms of a vortex glass of line vortices, lacking long-range order but possessing pronounced short-ranged order. This is the first direct observation of the vortex glass phase in a microscopic measurement[Me2]. The observation of negative third moments of the field distribution function deep into the vortex glass phase is indicative of strong three-body correlations favouring triangular lattice order locally, in the absence of long-ranged translational order. This work provides crucial support in favour of the idea of a “multi-domain glass” (Phys. Rev. B, 65, 104527 (2002)). Earlier data on BSCCO are currently being re-examined in the light of the predictions of this work, in particular the suggestion that negative third moments of the field distribution function should be observed in experiments on BSCCO at fields somewhat larger than those which have been accessed before.

Direct simulations of the depinning transition in the presence of an underlying structural phase transition are being attempted. Such studies will help to understand the relationship between the peak effect seen across phase boundaries between two structurally different phases in the disordered mixed phase.

Understanding how the presence of free surfaces affects phase transition behaviour is a problem of great interest in statistical physics. A calculation of these effects for the melting of a lattice of pancake vortices, in a simple model for the flux-lattice in the material BSCCO[Me1] has been carried out. The calculation combines a self-consistent phonon theory with density functional methods, introducing several new techniques which are potentially generalizable to study a class of related problems. The implications of these results for experiments, specifically to predicting how the profile of densities varies near free surfaces (i.e. where the surface can be melted while the material continues to be solid-like in the bulk), is being studied [Me1].

In infinite U Hubbard model, which leads to exclusion of double occupancy of sites, has been described by a free orthofermion Hamiltonian which is exactly soluble. It is found that the orthofermion distribution function is similar to the mean number of trapped electrons in an impurity in a semiconductor where the double occupancy of the impurity is forbidden. In one dimension, the thermodynamics of free orthofermions gives the exact results of infinite U Hubbard model. This shows that at least in one-dimension, the fermions with exclusion of double occupancy of sites behave as free orthofermions [Mi2].

CP-Violation, Neutrinos and B-Physics

In the Standard Model (SM), the cleanest extraction of the CP angles comes from neutral B decays that are dominated by a single decay amplitude. If there happens to be a New Physics (NP) contribution to the decay amplitude, with a different weak phase, this could seriously affect the cleanliness of the measurement. There is already a hint of such NP, as indicated by the discrepancy between the value of β extracted from $B_d^0(t) \rightarrow J/\psi K_s$ and that obtained from $B_d^0(t) \rightarrow \phi K_s$. However, it is important to confirm this through independent direct tests, and to make an attempt to obtain information about the NP amplitude, if

possible. It was found that this type of NP can be uniquely probed by performing an angular analysis of the related $B \rightarrow V_1 V_2$ decay modes. There are numerous independent relations that are violated in the presence of NP, and several of these signals remain nonzero even if the strong phase difference between the SM and NP amplitudes vanishes. The most incisive test is a measurement of the interference between CP-even and CP-odd contributions to the amplitude. For such observables (e.g. $\Lambda_{\perp i}$), neither tagging nor time-dependent measurements are required – one can also combine all neutral and charged B decays, making it easier to discover NP. Furthermore, should a signal for NP be found, one can not only place a lower bound on the size of the NP amplitudes, but also a bound on the difference between the measured and true phase of $B^0 - \bar{B}^0$ mixing. By applying this analysis to the decays $B_d^0(t) \rightarrow J/\psi K^*$ and $B_d^0(t) \rightarrow \phi K^*$, one can confirm the presence of the NP. It can even be applied within the SM to analyze decays such as $B_d^0(t) \rightarrow D^{*+} D^{*-}$, which receive both tree and penguin contributions. A significant achievement is that the size of NP as well as the the deviation from $B^0 - \bar{B}^0$ mixing phase are expressed purely in terms of experimental observables, unlike other tests of NP [Sin2, Sin6, Sin7, Sin4].

Starting with the hypothesis that quark and lepton mixings are identical at the GUT scale, it is shown that the large solar and atmospheric mixing angles together with the small reactor angle can be understood purely as a result of renormalization group evolution. The only requirements are that the three neutrinos must have the same CP parity and must be quasi-degenerate in mass. A high point of this approach is the recognition that the smallness of the reactor angle is correlated with the smallness of the third CKM angle which is known to be small, being of the order of the cube of the Cabibbo angle. This analysis predicts the common Majorana mass for the neutrinos to be larger than 0.1 eV which falls right in the range that will be probed in the on-going or future experiments searching for neutrino-less double beta decay [R4].

A complete model of leptons is constructed, based on a novel symmetry. Invariance under a specific 3×3 unitary matrix U in the lepton flavour space is chosen, such that the square of U implements a simple discrete symmetry among the three neutrino flavours and the 4th power of U is the unit matrix. Thus U generates the cyclic group Z_4 . The charged lepton mass matrix is nearly diagonal while the neutrino mass matrix is of the form suitable for explaining the maximal and large mixings in the atmospheric and solar neutrino oscillations, with nearly degenerate neutrino masses. Observable lepton flavour violation is predicted. Quarks can be incorporated into this Z_4 invariant model [R5].

Foundations of Quantum Mechanics

The basic difference between classical and quantum Physics is that in the later (i) non-orthogonal states exists and (ii) correlations that cannot be explained by any classical hypothetical theory (called entanglement) exists. Developing a theory of entanglement is essential in the field of quantum information. Hence identification and study of measures of entanglement is considered a priority in the recent research. Two measures of entanglement, namely entanglement cost and distillable entanglement are important due to their physical meaning. There indeed exists examples of states (called mixed states) where entanglement cost is strictly greater than distillable entanglement. This feature is called irreversibility. But it is still not known whether all mixed states are irreversible or not. In this aspect it has been shown that for a set of density matrices this irreversibility holds, thus strengthening

the belief that irreversibility is the generic property. In addition, the following results have been obtained:

A proof of impossibility of probabilistic exact $1 \rightarrow 2$ cloning of any three different states of a qubit has been given. The simplicity of the proof is due to the use of a surprising result of M.-Yong Ye et al (quant-ph/0307027) concerning remote state preparation. This result has been extended to higher dimensional cases for special ensemble of states [Gh1].

The necessary and sufficient amount of entanglement required for cloning of orthogonal Bell states by local operation and classical communication has been derived. Using this result, some new examples of reversible, as well as irreversible states have been provided [Gh2].

In $2 \otimes 2$, more than 2 orthogonal Bell states with single copy can never be discriminated with certainty if only local operations and classical communication (LOCC) are allowed. We have shown that more than d orthogonal maximally entangled states in $d \otimes d$, which are in canonical form, used by Bennett et. al. (Phys. Rev. Lett. 70 (1993) 1895) can never be discriminated with certainty when a single copy of the states is provided. Interestingly, it has been shown that all orthogonal maximally entangled states, which are in canonical form, can be discriminated with certainty if and only if two copies of each of the states are provided. The highly nontrivial problem of local discrimination of d or less number of pairwise orthogonal, maximally entangled states in $d \otimes d$ (in single copy case), which are in canonical form, has also been discussed [Gh3].

A new type of relation has been found between locally accessible information and final average entanglement, for given any ensemble. It has also been shown that in some well-known distillation protocol, this complementary relation is optimally satisfied. The interesting trade-off between locally accessible information and distillable entanglement in some states has been pointed out.

Mathematical Physics

The connection between the quantum many-particle density of states and the partitioning of an integer in number theory is being investigated. For N bosons in a one-dimensional harmonic oscillator potential, it is well known that the asymptotic density of states is identical to the Hardy-Ramanujan formula for the partitions $p(n)$, of a number n into a sum of integers. It is shown that the same statistical mechanics technique for the density of states of bosons in a power-law spectrum yields the partitioning formula for $p^s(n)$, the latter being the number of partitions of n into a sum of s -th powers of a set of integers. By making an appropriate modification of the statistical technique, it is possible to obtain $d^s(n)$ for distinct partitions. It is found that the distinct square partitions $d^2(n)$ show pronounced oscillations as a function of n , about the average given by the asymptotic result. The origin of these oscillations from the quantum point of view is being further investigated. Similar and analogous results are derived for restricted distinct and non-distinct partitions [Mu].

A q -generalization of the product densities in stochastic point processes is developed. The properties of these functions are studied and a q -generalization of the usual C_s^r coefficients is obtained. The q -product densities are investigated using q -Poisson distribution and this shows the stochastic point processes involving consistent q -generalization are inherently correlated. A closely related function to q -product densities is a q -generalized Janossy function

and a relation between the two is established [P2]. The q -fermion numbers emerging from the q -fermion oscillator algebra are used to reproduce the q -fermionic Stirling and Bell numbers. New recurrence relations for the expansion coefficients in the ‘anti-normal ordering’ of the q -fermion operators are derived. The roles of the q -fermion numbers in q -stochastic point processes and the Bargmann space representation for q -fermionic operators are explored [P1].

Katriel, Rasetti and Solomon introduced a q -analogue of the Zassenhaus formula for disentangling exponential operators (1996). It is shown that their q -Zassenhaus formula is not unique. A new q -Zassenhaus formula is proposed [Sr]. The proposed formula, has been proved by Quesne (math-ph/0310038) and has been shown to be the simplest form of the q -Zassenhaus formula.

The correct quantum generalisation of the Liouville-Arnold criterion for the classical integrability of a finite dimensional system is found: a system is most generally quantum-integrable if its state space carries a unitary representation of a central extension (by the circle group) of an Abelian Lie group of dimension equal to the number of degrees of freedom. The case when the extension is trivial covers the standard examples. Nontrivial extensions correspond to conservation laws with anomalies. There is a general method of diagonalising the Hamiltonians of such systems and the degeneracies are dimensions of representations of Weyl groups of certain classical Lie groups.

Non-perturbative QCD, Lattice Gauge Theory, QGP

Dilepton production in heavy ion collisions, in the Intermediate Mass Region (IMR) has consistently shown an excess over theoretical estimates. An attempt to understand this discrepancy between the observed dilepton pairs and the theoretical estimate is made through the production of the η_c meson and estimates obtained by NRQCD calculations. It is found that η_c production offers a satisfactory quantitative picture for explaining the discrepancy [Bas3].

Nonlinear Dynamics, Solitons and Chaos

A unified approach, presented earlier, showed that a solution of an integrable equation can be associated with three distinct space curves. It is applied to the Lamb equation, a C-integrable equation. Swept-out surfaces corresponding to novel envelope soliton and instanton solutions of the equation are found explicitly and plotted [B7].

An exact analysis is presented for the intrinsic dynamics of two types of biopolymers, described by the worm-like chain (WLC) and the worm-like rod chain (WLRC) models. Conformation dynamics is described by an integrable equation. The robust ‘conformon’ hypothesized in biopolymers thus gets identified with a soliton [B3].

The geometric phase associated with the time evolution of the wave function of a Bose-Einstein condensate in a double well trap is computed by using a model for tunneling between the wells. The importance of this phase in the context of some recent experiments is pointed out [B5].

By mapping the classical evolution equation for a unit vector which arises in various physical

contexts, to a space curve, classical analogues of the Schrödinger and Heisenberg pictures used in quantum mechanics are obtained. This analogy is clarified by using the relationship between this equation and the evolution equation for a two-level quantum system [B4].

Exact topological solitons in the form of traveling kinks and non-topological solitons in the form of moving precessing pulses are found for the classical anti-ferromagnetic Heisenberg chain in the continuum limit [B1].

Using the example of a classical, piece-wise linear driven damped oscillator exhibiting chaotic dynamics, the geometric phase associated with the various attractors of the system are found. This phase is shown to be resilient to fluctuations, responds to all bifurcations in the system, and also finds new transitions. A novel phenomenon of geometric localization is pointed out, which manifests itself as a significant deviation from planar dynamics over a short time interval [B6].

For the piece-wise linear, quantum, driven oscillator, the geometric phase associated with the wave function is computed. Preliminary results suggest that the classical geometric phase found earlier for this system, may be related to the difference between the geometric phases of two neighbouring eigenstates of the quantum system, pointing to a quantum-classical correspondence [B2].

The first experimental realisation of all the fundamental logic gates was achieved using a chaotic circuit. In the scheme, a simple threshold mechanism allowed the chaotic unit to controllably switch with ease between behaviours emulating the different gates. The combination of gates was also demonstrated through a half-adder implementation [Sinha5].

The effects of random non-local connections on networks of chaotic maps under threshold activated coupling was studied. In threshold regimes where a large number of unsynchronized attractors occur under regular connections, it was shown that non-local re-wirings yield synchronized networks. However, the dependence of the synchronized fraction on the fraction of randomised non-local links is typically non-monotonic here. Further the mean time to reach synchronization with respect to fraction of re-wiring also indicates an optimum degree of non-locality for which synchronization is most efficiently achieved [Sinha6, Sinha7].

A long-standing controversy in the study of complex systems is whether increasing diversity of a network (in terms of its size, connectivity and strength of connections) makes it more or less robust 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, we have considered a random network of nonlinear maps exhibiting a wide range of local dynamics, with the links having normally distributed interaction strengths [Sinh3]. The stability of such a system is examined in terms of the asymptotic fraction of nodes that persist in a non-zero state. Scaling results show that the probability of survival in the steady state agrees remarkably well with the May-Wigner stability criterion derived from linear stability arguments. This suggests universality of the complexity-stability relation for random networks with respect to arbitrary global dynamics of the system.

Perturbative QCD

A Next-to-Leading Order calculation of the cross section for the lepto-production of large- E_{\perp} hadrons is presented in [Bas1] and the predictions compared with H1 data on the forward production of π^0 . Large higher order corrections are found and so is an important sensitivity to the renormalization and factorization scales. These large corrections are shown to arise in part from BFKL-like diagrams at the lowest order.

The uncertainties involved in obtaining the injection spectra of UHECR particles in the top-down scenario of their origin are discussed in [Bas2]. The DGLAP Q^2 evolution of fragmentation functions (FF) to $Q = M_X$ (mass of the X particle) from their initial values at low Q are shown to be subject to considerable uncertainties. It is therefore argued that, for $x \lesssim 0.1$ (the x region of interest for most large M_X values of interest, $x \equiv 2E/M_X$ being the scaled energy variable), the FF obtained from DGLAP evolution is no more reliable than that provided, for example, by a simple Gaussian form (in the variable $\ln(1/x)$) obtained under the Modified Leading Log Approximation (MLLA). Additionally, for $x \gtrsim 0.1$, the evolution in Q^2 of the singlet FF, which determines the injection spectrum, is found to be “minimal” – the singlet FF changes by barely a factor of 2 after evolving it over ~ 14 orders of magnitude in $Q \sim M_X$. It is therefore argued that as long as the measurement of the UHECR spectrum above $\sim 10^{20} eV$ is going to remain uncertain by a factor of 2 or larger, it is good enough for most practical purposes to directly use any one of the available initial parametrisations of the FFs in the x region $x \gtrsim 0.1$ based on low energy data even without evolving them to the requisite Q^2 value.

Error propagation in DGLAP evolution of (unpolarised) parton densities at the leading and next-to-leading order were analysed using orthogonal Jacobi polynomials. While the non-singlet case is well-understood, the singlet case appears to be technically harder to define, due to problems with convergence.

Deep Inelastic Scattering Phenomenology

Asymmetry parameters in semi-inclusive Deep Inelastic Scattering (DIS) off polarised targets have been measured and are a subject of current interest. The asymmetry parameters involving photons have been investigated using models [M2].

Statistical Mechanics

How can the structure of disordered liquids be described theoretically? A replica-based description of liquid state structure was proposed some years ago – however, direct tests via *vis* simulations have been lacking hitherto. In the simulations of disordered fluids, both the diagonal and off-diagonal (in replica space) correlation functions of fluids with quenched disorder are extracted from a numerical simulation. These results are matched to liquid-state theory based calculations based on the Rogers-Young approximate closure. A new thermodynamically consistent liquid state theoretical approach to accurately represent the properties of disordered fluids is proposed.

The earlier studies of persistence with parallel dynamics in discrete spin systems are extended to study Ising spins in which the spin state at site ia and at time $t + 1$ depends on the

states of the spins at the sites $i, i - 1, i + 1$ at the previous time. The persistence of spin configurations can be either power-law in character or decay exponentially. An exact duality for the dynamics of spin configurations in this model is proved. Such duality can be used to rationalize the observation that persistence calculated at all times, or only at even/odd times differs qualitatively in behaviour.

The 'plate tectonics' and the earthquake dynamics from the point of view of the possible contact area between two surfaces with fractal characteristics are studied in [Ray1].

The persistence properties in the context of non-equilibrium evolution of various statistical mechanical systems such as spin systems, diffusion systems, systems which show directed percolation behavior etc have been studied. The aim is to study universal persistence properties [Ray2].

It has been suggested in the literature that parastatistics field could not be represented using path integrals. This argument follows from the fact that the parastatistics can not be based on the topology of three dimensional space. This problem has been closely examined with a view that any field theory that can be constructed using the canonical formalism can also be constructed using path integrals. It may be noted that parastatistics requires hidden degrees of freedom whose origin is not connected to the topology of the space. This has allowed a construction of a path integral formalism for the parastatistics [Mi1].

Wealth distribution across different societies and economies have been found to show power law characteristics (Pareto law). Recently there have been several attempts to find the origin of this power law distribution using asset exchange models inspired by kinetic theory of gases. How asset exchange models can be mapped to random iterated function systems (IFS) giving new insights into the dynamics of wealth accumulation in such models, has been explored. In particular, the focus has been on the "yard-sale" (winner gets a random fraction of the poorer players wealth) and the "theft-and-fraud" (winner gets a random fraction of the loser's wealth) asset exchange models. Several special cases including 2-player and 3-player versions of these 'games' allow one to connect the results with observed features in real economies, e.g., lock-in (positive feedback), etc. Subsequently, the realistic notion that a richer agent is less likely to be aggressive when bargaining over a small amount with a poorer player, has been implemented. When this simple feature is added to the yard-sale model, in addition to the accumulation of the total wealth by a single agent ("condensation"), the exponential and power-law distributions of wealth, is seen to emerge. Simulation results show that the power-law distribution occurs at the cross-over of the system from exponential phase to the condensate phase [Sinh2].

The magnetic field induced spin flipping dynamics in disordered systems is studied. The change of magnetization which takes place under the influence of an external field can be viewed from the perspective of growth of domains of flipped spins. The rule by which the spins are flipped can be mapped exactly to the rule by which empty sites in the growth Eden clusters are filled. In two-dimensions, it is shown that for uniform distributions of width Δ of the random fields, the spin flip process interpolates continuously from a compact cluster for small values of Δ to Invasion growth at a critical value of $\Delta = \Delta_c$ [Ro2].

String Theory

The classical supergravity solutions of Dp-branes in pp-wave background have been constructed and their black hole interpretation has been studied.

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 and Rossen Dandoloff*.

Exact topological and non-topological solitons in the classical antiferromagnetic chain. In *National Conference on Nonlinear Systems and Dynamics*, page 17. CTS, IIT Kharagpur, India, Dec 2003.

[B2]

Indubala I. Satija* and **Radha Balakrishnan**.

Geometric phase and classical-quantum correspondence. In *Quantum Mechanics and Chaos: From Fundamental Problems through Nanosciences*. Yukawa Institute, Japan, Mar 2004.
(To be published).

[B3]

Radha Balakrishnan and Rossen Dandoloff*.

Nonlinear elastodynamics and energy transport in biopolymers. 2003.
IMSc/2003/06/14; nlin.PS/0304060 (Submitted).

[B4]

Radha Balakrishnan and Rossen Dandoloff*.

Classical analogues of the Schrodinger and Heisenberg pictures in quantum mechanics using the Frenet frame of a space curve: An example. *Euro. Jour. Phys.*, **25**, 1, 2004.

[B5]

Radha Balakrishnan and Mitaxi Mehta*.

Geometric phase in a Bose-Einstein Josephson junctions. 2003.
IMSc/2003/06/15 (Submitted).

[B6]

Radha Balakrishnan and Indubala I. Satija*.

Anholonomy and geometrical localization in dynamical systems.

2003.

nlin. CD/0303071 (Submitted).

[B7]

S. Muruges* and Radha Balakrishnan.

Geometric characterizations of the Lamb equation.

Jour. Math. Phys., **44**, 1415, 2003.

[Ba1]

G. Baskaran.

Mott insulator to high t_c superconductor via pressure: Resonating valence bond theory and prediction of new systems.

Phys. Rev. Lett., **90**, 197007, 2003.

[Ba2]

G. Baskaran.

An electronic model for CoO_2 layer based systems: Chiral RVB metal and superconductivity. 2003.

cond-mat/0303649 (Submitted).

[Ba3]

G. Baskaran.

How ice enables superconductivity in $Na_xCoO_2.yH_2O$ by melting charge order: Possibility of novel electric field effects.

2003.

cond-mat/0306569 (Submitted).

[Bas1]

Patrick Aurenche*, Rahul Basu, Michel Fontannaz*, and Rohini M. Godbole*.

An NLO calculation of the electroproduction of large- E_\perp hadrons.

European Jour. of Phys. C, 2003.

IMSc/2003/11/35 (To be published).

[Bas2]

Rahul Basu and Pijush Bhattacharjee*.

On the injection spectrum of ultrahigh energy cosmic rays in the top-down scenario.

Phys. Rev. D, 2004.

IMSc/2004/03/14 (To be published).

[Bas3]

Rahul Basu and K. Sridhar*.

η_c production and dimuon enhancement in heavy ion collisions.

European Jour. of Phys. C, 2004.

hep-ph/0301091 (To be published).

[D]

G. Date and P. P. Divakaran.

The Landau electron on a cylinder.

Ann. phys., **309**, 421, 2004.

[Da1]

Martin Bojowald* and Ghanashyam Date.

Consistency conditions for fundamentally discrete theories.

Class. Quantum Grav., **21(1)**, 121, 2004.

[Da2]

Martin Bojowald* and Ghanashyam Date.

Quantum suppression of the generic chaotic behavior close to cosmological singularities.

Phys. Rev. Lett., **92**, 071302, 2004.

[Da3]

Martin Bojowald*, Ghanashyam Date, and Kevin Vandersloot*.

Homogeneous loop quantum cosmology: The role of the spin connection.

Class. Quantum Gravity, **21**, 1253, 2004.

[G]

P. M. Gade and Sudeshna Sinha.

How crucial is small world connectivity for dynamics?

Int. Jour. of Bif. and Chaos, 2004.

(To be published).

[Ga1]

Kaushik Bhattacharya* and Avijit K. Ganguly.

The axialvector- vector amplitude and neutrino effective charge in a magnetized medium.

Phys. Rev. D, 2003.

IMSc/2003/07/25 (To be published).

[Ga2]

Avijit K. Ganguly.

Axion photon mixing in a medium.

2003.

IMSc/2003/07/24 (Submitted).

[Ga3]

Avijit K. Ganguly and R. Parthasarathy.

Optical activity from extra dimensions.

Phys. Rev. D, **68**, 106005, 2003.

[Ga4]

Avijit K. Ganguly and G. Rajasekaran.

Photons in the background of streaming neutrinos.

2003.

Preprint: IMSc/2003/07/22 (Submitted).

[Gh1]

Sibasish Ghosh, Guruprasad Kar, Samir Kunkri*, and Anirban Roy.

Probabilistic cloning and signalling.

J. Phys. A: Math. Gen., 2003.

quant-ph/0312045 (Submitted).

[Gh2]

Sibasish Ghosh, Guruprasad Kar, and Anirban Roy.

Local cloning of Bell states and distillable entanglement.

Phys. Rev. A, 2003.

quant-ph/0311062 (Submitted).

[Gh3]

Sibasish Ghosh, Guruprasad Kar, Anirban Roy, and Debasis Sarkar*.

Distinguishability of maximally entangled states.

Phys. Rev. A, 2003.

quant-ph/0205105 (Submitted).

[Gu]

Nayantara N. Gupta.

Observability of neutron events above the Greisen-Zatsepin-Kuzmin cut-off due to violation of Lorentz invariance.

Phys. Lett. B, **580(3)**, 103, 2004.

[H]

E. Harikumar, Indrajit Mitra, and H. S. Sharatchandra.

Perturbation theory including topological degrees of freedom: Yang-Mills theory in three Euclidean dimensions.

2003.

hep-th/0304140 (Submitted).

[Ho]

Golam Mortuza Hossain.

The Hubble operator in isotropic loop quantum cosmology.

Class. Quantum Grav., **21**, 179, 2004.

[I1]

Arvind*, P. S. Chandi*, R. C. Singh*, D. Indumathi, and R. Shankar.

Random sampling of an alternating current source: A tool for teaching probabilistic observations.

American Jour. of Phys., **72(1)**, 76, 2004.

[I2]

D. Indumathi.

Neutrino factories.

Proceedings of the Indian National Science Academy, **70 A**, 79, 2004.

(To be published).

[J]

T. M. Janaki, Sudeshna Sinha, and N. Gupte*.

Evidence for directed percolation universality at the onset of spatiotemporal intermittency in coupled circle maps.

Phys. Rev. E, **67**, 056218, 2003.

[M1]

Swaranli Bandopadhyay*, Binayak Dutta-Roy*, and H. S. Mani.

Understanding the Fano resonance:through toy models.

American Jour. of Phys., 2003.

cond-mat/0310692 (Submitted).

[M2]

V. Gupta*, S. Salinas*, and H. S. Mani.

Predictions for hadron polarisations and left-right asymmetry in inclusive reactions involving photons.

Phys. Rev. D, 2004.

hep-ph/0402170 (Submitted).

[Me1]

Alvise de Col*, Vadim Geshkenbein*, Gautam I. Menon, and Gianni Blatter*.

Surface effects on the pancake vortex phase diagram.

In *Third European Conference on Vortex Matter in Superconductors*, Sep 2003.

(To be published).

[Me2]

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

Direct observation of the flux-line glass phase in a type-II superconductor.

Phys. Rev. Lett., 2004.

(To be published).

[Me3]

Sumithra Sankararaman*, Gautam I. Menon, and P.B. Sunil Kumar*.

Asters, spirals and vortices in mixtures of motors and microtubules: The effects of confining geometries on pattern formation.

2003.

cond-mat/0311540 (Submitted).

[Mi1]

Oscar W. Greenberg* and **Ashok K. Mishra.**

Path integrals for parastatistics.

2003.

(To be published).

[Mi2]

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

Thermodynamics of infinite U Hubbard model.

Physica C, 2003.

(To be published).

[Mi3]

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

Orthofermion statistics and its application to infinite U Hubbard model.

Physica B, 2004.

(Submitted).

[Mu]

Muoi N. Tran*, **M.V.N. Murthy**, and **Rajat K. Bhaduri***.

On the quantum density of states and partitioning an integer.

Annals of Physics, **311**(1), 204, 2004.

[P1]

R. Parthasarathy.

q-fermionic numbers and their roles in some physical problems.

Phys. Lett. A, 2004.

(To be published).

[P2]

R. Parthasarathy and **R. Sridhar.**

A q-generalization of product densities and Janossy function in stochastic point processes.
2004.

(Preprint: math-ph/0403059).

[R1]

G. Rajasekaran.

India-based neutrino observatory.

In *Proc of 5th International Workshop on Neutrino Factories & Superbeams, June 2003*, Jun
2003.

hep-ph/0402246 (Submitted).

[R2]

R N Mohapatra*, **M K Parida***, and **G. Rajasekaran.**

Bilarge neutrino mixings by radiative magnification.

In *Proceedings of PASCOS, Pramna Vol 62*, page 643, Mar 2004.

[R3]

M K Parida*, **C R Das***, and **G. Rajasekaran**.

Radiative stability of neutrino-mass textures.

In *Proceedings of PASCOS, Pramana Vol 62*, page 647, Mar 2004.

[R4]

Ernest Ma* and **G. Rajasekaran**.

New “square root” model of lepton family symmetry.

Phys. Rev. D, **68**, 071302, 2003.

[R5]

R. N. Mohapatra*, **M. K. Parida***, and **G. Rajasekaran**.

High scale mixing unification and large neutrino mixing angles.

Phys. Rev. D, **69**, 053007, 2004.

[Ra]

S. Kalyana Rama.

Asymptotic density of open p-brane states with zero-modes included.

Phys. Lett. B, **566**, 152, 2003.

[Ray1]

Srutarshi Pradhan*, **Bikas K. Chakrabarti***, **Purusattam Ray**, and **Malay K. Dey***.

Magnitude distribution of earthquakes: Two fractal contact area distribution.

Physica Scripta T, **106**, 77, 2003.

[Ray2]

Purusattam Ray.

Persistence in extended dynamical systems.

Phase Transitions, 2004.

cond-mat/0403508 (To be published).

[Ro1]

Ratnadeep Roy and **Purusattam Ray**.

Response of random field Ising model driven by an external field.

Int. J. Mod. Phys. B, **17(29)**, 5613, 2003.

[Ro2]

Ratnadeep Roy and **Purusattam Ray**.

From Eden to invasion: domain growth in driven random field ising systems.

2004.

IMSc/2004/03/10 (Submitted).

[S1]

Sumithra Sankararaman, **Gautam I. Menon**, and **P. B. Sunil Kumar***.

Self-organized pattern formation in motor-microtubule mixtures.

2003.

cond-mat/0307720 (Submitted).

[S2]

Sumithra Sankararaman, Gautam I. Menon, and P.B. Sunil Kumar*.

Modelling pattern formation in motor-microtubule mixtures.

Physica Scripta, **T106**, 26, 2003.

[S3]

Sumithra Sankararaman and Shankar R.

Quantum Hall Skyrmion lattices at $g \approx 0$.

Phys. Rev. B, **67**, 245102, 2003.

[Sa]

Swarnendu Sarkar and Bala Sathiapalan.

Closed string tachyons on C/Z_N .

Int. J. of Mod. Phys. A, 2003.

IMSC/2003/09/28, hep-th/0309029 (To be published).

[Sat]

Bala Sathiapalan.

Loop variables with Chan-Paton factors.

Mod. Phys. Lett A, **19(1)**, 59, 2004.

[Si]

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

PhyloGibbs: A Gibbs sampler incorporating phylogenetic information.

In E. Eskin et al., editor, *Proceedings of the First Annual RECOMB Satellite Workshop on Regulatory Genomics, March 26-27 2004 (Springer LNBI series)*. Springer-Verlag, Mar 2004.

(To be published).

[Sin1]

David London*, Nita Sinha, and Rahul Sinha.

Determining weak phases using $B \rightarrow D^*V$ decays.

In Peter Kluit Patricia Ball, Jonathan Flynn and Durham (U.K.) Achille Stocchi, IPPP, editors, *Proceedings of the Workshop on the CKM Unitarity triangle, IPPP Durham, April 2003*. Stanford Linear Accelerator Center Electronic Conference Proceedings Archive (eConf C0304052), Jul 2003.

[Sin2]

David London*, Nita Sinha, and Rahul Sinha.

Signals of new physics using angular analysis in $B \rightarrow V_1 V_2$ decays.

In Peter Kluit Patricia Ball, Jonathan Flynn and Durham (U.K.) Achille Stocchi, IPPP, editors, *Proceedings of the Workshop on the CKM Unitarity Triangle, IPPP Durham, April 2003*. Stanford Linear Accelerator Center Electronic Conference Proceedings Archive (eConf C0304052), Jul 2003.

[Sin3]

Nita Sinha and Rahul Sinha. γ from $B \rightarrow K_s \pi \pi$.In *Proceedings of the Workshop on the Discovery Potential of an Asymmetric B Factory at 10^{36} Luminosity*, Feb 2004.

IMSc/2004/02/03 (Submitted).

[Sin4]

David London*, Nita Sinha, and Rahul Sinha.Probing new physics in $B \rightarrow V_1 V_2$ decays.In *Proceedings of the Workshop on the Discovery Potential of an Asymmetric B Factory at 10^{36} Luminosity*, Feb 2004.

IMSc/2004/02/04 (Submitted).

[Sin5]

N. G. Deshpande*, Nita Sinha, and Rahul Sinha.Response to comment on "weak phase using isospin analysis and time-dependent asymmetry in $B_d \rightarrow K_s \pi^+ \pi^-$ ".*Phys. Rev. Lett.*, **91**, 139102, 2003.

[Sin6]

David London*, Nita Sinha, and Rahul Sinha.Searching for new physics via an angular analysis of $B \rightarrow V_1 V_2$ decays.*Europhysics Lett.*, 2003.

hep-ph/0304230 (Submitted).

[Sin7]

David London*, Nita Sinha, and Rahul Sinha.Bounds on new physics from $B \rightarrow V_1 V_2$ decays.*Phys. Rev. D*, 2004.

hep-ph/0402214 (To be published).

[Sin8]

Nita Sinha.

Exotic particles and perhaps new physics?

Current Science, **86(3)**, 379, 2004.

[Sinh1]

T. K. Shajahan*, Sitabhra Sinha, and Rahul Pandit*.

Ventricular fibrillation in a simple excitable medium model of cardiac tissue.

Int. J. Mod. Phys. B, **17(29)**, 5645, 2003.

[Sinh2]

Sitabhra Sinha.

Stochastic maps, wealth distribution in random asset exchange models and the marginal utility of relative wealth.

Physica Scripta T, **106**, 59, 2003.

[Sinh3]

Sitabhra Sinha and Sudeshna Sinha.

Evidence of universality for the May-Wigner stability theorem for random networks with local dynamics.

Phys. Rev. Lett., 2003.

nlin.AO/0402002 (Submitted).

[Sinha1]

T. Munakata* and Sudeshna Sinha.

Implementation of fundamental logical gates by 1-d chaotic elements.

In *Proceedings of COOL Chips VI, Yokohama*, page 73, Apr 2003.

[Sinha2]

Sudeshna Sinha.

Chaotic networks under thresholding.

In *Int. J. Mod. Phys. B*, page 5503, Nov 2003.

[Sinha3]

K. Murali* and Sudeshna Sinha.

Experimental control of chaos by thresholding.

Phys. Rev. E, **68**, 016210, 2003.

[Sinha4]

K. Murali*, Sudeshna Sinha, and W. L. Ditto*.

Realisation of the fundamental nor gate using a chaotic circuit.

Phys. Rev. E, **68**, 016205, 2003.

[Sinha5]

K. Murali*, Sudeshna Sinha, and W. L. Ditto*.

Implementation of nor gate by a chaotic Chua's circuit.

Int. J. Bif. and Chaos (Letters), **13**, 2669, 2003.

[Sinha6]

Sudeshna Sinha.

Spatiotemporal consequences of random coupling.

In R. E. Amritkar, editor, *Spatio-temporal chaos and pattern formation*. INSA, 2003.

(To be published).

[Sinha7]

Sudeshna Sinha.

Consequences of random connections in networks of chaotic maps under threshold activated coupling.

Phys. Rev. E, 2004.

(To be published).

[Sr]

R. Sridhar and R. Jagannathan.On the q -analogues of the Zassenhaus formula for disentangling exponential operators.*J. Comp. Appl. Math.*, **160(1-2)**, 297, 2003.

[Sri1]

K. Srinivasa Rao and C. Krattenthaler*.

Group theoretical aspects of hypergeometric functions and symmetries of angular momentum coefficients.

In *Symmetries in Science XIII*, Jul 2003.

(To be published).

[Sri2]

C. Krattenthaler* and K. Srinivasa Rao.

Automatic generation of hypergeometric identities by the beta integral method.

Jour. of Comp. and App. Math., **160(1-2)**, 159, 2003.

[Sri3]

K. Srinivasa Rao.

Carl Friedrich Gauss: versatile virtuoso.

Archives Internationales D'Histoire des Sciences, 2003.

(Submitted).

[Sri4]

K. Srinivasa Rao and G. Vanden Berghe.

Gauss, Ramanujan and hypergeometric series revisited.

Historia Scientiarum, **13(2)**, 123, 2003.

[Sri5]

K. Srinivasa Rao, G. Vanden Berghe*, and C. Krattenthaler*.

An entry of Ramanujan on hypergeometric series in his notebooks.

Jour. of Comp. and App. Math., 2003.

math.CA/0304317 (Submitted).

Books/Monographs Authored/Edited

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

[I]

D. Indumathi, M.V.N. Murthy, and G. Rajasekaran, editors.

Perspectives in Neutrino Physics, volume 70A of *Proceedings of the Indian National Science Academy*.

INSA, New Delhi, 2004.

(To be published).

[J]

R. Jagannathan, S. Kanemitsu*, G. Vanden Berghe*, and W. Van Assche*, editors.
Proc. Int. Conf. on Special Functions and their Applications, IMSc, Sept. 2002. Special Issue of J. Comp. Appl. Maths. Vol.160, Nos. 1-2, (2003). Dedicated to Prof. K. Srinivasa Rao on the occasion of his 60th birthday.
Elsevier, Amsterdam, 2003.

[R]

Purusattam Ray and Sitabhra Sinha, editors.
Proceedings of the Discussion Meeting on Statistical Mechanics of Threshold Activated Systems, volume 17 (No. 29) of *International Journal of Modern Physics B*.
World Scientific, Singapore, 2003.

2.3 Theoretical Computer Science

2.3.1 Research Summary

Algorithms and Data Structures

A transposition acting on a string exchanges two adjacent substrings in the string. Computing the minimum number of transpositions required to sort a permutation is a well-studied problem in the literature, owing to its connection with genome rearrangement problems. The problem is neither known to be in P nor known to be NP-hard. Restricting the length of the substrings involved in the transposition to be logarithmic in the string length does not make the problem easier. Consequently, bounded transpositions have also become the object of study. 3-bounded transpositions are of two types – a skip, exchanging two adjacent elements, and a hop, moving an element two positions away. It is known that *correcting hops* and *correcting skips*, those that do not create new pairs of out-of-order elements, suffice. In [M3], algorithmic and combinatorial aspects of correcting skips/hops are explored, with the aim of understanding 3-bounded transpositions better. The set of correcting-hop-free permutations is completely characterized, and an efficient algorithm to sort such permutations is obtained. The class of permutations which can be sorted using correcting hops alone is studied. Together, these results allow a tightening of the analysis of the current best approximation algorithm. The notion of correcting skips/hops is extended to *correcting moves* and it is shown that one can efficiently sort a permutation with a minimum number of correcting moves.

In [M1], two problems related to the well-studied *sorting by transpositions* problem are studied: (1) Given a permutation, sort it by moving a minimum number of *strips*, where a strip is a maximal substring of the permutation which is also a substring of the identity permutation. (2) Given a set of increasing sequences of distinct elements, merge them into one increasing sequence by making a minimum number of strip moves. The *merging by strip moves* problem is shown to have a polynomial time algorithm. Using this, a 2-approximation algorithm for the *sorting by strip moves* problem is given. The sorting by strip moves problem, as well as the sorting by transpositions problem, are also shown to be fixed-parameter-tractable.

The problem of succinctly representing an arbitrary permutation, π , on $\{0, \dots, n-1\}$ so that $\pi^k(i)$ can be computed quickly for any i and any (positive or negative integer) power k , is investigated. It is shown that a representation taking $(1 + \epsilon)n \lg n + O(1)$ bits suffices to compute arbitrary powers in constant time and a representation taking the optimal $\lceil \lg n! \rceil + o(n)$ bits can be used to compute arbitrary powers in $O(\lg n / \lg \lg n)$ time, or indeed in a minimal $O(\lg n)$ bit probes [Ra1].

Given a directed graph on n vertices and an integer parameter k , the feedback vertex (arc) set problem asks whether the given graph has a set of k vertices (arcs) whose removal results in an acyclic directed graph. The parameterized complexity of these problems, in the framework introduced by Downey and Fellows, are long standing open problems in the area. These problems are addressed in the well studied class of directed graphs called tournaments.

While the feedback vertex set problem is easily seen to be fixed parameter tractable in

tournaments, it is shown that the feedback arc set problem is also fixed parameter tractable and that the parametric dual problems (where the k is replaced by ‘all but k ’ in the questions) are fixed parameter tractable in oriented directed graphs (where there is at most one directed arc between a pair of vertices). [Ra2].

Succinct or space-efficient representation of static ordinal trees is obtained where, in addition to the standard navigational operations supported by earlier representations, the *level-ancestor* operation is added. The representation takes $2n + o(n)$ bits to represent an n node tree, which is within $o(n)$ bits of the information-theoretic minimum, and supports all operations in $O(1)$ time on the RAM model. In addition to the existing motivations for studying such data structures, the motivation for the current work comes from representing XML documents compactly so that XPath queries can be supported efficiently [Ra3].

Automata, Logic and Concurrency

A semantics is defined for a concurrent programming language with monitors and first-order procedures, which represents the independent operation of the concurrent processes [L2]. To model condition-synchronization using **wait** and **signal** statements, we use game trees *à la* Abramsky-McCusker. (Joint work with Uday Reddy.)

The semantics of messages has been studied [R4], in terms of the *knowledge* of the agents involved in the communication. Apart from applications to distributed computation, this is shown to be relevant in the more general linguistic contexts.

In the verification of security protocols, tagging schemes have been used to obtain well-typed runs, preventing type-flaw attacks. When runs are well-typed, the secrecy problem is easily seen to be decidable when the set of *nonces* is bounded. In [R3], it is shown that tagging schemes can be used to ensure decidability of secrecy for well-formed protocols even in the presence of unboundedly many nonces.

Given any set of n concurrent finite state automata (which communicate on certain common *synchronous* actions and are *asynchronous* otherwise), it is shown that it is possible to build a set of what are defined as *Sum automata* (as opposed to the well-known *Product automaton*) that are represented by a set of infinite trees, corresponding to the given set of concurrent automata. These infinite trees with cut-off states can be truncated to finite trees that completely represent the given CFSMs. The tree property of the sum automata is the result of inductive unfolding using a global *causality order* imposed by the synchronous environment. The local *anti-symmetry* simultaneously induces itself globally while recursively unfolding all components of the *sum automata*. The term *sum* essentially stems from the result that the entities defined as global configurations can be expressed as the set union of the component local configurations. The *trisimulation equivalence* among the given concurrent automata, and the derivable sum as well as the product automata is proved, *up to the reachability* of the states. This previous background work is reported in [N1].

The anti-symmetry of the local *descendent relation* R_i^* is used to build the *branching-time* operators X_i, F_i, G_i of the *future* (and the corresponding *past* operators). The symmetric relations R_{sync} and *co* are used to define the *branching-space* operators *must-cowait* and *pos-cowait* respectively. Using these operators we define the syntax and semantics of the

propositional modal (branching-time and branching-space) logic CDTL which is an abbreviation of *Computational Distributed Tree Logic*, and its *axiom system*. Just as the traditional CTL logic is built on the Kripke tree structure, so is the proposed CDTL on a set of *distributed, concurrent Kripke tree structures*. The axiom system is proved to be *sound* and *complete* for CDTL. This work is reported in [N2].

The *truth functional completeness* of the logic CDTL is proved by construction of its model. It is shown that, for every set of rooted graphs $G_{f_1}, G_{f_2}, \dots, G_{f_n}$ representing n communicating finite state automata, there exists a corresponding set of rooted, finite trees T_1, T_2, \dots, T_n representing the *Sum automata* (a CDTL structure) such that for any *boolean function* on n sets of k variables each, there exists a CDTL formula α such that α *computes* f . f is demonstrated to be a conjunctive composition of the boolean functions f_1, f_2, \dots, f_n respectively operating on the local trees T_1, T_2, \dots, T_n using k variables each. The n sets of k variables each are chosen to be certain arbitrary atomic propositions $p_{i_1}, p_{i_2}, \dots, p_{i_k}, \forall i \in \{1..n\}$ labeling the set of states/worlds of the CDTL structure.

As a *corollary* of the above result which is a *theorem*, it is shown that for any CDTL formula α , there is an equivalent formula α' in *modal DNF form*, which can be computed as the conjunction of local tree formulas using the local modal operators. The *universal* or *existential* local modal operators corresponding to *local configurations*, *local time* and *space* respectively, are distributed versions of the global *run* and *interleaving* modalities. Two points are key here: (i) Both local and global time scales map to one single *external observer's* time scale. (ii) *Conflicts* that lead to the branching-time aspect are originated locally and distributed globally. This is essentially why it suffices to consider local configurations as opposed to the global ones and build the latter from sets of the former.

The above results enable the design of an efficient and elegant *model-checking algorithm* for the CDTL formulas corresponding to *safety* and *liveness* properties. The elegance lies in the fact that with all the more expressiveness of CDTL formulas with their orthogonal *temporal* and *spatial* operators, corresponding to *runs* and their *interleavings* respectively as compared to the CTL ones, the complexity of checking the former is far less than that of the latter formulas. This is achieved by the faithful representation of concurrency and introducing and implementing space dimensional modalities with it. The work mentioned in the last two paragraphs is reported in [N3].

Computational Complexity

Given an algebraic number field K , such that $[K : \mathbb{Q}]$ is constant, we show that the problem of computing the units group \mathcal{O}_K^* is in the complexity class SPP. As a consequence, we show that *principal ideal testing* for an ideal in \mathcal{O}_K is in SPP. Furthermore, assuming the GRH, the class number of K , and a presentation for the class group of K can also be computed in SPP. A corollary of our result is that solving Pell's equation, recently shown by Hallgren to have a quantum polynomial-time algorithm, is also in SPP. These results are reported in [A3].

Building on McKenzie and Cook's classification of permutation group problems into four NC^1 Turing-equivalent sets, we show that all these problems are essentially captured by the generalized logspace mod-class ModL , where ModL is the logspace analogue of ModP (defined by Koebler and Toda). More precisely, our results are as follows:

For abelian permutation groups, the problems of membership testing, isomorphism testing and computing the order of a group are all in $ZPL(\text{ModL})$, and are all hard for ModL under logspace Turing reductions. The problems of computing the intersection of abelian permutation groups, and computing a generator-relator presentation for a given abelian permutation group are in $FL(\text{ModL})/\text{poly}$. Furthermore, the search version of membership testing is also in $FL(\text{ModL})/\text{poly}$. These results are reported in [A4].

The Group Isomorphism problem consists in deciding whether two input groups G_1 and G_2 given by their multiplication tables are isomorphic. We first give a 2-round Arthur-Merlin protocol for the Group Non-Isomorphism problem such that on input groups (G_1, G_2) of size n , Arthur uses $O(\log^6 n)$ random bits and Merlin uses $O(\log^2 n)$ nondeterministic bits. We derandomize this protocol for the case of solvable groups obtaining the following two results:

1. We give a uniform NP machine for Group Non-Isomorphism for solvable groups, that works correctly on all but $2^{\text{poly}(\log(n))}$ inputs of any length n . Furthermore, this NP machine is always correct when the input groups are non-isomorphic. The NP machine is obtained by an unconditional derandomization of the AM protocol.
2. Under the assumption that $\text{EXP} \not\subseteq \text{i.o-PSPACE}$ we get a complete derandomization of the above AM protocol. Thus, $\text{EXP} \not\subseteq \text{i.o-PSPACE}$ implies that Group Isomorphism for solvable groups is in $\text{NP} \cap \text{co-NP}$. These results are reported in [A6].

Graph Theory and Combinatorics

For an integer $b \geq 1$, the *b-choice number* of a graph G is the minimum integer k such that for every assignment of a set $S(v)$ of at least k colors to each vertex v of G , there is a b -set coloring of G that assigns to each vertex v a b -set $B(v) \subseteq S(v)$ ($|B(v)| = b$) so that adjacent vertices receive disjoint b -sets. This is a generalization of the notions of choice number and chromatic number of a graph. Using probabilistic arguments, it is shown in [S4] that, for some positive constant $c > 0$ (independent of b), the b -choice number of any graph G on n vertices is at most $c(b\chi)(\ln(n/\chi) + 1)$ where $\chi = \chi(G)$ denotes the chromatic number of G . For any fixed b , this bound is tight up to a constant factor for each n, χ . This generalizes and extends a result (and its proof) of Noga Alon wherein a similar bound was obtained for 1-choice numbers of complete χ -partite graphs with each part having size n/χ . We also show that the proof arguments can be made constructive leading to polynomial time algorithms for the list coloring problem on certain classes of graphs (like perfect graphs and circular-arc graphs) provided each vertex is given a list of sufficiently large size.

The chordality of a graph having at least one cycle is the length of the longest induced cycle in it. The even (odd) chordality is defined to be the length of the longest induced even (odd) cycle in it. In [S5], it is shown that co-circular-arc graphs and co-circle graphs have even chordality at most 4. We also identify few other classes of graphs having bounded chordality values.

2.3.2 List of Publications

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

[A1]

V. Arvind and Rainer Schuler*.

The query complexity of 0-1 knapsack and associated claw problems.

In Hirotaka Ono (Eds.) Toshihide Ibaraki, Naoki Katoh, editor, *Proceedings of the 14th International Symposium on Algorithms and Computation (ISAAC 2003), Kyoto, Japan, December 15-17, 2003. LNCS 2906*, page 168. Springer Verlag, Dec 2003.

[A2]

V. Arvind and Piyush P. Kurur.

Upper bounds on the complexity of some galois theory problems.

In Hirotaka Ono (Eds.) Toshihide Ibaraki, Naoki Katoh, editor, *Proceedings of the 14th International Symposium on Algorithms and Computation (ISAAC 2003), Kyoto, Japan, December 15-17, 2003, LNCS 2906*, page 716. Springer Verlag, Dec 2003.

[A3]

V. Arvind and Piyush P. Kurur.

The complexity of computing units in a number field.

In *Proceedings of the Sixth Algorithmic Number Theory Symposium, LNCS, to appear.* Springer Verlag, Feb 2004.

(To be published).

[A4]

V. Arvind and T.C. Vijayaraghavan.

Abelian permutation group problems and logspace counting classes.

In *Proceedings of the Nineteenth IEEE Conference on Computational Complexity, to appear.* IEEE, Feb 2004.

(To be published).

[A5]

Eric Allender*, V. Arvind, and Meena Mahajan.

Arithmetic complexity, Kleene closure, and formal power series.

Theory of Computing Systems., **36(4)**, 303–328, 2003.

[A6]

V. Arvind and J. Toran*.

Solvable group isomorphism is (almost) in $NP \cap coNP$.

In *Electronic Communication in Computational Complexity. (also, to appear in the proceedings of the nineteenth IEEE Conference on Computational Complexity).* 2004.

(Preprint: ECCC-008-2004).

[L1]

Kamal Lodaya, D. Ranganayakulu*, and K. Rangarajan*.

Hierarchical structure of 1-safe petri nets.

In V Saraswat, editor, *Proceedings of ASIAN 2003, LNCS*. Springer-Verlag, Dec 2003.

[L2]

Kamal Lodaya and Uday S. Reddy*.

Grainless concurrency semantics for monitors.

In *Proceedings of the 2nd APPSEM II Workshop.*, Feb 2004.

(To be published).

[M1]

Meena Mahajan, Rama Raghavan*, Venkatesh Raman, and S. Vijayakumar*.

Merging and sorting by strip moves.

In Paritosh Pandya and Jaikumar Radhakrishnan, editors, *Proceedings of the 23rd International Conference on Foundations of Software Technology and Theoretical Computer Science (FST&TCS 2003), LNCS 2914.*, pages 314–325. Springer-Verlag, Dec 2003.

[M2]

Eric Allender* and Meena Mahajan.

The complexity of planarity testing.

Information and Computation, **189(1)**, 117–134, 2004.

[M3]

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

On sorting by 3-bounded transpositions.

In D.K. Ray Chaudhuri, A.R. Rao, and B.K. Roy, editors, *Electronic Notes in Discrete Mathematics volume 15. (Proceedings of the R. C. Bose Centenary Symposium on Discrete Mathematics and Applications, 20–23 December 2002, ISI Kolkata.)*. Elsevier, 2003.

[M4]

Meena Mahajan, P. Subramanya*, and V. Vinay*.

The combinatorial approach yields an NC algorithm for computing Pfaffians.

Discrete Applied Mathematics, 2004.

(To be published).

[N1]

Vasumathi K. Narayanan.

A *sum composition* (as opposed to *product*) of a set of concurrent finite state automata. 2004.

(Preprint: IMSC/2004/03/06).

[N2]

Vasumathi K. Narayanan.

CDTL - computational sum graphs' logic: A branching time & space modal logic and its axiom system.

2004.

(Preprint: IMSC/2004/03/07).

[N3]

Vasumathi K. Narayanan.

Distributed verification of concurrent finite state automata using the logic *CDTL*.

2004.

(Preprint: IMSc/2004/03/08).

[R1]

R. Ramanujam and S. P. Suresh.

A decidable subclass of unbounded security protocols.

In R. Gorrieri, editor, *Proceedings of the Workshop on Information Theory and Security.*, page 11. ETAPS, Apr 2003.

[R2]

R. Ramanujam and S. P. Suresh.

An equivalence on terms for security protocols.

In R. Bharadwaj, editor, *Proceedings of the Workshop on Automatic Verification of Infinite State Systems.*, page 45. ETAPS, Apr 2003.

[R3]

R. Ramanujam and S. P. Suresh.

Tagging makes secrecy decidable for unbounded nonces as well.

In P. K. Pandya and J. Radhakrishnan, editors, *Proceedings of the 23rd International Conference on Foundations of Software Technology and Theoretical Computer Science (FST & TCS) 2004, LNCS 2914.*, page 363. Springer, Dec 2003.

[R4]

Rohit Parikh* and R. Ramanujam.

A knowledge based semantics of messages.

Journal of Logic, Language and Information, **12(4)**, 21, 2003.

[Ra1]

Ian Munro*, Rajeev Raman*, Venkatesh Raman, and S. S. Rao*.

Succinct representation of permutations.

In J. Parrow G. J. Woeginger J. C. M. Baeten, J. K. Lenstra, editor, *Proceedings of International Conference on Automata, Languages and Programmings (ICALP) 2003, Eindhoven, The Netherlands, LNCS 2719.*, page 345. Springer, Jun 2003.

[Ra2]

Venkatesh Raman and Saket Saurabh*.

Parameterized complexity of directed feedback set problems in tournaments.

In Jorg Rudiger Sack Frank Dehne and Michiel Smid, editors, *Proceedings of the Workshop on Algorithms and Data Structures (WADS) 2003, LNCS 2748.*, page 484. Springer, Jul 2003.

[Ra3]

Richard Geary*, Rajeev Raman*, and Venkatesh Raman.

Succinct tree representations for XML documents.

In Ian Munro, editor, *Proceedings of the Fifteenth ACM-SIAM Symposium on Discrete Algorithms.* ACM-SIAM, Jan 2004.

[S1]

L. Sunil Chandran*, T. Kavitha*, and C.R. Subramanian.

Isoperimetric inequalities and the width parameters of graphs.

In T. Warnow and B. Zhu, editors, *Proceedings of the Ninth International Conference on Computing and Combinatorics (COCOON 2003), LNCS.* Springer-Verlag, Jul 2003.

[S2]

L. Sunil Chandran* and C.R. Subramanian.

A spectral lower bound for the treewidth of a graph and its consequences.

Information Processing Letters, **87(4)**, 195, 2003.

[S3]

C.R. Subramanian.

Finding induced acyclic subgraphs in random digraphs.

The Electronic Journal of Combinatorics, **10**, #R46, 2003.

[S4]

C.R. Subramanian.

List set coloring : bounds and algorithms.

2003.

(Submitted).

[S5]

C.R. Subramanian and L. Sunil Chandran*.

Graphs of low chordality.

2004.

(Submitted).

2.4 Student Programmes

2.4.1 Degrees Awarded

Doctoral Degrees Awarded during 2003 – 2004

Physics

Name: **Muruges, S.**

Thesis Title: Geometry of moving space curves associated with integrable equations:
Connections and applications

Thesis Advisor: Balakrishnan, Radha

University: University of Madras

Doctoral Theses Submitted during 2003 – 2004

Mathematics

Name: **Dayal, Gautham N.**

Thesis Title: The Geometry of Abelian Surfaces with (1,5) Polarization

Thesis Advisor: Paranjape, Kapil H.

University: BITS, Pilani

Name: **Ghosh, Shamindra K.**

Thesis Title: On Planar Algebras and Representations of the Annular Category over a Planar
Algebra

Thesis Advisor: Sunder, V. S.

University: Indian Statistical Institute

Masters Degrees during 2003 – 2004

Mathematics

Mathematics

Name: **Sengupta, Ritabrata**

Thesis Title: Cyclic subgroups of the class group of quadratic fields

Thesis Advisor: Paranjape, Kapil H.

University: Anna University

Physics

Name: **Kumar, Alok**

Thesis Title: Spontaneous Chiral Symmetry Breaking (SCSB) in Quark Confinement

Thesis Advisor: Parthasarathy, R.

University: Anna University

Name: **Sharma, Chandradew**

Thesis Title: Angular Analysis of B decaying into Tensor, Vector and Scalar Modes.

Thesis Advisor: Sinha, Rahul

University: Anna University

Name: **Banerjee, Kinjal**

Thesis Title: A Comparative Study of String Theory and Loop Quantum Gravity in
Cosmological Context

Thesis Advisor: Date, G.

University: Anna University

Name: **Biswas, Turbasu**

Thesis Title: Proton Decay in Higher Dimensions

Thesis Advisor: Sathiapalan, Balachandran

University: Anna University

Name: **Mitra, Mithun Kumar**

Thesis Title: A microscopic model for microtubules

Thesis Advisor: Menon, Gautam I

University: Anna University

Name: **Bagchi, Arjun**

Thesis Title: Scalar Tensor Theory for Gravity in D dimensions

Thesis Advisor: Kalyana Rama, S

University: Anna University

Theoretical Computer Science

Name: **Muthu, Rahul**

Thesis Title: A Study of Graph Colouring Notions

Thesis Advisor: Subramanian, C. R.

University: Anna University

Name: **Sarma, Jayalal M.**

Thesis Title: Refining Randomness and Applications to De-randomization

Thesis Advisor: Mahajan, Meena B.

University: Anna University

2.4.2 Lecture Courses During 2003 – 2004.

The following **lecture courses** were offered during 2003 – 2004.

Course Title	Period	Lecturer
Mathematics		
Advanced Operating Systems	Aug–Nov 2003	Paranjape, Kapil H.
Algebra	Aug–Nov 2003	Raghavan, K. N.
Number Theory (Reading course)	Aug–Dec 2003	Srinivas, K.
Real Analysis	Aug–Dec 2003	Sunder, V. S.
Topology II	Aug–Dec 2003	Sankaran, Parameswaran
Differential Equations	Jan–Mar 2004	Krishna, M.
Topology II	Jan–Mar 2004	Nagaraj, D. S.
Functional Analysis	Jan–Apr 2004	Kesavan, S.
Physics		
Condensed Matter Physics	Jan–May 2003	Sinha, Sitabhra
Particle Physics	Jan–May 2003	Indumathi, D.
Quantum Field Theory I	Jan–Apr 2003	Basu, Rahul
Introduction to General Relativity	Jun–Oct 2003	Date, G.
Nonlinear Dynamics	Jun–Oct 2003	Sinha, Sitabhra
Advanced Particle Physics	Jul–Dec 2003	Sinha, Rahul
Advanced Topics in Condensed Matter Physics	Jul–Dec 2003	Menon, Gautam I.
Classical Mechanics	Aug–Dec 2003	Sinha, Sudeshna
Mathematical Physics	Aug–Dec 2003	Mishra, Ashok K.
Quantum Field Theory II	Aug–Dec 2003	Basu, Rahul
Quantum Mechanics	Aug–Dec 2003	Hari Dass, N. D.
Advanced Topics in Condensed Matter Physics	Sep–Dec 2003	Baskaran, G.
Particle Physics	Jan–Mar 2004	Rajasekaran, G.
Statistical Mechanics	Jan–Mar 2004	Balakrishnan, Radha
Theoretical Computer Science		
A first course in Logic	Jan–May 2003	Ramanujam, R.
Algorithms II	Jan–May 2003	Raman, Venkatesh
Introduction to Computational Complexity	Jan–May 2003	Mahajan, Meena B.
Theory of Computation II	Jan–Apr 2003	Lodaya, Kamal
Complexity Theory II	Aug–Dec 2003	Mahajan, Meena B.
Design and Analysis of Algorithms	Aug–Dec 2003	Subramanian, C. R.
Discrete Mathematics	Aug–Nov 2003	Arvind, V.
Programming Languages	Aug–Dec 2003	Lodaya, Kamal

Randomized Algorithms	Aug–Dec 2003	Raman, Venkatesh
Recursion Theory	Aug–Dec 2003	Lodaya, Kamal
Verification	Aug–Dec 2003	Ramanujam, R.

In addition, the following **lecture courses** were offered during 2003 – 2004 by IMSC faculty in the National Undergraduate programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer
Mathematics		
Calculus I	Aug-Dec 2003	Nagaraj, D. S.
Calculus II	Jan-Apr 2004	Kesavan, 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 our faculty members for a period of four to six weeks. The following students visited the institute during Apr 2003 - Mar 2004.

Student	Faculty
Mathematics	
Vidyaranya, K., First Grade College, Tirthahalli, Karnataka	Kesavan, S.
Dwivedi, Shivanand, IIT, Mumbai	Kesavan, S.
Dravid, Bharat, IIT, Kharagpur	Raghavan, K. N.
Sebastian, Ronnie, IIT, Kanpur	Raghavan, K. N.
Physics	
Sekhar, IIT, Chennai	Baskaran, G.
Jagannath, IIT, Chennai	Baskaran, G.
Sudha, J., The American College, Madurai	Baskaran, G.
Joseph, A., The American College, Madurai	Baskaran, G.
Joshi, Nikhil J., IIT, Kanpur	Date, G.
Chandra, Amar V., IIT, Kanpur	Date, G.
Kanjilal, Krittika, St Xavier's College, Mumbai	Hari Dass, N. D.
Nirmal Thyagu, N., IIT, Chennai	Sinha, Sitabhra
Sridhar, S., IIT, Chennai	Sinha, Sitabhra
Bijilash, B. S., IIT, Chennai	Sinha, Sitabhra

As an additional feature, the Physics summer students were given the following talks:

- *Introduction to Library and E-Journals*, Paul Pandian
- *Introduction to IMSc Computing facility*, G. Subramoniam
- *Birth and Death of a Star*, N.D. Hari Dass
- *Harmonic Oscillators, Coherent States etc.* (two talks), R. Parthasarathy
- *Pancharathnam, Berry and Geometric Phases*, R. Simon

Theoretical Computer Science

Polychroniadis, Olivier, ENS de Cachan
 Sohier, Julien, ENS de Cachan
 Kulkarni, Raghav, CMI, Chennai
 Verma, Shobhit K., CMI, Chennai
 Roy, Debadyuti, CMI, Chennai
 Chattopadhyay, Amit, ISI, Kolkata
 Gupta, Sushmita, CMI, Chennai

Lodaya, Kamal
 Lodaya, Kamal
 Mahajan, Meena B.
 Raman, Venkatesh
 Ramanujam, R.
 Ramanujam, R.
 Subramanian, C. R.

2.4.4 Other Students

Students also do their projects under the supervision of our faculty during the academic year. The following students visited the institute during Apr, 2003 - Mar, 2004.

Student	Faculty
Cabot, Jessica A., Univ. of Mass. at Amherst, USA	Murthy, M.V.N.
Macharla, Sandeep, IIT, Kharagpur	Ramanujam, R.
Madonna, K. S., Anna Univ., Chennai	Krishna, M.

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 course.

During this academic year, the fellowship was awarded to Mr. Chaitra Shreepad Hegde & Ms. M. D. Prabha of IIT, Chennai in Physics and to Mr. B. Kumar of IIT, Chennai in Mathematics.

2.5 Honours and Awards

Murthy, M. V. N. was elected as a Fellow of the Indian Academy of Sciences.

Sunder, V. S. was elected as a Fellow of the Indian National Science Academy.

Chapter 3

Other Professional Activities

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

Anuradha, N.

Reviewer of Mathematical Reviews, American Mathematical Society.

Arvind, V.

Member of Programme Committee, FSTTCS 2003 during Jan – Dec, 2003.

Balasubramanian, R.

Convener of Sectional Committee-I Indian National Science Academy, Delhi during Jan 2001 – Jul 2003.

Member of Governing Council Chennai Mathematical Institute during Mar 2001 – Jul 2003.

Member of Executive Committee, School of Mathematics, Anna University during May 2001 – Jul 2003.

Member of Fellowship Scrutiny Committee, The National Academy of Sciences, Allahabad during Aug 2001 – Jul 2003.

President of Cryptology Research Society of India, Kolkata during Oct 2001 – Jul 2003.

Baskaran, G.

Member of Board of Trustees of K S Krishnan Memorial Trust during Aug 2002 – Dec 2003.

Member of Council, International Center for Condensed Matter Physics, Brasilia, Brazil during Nov 2002 – Nov 2003.

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

Basu, Rahul

Member of National Organising Committee of XV DAE Symposium during Aug – Nov, 2003.

Member of National Organising Committee of QCD 2002 during Aug – Nov, 2003.

Date, G.

Member of Scientific Organising Committee for the International Conference on Gravitation and Cosmology, ICGC-2004 during Mar 2003 – Jan 2004.

Member of The Council of the Indian Association for General Relativity and Gravitation.

Member of National Organising Committee for Field Theoretic Aspects of Gravity – IV held at Pelling, Sikkim during Mar 2 – Mar 6, 2004.

Hari Dass, N. D.

Visit to High Schools at Childrens Club, Mylapore on May 23, 2003. Gave a slide based talk on the birth and death of stars.

Visit to High Schools at PS Higher Secondary School, Chennai on May 28, 2003. Gave a talk on the birth and death of stars.

Endowment Lecture at Vivekananda College on Aug 10, 2003. Gave a lecture on Parallel Computers.

Convener of National Organising Committee for International Conference on General Relativity and Cosmology held at Cochin during Jan 1 – Jan 7, 2004.

Visit to High Schools at The School, KFI on Feb 11, 2004. Throughout the year I have visited KFI. On one occasion took a class for XIIth standard and the topic of discussion was special relativity and black holes. Also addressed 5 assemblies for mixed age group on a variety of topics including Cryptography.

Indumathi, D.

Member of National Organising Committee for Workshop in high energy particle physics phenomenology (WHEPP8) held at IIT, Mumbai during Jan 5 – Jan 16, 2004.

Lecture at Meenakshi College, Chennai on Feb 24, 2004. Gave a lecture on elementary particle physics

Kesavan, S.

Convener of Local Organising Committee for National Board for Higher Mathematics Nurture Programme held at IMSc during Jul 7 – Jul 25, 2003.

Member of National Board for Higher Mathematics during Aug 2003 – Mar 2004.

Member of Editorial Board, Journal of Analysis and Applications during Aug 2003 – Mar 2004.

Member of Apex Committee, National Undergraduate Programme, Chennai Mathematical Institute during Aug 2003 – Mar 2004.

Member of Programme Implementation Committee, National Undergraduate Programme, Chennai Mathematical Institute during Aug 2003 – Mar 2004.

Member of Editorial Board, Mathematics Newsletter, Ramanujan Mathematical Society during Aug 2003 – Mar 2004.

Reviewer of Mathematical Reviews, AMS during Aug 2003 – Mar 2004.

Fellow of Forum d'Analystes during Aug 2003 – Mar 2004.

Member of Editorial Board, Journal of the Kerala Mathematical Association during Aug 2003 – Mar 2004.

Kodiyalam, Vijay

Reviewer of Mathematical Reviews, AMS

Lodaya, Kamal

Member of Programme Committee, 23rd FSTTCS Conference, 2003 during Jan – Dec, 2003.

Convener of Local Organising Committee for 3rd IMSc Update Meeting: Automata and verification held at IMSc during Feb 29 – Mar 2, 2004.

Mani, Harihara H.

Member of Scrutiny committee, Indian Academy of Sciences during Jan 2002 – Dec 2003.

Convener of Local Organising Committee for Kodai enrichment school held at Kodaikanal during Jul 15 – Jul 22, 2003.

Convener of Local Organising Committee for SERC Preparatory School held at University

of Hyderabad during Nov 17 – Nov 30, 2003.

Menon, Gautam I.

Convener of Local Organising Committee for Fifth SERC School on the Physics of Disordered Systems held at IMSc during Apr 1 – Apr 21, 2003.

Murthy, M.V.N.

Member of Program Management Committee, India-Based Neutrino Observatory (INO) during Sep 2002 – Mar 2004.

Member of Editorial Board, Pramana - Journal of Physics during 2004.

Nadkarni, M. G.

Member of Sectional Committee, INSA, during 2004.

Member of Net Examination Committee, CSIR, during 2004.

Member of Swarnajaynti Fellowship Committee, DST, during 2004.

Member of Harish-Chandra Award Committee, TIFR, Mumbai, during 2004.

Narayanan, N

Member of Local Organising Committee for Update meeting on Automata theory held at IMSc during Feb 29 – Mar 2, 2004.

Paranjape, Kapil H.

Associate Editor of Editorial Board, Proceedings of Indian Academy of Sciences (Mathematical Sciences) during Dec 1995 – Jul 2003.

Member of Editorial Board, Journal of the Ramanujan Mathematical Sciences during Jan 1996 – Jul 2003.

Member of Editorial Board, Texts and Readings in Mathematics (TRIM) during Jul 1998 – Jul 2003.

Member of Advisory Board of arXiv.org during Mar 2002 – Jul 2003.

Raghavan, K. N.

Gave a talk on “Counting Magic Squares” at Queen Mary’s College on Feb 6, 2004.

Rama, S. Kalyana

Convener of Local Organising Committee for Subhashis Nag Memorial Endowment Lecture held at IMSc on Dec 29, 2003.

Raman, Venkatesh

Member of Council of Indian Association for Research in Computing Science during Dec 2002 – Mar 2004.

Ray, Purusattam

Convener of Local Organising Committee for Fifth SERC School on the “Physics of Disordered Systems” held at IMSc during Apr 1 – Apr 21, 2003.

Sankaran, Parameswaran

Convener of Local Organising Committee for Nag Memorial Endowment Lecture-2003 held at IMSc on Dec 29, 2003.

Srinivas, K.

Convener of Local Organising Committee for Conference in Analytic Number Theory held at NIAS, Bangalore during Dec 13 – Dec 15, 2003.

Sunder, V. S.

Member of Editorial Board of the Journal of the Ramanujan Mathematics Society during Aug 2001 – Mar 2004.

Member of Editorial Board of the Proceedings of the Indian Academy of Sciences (Math. Sci.) during Aug 2001 – Mar 2004.

Member of Editorial Board of the ‘Texts and Readings in Mathematics’ (TRIM) series published by the Hindustan Book Agency during Aug 2001 – Mar 2004.

Member of ‘Technical Advisory Committee’ of the Indian Statistical Institute during Aug 2001 – Mar 2004.

Member of Mathematical Sciences Research Committee constituted by the CSIR (to assess various proposals, etc.) during Aug 2001 – Mar 2004.

Member of International Organising Committee for Geometry and Topology inspired by Physics held at Physics Department of Cochin University of Science and Technology during Dec 4 – Dec 8, 2003.

Convener of Local Organising Committee for Two-Day Meeting on Operator Algebras held at IMSc during Dec 15 – Dec 16, 2003.

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

Lectured on *When is a knot not the unknot?* to high school at Vidya Mandir, Mylapore on Feb 26, 2004.

Chapter 4

Colloquia

4.1 Conferences/Workshops Held at IMSc

4.1.1 Fifth SERC School on the Physics of Disordered Systems

An SERC School on the “Physics of Disordered Systems” was held at IMSc during April 1-21, 2003. This school was jointly organized by Gautam I. Menon and Purusattam Ray of IMSc. About 34 participants from 22 Universities/Institutes from all over India, including both experimentalists and theorists, participated in this school. The speakers and topics covered were:

- **M. Barma**, TIFR, Mumbai
Overview and Introduction to Spin Glasses
- **S. Bhattacharya**, TIFR, Mumbai
Depinning in Random Media
- **S. M. Bhattacharjee**, IOP, Bhubaneswar
Directed Polymers in Random Media
- **D. Dhar**, TIFR, Mumbai
Percolation
- **B. K. Chakrabarti**, SINP, Kolkata
Disordered Quantum Spin Models
- **S. P. Das**, JNU, New Delhi
Mode Coupling and the Structural Glass Transition
- **S. N. Kaul**, Central University, Hyderabad
Experiments on Spin Glasses and other Disordered Spin Systems
- **Deepak Kumar**, JNU, New Delhi
Dilute Magnets
- **T. V. Ramakrishnan**, IISc, Bangalore
An Introduction to Disordered Quantum Systems

- **G. Ravikumar**, BARC, Mumbai
Vortex Glasses
- **S. S. N. Murthy**, JNU, New Delhi
Experiments on Glasses
- **S. Sastry**, JNCASR, Bangalore
Structural Glasses: Phenomenology, Theory and Simulations
- **Prabodh Shukla**, NEHU, Shillong
Random Field Systems

Special lectures on related topics were also given by Sitabhra Sinha, Purusattam Ray and Gautam Menon of IMSc. In addition, a program of talks by speakers from IMSc was also scheduled as part of the school. Speakers in this program included Profs. N. D. Hari Dass, R. Simon, V. Arvind, M. V. N. Murthy, R. Balasubramanian and R. Shankar.

4.1.2 NBHM Nurture Programme

The Nurture Programme for the INMO awardees of 1999 - 2000 continued at the Institute of Mathematical Sciences Chennai and the participants were under the charge of the faculty comprising of Drs. V. Balaji, S. Kesavan (Convener), K. H. Paranjape, K. N. Raghavan and V. S. Sunder. The syllabus for self-study during the second year of the programme, *i.e.* 2002 - 2003, was Functional Analysis (based on the second part of the book by G. F. Simmons, Introduction to Topology and Modern Analysis), Algebra (Chapters 8, 9, 11, 12 and 14 of the book by M. Artin), Topology (based on Part II, Chapters 9 - 13 of the book by J. R. Munkres) and Analysis of Several Variables (based on Chapters 8 - 10 of W. Rudin's Principles of Mathematical Analysis).

The Contact Programme was held at the Institute of Mathematical Sciences, Chennai, from Monday, July 7 to Friday, July 25, 2003. Out of the 6 registered participants remaining at the end of the second year, 3 attended the programme.

During the first two days of this summer camp, the above subjects were revised by the members of the faculty. This was followed by lecture courses which built upon these subjects. Dr. D. S. Nagaraj gave two revision lectures in Topology followed by two lectures on the Topology of manifolds. This was continued by Dr. V. Balaji (4 lectures) and Dr. K. H. Paranjape (2 lectures). Dr. V. S. Sunder gave 6 lectures on Functional Analysis leading to an introduction to C^* - Algebras. Dr. K. N. Raghavan gave 7 lectures on Representation Theory. Dr. S. Kesavan gave 6 lectures on Distribution Theory. Dr. R. Balasubramanian gave 6 lectures on Galois Theory. Dr. M. Krishna gave 5 lectures on Wavelets.

In addition, Dr. K. H. Paranjape gave a special lecture on 'The Definition and Representation of Algebraic Numbers Geometrically' and Dr. V. Arvind gave a special lecture on 'The Graph Isomorphism Problem'.

The programme concluded with the screening of a musical film (produced by the Clay Mathematical Institute) entitled 'Fermat's Last Tango' based on the experiences of A. Wiles in proving Fermat's Last Theorem.

During the last week, the participants were interviewed by the faculty to assess their progress.

4.1.3 Subhashis Nag Memorial Endowment Lecture

The *Subhashis Nag Memorial Endowment Lectures* were instituted in the year 2002 through the generous contribution of Mrs. Sutapa Nag, widow of Subhashis Nag. It aims to promote research in mathematical sciences by inviting to the Institute of Mathematical Sciences, Chennai, an eminent mathematical scientist, one each year, to deliver a series of lectures. The *first* of these lectures is designated as the ‘Subhashis Nag Memorial Endowment Lecture’. For the year 2002, the Nag Memorial Lecture was delivered by Professor Dennis Sullivan, CUNY Graduate Center, New York, on *String Topology*.

The Nag Memorial Endowment Lecture for the year 2003 was held on 29th December 2003. Professor Ashoke Sen, Harish-Chandra Research Institute, Allahabad, delivered the Endowment lecture on *Search for unified theory*. This was followed by week long series of seminars on *Tachyon dynamics on open string theory*.

There were about a dozen out station participants from TIFR, HRI, IoP, SINP, IIT-Madras, and University of Madras. The lectures were coordinated by Parameswaran Sankaran and S. Kalyana Rama.

4.1.4 Two-Day Meeting on Operator Algebras

This meeting was organised as a ‘satellite conference’ to the AMS-India meeting that was held in Bangalore from the 17th of December. Many of the operator algebraists who came to Bangalore stopped by in Chennai for this short and quite successful meeting. Among the better-known of the speakers at the meeting were: Bill Arveson, Michael Cowling, Ron Douglas, Dai Evans, Gilles Pisier, K.R. Parthasarathy and Jean-Luc Sayvageot.

4.1.5 Institute Seminar Week

The *Institute Seminar Week* was organized during February 23 to 27, 2004 and was coordinated by V. Arvind (Theoretical Computer Science), Jaya N. Iyer (Mathematics), and Bala Sathiapalan (Physics). There were 31 seminar talks of about twenty-five minute duration each, with the speakers presenting their current work and explaining problems of their current research interest. Seminars were held daily from 10 a.m. to 1 p.m. The talks and speakers are listed below.

- **S. Kesavan**
How to load a drum — or — Optimizing the first eigenvalue of the Laplacian in the presence of an obstacle.
- **Meena Mahajan**
Sorting using Skips and Hops.
- **N.D. Hari Dass**
On quark confinement.
- **R. Balasubramanian**
On divisor functions.

- **Vijay Kumar**
Transpositions Vs. Strip Moves.
- **Amritanshu Prasad**
On a relationship between the local constituents of some automorphic representations for groups over a global field.
- **Piyush Kurur**
On the complexity of computing the Units group and Class group of a number field.
- **K.N.Raghavan**
Tangent Cones to Schubert Varieties.
- **Sudeshna Sinha**
Clipping Chaos to Cycles.
- **T. Muthukumar**
Homogenization and Control Problems.
- **Anuradha Narasimhan**
Improvements on the Hasse-Weil bound.
- **M.V.N Murthy**
Quantum density of states and partitioning an integer.
- **Anirban Roy**
Probabilistic Cloning and Remote state preparation.
- **Arijit Dey**
Harder-Narasimhan(H-N) reduction for (Γ, G) -bundles and ramified G -bundles over a smooth curve.
- **R. Ramanujam**
Bringing logic to security policies.
- **R. Jagannathan**
 q -Analogues of the BCH and the Zassenhaus formulas.
- **M. Krishna**
Jacksic-Last conjecture using Bourgain's lemma.
- **R. Narasimhan**
Coverings of projective varieties.
- **V. Narayanan**
Branching time and space logics of concurrent automata and their application to formal verification.
- **Nita Sinha**
B Decays and signals of New Physics.
- **Vijay Kodiyalam**
Subfactors and 1+1 dimensional TQFT's.

- **D.S.Nagaraj**
Singular plane curves.
- **V. Raman**
Succinct Data Structures.
- **K. Srinivasa Rao**
Ramanujan and his work: A multimedia presentation.
- **S. Ghosh**
Local cloning of Bell states and distillable entanglement.
- **P. Sankaran**
Coarse geometry of infinite groups.
- **Radha Balakrishnan**
The Lamb equation, its integrability, geometry and applications.
- **K.Srinivas**
Zeros of zeta functions on the critical line.
- **G. Menon**
Stretching single molecules.
- **R. Shankar**
Quantum Hall Plateaus.
- **K. Srinivasa Rao**
Srinivasa Ramanujan: His life and work.

4.1.6 3rd IMSc Update Meeting: Automata and verification

The update meetings are intended as a forum for Indian researchers in theoretical computer science to update themselves on current trends and to explore new research areas. The meetings held in 1992 and 1997 were on the themes of Models for Programs and Timed Systems respectively.

This 3rd Update Meeting, held during Feb 29 – Mar 2, 2004, aimed to tell researchers (especially students) about happenings in the areas of automata and verification. The speakers attempted to give a flavour of the exciting work going on in these fields. The lectures were of a survey nature.

Professor Rani Siromoney was felicitated by the Director, IMSc, for her work for over forty years on formal languages and automata theory. She gave a special lecture of reminiscences.

The meeting was well-liked by the participants. The Institute administration ensured smooth running of the meeting even during the holidays. Following is the list of speakers and talks.

- **Rani Siromoney, CMI**
40 years of formal languages & automata theory

- **Supratik Chakraborty**, IIT Bombay
SAT solving
- **Paritosh Pandya**, TIFR
Model checking description and modal logics
- **Anil Seth**, IIT Kanpur
Game semantics
- **Bharat Adsul**, CMI
Infinite two-player games
- **K Narayan Kumar**, CMI
Automata on infinite trees
- **Deepak D'Souza**, IISc
Distributed controller synthesis
- **Swarup Mohalik**, Hewlett-Packard
Games for distributed synthesis
- **Kamal Lodaya**, IMSc
Infinite state automata
- **Madhavan Mukund**, CMI
Decidable logics on graphs
- **R Ramanujam**, IMSc
Security theory
- **S P Suresh**, CMI
Decidability of security properties
- **B Meenakshi**, Honeywell
Modelling and verification with SPIN

4.2 Other Conferences/Workshops Organized by IMSc

4.2.1 Geometry and Topology inspired by Physics

The past few decades have witnessed an explosion of Physics-inspired developments in Geometry and Topology - starting with developments in String theory, Quantum gravity and Nonperturbative aspects of Quantum Field theory. Major ideas have emerged in such diverse areas as quantum invariants of low dimensional topology, symmetries of complex manifolds, noncommutative geometry, etc. This workshop focused on some of these developments and on some important contributions by young Indians.

4.2.2 Conference in Analytic Number Theory

This conference was held as a satellite conference for Joint AMS Mathematics meeting. On this occasion Prof. K. Ramachandra was felicitated for his 70th birth anniversary. About 35 mathematicians participated (15 from abroad). The lectures focussed on the recent developments in Analytic number theory.

4.2.3 International Conference on General Relativity and Cosmology

The *International Conference on Gravitation and Cosmology* is a series of conferences held approximately every four years in India. The series has been conceived as a means to provide younger researchers an exposure to latest research trends and to promote interaction between the International and the Indian research communities. Each of these conferences focuses on two or three 'theme topics' and are typically attended by about a 100 participants from India and abroad. The previous conferences in this series were held at Goa (1987), Ahmedabad (1991), Pune (1995) and Kharagpur (2000) and have been quite successful in the stated objectives.

The fifth conference in the ICGC series, ICGC-2004, was organised by the Cochin University of Science and Technology (CUSAT) at the *Riviera Suites* on the outskirts of Cochin during January 5–10, 2004. It had 17 plenary talks and, as a new feature, it also had 8 short talks which were more specialized than the plenary talks but still accessible to a wider audience. There were three focus themes: Cosmology, Gravitational Waves and Quantum Gravity. About 70 contributed papers were presented in oral presentations and poster sessions in four workshops on: Quantum Aspects of Gravitation, Classical Aspects of Gravitation, Cosmology and Gravitational waves and Relativistic astrophysics.

The plenary talks (pdf/ppt/ps files) are available at <http://meghnad.iucaa.ernet.in/~iagrg>. The proceedings of the conference are to be published as a special issue of *Pramana – Journal of Physics*.

The conference was sponsored by: The Abdus Salam ICTP, Italy; BRNS (DAE), Mumbai; CSIR, New Delhi; DST, New Delhi; HRI, Allahabad; IIA, Bangalore; ISRO, Bangalore; IMSc, Chennai; IOP, UK; IUCAA, Pune; RRI, Bangalore and UGC, New Delhi.

4.2.4 Field Theoretic Aspects of Gravity – IV

This was the fourth of a series of discussions meetings on field theoretic aspects of gravity and was organized by Dept. of Physics, North Bengal University, Siliguri with partial funding from IMSc and IUCAA. The first of meeting of this series was organized by IUCAA, Pune; the second was organized by IMSc, Chennai and the third was organized by Cochin University of Science & Technology, Cochin. This series is intended to bring together a small number of researchers in the areas of classical and quantum gravity from research institutes, IITs and colleges/universities and has been proposed to be made in to a regular annual feature.

FTAG-IV was held at Pelling, Sikkim during Mar 2-6, 2004. About 25 participants including several from IMSc attended. Topics ranged from various aspects of cosmology both observational as well as theoretical models, black holes, gravitational collapse, to more general perspectives on gravity. The very informal and intense discussions were appreciated by the participants. Given below is the list of speakers and topics.

- **N. K. Dadhich**, IUCAA, Pune
Universality as a Guiding Physical Principle
- **M. Sami**, IUCAA, Pune
Joining the Two Ends
- **G. Date**, IMSc, Chennai
Anisotropic Loop Quantum Cosmology: Non Chaotic Bianchi IX behavior
- **T. R. Govindarajan**, IMSc, Chennai
Gravity and Non-commutative Geometry
- **J. Maharana**, IOP, Bhubaneswar
Dilaton Axion String Cosmology
- **Soumen Basak**, IMSc, Chennai
Acoustic Analog Models of Gravity
- **Golam Hossain**, IMSc, Chennai
Reconstruction of Effective Space Time in Loop Quantum Cosmology
- **P. Majumdar**, SINP, Kolkata
Parity Violating Kalb Ramond/Maxwell Interaction and CMB anisotropy in an RS Braneworld
- **Romesh Kaul**, IMSc, Chennai
Gauge Theory of Gravity
- **L. P. Singh**, Utkal University, Bhubaneswar
Some Cosmological Aspects of Generalized Brans Dicke Theory
- **Sukratu Barve**, PRL, Ahmedabad
Reissner-Nordstrom Solution: Hadamard States and Choice of Foliation
- **S. Panda**, HRI, Allahabad
De Sitter Solution in Gauged Supergravity Coupled to Matter

- **V. C. Kuriakose**, CUSAT, Cochin
Black Hole in Thermal Equilibrium with a Quantum Field
- **S. Mukherjee**, North Bengal University, Siliguri
Space Time: Classical or Quantum?
- **B. C. Paul**, North Bengal University, Siliguri
Inflation Driving Tachyon Potential in R^2 – – Gravity
- **A. Bhadra**, North Bengal University, Siliguri
Quantum Gravity: Looking for Observational Effects

4.3 Seminars

Date	Speaker Affiliation	Title
3-4-2003	Thomas Schroeder NORDITA, Denmark	A tunable, coarse-grained off-lattice protein model
10-4-2003	Parvati Shastri Mumbai University	Integral points on the unit circle
11-4-2003	P. Hislop University of Kentucky	Edge currents in Quantum Hall Geometries
16-4-2003	T. C. Vijayaraghavan IMSc	Derandomizing Polynomial Identity Tests
16-4-2003	Somendra M. Bhattacharjee IOP, Bhubaneswar	Unzipping DNA
17-4-2003	Dutta Sreedhar TIFR, Mumbai	Asymptotic Distributions of Periodically Driven Stochastic Systems
24-4-2003	A. Jensen University of Aalborg, Denmark	The Nelson model with less than 2 photons
29-4-2003	Tribikram Gupta HRI, Allahabad	Ultrasonic Attenuation in d-wave Superconductors
30-4-2003	J. Maharana IOP, Bhubaneswar	Symmetries of Dilaton-Axion string cosmology
6-5-2003	Rahul Muthu IMSc	Algorithmic Aspects of Lovasz Local Lemma
7-5-2003	A. Mukherjee ISI, Calcutta	Recent developments on the Poincare Conjecture
8-5-2003	A. Narasimhan IMSc	Jacobsthal sums over Finite Fields and some applications

8-5-2003	K Narayan Kumar Chennai Mathematical Institute	Local LTL with past constants is expressively complete for Mazurkiewicz traces.
16-5-2003	Sharadha Ramanan TCS, Chennai	Informal talk
20-5-2003	Pijush Bhattacharjee Indian Institute of Astrophysics, Bangalore	Ultrahigh Energy Cosmic Rays: New Physics or Extreme Astrophysics?
21-5-2003	Madhav V. Ranganathan Stanford University, USA	Kinetic theory for density fluctuations in one-component monoatomic fluids at equilibrium
21-5-2003	R. Balasubramanian IMSc	Number theoretic aspects of cryptology
22-5-2003	S. Anbarasu Anna University	DNA Computing
27-5-2003	Gautam I. Menon IMSc	Seeing vortex glasses
28-5-2003	Tomy Scaria SNBNCBS, Kolkata	Abelian gauge transformations and Wigner's little group
30-5-2003	Gautam I. Menon IMSc	Pattern Formation in Mixtures of Molecular Motors and Microtubules
3-6-2003	N. Ganeshwar IIT, Powai	Spectral approximation of integral Operators
4-6-2003	Mohua Banerjee IIT, Kanpur	Algebras from Rough Sets
4-6-2003	P.M. Gade IMSc	Physicists in Finance
1-7-2003	N. Gurappa IMSc	A New Technique to Solve Linear Differential Equations with an application to Calogero-Sutherland Models

8-7-2003	Rahul Siddharthan Rockefeller/IMSc	DNA, gene regulation, development and evolution: A beginner's introduction (Talk 1)
10-7-2003	Rahul Siddharthan Rockefeller/IMSc	DNA, gene regulation, development and evolution: A beginner's introduction (Talk 2)
11-7-2003	Rahul Siddharthan Rockefeller/IMSc	DNA, gene regulation, development and evolution: A beginner's introduction (Talk 3)
11-7-2003	L. Sunil Chandran MPI for Informatik, Germany	Girth and Treewidth
17-7-2003	Jaikumar Radhakrishnan TIFR, Mumbai	The bounded round quantum communication complexity of set disjointness
23-7-2003	Santosh Vempala MIT, USA	How to Compute the Volume?
23-7-2003	Tabish Qureshi Jamia Milia University, Delhi	Popper's Experiment and Nonlocality in Quantum Mechanics
25-7-2003	Girish Setlur IMSc	A Unified Theory of Landau Fermi Liquids, Luttinger Liquids and Wigner Crystals
28-7-2003	M. Muthukumar University of Massachusetts, Amherst	Soups of Coulomb Strings: DNA Solutions
29-7-2003	Prasanna Thati University of Illinois, Urbana-Champaign	Verification of Asynchronous Systems with Unbounded and Unordered Message Buffers
30-7-2003	M. Muthukumar University of Massachusetts, Amherst	Charge Regularization and DNA Condensation
31-7-2003	Ashvin Vishwanath MIT, USA	Luttinger Theorem from Momentum Counting: Analogues for Superfluids and Fractionalized Phases

31-7-2003	Madhavan Mukund Chennai Mathematical Institute	Netcharts: Bridging the gap between HMSCs and executable specifications
1-8-2003	M. Muthukumar University of Massachusetts, Amherst	Collective Behavior of DNA Solutions
6-8-2003	Guruprasad Kar IMSc	From No-go Theorem to quantum information (I)
8-8-2003	Guruprasad Kar IMSc	From No-go Theorem to Quantum Information (II)
13-8-2003	Aravind Srinivasan University of Maryland	A new tail-bound of Vu and Janson-Rucinski
13-8-2003	Tapash Chakraborty IMSc	How to probe a fractionally charged quasi-hole
19-8-2003	Hasi Ray IIT, Rourkee	An Introduction to Positronium Physics
21-8-2003	Piyush P Kurur IMSc	Upper bounds for the complexity of some Galois theory problems
22-8-2003	Pinaki Majumdar HRI, Allahabad	Metastability, persistent field memory, and giant tunneling magneto-resistance at nanoscale coexistence
26-8-2003	Sudhansu S. Mandal IACS, Kolkata	Two Dimensional Electron System in High Magnetic Fields: Wigner Crystal vs Composite-Fermion Liquid
27-8-2003	G. Rajasekaran IMSc	Can we destroy nuclear bombs using neutrino beams?
28-8-2003	C. S. Seshadri and S. Ramanan CMI and IMSc	Remembering Professor A. Borel
2-9-2003	Arul Lakshminarayan IIT, Chennai	Quantum Entanglement and Classical Chaos

4-9-2003	M. Rajesh IMSc	Asymptotic of an optimal location problem
10-9-2003	Tapash Chakraborty IMSc	Spintronics:Quantum Mechanics of a Spin Transistor
11-9-2003	S. Venkatesh Max Planck Institute, Saarbruecken	The Power of Concurrent Read
12-9-2003	S. Venkatesh Max Planck Institute, Saarbrücken	On the Power of Concurrent Read
16-9-2003	Sourendu Gupta TIFR	Jumping off the Wall
16-9-2003	Mathematics IMSc	Meeting with College folk from Erode
17-9-2003	Rajan Gupta Los Alamos National Laboratory	Discovering Elementary Particles and Estimating Their Masses
18-9-2003	Raghunath Ratabole CTS, IISc.	Transverse Lattice QCD at Strong Coupling and Large-N
18-9-2003	Wolfgang Luh University of Trier, Germany	Universal Functions-Overview
19-9-2003	K.S. Krishnan TIFR	Potions from Poisons
19-9-2003	Saurabh Rindani PRL, Ahmedabad	Transverse Polarization at e^+e^- Collider and CP violation
20-9-2003	K.S.Krishnan TIFR	Cellular Traffic: The Synaptic Detour
22-9-2003	Balwant Singh IIT, Mumbai	Subintegrality, invertible modules and the Picard group
23-9-2003	Nitin Nitsure TIFR, Mumbai	Grothendieck's q-sheaves and representability

25-9-2003	Anirban Mukhopadhyaya IMSc	Almost Squares in Arithmetic Progression
30-9-2003	N. Vanaja	Co-polyform modules
1-10-2003	Uma Subramanian IMSc	Biting convergence of null-Lagrangians
15-10-2003	P. P. Divakaran TIFR	What is Quantum Integrability?
16-10-2003	Jaya Iyer IMSc	Cycles on Complete Intersections
23-10-2003	Kapil H. Paranjape IMSc	Resolution of Singularities
27-10-2003	Arjun Bagchi IMSc	Hagedorn Transition in String Theory
28-10-2003	Ananth Chikkatur MIT (Boston)	Microscopic Superfluidity in Bose-Einstein Condensates
29-10-2003	N. Aizawa Osaka Women's University, Osaka, Japan	Noncommutative geometry of Jordanian quantum superspace
29-10-2003	Kinjal Banerjee IMSc	Beta Functions in Non-Linear Sigma Model in String Theory.
29-10-2003	Rajendra Bera IBM, Center for Advanced Studies	Quantum Encryption and Quantum Teleportation
30-10-2003	V. Uma IMSc	Topology of Real Toric Varieties
31-10-2003	Turbasu Biswas IMSc	Dynamical Supersymmetry Breaking
3-11-2003	Chandradev Sharma IMSc	CP Violation in Kaon Decay
5-11-2003	Alok Kumar IMSc	Spontaneous Chiral Symmetry Breaking in Quark Confinement

5-11-2003	Naba K Mondal TIFR, Mumbai	Status of the India-based neutrino observatory (INO)
6-11-2003	Anil Joshi	Rural Technology and Empowerment
7-11-2003	Soumen Basak IMSc	Acoustic Analog Model of Gravity
7-11-2003	Mithun Kumar Mitra IMSc	Dynamic Instability in Microtubules
11-11-2003	Golam Hossain IMSc	Hubble Operator in Isotropic Loop Quantum Cosmology
12-11-2003	Murali K. Vemuri CMI	Kirillov Theory
13-11-2003	V. S. Sunder IMSc	Unitary invariants for tensors
17-11-2003	Saptarshi Mandal IMSc	Anyons in a Hexagonal Lattice Model
19-11-2003	V. Kodiyalam IMSc	An application of the Kempf-Ness Theorem and a question
19-11-2003	Ivan Solomon IMSc	Known Measures of Entanglement
20-11-2003	Sachin Gautam IMSc	Coxeter Groups
20-11-2003	Swagata Sarkar IMSc	Structure of simple rings
20-11-2003	K. Srinivas IMSc	The zeros of the Epstein zeta-function
21-11-2003	Sarnath Ramnath St. Cloudstate University, USA	Routing Signal Nets in VLSI Design
27-11-2003	Ved Prakash Gupta IMSc	Banach-Tarski Paradox

27-11-2003	R. Parthasarathy TIFR	Skew-product Cantor Dynamical Systems
4-12-2003	Jayalal Sarma IMSc	Randomness-efficient Amplification
5-12-2003	Anjan Dasgupta Department of Biochemistry, University of Calcutta	From Blood to Music: Dynamics of the NOthing
5-12-2003	S. Vijayakumar IIT, Chennai	Sorting by Short Transpositions
9-12-2003	Vikram Tripathi Cavendish Lab, Cambridge University	Coulomb Blockade and Quantum tunneling in the Low Conductivity Phase of Granular Metals
10-12-2003	Arnab K Ray IACS, Calcutta	Realizability of Stationary Spherically Symmetric Transonic Accretion
11-12-2003	Norman Wildberger University of NSW	Multisets for the multitudes
12-12-2003	O. W. Greenberg University of Maryland	The Interplay of CPT Invariance, Lorentz Invariance and Locality and their Violations.
17-12-2003	O. W. Greenberg University of Maryland	Quarks and Color
18-12-2003	Mohan Srinivasarao Georgia Tech, Atlanta, USA	Colors in Biology
19-12-2003	Pearl Katz Johns Hopkins University; Author of "The Scalpels Edge"	The Culture of Surgeons
22-12-2003	Aalok Misra IIT, Roorkee	Non-perturbative Superpotentials, (barely) G_2 manifolds, (orientifold of) a Compact CY and an N=1 Triality
22-12-2003	Ramesh Bharadwaj Naval Research Laboratory USA	Rigorous Methods for Software Construction: Retrofitting "Engineering" into Software Engineering

23-12-2003	V. Srinivas TIFR	A problem in Linear Algebra
23-12-2003	Siv Sivaloganathan University of Waterloo	Brain Biomechanics
23-12-2003	V. Trivedi TIFR	Semi-stability and Hilbert-Kunz multiplicities
23-12-2003	V. Kumar Murty University of Toronto	Splitting of Primes in Infinite extensions
24-12-2003	Sriram K. Rajamani Microsoft Research	Concurrent Bebop
24-12-2003	Uday Reddy University of Birmingham	Correctness of data representations involving heap data structures
24-12-2003	M. Ram Murty Queen's University	Symmetric Power L-functions
26-12-2003	S.G. Rajeev University of Rochester	Ricci Flow
26-12-2003	Jennifer Seberry University of Wollangong	Stream Ciphers
29-12-2003	M. Ram Murty Queen's University	Symmetric Power L-functions
29-12-2003	Ashoke Sen HRI, Allahabad	Tachyon Dynamics in Open String Theory
30-12-2003	Dinakar Ramakrishnan Caltech	Average L-values, class numbers and rational points
30-12-2003	Dilip Ghosh University of Oregon	Observing CP Violating MSSM Higgs Bosons at e^+e^- and Hadron Collider
31-12-2003	Debashis Ghoshal HRI, Allahabad	Non-commutative Solitons in a Non Local Field Theory
31-12-2003	M. Ram Murty Queen's University	Symmetric Power L-functions

2-1-2004	Iftikhar Burhanuddin University of Southern California	On computing discrete logarithms in formal groups and applications
5-1-2004	Justin David ICTP, Trieste	Partial Supersymmetry Breaking and Gravity Deformed Chiral Rings
6-1-2004	Naseem Rahman ICTP, Trieste	Application of Supersymmetric Field Theory in Laser Physics
6-1-2004	S. S. Abhyankar Purdue University	On Serre's criterion
6-1-2004	M. Ram Murty Queen's University	Symmetric Power L-functions
6-1-2004	B. Ravikumar California State University, Sonoma, USA	Weak minimization of automata - an algorithm with applications
7-1-2004	Vijay Kumar Tohoku University, Japan	Novel Fullerenelike and Nanotube Structures of Silicon - a New Paradigm for Silicon Based Nanodevices.
7-1-2004	M. Ram Murty Queen's University	Symmetric Power L-functions
8-1-2004	S. S. Abhyankar Purdue University	On Serre's criterion
8-1-2004	A. M. M. Pruisken University of Amsterdam, The Netherlands	The Quantum Hall Effect - an Experimental Realization of the Instanton Vacuum.
9-1-2004	D. Venkataraman University of Massachusetts, USA	Crystal Engineering and Superconductors
12-1-2004	Jnanadeva Maharana IOP, Bhubaneswar	Integrability Properties of Strings in AdS background
12-1-2004	Martin Bojowald AEI, Potsdam, Germany	Loop Quantum Cosmology - Recent Progress.

13-1-2004	Professor R. P. Kerr Dept. of mathematics, University of Canterbury, New Zealand	History of the Kerr Solution
13-1-2004	Rohit Parikh City University of New York, USA	The Logic of Finite Information
14-1-2004	Rohit Parikh City Univesity of New York, USA	Knowledge, action and public action
16-1-2004	Ulf Persson Chalmers University of Technology, Sweden	Geography of Surfaces
16-1-2004	R. K. Bhaduri McMaster University, Canada	Number Fluctuations in Statistical Mechanics - A Pathological Case
16-1-2004	Rajagopalan Balaji Colorado University, USA	Year-to-Year Variability of Indian Summer Monsoon
20-1-2004	R. Srikanth RRI, Bangalore	Quantum Bit Commitment
21-1-2004	Sandip Trivedi TIFR, Mumbai	De Sitter Vacua and the Emerging Landscape of String Theory
21-1-2004	Kurt Mehlhorn Max Panck Institut fuer Informatik, Saarbruecken, Germany	EXACUS: Efficient and Exact Computations with Curves and Surfaces
21-1-2004	R. Narasimhan University of Chicago	Gromov's h-principle
22-1-2004	V. Lakshmibai North Eastern University, USA	Equivariant K-theory of G/B
22-1-2004	Sandip Trivedi TIFR, Mumbai	Inflation in String Theory Warped Compactifications
22-1-2004	Anuradha Narasimhan IMSc	Maximal and minimal curves over Finite Fields

23-1-2004	Joshua Scott North Eastern University	Cluster Algebras I (Grassmannians)
27-1-2004	Joshua Scott North Eastern University	Cluster Algebras II
27-1-2004	John Peter Arulmigu Kalasalingam College of Engineering, Viruthunagar	Metal Insulator Transition in Low Dimensional Semiconductor Systems
27-1-2004	S. Ramanan IMSc	Moduli spaces as Fano varieties
28-1-2004	Siddhartha Sen Trinity College, Dublin and IACS, Kolkata	Black Hole Entropy and CFT
28-1-2004	Raghavan Narasimhan University of Chicago	Gromov's h-Principle
28-1-2004	Amritanshu Prasad IMSc	Iwahori Hecke algebras II
29-1-2004	M. Demuth University of Clausthal	Results in Stochastic spectral analysis
30-1-2004	V.Lakshmibai Northeastern University	Equivariant K-theory of G/B
30-1-2004	Adi Shamir Weizmann Institute of Science, Israel	Hardware Based Implementations of Factoring Algorithms
3-2-2004	Adi Shamir Weizmann Institute of Science, Israel	Cryptography: State of the Science
3-2-2004	S. Ramanan IMSc	Moduli spaces as Fano varieties II
4-2-2004	V. Ganesan Inter University Consortium, Indore	Coherence in an Otherwise Kondo Insulator

4-2-2004	Siddhartha Sen Trinity College, Dublin and IACS, Kolkata	Geometric Discretisation
4-2-2004	Raghavan Narasimhan University of Chicago	Gromov's h-principle
4-2-2004	K.N. Raghavan IMSc	The LS Gallery Character formula
5-2-2004	M. K. Parida NEHU, Shillong	Probing Seesaw Mechanisms through Neutrino Masses and Lepton Flavour Violating Decays
5-2-2004	D.S. Nagaraj IMSc	Vector bundles on projective spaces
6-2-2004	V. Subrahmanyam IIT, Kanpur	Quantum Entanglement in Spin/Fermi Systems
6-2-2004	Tanusri Saha-Dasgupta SNBNCBS, Kolkata	Understanding Physics and Chemistry of Complex Materials by N-MTO Method.
9-2-2004	S. Ramanan IMSc	Moduli spaces as Fanos
11-2-2004	Raghavan Narasimhan University of Chicago	Gromov's h-principle
11-2-2004	P. N. Swamy Southern Illinois State University, Edwardsville, USA	Interpolating Statistics and Detailed Balance
11-2-2004	Murali K.Vemuri CMI	$O(p,q)$ -module structure of homogeneous functions on light cones (Contd.)
12-2-2004	M. Krishna IMSc	The Simon-Wolff Theorem
13-2-2004	Jasjeet Singh Bagla HRI, Allahabad	Cluster Computing at HRI

16-2-2004	C. R. Das IISc Bangalore	Examples of RGE Analysis - Analytic and Numerical
16-2-2004	S. Ramanan IMSc	Moduli spaces as fanos
16-2-2004	Y. Holla TIFR	Topological classification of principal bundles
18-2-2004	Raghavan Narasimhan University of Chicago	Gromov's h-Principle
18-2-2004	K.N. Raghavan IMSc	The LS Gallery Character formula
19-2-2004	Alexander Schmitt University of Essen	Group actions and classification problems in Algebraic geometry
3-3-2004	C. R. Rao Pennsylvania State University	Anti-eigenvalues of Matrices
3-3-2004	Matthias Meulien CMI	On invariants of Grassmanians of binary forms I
4-3-2004	S. Kesavan IMSc	Symmetrization and Isoperimetric inequalities
8-3-2004	Jaya Iyer IMSc	Syzygies of projective varieties
10-3-2004	Akash Nanavati UCLA	Coordinated Mechanisms
10-3-2004	Murali Vemuri CMI	Harmonic analysis on spheres
10-3-2004	Matthias Meulien CMI	On invariants of Grassmanians of binary forms II
11-3-2004	Nalin Gautam IIT Delhi	Modelling and Simulation of Solar Photo-Voltaic Array's Characteristics

12-3-2004	R. Murugaraj Pondicherry University	AC Conductance in Disordered Ionic Solids: Theoretical and Experimental Aspects
15-3-2004	Rajat Tandon University of Hyderabad	A generalization of the Frohlich-Queyrut Theorem
15-3-2004	V. Lakshmibai Northeastern University	Toric degeneration of Schubert varieties
16-3-2004	Bhaskar Ramamurthy Dept. of Electrical Engineering, IIT, Chennai	Mobile Wireless Access - The Next Generation
17-3-2004	Bhaskar De IMSc	Particle Production in High Energy Nuclear Collisions and a Combinational Approach
17-3-2004	Amritanshu Prasad IMSc	Spherical functions for the hyperbolic group
18-3-2004	Sudhir Vempati INFN, Padova, Italy	Seesaw Signatures from SUSY GUT Theories
18-3-2004	V. Lakshmibai Northeastern University	Standard monomial theory for nilpotent orbit closures
22-3-2004	K.N. Raghavan IMSc	Groebner geometry of Schubert polynomials
22-3-2004	S. V. M. Satyanarayana IGCAR	In Silico Studies on Cell Mobility
23-3-2004	V. Lakshmibai Northeastern University	Quantum cohomology of Flag varieties
23-3-2004	Prasanta Kumar Das HRI Allahabad	The triviality bound on Higgs mass due to a light stabilized radion in Randall-Sundrum model(RS).
24-3-2004	Pushan Majumdar University of Graz	Accurate Measurements in Lattice Gauge Theories

24-3-2004	Murali Vemuri CMI	$O(p,q)$ -module structure on homogeneous functions on a light cone-III
24-3-2004	Amritanshu Prasad IMSc	Spherical functions on the special orthogonal groups and the hyperbolic group
25-3-2004	R. Ramaswamy School of Physics, JNU, Delhi.	Hunting the DNA: Finding Genes (and other things) in DNA sequences
25-3-2004	C.S. Aravinda CMI	Ricci flow and geometrisation
26-3-2004	Kamales Kar Saha Institute, Kolkata	Random Matrix Ensembles and Many Fermion Systems
29-3-2004	K. Santosh Kumar IMSc	Quantum Field Theory with String Tension-I
30-3-2004	G. Baskaran IMSc	A Resolution to Doping Asymmetry in High T_c Cuprates
30-3-2004	K. Santosh Kumar IMSc	Quantum Field Theory with String Tension -II
31-3-2004	Amritanshu Prasad IMSc	Spherical functions for the hyperbolic group

Chapter 5

External Interactions

5.1 Collaborative Projects with Other Institutions

5.1.1 Automata and concurrency: Syntactic methods for verification

During May 2002, M. Mukund (CMI) and K. Narayan Kumar (CMI) visited A. Petit (LSV, ENS Cachan), P. Gastin (LIAFA Paris) and P. Weil (LaBRI, Bordeaux) under this project.

During Jan-Feb 2003, A. Petit, P. Gastin, P. Weil and C. Dima (LaBRI, Bordeaux) visited IMSc under this project. They also took part in the 2nd Workshop on Automata, Concurrency and Logic, held during Jan 2003 at IMSc.

The project was extended up to 31 Oct 2003. K. Lodaya worked with P.K. Pandya (TIFR Mumbai) on expressiveness of interval temporal logic.

5.1.2 CD-ROMs Project on the *Life and Work of Srinivasa Ramanujan*

This was a joint Project between the IMSc and the National Multimedia resource Center of C-DAC, Pune, funded by the Department of Science and Technology, Government of India. The object was to bring out two (or more) CD ROMs on the Life and Works of Srinivasa Ramanujan. Prof. K. Srinivasa Rao was the Domain Expert / Content Provider for this Project.

The CD ROMs project was extended till the middle of January 2004. The work was brought to a completion and the CD ROMs were presented at a meeting called for by the DST at New Delhi, on March 25, 2004.

The first CD ROM contains the biographical (multimedia) part on the life of Ramanujan, besides Entries in the Notebooks of Ramanujan; Ramanujan's Collected Papers; interviews of some experts on the work of Ramanujan. The second CD ROM includes (the copyrighted) five part work of Bruce C. Berndt on Ramanujan's Notebooks (with the agreement of the publisher: Springer-Verlag). A web site on Srinivasa Ramanujan has also been created at <http://www.imsc.res.in/~rao/ramanujan/introindex.html>

5.1.3 ILGTI

The objective of the Indian Lattice Gauge Theory Initiative(ILGTI), a Xth Plan project, is to develop state of the art facilities for High Performance Computing in the area of Lattice Gauge Theories and to use these to promote collaborations between the other participating institutions TIFR and SINP. During this year major time was spent on studying the 9-node Pilot cluster built in March 2003 and on building the second stage of the cluster with 80+1 nodes of Dual Xeons. This work was completed by Dec 2003 and a performance of 539 GFlops was obtained on this intermediate cluster. The full cluster consisting of 144 nodes (288 CPUs) is expected to be fully functional, including software installation and tuning the cluster for best performance, by April, 2004. The Principle Coordinator from IMSc for this project is Prof. N. D. Hari Dass.

Source codes for very accurate measurements were developed with Pushan Majumdar of Graz, Austria and double precision implementation of MILC codes for QCD were completed with Shyam Srinivasan. Collaboration with TIFR was begun on investigating sound velocity in QCD plasma.

While this annual report was being prepared, in June, 2004, the fully commissioned cluster, named KABRU, made it to the top 500 super computers world-wide. It is ranked 257th with sustained performance of 959 Gflops and is the fastest academic computer in the country.

5.1.4 India-based Neutrino Observatory (INO)

The Feasibility study for India-based Neutrino Observatory (INO) is in full swing after a Memorandum of Understanding (MOU) was signed in September of 2002 leading to the formation of a National Neutrino Collaboration Group. An interim project report(IPR) is being prepared by the INO group at IMSc which is i-charge of preparing the IPR after receiving the reports of the work done by all the groups. The members from IMSc in INO are involved in (a) Simulation studies for the large Iron-Calorimeter (ICAL) detector, (b) site survey for locating INO and (c) awareness campaign in order to generate human resources necessary for such a large project.

(a) In the area of simulations the group has installed a Neutrino Event Generator program—NUANCE. This is a general purpose program developed at UC-Irvine and has now been successfully adapted with suitable modifications for the ICAL detector to generate events from atmospheric neutrinos (the main programme of ICAL). The group is now engaged in extending the event generator program to cover other interesting neutrino sources from neutrino factories (long-baseline) and Ultra-High Energy Neutrino sources (UHE). Work is also in progress in the area of detector simulation using the CERN-based GEANT code as also in the area of track recognition and fitting.

To begin with a magnetised 35k Ton Iron Calorimeter (ICAL) detector will be the main neutrino detector at INO which may subsequently house more than one detector/experiments. A unique feature of ICAL is charge identification apart from good timing (nanoseconds). The main physics goal of the ICAL detector is to study the atmospheric neutrinos and establish the phenomenon of neutrino oscillation on a firm footing in the first phase of its operation. In the second phase the ICAL detector may be in a position to study neutrinos produced at

a neutrino factory several thousand kilometers away. Possibility of housing a heavy water detector similar to existing one at Sudbury is at a very preliminary stage of discussion. INO is also expected to become a fullfledged laboratory for underground sciences in the not so distant future.

The main detector element, namely Resistive Plate Chamber, with nanosecond timing and good position resolution is functioning with efficiencies in excess of 90 percent. Investigation of the engineering aspects of the structure for supporting the huge detector, weighing 35 kTons, has also been completed. The study of muon energy spectrum and direction has already indicated that one may be able to resolve the energy and direction of the incoming neutrino to a reasonable extent. The study of hadrons is in progress and once completed it will be possible to determine the energy of the neutrino to a better accuracy.

(b) The site survey for locating INO at PUSHEP in Nilgiri mountains has now been completed. The full feasibility report including geotechnical report from the Geological Survey of India, Chennai is now available. It has been concluded that the PUSHEP site in Singara offers one of the best sites for locating INO, considering various critical factors such as (1) physics requirements, (2) geotechnical assessment and recommendation, (3) ease of access, (4) local scientific and industrial infrastructure, etc. Work is in progress to study the stress conditions at the cavern location and the access tunnel in order to facilitate laboratory cavern design.

The reports on site surveys are ready. Design of front-end electronics, gas mixing units and magnetisation are in progress. It is expected that the report will be submitted before the end of the two year period since MOU was signed, which is August 2004.

(c) Apart from its involvement in many of the activities mentioned above, INO group at IMSc continues to be engaged in giving series of lectures at various educational institutions to attract and train large number of scientists and also engineers. Being a large project, INO would require a huge number of scientists and engineers to conduct experiments and maintain the laboratory infrastructure. Proposals have been made to train the required human resources for INO as well as future large experimental projects in India.

More details may be found on website, <http://www.imsc.res.in/~ino>

INO Group at IMSc includes: G. Dutta (from Feb–July 2003), D. Indumathi, H.S. Mani (from Jun 2003), M.V.N. Murthy, G. Rajasekaran and Abdul Salam (from Feb 2003).

5.1.5 Novel Materials for applications in Molecular Electronics and Energy Storage Devices

DRDO has sanctioned in January 2002 a project on Novel Materials for Applications in Molecular Electronics and Energy Storage Devices. The project team consists of A.K. Mishra (IMSc), Sheela Berchmans (CECRI), and V. Yeganaraman (CECRI). The project duration is for three years.

5.1.6 Spectral Theory of Schrödinger Operators

This is a project to do research on spectral theory of some random and deterministic Schrödinger operators. The project is funded by Deutsche Forschungsgemeinschaft (DFG), Germany and the Indian National Science Academy (INSA), India. The principal investigators from the German side are M Demuth, Technical University of Clausthal and W. Kirsch, Ruhr University, Bochum. The principal investigator from the Indian side is M. Krishna, Institute of Mathematical Sciences, Chennai. The project period is three years starting July, 2003.

5.1.7 Studies in Quantum Statistics

An Indo-US Collaboration project on ‘Studies in Quantum Statistics’, involving Institute of Mathematical Sciences (India) and University of Maryland (USA), has been approved. The project team consists of A.K. Mishra (IMSc) and Prof. O.W. Greenberg (Maryland Univ.). The project duration is for three years and it commenced from May 2002.

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 is for a period of three years and (s)he is expected to visit the institute at least twice during this period.

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

Associates who visited the institute during the period 01.04.03 to 31.03.04 are :

P. Paulraja

Dept. of Mathematics, Annamalai Univ., Annamalainagar
02.05.2003 to 23.05.2003

Santhosh George

Govt. College of Arts, Science & Commerce, Sanquelim, Goa
03.05.2003 to 23.05.2003

M. S. Datt

Dept. of Mathematics, Univ. of Hyderabad, Hyderabad
05.05.2003 to 05.06.2003

C. S. Narayanamurthy

Applied Physics Dept., M.S. Univ. of Baroda, Gujarat
15.05.2003 to 10.06.2003

Mohua Banerjee

Dept. of Mathematics, IIT, Kanpur
06.05.2003 to 07.06.2003

D. K. Choudhury

Dept. of Physics, Guwahati Univ., Guwahati
22.06.2003 to 05.07.2003

Ranbir Chakraborti

Dept. of Theoretical Physics, Univ. of Madras, Chennai
17.04.2003 to 30.06.2003 and 17.12.2003 to 31.12.2003

P. S. Joag

Dept. of Physics, Univ. of Pune, Pune
08.06.2003 to 05.07.2003 and 03.01.2004 to 24.01.2004

Swapan Mandal

Dept. of Physics, Viswa-Bharati, Santiniketan
17.12.2003 to 05.01.2004

Prabodh Shukla

Dept. of Physics, North Eastern Hill Univ. Shillong
20.12.2003 to 17.02.2004

Neyaz Ahmad Sheik

Dept. of Mathematics, National Institute of Tech., Srinagar
23.01.2004 to 21.02.2004

5.3 Conference Participation and Visits to Other Institutions

Arvind, V.

Visited IIT, Kanpur during Aug 24 – Aug 28, 2003. Gave two lectures at the CSE Department of IIT, Kanpur.

Balakrishnan, Radha

Visited George Mason University, USA during Jul 7 – Jul 31, 2003 for research collaboration.

Visited Center for Nonlinear Studies, Los Alamos National Laboratory, USA during Aug 1 – Sep 15, 2003 for research collaboration.

Visited Raman Research Institute on Dec 11, 2003. Seminar on “Connection between the Schrodinger equation and a moving space curve”.

Participated in *National Conference on Nonlinear Systems and Dynamics* held at IIT, Kharagpur during Dec 28 – Dec 30, 2003. Gave an invited talk on “Exact topological and non-topological solitons in a classical antiferromagnetic chain” and chaired a session.

Participated in *International Conference on Nonlinear Phenomena* held at IISc, Bangalore during Jan 5 – Jan 7, 2004. Gave an invited talk on “Geometric characterizations of the Lamb equation”.

Balasubramanian, R.

Visited Amrita Institute of Technology & Science, Kollam Dist. on Apr 11, 2003. Gave a lecture on “Cryptology” at *National Workshop on Information Security and Cryptography*.

Visited Kishore Vaigyanik Protsahan Yojana, Bangalore on May 6, 2003. Gave a lecture on “Prime Numbers”.

Visited Indian Institute of Technology, Kanpur on Jun 3, 2003. Gave a lecture on “Cryptology”.

Visited BARC, Mumbai on Jun 14, 2003. Gave a lecture on “Prime Numbers”

Baskaran, G.

Visited Physics Department, Bhanaras Hindu University, Banaras during Apr 3 – Apr 4, 2003 and gave a lecture on “New Superconductors”.

Visited Physics Department, IIT, Roorkee during Apr 7 – Apr 8, 2003 and gave a talk on “Spinonics”.

Participated in *Frontiers in Physics* held at Physics Department, IIT, Roorkee during Apr 7 – Apr 8, 2003 as an Invited Speaker.

Visited Physics Department, Utkal University, Bhubaneswar on Apr 9, 2003 and gave a talk on “Physics Meets Biology”.

Visited National Brain Research Center, Manesar, Haryana during May 6 – May 8, 2003 for Scientific Council Meeting.

Participated in *M2S International Conference on High Temperature Superconductivity* held at Rio de Geneir, Brazil during May 25 – May 30, 2003 as an Invited Speaker.

Basu, Rahul

Participated in *Quark Gluon Plasma* held at VECC, Kolkata during May 5 – May 7, 2003.

Participated in *Linear Collider Workshop* held at TIFR, Mumbai during May 8 – May 10, 2003.

Visited LAPTH, Annecy, France during Jun 23 – Jul 25, 2003 for research Collaboration.

Participated in *XV DAE Symposium in High Energy Physics* held at Jammu University during Nov 11 – Nov 15, 2003.

Participated in *QCD 2002* held at IIT, Kanpur during Nov 18 – Nov 22, 2003.

Participated in *The 6th ACFA Workshop on Physics and Detector at Linear Collider* held at TIFR, Mumbai during Dec 15 – Dec 17, 2003.

Participated in *Eighth Workshop in High Energy Physics Phenomenology (WHEPP-8)* held at IIT, Powai, Mumbai during Jan 5 – Jan 16, 2004.

Visited SNBNCBS, Kolkata during Mar 1 – Mar 2, 2004 for *TPSC conveners meeting*.

Visited IOP, Bhubaneswar during Mar 3 – Mar 6, 2004 under the TPSC program.

Das, Paramita

Participated in *Joint India-AMS Mathematics meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003.

Date, G.

Participated in *International Conference on Gravitation and Cosmology (ICGC-2004)* held at CUSAT, Cochin during Jan 5 – Jan 10, 2004. Summarised the conference in the “conference overview” talk.

Visited IUCAA, Pune during Jan 14 – Jan 20, 2004.

Participated in *Workshop on Braneworlds and Quantum Cosmology* held at IUCAA, Pune during Jan 14 – Jan 16, 2004. Gave a talk on “Anisotropic Loop Quantum Cosmologies”.

Participated in *Field Theoretic Aspects of Gravity-IV* held at Pelling, Sikkim during Mar 2 – Mar 6, 2004. Gave a talk on “Anisotropic Loop Quantum Cosmology: Non-Chaotic Behaviour of Bianchi IX”.

Ezhuthachan, Bobby V. K.

Participated in *workshop on string theory* held at IIT, Kanpur during Dec 8 – Dec 21, 2003.

Ghosh, Sibasish

Visited the Physics and Applied Mathematics Unit of ISI, Kolkata during Oct 6 – Oct 15, 2003. Gave a talk on “Bound entanglement and its applications”.

Visited SNBNCBS, during Oct 27 – Oct 31, 2003 under the TPSC Programme and gave a talk on “Robustness of some UPB-generated bound entangled states”.

Visited the School of Physics, TIFR, Mumbai during Nov 18 – Nov 23, 2003. under the TPSC programme, and gave a talk on “local distinguishability of maximally entangled states”.

Visited the Physics Department of Pune University during Nov 24 – Nov 29, 2003, under the TPSC Programme and gave two talks on “Properties of bound entangled states”, and “Local cloning of Bell states”.

Participated in *SERC School on Quantum Information and Quantum Optics* held at PRL, Ahmedabad during Feb 1 – Feb 14, 2004. Gave two lectures on “Quantum Maps”, in the SERC school.

Hari Dass, N. D.

Participated in *Workshop on the Colour of Sky and Sea* held at Agartala, Tripura during Apr 1 – Apr 8, 2003. Conducted this workshop for High School Children for the Jagdis Bose National Science Talent Search.

Visited TIFR during Apr 9 – Apr 18, 2003. To set up collaboration activities under ILGTI.

Visited BARC, Mumbai on Apr 15, 2003. Benchmarking on their 64-node cluster.

Visited TIFR, Mumbai during Jun 13 – Jun 23, 2003 to discuss ILGTI collaboration. Also, delivered a seminar on the “Statistical Significance of Single Quantum States”.

Visited BARC, Mumbai on Jun 19, 2003 for Benchmarking and also delivered a seminar on “Parallel Computing in QCD”.

Visited CDAC, Pune during Jul 6 – Jul 8, 2003 for Benchmarking on Param Padma.

Visited CDAC, Bangalore during Jul 23 – Jul 24, 2003 for Benchmarking on Param Padma.

Participated in *Workshop on Parallel Computing and its application in Science and Engineering* held at BARC, Mumbai during Nov 28 – Nov 29, 2003. Gave an invited talk on “Efficiency Issues in Cluster Computing”

Participated in *Workshop on Non-equilibrium Field Theory* held at TIFR, Mumbai during Dec 10 – Dec 15, 2003.

Visited CTS, IISc, Bangalore during Dec 28, 2003 – Jan 1, 2004. Delivered a seminar on “No-Go Theorems for De Sitter Compactifications?”

Participated in *International Congress on Philosophy and Foundations of Science* held at India International Centre, New Delhi during Jan 10 – Jan 14, 2004. Gave two invited talks on “Statistical Significance of Single Quantum States” and “John von Neumann and the Foundations of Quantum Statistical Mechanics”.

Visited Physics Department, Jamia-Milia University, Delhi on Jan 13, 2004. Delivered a seminar on “Statistical Significance of Single Quantum States”.

Hossain, Golam Mortuza

Participated in *International Conference on Gravitation and Cosmology* held at CUSAT, Kochi during Jan 5 – Jan 10, 2004. Gave a talk on “Hubble operator in isotropic loop quantum cosmology”.

Participated in *Workshop on Braneworlds and Quantum Cosmology* held at IUCAA, Pune during Jan 14 – Jan 16, 2004. Gave a talk on “Hubble operator in isotropic loop quantum cosmology”.

Participated in *Field Theoretical Aspects of Gravity - IV* held at IUCAA Reference Center, NBU, Pelling during Mar 2 – Mar 6, 2004. Gave a talk on “Reconstruction of effective space-time in Loop Quantum Cosmology”.

Visited SINP during Mar 7 – Mar 13, 2004. Gave a talk on “Reconstruction of effective space-time in Loop Quantum Cosmology”.

Indumathi, D.

Participated in *INO Update meeting* held at SINP, Kolkata during Apr 1 – Apr 3, 2003.

Participated in *Neutrino meeting* held at PRL, Ahmedabad during Aug 4 – Aug 7, 2003. Gave an invited talk on “Neutrino Factories”.

Participated in *Indo-US interaction meeting on Linear collider and neutrino physics* held at INSA, New Delhi during Nov 11 – Nov 12, 2003. Gave an invited talk on “Simulations Status of the India-based Neutrino Observatory (INO)”.

Participated in *Workshop in high energy physics phenomenology, WHEPP8* held at IIT Bombay, Mumbai during Jan 5 – Jan 16, 2004. Gave an invited talk on the “India-based neutrino observatory (INO)”.

Ivan, Solomon J.

Participated in *SERC School On Quantum Information And Quantum Optics* held at PRL, Ahmedabad during Feb 1 – Feb 14, 2004.

Iyer, Jaya N.

Participated in *Algebra and Number theory* held at University of Hyderabad during Dec 11 – Dec 15, 2003.

Participated in *Special Session for Young researchers in Comm.algebra and Algebraic geometry, AMS-India meeting at Bangalore.* held at IISc, Bangalore on Dec 16, 2003.

Jayalal Sarma, M.N.

Participated in *23rd Conference on Foundations Of Software Technology and Theoretical Computer Science (FSTTCS 2003)* held at IIT, Mumbai during Dec 15 – Dec 17, 2003.

Participated in *Workshop on Algorithms for Processing Massive Data Sets* held at IIT, Mumbai during Dec 18 – Dec 19, 2003.

Participated in *3rd Update Meeting: Automata and Verification* held at IMSc, during Feb 29 – Mar 2, 2004.

Participated in *Inter Research Institute Student Seminar (IRISS) - 2004* held at IIT, Mumbai during Mar 26 – Mar 27, 2004.

Kanhere, Aaloka V.

Participated in *All India AMS workshop* held at ISI, Bangalore during Dec 11 – Dec 16, 2003.

Participated in *All India AMS conference* held at IISc, Bangalore during Dec 17 – Dec 20, 2003.

Kesavan, S.

Visited RKM Vivekananda College, Chennai. on Aug 22, 2003. Delivered the “Inaugural address of the Mathematics Association”.

Visited Padma Seshadri Bala Bhavan Senior Secondary School, Chennai on Nov 11, 2003. Addressed the Mathematics Club.

Participated in *Refresher Course on Analysis* held at Pondicherry University during Nov 20 – Nov 22, 2003. Delivered a series of 6 lectures on “Elliptic Partial Differential Equations”.

Participated in *Indo-French Project FICUS* held at IISc, Bangalore on Dec 11, 2003. Delivered a course of lectures on “Homogenization Theory”. This was broadcast live via satellite to Ph.D. students at the Université Paul Sabatier, Toulouse, France.

Participated in *Refresher Course on Measure and Integration* held at Ramanujan Institute, University of Madras during Dec 13 – Dec 16, 2003. Delivered a series of six lectures on “Product measures”.

Participated in *Joint India - AMS Mathematics Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Delivered an invited talk.

Participated in *International Conference on Analysis and Applications* held at Banaras Hindu University, Varanasi during Dec 22 – Dec 25, 2003. Delivered an invited talk.

Participated in *The Regional Workshop on Analysis, RWA - 2004* held at Theivanai Ammal College for Women, Villupuram, Tamil Nadu during Jan 30 – Jan 31, 2004. Delivered an invited talk.

Participated in *Fr. Racine Memorial Lecture* held at Loyola College, Chennai. on Mar 3, 2004. Delivered “The Racine Memorial Lecture on Isoperimetric Inequalities”.

Participated in *One Day Colloquium of the Prof. R. Vaidhyanathaswamy Mathematics Trust* held at Ramanujan Institute, University of Madras on Mar 8, 2004. Delivered an invited talk.

Participated in *International Workshop on Mathematics and Physics of Complex and Non-*

linear Systems held at IIT, Kanpur during Mar 14 – Mar 19, 2004. Delivered a series of 5 lectures on “Topological Degree and Bifurcation Theory”.

Kodiyalam, Vijay

Visited ISI, Bangalore during Sep 29 – Oct 31, 2003.

Participated in *Workshop on Geometry and Topology inspired by Physics* held at Department of Physics, CUSAT, Kochi during Dec 4 – Dec 8, 2003. Gave a talk on “From subfactors and planar algebras to 1+1 dimensional TQFT’s”.

Participated in *India-AMS Meeting* held at Bangalore during Dec 17 – Dec 20, 2003. Gave a talk on “An application of classical invariant theory to distinguishing algebraic objects”.

Participated in *Eleventh Ramanujan Symposium on Recent Trends in Operator Theory and Banach Algebras* held at Ramanujan Institute, University of Madras during Mar 3 – Mar 5, 2004. Delivered a talk on “1+1 dimensional topological quantum field theories”.

Krishna, M.

Visited Ruhr University Bochum, Germany during Jul 1 – Jul 5, 2003.

Visited Technical University of Clausthal during Jul 6 – Jul 15, 2003. Gave a talk on “New criteria to identify spectrum”.

Participated in *AMS-INDIA meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Organized a special session jointly with Peter Hislop on “Schrödinger Operators”.

Kumar, Alok

Participated in *SERC(HEP) main school* held at Rajasthan University, Jaipur during Feb 9 – Feb 28, 2004.

Kurur, Piyush P.

Visited Tokyo Institute of Technology during Dec 11 – Dec 14, 2003. Gave a seminar.

Participated in *International Symposium on Algorithms and Computation (ISAAC) 2003* held at Kyoto, Japan during Dec 15 – Dec 17, 2003. Gave a talk title “Upper bounds on the Complexity of some Galois theory problems”.

Lodaya, Kamal

Visited School of Computer Science, University of Birmingham during May 26 – Jun 27, 2003. Gave a seminar and a course of lectures on “Models and logics for concurrency.”

Visited School of Computing Science, University of Newcastle on Jun 18, 2003. Gave a seminar on “A syntax for Petri nets.”

Visited TIFR, Mumbai during Aug 11 – Aug 15, 2003. PC meeting, FSTTCS 2003.

Participated in *National Workshop on Logic and Artificial Intelligence* held at University of Calcutta during Oct 13 – Oct 16, 2003. Gave 3 lectures on “Time points and intervals”.

Participated in *8th ASIAN Conference* held at TIFR, Mumbai during Dec 10 – Dec 12, 2003. Presented a paper.

Participated in *23rd FSTTCS* held at IIT, Mumbai during Dec 15 – Dec 17, 2003.

Participated in *TECS Week 04* held at TRDDC, Pune during Jan 5 – Jan 9, 2004.

Participated in *3rd IMSc Update Meeting: Automata and verification* held at IMSc, during Feb 29 – Mar 2, 2004. Gave a talk on “Infinite state automata”.

Visited IIT, Delhi on Mar 5, 2004. Gave a talk on “Infinite state automata”.

Mahajan, Meena B.

Participated in *Workshop on automata theory* held at SSN College of Engineering, Chennai during Apr 21 – Apr 30, 2003. Gave a lecture on “Algorithms for Automata”.

Visited Rajalakshmi Engineering College, Chennai on Jul 18, 2003. Gave a talk titled “Algorithmic Issues in Sorting”.

Participated in *Conference on Foundations of Software Technology and Theoretical Computer Science 2003*. held at IIT, Mumbai, India during Dec 15 – Dec 17, 2003.

Participated in *Workshop on Algorithms for Massive Data Sets* held at IIT, Mumbai during Dec 18 – Dec 19, 2003.

Visited Tata Research, Design, and Development Centre, (TRDDC) Pune on Mar 25, 2004. Gave a talk titled “From potatoes to tomatoes via sorting”.

Participated in *IRISS (Inter-Reserach-Institute Student Seminars)* held at Department of Computer Science and Engineering, IIT, Mumbai during Mar 26 – Mar 27, 2004.

Mani, Harihara S.

Participated in *Kodai enrichment Programme* held at Kodaikanal during Jul 15 – Jul 25, 2003. Gave a course of 8 lectures on “Quantum mechanics”.

Participated in *SERC preparatory School* held at University of Hyderabad during Nov 17 – Nov 30, 2003. Gave a set of 12 lectures in the “Quantum Field Theory” course.

Menon, Gautam I.

Participated in *Interdisciplinary Aspects of Biological Systems* held at IIT, Chennai on Apr 25, 2003. Gave an invited talk on “Pattern Formation in Motor-Microtubule Mixtures”.

Visited TIFR, Mumbai during May 2 – May 6, 2003. Delivered a seminar on “Local Structure in Vortex Glass Phases”.

Visited University of Fribourg, Fribourg, Switzerland during Jun 11 – Jun 15, 2003. Delivered a seminar on “Asters, Spirals and Vortices in a Model for Pattern Formation in Motor-Microtubule Mixtures”.

Participated in *Systemes Fortement Correes: A Workshop on Strongly Correlated Systems* held at University of Geneva, Geneva, Switzerland on Jun 13, 2003. Gave an invited talk on “Strong Correlations in Unusual (Classical) Contexts”.

Visited University of Lausanne, Lausanne, Switzerland on Jun 16, 2003. Delivered a seminar on “Asters, Spirals and Vortices in a Model for Pattern Formation in Motor-Microtubule Mixtures”.

Visited Paul Scherrer Institute, Villigen, Switzerland on Jun 17, 2003. Delivered a seminar on “Local Structure in Vortex Glass Phases”.

Visited ETH, Zurich, Switzerland during Jun 18 – Jun 20, 2003. Delivered a seminar on “Local structure in Vortex Glass Phases”. Participated in collaborative research on the structure of pancake vortices near free surfaces.

Participated in *Ninth International Workshop on Vortex Matter and European Science Foundation Workshop on Vortex Dynamics* held at CNRS Centre, Oleron Island, France during Jun 23 – Jun 27, 2003. Gave an invited presentation (talk + poster) on “Local Structure in Vortex Glass Phases”.

Visited University of Toulouse, Toulouse, France during Jun 28 – Jul 2, 2003. Delivered a seminar on “Pattern Formation in Motor-Microtubule Mixtures”.

Visited University of St. Andrews, St. Andrews, Scotland during Jul 6 – Jul 9, 2003. Engaged in collaborative research with the St. Andrews group on the interpretation of muon-spin-rotation spectra in high- T_c superconductors. Gave a seminar on “Local Structure in

Vortex Glass phases”.

Visited SNBNCBS, Kolkata, during Sep 14 – Sep 23, 2003. Gave two seminars, one on “Pattern Formation in Motor Microtubule Mixtures”, and the other on “The Third Moment of the field distribution in a type-II superconductor” during this TPSC visit.

Participated in *NCBS Japan Workshop on Single Molecule Biophysics* held at NCBS, Bangalore, during Jan 4 – Jan 15, 2004. Invited Talk on “Asters, Spirals and Vortices in a Model for Pattern Formation in Motor Microtubule Mixtures”.

Participated in *International Symposium on Machines, Molecules and Networks* held at NCBS, Bangalore, during Jan 5 – Jan 9, 2004.

Participated in *International Conference on Mathematical Biology* held at IIT, Kanpur, during Feb 19 – Feb 21, 2004. Gave an invited Talk on “Pattern Formation in Motor-Microtubule Mixtures”.

Visited BARC, Mumbai during Mar 29 – Mar 30, 2004. Delivered a seminar on “Local Correlations in Vortex Glass phases”.

Mishra, Ashok K.

Visited CECRI, Karaikudi, during Jul 20 – Jul 25, 2003 in connection with DRDO Research Project on *Novel Materials for applications in Molecular Electronics and Energy Storage Devices*.

Mitra, Indrajit

Visited HRI, Allahabad and IIT, Kanpur during Dec 1 – Dec 7, 2003. Gave TPSC talks in both places.

Mukhopadhyay, Anirban

Participated in *Prof K. Ramachandra’s 70th birthday conference* held at NIAS, Bangalore during Dec 13 – Dec 16, 2003.

Participated in *AMS-India joint mathematics meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003.

Visited HRI, Allahabad during Feb 18 – Mar 18, 2004.

Murthy, M.V.N.

Visited VECC, SINP during Mar 31 – Apr 2, 2003 for INO-Collaboration meeting and reported on the Site Survey results for INO.

Visited Department of Physics and Astronomy, McMaster University, Hamilton, Canada during May 2 – Jun 24, 2003. This was for research collaboration concerning many particle density of states of trapped bosons.

Participated in *Discussion Meeting on Neutrino Physics* held at PRL, Ahmedabad during Aug 4 – Aug 7, 2003. Gave an Invited Talk on "The Status of India-based Neutrino Observatory" project.

Visited BARC, Mumbai on Aug 8, 2003. Participated in the Program Management Committee/Group Coordinators Meeting.

Visited Institute For Theoretical Physics University Regensburg, Regensburg, Germany during Sep 1 – Sep 13, 2003 for research collaboration on the exact and semiclassical description of the particle number and kinetic energy densities for trapped fermion gases for arbitrary potentials.

Visited Physics Department, MCC, Tambaram on Sep 19, 2003. Gave the inaugural Address of the Physics Society, MCC- "Why detect Neutrinos".

Participated in *Indo-US Meeting on Linear Colliders and Neutrino Physics* held at INSA, New Delhi on Nov 12, 2003. Participated as a panel member in the Panel Discussion on the "Collaboration on Neutrino Experiments".

Muthu, Rahul

Participated in *FSTTCS 2003* held at IIT, Mumbai during Dec 15 – Dec 17, 2003.

Participated in *Workshop on Data Structures for Massive Data Sets* held at IIT, BOMBAY during Dec 16 – Dec 17, 2003.

Participated in *Automata Theory Update School* held at IMSc during Feb 29 – Mar 2, 2004.

Participated in *IRISS '04* held at IIT, Mumbai during Mar 26 – Mar 28, 2004.

Muthukumar, T.

Participated in *Workshop on Partial Differential Equations, Viscosity Solutions and Applications* held at Department of Mathematics, Indian Institute of science, Bangalore during Jul 21 – Aug 8, 2003.

Participated in *Joint India-AMS Mathematics Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Also participated in the workshop preceding it from 11 Dec. 2003 to 16 Dec. 2003.

Nadkarni, M. G.

Visited Indian Statistical Institute, Calcutta, April 2003. Gave a talk on Cantor’s work on Measure and Integral.

Visited Ramanujan Institute, Chennai. Gave the Keynote address on “Cantor’s work on Measure and Integral” at the Refresher Course in Measure and Integral, May 2003.

Participated in *Indo-US Math. Soc. meeting* held during Dec, 2003. Gave a talk on Invariant Subspaces.

Participated in *Conference on History of Mathematics* held at Raipur, Dec. 2003. Gave a talk on Cantor’s work on measure and integral.

Participated in Refresher Course in Financial Mathematics at University of Mumbai and gave four lectures on “Random Variables, Information and Entropy”.

Narayanan, N

Participated in *Update meeting on Automata theory* held at IISc, during Feb 29 – Mar 2, 2004.

Participated in *IRISS-04* held at IIT, Mumbai during Mar 26 – Mar 28, 2004.

Nagaraj, D S

Visited Universite D’Artois. at Lens, France. during May 7 – Jun 6, 2003. Gave four lectures on “Characteristic Classes”. Visited University of Lille, at Lille, France and gave one seminar on “Krull-Schmidt reduction theorem for Principal bundles”.

Participated in *Mini-Workshop on Curves over finite fields.* held at University of Mumbai, Mumbai during Jul 21 – Jul 25, 2003. Gave two lectures titled “Curves and their function fields” and “Riemann-Roch Theorem”.

Visited IIT, Chennai on Aug 21, 2003. Gave a lecture on “Algebraic Curves”.

Visited Institute of Mathematics and Applications, Bhubaneswar during Oct 5 – Oct 12, 2003. Resource person at the Interactive Training camp for under graduate students of Orissa state conducted by the Institute. Gave six lectures on “Topology” in the training camp.

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Visited University of Mysore at Mysore. during Dec 1 – Dec 4, 2003. Gave six lectures on “Algebraic Geometry” at the 7th Refresher course in Mathematics conducted by the UGC-Academic Staff college and department of Mathematics of the Mysore University.

Visited University of Hyderabad at Hyderabad during Dec 12 – Dec 16, 2003. Participated in the *International conference on Algebra and Number Theory* Chaired a Session.

Participated in *International colloquium on Algebraic Groups and Homogeneous Spaces* held at TIFR, Mumbai during Jan 6 – Jan 14, 2004.

Paranjape, Kapil H.

Participated in *Fifth National Meeting in Commutative Algebra and Algebraic Geometry (CAAG V)* held at Department of Mathematics, IIT, Mumbai during Apr 1 – Apr 5, 2003. Gave an invited address on “A finitistic definition for arithmetical schemes”.

Visited CIMAT, Guanajuato, Mexico during Jun 12 – Jun 15, 2003 for discussions with colleagues.

Participated in *The Arithmetic, Geometry and Topology of Algebraic Cycles* held at UNAM, Morelia, Mexico during Jun 15 – Jul 4, 2003. Gave a course on “Explicit computations of and in Chow groups” in the Workshop component. Also gave an invited talk.

Participated in *International Conference on Algebraic Number Theory* held at Department of Mathematics, University of Hyderabad during Dec 3 – Dec 7, 2003.

Parthasarathy, R.

Participated in *Fifth International Conference on Symmetry in Nonlinear Mathematical Physics*. held at National Academy of Sciences of Ukraine, Kiev during Jun 23 – Jun 29, 2003. Invited talk on “Diagonal Representation of Density matrix using q-Coherent states”. Chaired a session in the conference.

Raghavan, K. N.

Visited ISI, Bangalore during Sep 29 – Oct 3, 2003 for research collaboration and gave a talk.

Participated in *International Conference on Commutative Algebra and Combinatorics* held at HRI, Allahabad during Dec 8 – Dec 13, 2003. Gave a talk with title “Geometry of local rings of certain Schubert Varieties”.

Participated in *Instructional Workshop* held at ISI, Bangalore on Dec 15, 2003. Gave two lectures to graduate students on “Dedekind’s Unique Factorization Theorem”.

Participated in *Session for Young Researchers in Commutative Algebra and Algebraic Geometry* held at IISc, Bangalore on Dec 16, 2003. Gave a talk entitled “Hilbert functions of points on Schubert varieties of maximal isotropic subspaces”.

Participated in *Joint India-AMS Mathematics Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003.

Visited IIT, Mumbai during Jan 2 – Jan 5, 2004. for research collaboration and gave a talk on “Picture Invariants for Lie Algebras”.

Participated in *International Colloquium on “Algebraic Groups and Homogeneous Spaces”* held at TIFR during Jan 6 – Jan 14, 2004.

Visited IISc on Mar 31, 2004. Gave a talk on “Tangent cones to Schubert varieties”.

Rajasekaran, G.

Participated in *Neutrino Collaboration Meeting* held at SINP, Kolkata during Mar 31 – Apr 3, 2003. Gave a talk “Introduction to INO”.

Participated in *Workshop on Neutrinos* held at Kavli Institute of Theoretical Physics, University of California, Santa Barbara, USA during Apr 7 – May 9, 2003. Presented two papers titled “Dynamical Breaking of Electroweak Symmetry” and “Unification of Quark and Neutrino Mixings”.

Visited University of California, Riverside, USA during May 12 – Jul 4, 2003. Pursued collaborative research with faculty at UCR and gave a talk on “Neutrino mixing and its unification with quark mixing”.

Participated in *5th International Workshop on Neutrino Factories and Superbeams* held at Columbia University, New York during Jun 5 – Jun 11, 2003. Presented a talk titled “India-based Neutrino Observatory and its role in long-base-line experiments”.

Participated in *Neutrino Meeting* held at PRL, Ahmedabad during Aug 4 – Aug 8, 2003. Gave talk on “Neutrino Models” and a Colloquium on “Recent Discoveries in Neutrino Physics”.

Visited Ahmedabad Management Association (AMA) on Aug 7, 2003. AMA organized an Interaction Meeting for me to meet students and faculty from Ahmedabad Colleges and Universities. Gave a general talk on “Opportunities for Research in Physics and Mathematics in India”.

Visited CMI during Sep 10 – Sep 20, 2003. Gave a series of 4 talks on “An Overview of Physics” at an introductory level.

Participated in *Symposium of the National Academy of Sciences of India, on “Astronomy in*

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the New Millennium” held at PRL, Ahmedabad during Oct 10 – Oct 12, 2003. Gave invited talk on “Recent Developments in Neutrino Physics and India-based Neutrino Observatory”

Participated in *Indo-US Collaboration Meeting on Neutrino Physics* held at INSA, New Delhi on Nov 12, 2003. I was a panel member.

Visited Cochin University of Science and Technology, during Dec 4 – Dec 8, 2003. Gave a talk on “Neutrinos and INO”.

Participated in *Workshop on “Geometry and Topology inspired by Physics”* held at Cochin University of Science and Technology, during Dec 4 – Dec 8, 2003. Gave a talk on “Theory of new Fock spaces as the basis for new forms of quantum statistics”.

Participated in *Eighth Workshop on High Energy Physics Phenomenology, WHEPP8* held at IIT, Mumbai during Jan 5 – Jan 16, 2004. Talked on “A to Z Neutrino Models” and gave a Colloquium on “Neutrinos and the India-based Neutrino Observatory”.

Participated in *SERC Workshop on “Plasma based accelerator mechanisms”* held at Institute for Plasma Research, Gandhinagar during Jan 27 – Jan 31, 2004. Gave a talk on “The Future of High Energy Physics” and a Colloquium on “Recent discoveries in neutrino physics”.

Participated in *National Conference on Neutrinos in Nuclear, Particle and Astro Physics* held at IIT, Kharagpur during Feb 26 – Feb 28, 2004. Gave an invited talk on “Recent discoveries in neutrino physics” and a general talk addressed to the IIT students “Is there a Final Theory?”

Raman, Venkatesh

Participated in *Dagstuhl Seminar on Fixed Parameter Algorithms* held at Schloss Dagstuhl, Germany during Jul 27 – Jul 31, 2003. Gave a talk on “Parameterized Complexity of Feedback Set Problems”.

Participated in *Workshop on Algorithms and Data Structures* held at Ottawa, Canada during Aug 1 – Aug 3, 2003. Presented the paper on “Parameterized Complexity of Feedback Set Problems in Tournaments”.

Visited University of Waterloo, Canada during Aug 3 – Aug 7, 2003. Collaborated with Ian Munro and S. Srinivasa Rao.

Visited Sacred Hearts College, Tirupattur during Dec 11 – Dec 12, 2003. Gave a series of lectures on “Data structures and algorithms”.

Participated in *FSTTCS 2003* held at Mumbai, India during Dec 15 – Dec 17, 2003.

Participated in *Workshop on Massive Data Sets* held at Mumbai, India during Dec 18 – Dec 19, 2003.

Visited MOP Vaishnav College, Chennai on Dec 23, 2003. Gave a talk on “An insight into modern cryptography” in the symposium titled “Mathematics - root and route to technology”.

Ramanujam, R.

Participated in *Workshop on automata theory* held at SSN College of Engineering, Chennai during Apr 21 – Apr 30, 2003. Gave a lecture on “Automata theory for verification”.

Participated in *Workshop on network security* held at MIT, Chennai during May 28 – May 30, 2003. Gave a lecture on “Analysis of security protocols”.

Participated in *Summer School on Networking to E-seva* held at SSN College of Engineering, Chennai during Jun 10 – Jun 30, 2003. Gave a lecture on “Foundations of network security”.

Participated in *FST & TCS 2004* held at IIT, Mumbai during Dec 15 – Dec 17, 2003. Presented a paper.

Participated in *3rd IMSc update meeting on Automata and Verification* held at IMSc during Feb 29 – Mar 2, 2004. Gave two lectures on “security theory”.

Participated in *National seminar on applications of mathematics in engineering* held at Mepco-Schlenck College of Engineering, Sivakasi during Mar 4 – Mar 6, 2004. Gave an invited talk on “Games and computation”.

Visited IIT, Bombay during Mar 19 – Mar 20, 2004. Lecture on “Games computation and logic”.

Ray, Purusattam

Visited SINP, Kolkata during Dec 5 – Dec 18, 2003. Gave a talk “Growth and Avalanches: Novelty in 2d Random Systems”.

Visited Science College, Calcutta University, Kolkata on Dec 17, 2003. Gave a talk titled “Hysteresis in 2d Random-Field Ising Model”.

Roy, Ratnadeep

Participated in *Fifth SERC School on The Physics of Disordered systems* held at IMSc during Apr 1 – Apr 21, 2003.

Participated in *SERC school on Statistical Physics* held at TIFR during Feb 16 – Feb 28, 2004.

Sankaran, Parameswaran

Visited Department of Mathematics and Statistics, University of Calgary, Calgary, Canada. during May 2 – Jul 31, 2003. Gave a talk on “Topology of toric varieties” in the Non-commutative Geometry Seminar, on 10th June, 2003.

Participated in *Canadian Mathematical Society- Summer Meet* held at University of Alberta, Edmonton, Canada, during Jun 14 – Jun 16, 2003. Gave a talk on “A coincidence theorem for holomorphic maps G/P ”.

Visited University of British Columbia, Vancouver, Canada during Jul 7 – Jul 9, 2003. Gave a seminar talk on “Cohomology of toric bundles”.

Visited University of Toronto, Mississauga, Ontario, Canada during Jul 28 – Jul 31, 2003. Gave two talks on “A coincidence theorem for holomorphic maps to G/P ” and “Cohomology of toric bundles”.

Visited University of Calgary, Calgary, Canada during Aug 1 – Aug 8, 2003. Gave a talk on “quasi-isometry of finitely generated groups”.

Participated in *Interactive Training Camp* held at Institute of Mathematics and Applications, Bhubaneswar, during Sep 25 – Oct 24, 2003. Gave six lectures on “Groups and fields”.

Participated in *Joint India-AMS Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Organizer of special session on algebraic and geometric topology.

Visited IIT, Mumbai. during Jan 4 – Jan 5, 2004. Gave a talk in the mathematics seminar on “A very remarkable group of Richard Thompson.”

Participated in *International Colloquium on algebraic groups and homogeneous spaces* held at TIFR, Mumbai. during Jan 6 – Jan 14, 2004.

Sathiapalan, Balachandran

Visited ICTP, Trieste, Italy during Jun 13 – Jul 29, 2003 for research and gave a seminar on “Loop Variables”.

Participated in *Workshop on String Theory* held at IIT, Kanpur during Dec 14 – Dec 21, 2003. Gave an invited talk on “Loop Variables in String Theory”.

Siddharthan, Rahul

Visited Cornell University, Ithaca, NY and The Rockefeller University, NY, USA during Jul 28, 2003 – Mar 31, 2004 for continuation of postdoctoral work on sequence analysis and regulatory site detection.

Participated in *American Physical Society March Meeting* held at Montreal, QC, Canada during Mar 21 – Mar 25, 2004. Presented “A Gibbs sampler incorporating phylogenetic information”.

Participated in *RECOMB Satellite Workshop on Regulatory Genomics* held at San Diego, CA, USA during Mar 26 – Mar 27, 2004. Presented “PhyloGibbs: a Gibbs sampler incorporating phylogenetic information”.

Sinha, Nita

Participated in *Workshop on the CKM Unitarity Triangle* held at Institute for Particle Physics Phenomenology (IPPP), Durham, UK during Apr 5 – Apr 9, 2003. Gave an invited plenary talk on “Determining weak phases using $B \rightarrow D^*V$ Decays”.

Visited Theory Group, Stanford Linear Accelerator Center, Stanford University, USA during May 6 – May 13, 2003.

Participated in *Workshop on the Discovery Potential of an Asymmetric B Factory at 10^{36} Luminosity* held at Stanford Linear Accelerator Center, Stanford University, USA during May 8 – May 10, 2003. Gave an invited talk on “Weak phase γ using $B \rightarrow K\pi\pi$ modes”.

Visited Institute of Theoretical Sciences, University of Oregon, USA during May 14 – May 21, 2003. Delivered the High Energy Physics Seminar, “Clean techniques to measure γ ”.

Visited Laboratoire René J.-A. Lèvesque, Université de Montréal, Montréal, Canada during May 22 – Jun 3, 2003.

Participated in *Workshop on High Energy Physics Phenomenology (WHEPP-8)* held at IIT, Mumbai during Jan 5 – Jan 16, 2004. Presented an invited talk on “Probing New Physics using $B \rightarrow V_1V_2$ decays”.

Sinha, Rahul

Participated in *Workshop on the CKM Unitarity Triangle* held at Institute for Particle Physics Phenomenology (IPPP), Durham, UK during Apr 5 – Apr 9, 2003. Delivered an invited talk, “Signals of New Physics using angular analysis in $B \rightarrow V_1V_2$ decays”.

Visited Department of Theoretical Physics, University of Oxford, Oxford, UK during Apr 9 – Apr 10, 2003. Delivered a talk entitled “Extracting CP violating weak phases without hadronic uncertainty”.

Visited Theory Group, Stanford Linear Accelerator Center, Stanford University, USA during May 4 – May 13, 2003.

Participated in *Workshop on the Discovery Potential of an Asymmetric B Factory at 10^{36}*

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Luminosity held at Stanford Linear Accelerator Center, Stanford University, USA during May 8 – May 10, 2003. Delivered an invited talk “Signals of New Physics using angular analysis in $B \rightarrow V_1 V_2$ decays”.

Visited Institute of Theoretical Sciences, University of Oregon, USA during May 14 – May 21, 2003 for collaboration.

Visited Laboratoire René J.-A. Lèvesque, Université de Montréal, Montréal, Canada during May 22 – Jun 3, 2003 for collaboration.

Participated in *Indo-US Workshop on Linear Collider & Neutrino Physics* held at Indian National Science Academy, New Delhi during Nov 10 – Nov 11, 2003.

Participated in *6th ACFA Workshop on Physics and Detector at Linear Collider* held at TIFR, Mumbai during Dec 15 – Dec 17, 2003.

Participated in *Eighth Workshop on High Energy Physics Phenomenology, WHEPP 8* held at IIT, Mumbai during Jan 5 – Jan 16, 2004.

Visited Department of Physics and Astronomy, University of Hawaii, Honolulu, Hawaii, USA during Jan 16 – Jan 26, 2004 for collaboration and conference participation.

Participated in *Super B Factory Workshop, 2004* held at Honolulu, Hawaii, USA during Jan 19 – Jan 22, 2004 as an invited speaker.

Sinha, Sitabhra

Visited MIDS, Chennai on Jun 30, 2003. Gave a talk on “A Simple Model of Social Choice Dynamics”.

Visited SINP, Kolkata during Sep 1 – Sep 4, 2003. Gave a talk on “A Simple Model of Social Choice Dynamics”.

Visited Bose Institute, Kolkata on Sep 5, 2003. Gave a talk on “A Simple Model of Social Choice Dynamics”.

Participated in *Pattern Formation in Physics and Biology* held at KITP, Santa Barbara, USA during Oct 5 – Nov 1, 2003. Gave a talk on “Spatiotemporal Chaos and Control in Models of Cardiac Arrhythmia”.

Visited Department of Physics, Technical University-Berlin during Nov 12 – Nov 14, 2003. Gave a talk on “Spatiotemporal Chaos and Control in Models of Cardiac Arrhythmia”.

Visited SINP, Kolkata during Feb 9 – Feb 11, 2004. Gave a talk on “Brownian Ratchets and Evolutionary Dynamics: How to maintain genetic diversity with a little bit of randomness”.

Participated in *International Conference on Mathematical Biology* held at IIT, Kanpur during Feb 19 – Feb 21, 2004. Gave an invited talk on “Terminating ventricular tachycardia by pacing induced dynamical inhomogeneities in the reentry circuit”.

Visited Department of Physics, University of Delhi during Feb 23 – Feb 27, 2004. Gave a talk on “Are complex systems unstable ?”

Visited National Brain Research Center, Delhi on Feb 24, 2004. Gave a talk on “Are complex systems unstable ?”

Sinha, Sudeshna

Visited Biomedical Engineering Department, University of Florida, Gainesville during May 21 – Jun 6, 2003. Delivered a talk in the Electrical and Computer Engineering Department.

Participated in *Workshop on Nonlinear Dynamics and Control* held at University of Florida during May 29 – May 30, 2003 as an invited speaker.

Participated in *International Conference on Nonlinear Phenomena* held at Bangalore during Jan 5 – Jan 10, 2004 as an invited speaker.

Siwach, Sanjay

Participated in *the National Workshop on String Theory* held at IIT, Kanpur during Dec 8 – Dec 21, 2003.

Visited IIT, Kanpur during Feb 9 – Feb 29, 2004. Interacted with the high energy group of the physics department and gave a seminar titled “Holography, Black Holes and PP-wave Space-times”.

Srinivas, K.

Visited Institut de Mathematiques de Luminy, France during Apr 3 – Jun 30, 2003. visited as a CNRS research associate, initiated a project with Gilles Lachaud and Tsfasman.

Participated in *European school on Algebraic Geometry and Information Theory* held at CIRM, Luminy, France during May 12 – May 16, 2003.

Participated in *Conference on Arithmetic, Algebraic Geometry and Coding Theory* held at CIRM, Luminy, France during May 19 – May 23, 2003. Gave a talk on “Distinct zeros in the Selberg Class”.

Visited Department of Mathematics, University of Turku, Finland during May 24 – Jun 4, 2003. Gave a talk on “Distinct zeros of functions in the Selberg class” on 27th May,

2003, worked with Matti Jutila on some problems related to the zeros of the Epstein's zeta function.

Visited Department of Mathematics, University of Lille, Lille, France during Jun 19 – Jun 20, 2003. Delivered a talk on “Selberg Class”.

Visited University of Paris VI, Paris during Jun 21 – Jun 24, 2003. Delivered a talk on “Recent results in Selberg Class”.

Visited Department of Mathematics, University of Nancy, France during Jun 25 – Jun 26, 2003. Delivered a talk on “Selberg Class”.

Visited Department of Mathematics, University of Genova, Italy during Jul 4 – Jul 15, 2003. Delivered a talk on “Recent developments in Selberg class”, discussed with Alberto Perelli on the zeros of functions of degree up to 2 in the Selberg class on the critical line.

Visited Department of Mathematics, University of Roma tre, Rome during Jul 16 – Jul 19, 2003.

Participated in *National workshop on cryptology* held at Anna University during Oct 16 – Oct 18, 2003.

Participated in *Indocrypt 2003* held at ISI, Delhi during Dec 6 – Dec 10, 2003.

Participated in *Joint India-AMS Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Delivered an invited talk.

Srinivasa Rao, K.

Visited Flemish Royal Academy of Belgium for Science and the Arts, Brussels, Belgium. during Feb 15 – Jun 30, 2003 for the second part of the Project on Creativity in Science.

Visited University of Brussels, Belgium. on May 8, 2003. Delivered a lecture on “Gauss, Ramanujan and Hypergeometric series”.

Visited Department of Mathematics, Cornell University, Ithaca, USA. during May 17 – May 20, 2003. Delivered a lecture on the “Life and Work of Ramanujan”.

Visited Department of Mathematics, State University of Delaware, Delaware, USA. on May 21, 2003. Delivered a lecture on the web site created for Srinivasa Ramanujan.

Visited Department of Mathematics, University of Delaware, Delaware, USA on May 22, 2003. Delivered a power point presentation of “The life and work of Srinivasa Ramanujan”.

Visited University of Gent, Belgium. during Jun 27 – Jul 4, 2003. as an Examiner for the

Ph.D. Viva-Voce exam of Stijn Lievens and for discussions on problems of mutual interest.

Visited University of Brussels, Brussels during Jul 7 – Jul 11, 2003 for discussions with Prof. C. Quesne on problems of mutual interest in q -series.

Participated in *Symmetries in Science - XIII* held at Kloster Mehrerau, Collegium Bernardi, Bregenz, Austria during Jul 20 – Jul 24, 2003. This conference was in honour of Professors Francesco Iachello, Akito Arima and Marcos Moshinsky. Gave an invited talk on “Group theoretical aspects of hypergeometric functions and Symmetries of Angular Momentum Coefficients” and chaired a session.

Visited DST on Mar 25, 2004. The two CD ROMs on the Life and Work of Ramanujan were presented to the Project Program Monitoring Group and the same submitted to the Secretary, DST. This marks the completion of the two-year Project with K. Srinivasa Rao as the Principal Investigator.

Subramanian, C. R.

Visited Tata Institute of Fundamental Research, Mumbai during Jul 21 – Jul 23, 2003. Gave two talks, one on “Tight upper bounds on list chromatic numbers”, the other “On sampling colorings of bipartite graphs”.

Visited Department of Mathematics, Cochin University of Science & Technology, Cochin. during Jul 30 – Jul 31, 2003. Gave a talk on “Probabilistic arguments in Combinatorics”.

Participated in *Workshop on Graph Theory* held at Rajagiri School of Engineering and Technology, Cochin during Jul 30 – Jul 31, 2003. Gave three lectures on “Randomized algorithms for network reliability”.

Visited Theivanai Ammal College for Women, Villupuram on Sep 6, 2003. Gave an expository talk on “Design and analysis of algorithms” for graduate and undergraduate students.

Visited Sacred Hearts College, Tirupattur on Dec 12, 2003. Gave two lectures on “Hardness of computation and strategies for coping with it”.

Sunder, V. S.

Visited ISI, Kolkata during Apr 29 – Apr 30, 2003. Attended a meeting of the Technical Advisory Committee and gave a lecture on “A complete family of numerical invariants for a subfactor”.

Visited University of Delhi during Aug 27 – Sep 2, 2003. Gave a series of four lectures on “Planar Algebras” at the Mathematics Department of Delhi University, and gave a lecture on “Knots and polynomials” at Hindu College on Aug. 30, 2004.

Visited Tata Institute of Fundamental Research on Sep 24, 2003. Gave a talk on “Complete invariants for complex semi-simple Hopf algebras”.

Visited University of Roma II, “Tor Vergata” during Sep 27 – Oct 26, 2003. Gave a Math colloquium talk on “A complete family of numerical invariants for subfactors”.

Participated in *Geometry and Topology inspired by Physics* held at CUSAT during Dec 4 – Dec 8, 2003. Together with Vijay Kodiyalam, gave a two-part lecture on “Subfactors and 1+1-dimensional TQFTs”.

Participated in *AMS-India Meeting* held at IISc, Bangalore during Dec 17 – Dec 20, 2003. Gave a lecture on “A Complete family of numerical invariants for subfactors”.

Visited ISI, Bangalore on Dec 24, 2003. Gave a talk on “Unitary invariants for tensors”.

Visited IISc on Dec 24, 2003 to attend a meeting of a Selection Committee.

Participated in *Non-Commutative Geometry in Mathematics and Physics* held at CIRM, Luminy, France during Jan 26 – Feb 6, 2004. Gave an invited lecture on “Numerical invariants for subfactors” during the week devoted to von Neumann algebras.

Participated in *Eleventh Ramanujan Symposium on Operator Theory and Banach algebras* held at Ramanujan Institute, University of Madras on Mar 3, 2004. Gave a lecture on “Amenability and orbit equivalence rigidity”.

Visited ISI, Kolkata on Mar 26, 2004. Attended a meeting of the Technical Advisory Committee of the ISI, and also gave a lecture on “Unitary invariants for tensors”.

Suresh, S.P.

Participated in *WITS'03-Workshop on Issues in the Theory of Security, part of ETAPS'03* held at Warsaw, Poland during Apr 5 – Apr 6, 2003. Presented a paper titled “A decidable subclass of unbounded security protocols”.

Visited IPI PAN - The Institute of Computer Science of the Polish Academy of Sciences on Apr 9, 2003. Gave a talk titled “Decidable subclasses of security protocols”.

Participated in *AVIS'03-Workshop on Automated Verification of Infinite-State Systems, part of ETAPS'03* held at Warsaw, Poland on Apr 12, 2003. Presented a paper titled “An Equivalence on Terms for Security Protocols”.

Uma, V.

Participated in *The Fifth National Meeting in Commutative Algebra and Algebraic Geometry (CAAG V)* held at IIT, Mumbai and the University of Mumbai during Apr 1 – Apr 5, 2003. Gave a talk titled “Cohomology of toric bundles”.

Participated in the *Joint India AMS Meet* held at IISc, Bangalore during Dec 16 – Dec 20, 2003. Gave a talk titled “K-theory of toric bundles” in the “Session for Young Researchers in Commutative Algebra and Algebraic Geometry” held on December 16, 2003 at the Department of Mathematics, IISc, Bangalore.

5.4 Visitors from Other Institutions

Name	Affiliation	Period of Visit
Diptiman Sen	IISc, Bangalore	04.04.03
Peter D. Hislop	University of Kentucky, USA	04.04.03 – 14.04.03
P.N. Maya	CUSAT, Cochin	10.03.03 – 10.04.03
P.M. Gade	BITS, Pilani	16.01.03 – 16.04.03 15.05.03 – 15.09.03
Sreedhar Dutta	TIFR, Mumbai	29.03.03 – 19.04.03
S.M. Srivastava	ISI, Kolkata	21.04.03 – 29.04.03
A. Jensen	University of Alborg, Denmark	16.04.03 – 27.04.03
Jnanadeva Maharana	IOP, Bhubaneswar	27.04.03 – 04.05.03
Harvinder Kaur Jassal	IUCAA, Pune	27.04.03 – 03.05.03
Swapan Majhi	HRI, Allahabad	24.04.03 – 05.05.03
K. Gowri Navada	FMKMC College, Madikeri	09.04.03 – 07.05.03
Amiya Mukherjee	ISI, Kolkata	14.03.03 – 11.05.03
Ajay Patwardhan	St. Xavier's College, Mumbai	11.05.03 – 25.05.03 23.10.03 – 02.11.03
Suresh Vettoor	St. Dominics College, Kerala	26.05.03 – 31.05.03
S. Thangavelu	ISI, Kolkata	25.05.03 – 27.05.03
V. Ravindran	HRI, Allahabad	26.05.03 – 30.05.03
K.V. Vidyaranya	Tunga Mahavidyalaya, Karnataka	15.05.03 – 13.06.03
Shajahan T.K.	IISc, Bangalore	15.05.03 – 30.06.03
Stephen Baier	HRI, Allahabad	20.06.03 – 05.07.03

N. Narayanan	TIFR, Mumbai	17.04.03 – 11.07.03
N. Mukunda	IISc, Bangalore	04.07.03 – 05.07.03
Sunil Chandran L.	Max-Planck Institute for Informatik, Germany	09.07.03 – 12.07.03
Santhosh Vempala	MIT, USA	22.07.03 – 23.07.03
Ashvin Vishwanath	MIT, USA	30.07.03 – 06.08.03
A.P. Balachandran	Syracuse University, USA	03.08.03 – 08.08.03
Tabish Qureshi	Jamia Milia University, New Delhi	09.07.03 – 08.08.03
Yashodhan Hatwalne	RRI, Bangalore	20.07.03 – 09.08.03
Polychroniadis Olivier	ENS Cachan, France	14.07.03 – 16.08.03
Pinaki Majumdar	HRI, Allahabad	21.08.03 – 23.08.03
Sudhansu S. Mandal	IACS, Jadavpur	24.08.03 – 29.08.03
Madhavan Varadarajan	RRI, Bangalore	03.09.03 – 07.09.03
Sourendu Gupta	TIFR, Mumbai	15.09.03 – 17.09.03
Ragunath Ratabole	IISc, Bangalore	14.09.03 – 19.09.03
K.S. Krishnan	TIFR, Mumbai	19.09.03 – 21.09.03
N. Vanaja	University of Mumbai, Mumbai	12.09.03 – 16.10.03
Purabi Mukherji	Basanti Devi College, Kolkata	06.10.03 – 18.10.03
Pradeep Kumar Mishra	ISI, Kolkata	15.10.03 – 25.10.03
Ananth Chikkatur	MIT, USA	26.10.03 – 29.10.03
Naba K. Mondal	TIFR, Mumbai	26.10.03 – 06.11.03
Amitava Ghosh	REC, Durgapur	01.11.03 – 05.12.03
R. Parthasarathy	TIFR, Mumbai	15.11.03 – 02.12.03

Samir Kunkri	ISI, Kolkata	08.09.03 – 06.12.03
Klopotowski	University of Paris, France	30.10.03 – 11.12.03
Tapobrata Sarkar	ICTP, Italy	08.12.03 – 14.12.03
Vikram Tripathi	Cambridge University, UK	05.12.03 – 10.12.03
Anjan KR Dasgupta	Calcutta University, Kolkata	29.11.03 – 11.12.03
Arnab K. Ray	IACS, Kolkata	09.12.03 – 13.12.03
D.N. Verma	TIFR, Mumbai	08.11.03 – 15.12.03
S. Chaturvedi	University of Hyderabad, Hyderabad	14.12.03 – 16.12.03
Bosco Emmanuel	CSIR, Karaikudi	27.11.03 – 20.12.03
Kannan Soundararajan	University of Michigan	24.12.03
V. Kumar Murty	University of Toronto, Canada	21.12.03 – 28.12.03
Aalok Misra	IIT, Roorkee	21.12.03 – 26.12.03
S.D. Adhikari	HRI, Allahabad	22.12.03 – 27.12.03
Jennifer Seberry	University of Wollongong, Australia	23.12.03 – 30.12.03
Uday Reddy	University of Birmingham, UK	18.12.03 – 03.01.04
Vaibhav Anand	IIT, Mumbai	05.12.03 – 03.01.04
Dilip Kumar Ghosh	University of Oregon, USA	29.12.03 – 01.01.04
C.S. Dalawat	HRI, Allahabad	22.12.03 – 11.01.04
Dinakar Ramakrishnan	California Institute of Technology, USA	22.12.03 – 04.01.04
A.M.M. Pruisken	University of Amsterdam	02.01.04 – 09.01.04
Naseem Rahman	University of Trieste, Italy	05.01.04 – 10.01.04
Shreeram Abhyankar	Purdue University, USA	04.01.04 – 09.01.04

J. Maharana	IOP, Bhubaneswar	11.01.04 – 13.01.04
Roy Kerr	University Canterbury, New Zealand	11.01.04 – 14.01.04
Martin Bojowald	AEI Potsdam, Germany	11.01.04 – 14.01.04
Rohit Parikh	City University of New York, USA	12.01.04 – 15.01.04
Rajat Bhaduri	McMaster University, Canada	09.01.04 – 18.01.04
Niranjan Ramachandran	University of Maryland, USA	18.01.04 – 20.01.04
Ulf Persson	University of Goteburg, Sweden	06.01.04 – 24.01.04
Sandip Trivedi	TIFR, Mumbai	21.01.04 – 22.01.04
Adi Shamir	The Weizmann Institute of Science, Israel	29.01.04 – 04.02.04
Siddhartha Sen	Trinity College, Dublin & IACS, Kolkata	23.01.04 – 06.02.04
Rohini Godbole	IISc, Bangalore	30.01.04 – 05.02.04
M. K. Parida	North Eastern-Hill University, Shillong	04.02.04 – 08.02.04
Tanusri Saha Dasgupta	SNBNCBS, Kolkata	06.02.04 – 10.02.04
Patrick Aurenche	LAPTH, Annecy, France	24.01.04 – 13.02.04
Yogish I. Holla	TIFR, Mumbai	10.02.04 – 17.02.04
J. S. Bagla	HRI, Allahabad	13.02.04 – 15.02.04
Sandeep Chellapilla	University of Illinois, Urbana	31.01.04 – 19.02.04
Chitta Ranjan Das	IISc, Bangalore	13.02.04 – 18.02.04
Alexander Schmitt	Universitaet Duisburg-Essen	12.02.04 – 22.02.04
Michael Demuth	Institute of Mathematics, Germany	02.11.03 – 26.02.04
J. Pasupathi	IISc, Bangalore	09.11.03 – 10.03.04

Nalin Kumar Gautam	IIT, Delhi	10.03.04 – 11.03.04
R. Murugaraj	Pondicherry University, Pondicherry	12.03.04
Sudhir Vempati	Univ-Di Padova, Italy	18.03.04 – 19.03.04
Indranil Biswas	TIFR, Mumbai	22.03.04 – 27.03.04

Chapter 6

Infrastructure

6.1 Computer Facilities

The Linux O/S of access stations has been upgraded and the old access stations have been replaced with new ones. A few AMD Athlon 2200+ processor based systems with 15" TFT LCD color screens operating under Linux have also been introduced into the network.

The Computer Installations Security Audit Group constituted by DAE carried out the IT Security Audit at IMSc and its valuable suggestions have been incorporated.

The ILGTI Linux Cluster (named KABRU) with 144 nodes of Dual Xeons (a total of 288 CPU's) is fully commissioned. The best recorded performance on HPL is 951.7 GFlops (sustained) and 1.382 Teraflops (Theoretical Peak).

A 40KVA APC Silicon UPS was added to the existing PRS UPS system to support for the additional load of ILGTI cluster.

Two laser printers with duplex and one copier with network printing enabled were included in the network.

An additional two EPSON 1500lumens multimedia data projectors were added for presentation purposes.

Wireless access points were installed in selective locations to enable wireless connections through DHCP server.

6.2 The Library

The Institute Library holds a total collection of 50569 books and bound periodicals as on March 31, 2004. This includes an addition of 1161 volumes during the current year April 2003 - March 2004. The library subscribes to about 300 national and international journals in the subject areas of Theoretical Physics, Mathematics and Theoretical Computer Science. The library has a well balanced collection on these subject areas and is a resource for research workers of the entire southern region.

The library has access to over 2000+ online journals from major publishers such as Elsevier, American Mathematical Society, American Physical Society, Springer Verlag, World Scientific, Institute of Physics, etc., as well as access to Nature online and JSTOR digital archive. Access to online journals is limited to the members of the Institute.

The NBHM has recognized this Institute library as the Regional Library for Mathematics. There are about 4220 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.

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 web site dedicated to host all the electronic information resources and to provide information about the library and its services.

The library has been reorganised and renovated. The installation of compact storage systems to stack back volumes, has enabled optimum utilisation of space in the library.

The IMSc Library is a member of DAE Libraries Consortium that subscribes to SCIENCE DIRECT SERVICE of Elsevier and is an institutional member of AMS, MALIBNET, and IAPT. The library is also coordinating the MathSciNet consortium which provides online access to MathSciNet for 8 participating institutions in the southern region.

Acknowledgment:

The Library gratefully acknowledges the donation of valuable books, and other reading materials received during the current year from the persons and organizations as mentioned below:

IMSc members: R. Balasubramanian, S. Kalyana Rama, S. Kesavan, Kamal Lodoya, Venkatesh Raman, K. Srinivasa Rao ;

Non-IMSc Individuals: Michael Demuth, van Benthem Johan, Kishorilal Kesarwani (In memory of Dushyant Kesarwani), J. C. Misra, V. N. Muthukumar, R. Sridhar ;

Organizations: Abdus Salam International Centre for Theoretical Physics, Italy, DAE Publication division, DOOR Programme, Indian Academy of Sciences, Living media-Time magazine, Mathematical Society of Japan, National Board of Higher Mathematics, Refresher course in Physics for college teachers, IMSc.

Obituaries

K. R. Unni (1933 – 2003)

Professor K. R. Unni passed away on 5th November, 2003. He was 70. He is survived by a son and two daughters.

Professor Unni was born on 28th March, 1933. He was a teacher at Annamalai University before he went North-Western University for his doctoral work in Mathematics. He received his Ph. D. in 1963 and joined the Institute of Mathematical Sciences in 1965 as a CSIR Pool Officer. He became a permanent member of the Institute in July 1966. He served as the acting Director of the Institute during 1990 and retired in 1993.

He spear-headed research in the areas of Functional Analysis, Approximation Theory including Splines and Abstract Harmonic Analysis and made significant contributions. In recent times Prof. Unni was interested in the theory of wavelets and was nearing completion of a book on the subject.

He had an active academic career and guided several doctoral students. He organized annual seminars in Analysis as well as an International Conference in Functional Analysis in Chennai. He was a Vice President and a member of the Council for Calcutta Mathematical Society for many years. He was a member of Board of Editors of the Bulletin of Calcutta Mathematical Society and the Journal of Mathematical and Physical Sciences.

Dushant Kesarwani (1981 – 2004)

Mr. Dushant Kesarwani was born on 17th November, 1981 in Kanpur. He did his undergraduate studies at the St. Stephens College, Delhi. He joined as Junior Research Fellow of the Institute in August 2003 to undertake his doctoral work in Theoretical Computer Science. Due to a tragic accident this young promising life was cut short on March 13th, 2004.