THE INSTITUTE OF MATHEMATICAL SCIENCES

C. I. T. Campus, Taramani,

Chennai - 600 113.

ANNUAL REPORT

August 2000 - July 2001

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Foreword

I take this opportunity to place on record our deep appreciation and gratitude for the excellent support provided by Dr. R. Chidambaram, (former Chairman, AEC and Secretary to Government of India, Department of Atomic Energy) under whose stewardship the Institute made significant contributions in the chosen areas of Mathematics, Theoretical Physics and Theoretical Computer Science. Dr. Chidambaram provided generous and unstinted support to all the expansion plans and scientific activities of the Institute. I wish to place on record our sincere thanks to Dr. Chidambaram.

It gives me great pleasure to welcome to our Board of Governors, his successor Dr. Anil Kakodkar (Chairman, AEC and Secretary to Government of India, Department of Atomic Energy) and I am sure under his leadership the Institute will continue its march towards scientific excellence both in terms of seminal research output and updated facilities to our scientists.

We had the nice opportunity of honouring Prof. G. Rajasekaran on his 65th birthday. A one-day symposium was organized in the Institute in his honour in which several of his collaborators and associates talked about the significant contributions of Prof. Rajasekaran.

It is with profound grief I place on record the passing away of our Patron, Bharat Ratna Shri C. Subramaniam, the guiding spirit in the establishment and growth of our Institute. His demise is an irreparable loss to our Institute.

As usual, the academic year 2000-2001 had been an eventful one for the Institute in terms of scientific publications and scientific meetings. I take this opportunity to congratulate Prof. K. Srinivasa Rao and Prof. Radha Balakrishnan who were awarded the Popularization of Science Award and the Tamil Nadu Scientists Award for Physical Sciences, respectively, by the Tamil Nadu State Council for Science and Technology. I congratulate Dr. N. Sabu, who has received the best thesis award of this Institute. I am sure our scientists will continue to win many more laurels for their excellent scientific contributions.

The Institute took the initiative to organize and to host several conferences, workshops and training programmes for college/university teachers as is recorded in this report.

The Institute has also entered several international collaborative projects such as the DST-DAAD joint research project on Electrochemical Interface with University of Ulm, Germany; project on Syntactic Methods for verification supported by Indo-French center for promotion of Advanced Research; project on High Efficient Data Structure supported by UK-India, Science and Technology Research fund of DST; project on Parameterized Complexity under the DST-DAAD Personnel Exchange Programme - 1999; DST-NSF (USA) exchange pro-

gramme in Mathematical Physics and the existing Federation agreement with Abdus Salam International Centre for Theoretical Physics, Trieste, Italy.

This report has been compiled through the efforts of a committee that consists of Drs. R. Sridhar, G. Date, S. Kalyan Rama, V. Arvind, D.S. Nagaraj, K. Srinivasa Rao and Mr. K.S. Santhanagopalan together with help from Drs. Venkatesh Raman and Rahul Basu. I owe my gratitude to all of them.

I look back with satisfaction and look forward to a more exciting and rewarding year.

August, 2001 **R. Balasubramanian**

Contents

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 (From May 2001)
(**Chairman**)

Hon'ble Prof. **K. Anbazhagan**, Minister for Education, Government of Tamil Nadu, Fort St. George, Chennai 600 009 (Upto May 2001)
(**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**)

Dr. **R. Chidambaram**, Chairman, Atomic Energy Commission and Secretary to Government of India, Department of Atomic Energy, CSM Marg, Bombay(Upto November 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. **A. Kalanidhi**, Vice Chancellor, Anna University, Chennai 600 025
(**Member**)

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

Prof. **Mustansir Barma**, Department of Physics, Tata Institute of Fundamental Research, Mumbai 400 005 (From March 2001)
(**Member**)

Prof. **J.K. Bhattacharjee**, Department of Theoretical Physics, Indian Association for the Cultivation of Science, Jadavpur, Calcutta 700 032(Upto March 2001)
(**Member**)

Prof. **H.S. Mani**, Director, Harish Chandra Research Institute, Chhatnag Road, Jhusi, Allahabad 211 019
(**Member**)

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

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

Shri **Mohan Varghese Chunkath**, I.A.S., Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St. George, Chennai 600 009(From June 2001)
(**Member**)

Thiru **I.V. Manivannan**, I.A.S., Secretary to Government of Tamil Nadu, Higher Education Department, Fort St.George, Chennai(Upto June 2001)
(**Member**)

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

Prof. **Mustansir Barma**, Department of Physics, Tata Institute of Fundamental Research, Mumbai 400 005(From March 2001)
(**Member**)

Prof.**H.S. Mani,** Director, Harish Chandra Research Institute, Chhatnag Road, Jhusi, Allahabad 211 019
(**Member**)

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(**Member**)

Shri **Mohan Verghese Chunkath,** I.A.S., Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St.George,Chennai 600 009(From June 2001)
(**Member**)

Thiru **I.V. Manivannan,** I.A.S.,Secretary to Government, Higher Education Department, Government of Tamil Nadu, Fort St.George, Chennai 600 009(Upto May 2001)
(**Member**)

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

PATRON
Shri **C. Subramaniam***

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* Passed away on November 7, 2000.

1.3 Faculty

Name	*Userid*	*Res. Phone No*
MATHEMATICS		
Balaji, V.[1]		
Balasubramanian, R.	balu	245 3926
Kesavan, S.	kesh	641 2839
Kodiyalam, V.	vijay	490 2041
Krishna Maddaly,	krishna	449 1499
Nagaraj, D.S.	dsn	448 1260
Paranjape, K.H.	kapil	492 7243
Srinivas, K.	srini	
Sunder, V.S.	sunder	847 5543
Sankaran, P.[2]	sankaran	446 0909
PHYSICS		
Anishetty, R.	ramesha	496 0586
Balakrishnan, Radha	radha	434 0102
Baskaran, G.	baskaran	492 7304
Basu, R.	rahul	245 4794, 245 3297
Chakraborty, T	tapash	492 5271
Date, G.	shyam	245 6148
Govindarajan, T.R.	trg	492 7309
Hari Dass, N.D.	dass	442 2767
Indumathi, D.	indu	492 8138
Jagannathan, R.	jagan	240 1546
Jayaraman, T.	jayaram	492 9527
Kalyana Rama, S.	krama	
Kaul, R.	kaul	441 3264
Majumdar, P.	partha	448 0793
Menon, G.I.	menon	645 1897
Mishra, A.K.	mishra	
Murthy, M.V.N.	murthy	235 2652
Parthasarathy, R.	sarathy	221 2021
Rajasekaran[3], G.	graj	441 3395
Ramachandran, R.	rr	442 0387
Rao, M.[4]	madan	
Ray, P.	ray	492 7832
Sathiapalan, B.	bala	492 7832
Shankar, R.	shankar	448 1914
Sharatchandra, H.S.	sharat	441 8059
Simon, R.	simon	451 0280
Sinha, R.	sinha	448 2190
Sinha, S.	sudeshna	492 7243
Sridhar, R.	sridhar	441 9145
Srinivasa Rao, K.	rao	441 1347

Name	*Userid*	*Res. Phone No*
THEORETICAL COMPUTER SCIENCE		
Arvind, V.	arvind	235 2556
Lodaya, K.	kamal	445 3312
Mahajan, M.	meena	440 4395, 4404396
Raman, V.	vraman	492 9845
Ramanujam, R.	jam	492 8138
Seth, A.[5],	seth	492 7647
SCIENTIFIC OFFICER		
Subramoniam, G.	gsmoni	246 0520
ERNET PROJECT ASSISTANT		
Arun Kumar, S.[6]	arun	
Ashokan, A.V. [7]	ashok	

email: userid@imsc.ernet.in

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[1] Joined on 2.8.2000 and resigned on 2.7.2001
[2] Joined on 31.8.2000
[3] upto Feb. 2001
[4] Relieved on 31.12.2000
[5] Relieved on 1.5.2001
[6] Resigned on 28.11.2000
[7] Joined on 5.1.2001

1.4 Visiting Scientists

Name	*Userid*
Gupta, A.[1]	anshu
Subramanian, C.R.[2]	crs

1.5 Project Scientists

Name	*Userid*
Rajasekaran, G.[3]	graj
Sinha, N.[4]	nita

1.6 Post-Doctoral Fellows

Name	*Userid*
MATHEMATICS	
Biswas, Jishnu Gupta[5]	jishnu
Thangadurai, R.	thanga
PHYSICS	
Apalkov, Vadim[6]	vadim
Barve, Sukratu[7]	sukratu
Dong, Shin Shin[8]	shin
Ghosh, Sankalpa	sankalpa
Gupta, Anshu[9]	anshu
Guruppa, N.[10]	
Takata, Hiroyuki[11]	takata

[1] From 17.1.2001 to 6.4.2001
[2] From 27.10.2000
[3] From 1.3.2001, INSA Honorary Scientist
[4] From 1.5.2001, Project Investigator, DST Scheme for Young Scientists (Physics)
[5] Relieved on 16.12.2000
[6] Resigned on 18.11.2000
[7] Joined on 28.9.2000
[8] Resigned on 1.7.2001
[9] Joined on 9.4.2001
[10] Joined on 14.9.2000 and resigned on 13.1.2001
[11] Joined on 1.4.2000

1.7 Ph.D. Students

Name	*Userid*
MATHEMATICS	
Das, Paramita	pdas
Dey, Arijit	arijit
Ghosh, Shamindra Kumar	shami
Gyan Prakash	gyan
Muthukumar T.	tmk
Ravindra G.V.	ravindra
Uma V.	uma
PHYSICS	
Bal, Subrata	subrata
Balaji, K.R.S.	balaji
Basak, Souman	soumen
Basu, Pallab	pallab
Ezhuthachan, Bobby Vinod Kr.	bobby
Ghosh, Tarun Kanti	tkghosh
Gupta, Samik Das [1]	samik
Hossain G.M.	golam
Karthik G.V.S.	karthik
Kumar, Santosh	sant
Manoj G.	manoj
Murugesh	mgesh
Rajesh, V.	chinta
Santosh Kumar, K.	sant
Sarkar, Swarendu	swaren
Sumithra, S.R.	sumithra
Surendran, Naveen	naveen
Varadarajan, Suneeta	suneeta
THEORETICAL COMPUTER SCIENCE	
Karur Piyush, P	ppk
Madhusudan, P[2]	madhu
Meenakshi, B.	bmeena
Srinivasa Rao, S.	ssrao
Suresh, S.P.	spsuresh

[1] resigned on 24.7.2001
[2] term ended on 31.1.2001

1.8 Administrative Staff

Ramakrishna Manja,	Chief Administrative Officer
Jayaraman, R.	Administrative Officer
Krishnan, S.	Accounts Officer
Santhanagopalan, K.S.	Librarian
Sampath, N.S.[1]	Junior Administrative Officer
Gayatri, E.	Junior Accounts Offier
Mohan, S.	Junior Engineer(Electrical)
Arangarajan, R.	Junior Engineer(Civil)
Venkatesan, G.	Deputy Librarian

Amulraj, D.
Ashfack Ahmed, G.
Balakrishnan, A.R.
Balakrishnan, J.
Elumalai, G.
Ganapathi, R.
Geetha, M.
Indra, R.
Janakiraman, J.
Moorthy, E.
Munuswamy, N.
Munuswamy, M.
Muthukrishnan, M.
Muthusigamani, S.
Nandhini, M.[2]
Nithyanandam, G.
Parijatham, S.M.
Parthiban, V.
Prema, P.[3]
Radhakrishnan, M.G.
Rajasekaran, N.
Rajendran, C.
Ramesh, M.
Ravichandran, N.
Ravindran, A.
Rizwan Shariff, H.
Sankaran, K.P.
Selvaraj, M.
Tamil Mani, M.
Usha Devi, P.
Usha Otheeswaran,
Vasudevan, T.V.
Varadaraj, M.
Venugopal, T.

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[1] Retired after superannuation on 31.3.2001
[2] joined on 30.4.2001
[3] joined on 2.5.2001

Chapter 2

Academic Activities

2.1 Mathematics

2.1.1 Research Summary

Algebraic Geometry and Topology

The semistable reduction theorem for G-bundles over a smooth projective curve has been proved (here G is a semisimple algebraic group). The methods used also generalise for families of principal Higgs bundles over smooth projective varieties and give a semistable reduction theorem in that case as well [**M:B1**].

The existence and the projectivity of the moduli spaces of principal G-bundles on a smooth projective curve over fields k of characteristic p has been proved (here, G is a semisimple algebraic group and p is a prime number bigger than a certain representation theoretic index associated to the heights of representations of G). The projectivity is obtained as a consequence of the semistable reduction theorem for principal G-bundles. The irreducibility of the moduli spaces of semistable G-bundles for G simple and simply connected is obtained as a consequence. The earlier known results were only in characteristic 0 [**M:B2**].

The work on Parabolic bundles over projective manifolds with parabolic structure over a divisor has been further developed and more precise results have been obtained [**M:BN2**].

A coincidence theorem for holomorphic maps from a generalized Hopf manifold or a generalized Calabi-Eckmann manifold into certain simply connected homogeneous complex projective varieties has been obtained [**M:Sa**].

Some progress was made on the topology and geometry of toric varieties and toric fibrations.

For any smooth projective variety there are examples of algebraic cycles which are not detected by existing cohomology theories. A cohomology theory was defined and it was conjectured that this theory captures all cycles. This conjecture has been verified in several examples.

Elliptic modular varieties are a family of explicitly constructed varieties. Many arithmetic and geometric properties of these varieties are still being explored. A particular case is a question raised by S. Bloch and C. Schoen relating a certain elliptic modular threefold with

the quintic threefold $\sum X_i^5 - 5\prod X_i$ in projective four space. A preliminary simplification of this problem has been found. Other examples of elliptic modular threefolds with trivial canonical bundle seem to indicate that the geometric version of Eichler-Shimura theory should relate eigenforms with rational coefficients with the cohomology of varieties with trivial canonical bundle.

A. A. Belyi in 1983, proved that algebraic curves defined over number fields (i. e. arithmetic algebraic curves) can be characterized by the fact that they are obtained as covers of the projective line that are étale outside the three points 0, 1 and ∞. This work has led to the *dessin d'enfant* work by A. Grothendieck and the recent results of S. Mochizuki on the absolute Galois group. There has been a search for higher dimensional analogue of this statement ever since this result appeared. By the work of A. Grothendieck it is clear that geometrically rigid objects are arithmetically defined. A large class of geometrically rigid subvarieties of projective space have been found so that this can be shown to include (and thus be equal to) all arithmetically defined varieties.

Analysis

The rate of convergence to fixed points of some class of non-linear maps on Banach spaces was proved [**M:Kr3, M:Kr4**].

It has been proved that certain almost Mathieu operators are not invertible [**Ba1**].

Differential Equations

It was shown that the problem of computing the limit of certain types of quadratic functionals of Dirichlet type with oscillating coefficients involving the solution of second order elliptic problems whose operator (in divergence form) also involves oscillating coefficients is equivalent to solving an optimal control problem with the above functional appearing in the objective function. The uniqueness of the limit matrix in the functional was established. A new formulation of the limit matrix in terms of the corrector matrices of H-convergence theory for the differential operator and the matrix in the functional was proved. From this it is easy to read off the symmetry and ellipticity of the limit matrix. The problems posed both in the framework of H-convergence and H_o-convergence (for perforated domains) was solved [**M:Ke2, M:Ke3**].

Financial Mathematics

A study of some of the scrips traded in the Bombay Stock Exchange was undertaken. The Value at Risk in the scrips was studied with a three year window for scrips forming part of the sensex and a two year window for two scrips in the rolling settlement. The Value at Risk for the investor was found to be influenced by the "circuit breakers" imposed in the market [**M:Kr7**].

Mathematical Physics

Density of states in the one dimensional Anderson type models with either decaying or growing interactions was considered. It's degree of smoothness, in the sense of the degree of the differentiability of the density, with respect to Lebesgue measure, was shown to be connected to the rate of decay of the distribution of the random potential [**M:Kr6**].

A random Schrödinger operator with singular interactions was considered in dimensions up

to three and their spectral properties studied. In particular the exponential localization, dynamical localization are shown at the lower band edge in addition to showing the Lipshitz continuity of the integrated density of states of the model in that energy regime [**M:Kr2**].

Number Theory

Further progress was obtained in the problem of Erdös on getting a good lower bound for the cardinality of the set which has the property that it is an additive complement of the squares[**M: Ba4**].

The uniform distribution modulo 1 of the sequence $\{n^\alpha\}_{n=1}^{\infty}$ where $\alpha > 0$ and α is not an integer has been investigated in the literature, though no explicit error terms have been written down. Work is in progress in this direction. Work is also in progress towards getting good estimates for $\sum_{p \leq x} e^{2\pi i p^\alpha \theta}$, where the sum is over primes and θ is a rational number.

Further progress was obtained in the combinatorial problem of Steinhaus of a set in the plane which contains exactly one lattice point under translation and rotation.

The problem of minimal zero sequence in an Abelian group is studied. The the maximal length of a minimal zero sequence in an Abelian group is known as the Davenport Constant of the group. Some results about the Davenport constant and related problems were obtained.

Operator Algebras

An attempt to understand the relation between semisimple, co-semisimple Hopf algebras (over arbitrary algebraically closed fields) on the one hand, and 'general (not necessarily unitary) paragroups' has been made. There seems to be reason to believe (hope?) that some of these ideas might shed light on the (still open) problem of whether a finite-dimensional Hopf algebra over $\mathbb{C}$ necessarily admits a natural structure of a Hopf C*-algebra.

Generalized paragroups over any algebraically closed field satisfying a property ('Three $*$ flatness') have been defined. This flatness condition has been shown to imply various other notions of flatness found in the literature. These objects are shown to give rise to fusion algebras over the ring of integers just as in the classical unitary case. It was shown that the harmonicity axiom for paragroups is redundant. An example of a generalized paragroup over $\mathbb{C}$ which is not unitarizable was found.

It has been shown that over an arbitrary base-field, there is a bijective correspondence between isomorphism classes of (generalized) paragroups of depth two and semisimple and co-semisimple Hopf algebras. This generalises the Ocneanu-Syzmanski correspondence between finite dimensional Kac algebras and depth two unitary paragroups. The proof is completely algebraic and avoids use of subfactor theory.

A natural (and intrinsic) notion of what may be termed the 'planar depth' of a planar algebra, has been identified; some conclusions regarding this concept have been obtained [**M: Su2**].

A class of planar algebras - the so-called exchange relation algebras - had been identified in the literature as a class for which certain desirable finite-dimensionality requirements are automatically satisfied. These are planar algebras which are 'planarly generated' by its 'two

boxes' (which satisfy certain relations); they were known to include several known examples. Now, a natural generalization of these exchange relation algebras has been identified. These 'higher exchange relation algebras' are required only to be finitely planarly generated and to satisfy certain relations. What is interesting is that these examples have been shown to include even the sporadic E_6 and E_8 examples. It is even possible that *all* 'finite-depth planar algebras' fall into this class.

2.1.2 List of Publications

The following conventions have been adopted in the list of publications: firstly, names of (co)authors who are not members of the Institute have been marked with a superscript *; secondly, in order to facilitate cross-referencing between this list and the 'summary of research' above, all entries in this list have been given a label and finally, the entries are listed according to alphabetical order of their labels.

[**M:B1**]
Balaji, V. and Seshadri, C.S.*
Semistable principal bundles-I (in characteristic zero).
Submitted to *Transformation Groups.*

[**M:B2**]
Balaji, V. and Parameswaran, A.J.*
Semistable principal bundles-II (in positive characteristics)
Submitted to *Transformation Groups.*

[**M:Ba1**]
Balasubramanian, R., Kulkarni, H.S.* and Radha, R.*
Non-invertibility of certain almost Mathieu operators.
*Proc. AMS.,***129** (2001) (2017-2018)

[**M:Ba2**]
Balasubramanian, R., Ponnusamy, S.* and Vuorinen, M.*
Role and properties of hypergeometric functions in function spaces.
To appear in *Journal of Computational and Applied Mathematics.*

[**M:Ba3**]
Balasubramanian, R., Ponnusamy, S.*, Sunanda Naik* and Vuorinen, M.*
Elliott's identity and hypergeometric functions.
Submitted to *Mathematics of Computation.*

[**M:Ba4**]
Balasubramanian, R. and Suryaramana, D*.
Additive complements of the squares.
C.R. Maths. Acad. Soc., Canada. **23**(2001) 6-11.

[**M:BaS**]
Balasubramanian, R., Ramachandra, K.*, Sankaranarayanan, A.* and Srinivas, K.
Notes on Riemann zeta-function-V.
Hardy-Ramanujan Journal. **23** (2000) 2-9.

[**M:BaT**]
Adhikari, S.D.*, Balasubramanian, R. and Thangadurai, R.
Further remarks on Steinhaus sets
Publ. Maths. Debre., **57** (2000) 277-281.

[**M:BN1**]
Balaji, V., Biswas, I.* and Nagaraj, D.S.
Principal Bundles over projective manifolds with parabolic structure over a divisor.
To appear in *Tohuku Math Jour*, **53**, No.3, (2001).

[**M:BN2**]
Balaji, V., Biswas, I* and Nagaraj, D.S.
Principal bundles with parabolic structures.
Electronic Research Announcements of the AMS., **7** (2001) 37-44

[**M:Ke1**]
Kesavan, S.
Isoperimetric inequalities in partial differential equations
Proc. Nat.Acad. Sc, India. **LXIX**, Section A, 1999, 393 - 418.

[**M:Ke2**]
Kesavan, S. and Rajesh, M.*
On the limit matrix obtained in the homogenization of an optimal control problem.
Submitted to *Proc. Indian Academy of Sciences (Math. Sci.).*

[**M:Ke3**]
Kesavan, S. and Saint Jean Paulin, J.*
Quelques problèmes de contrôle bon marché.
Comptes Rend. Acad. Sc., Paris, **t. 332**, Série 1, 2001, 67 -72.

[**M:KoSu1**]
Kodiyalam, V. and Sunder, V.S.
Spectra of principal graphs.
International Journal of Mathematics, **12**, (2001), 203-210.

[**M:KoSu2**]
Kodiyalam, V. and Sunder, V.S.
Flatness and fusion coefficients.
To appear in *Pacific Journal of Mathematics.*

[**M:KoSu3**]
Kodiyalam, V., Srinivasan, R.* and Sunder, V.S.
Algebra of G-relations.
Proc. of Indian Acad. of Sci., (Math. Sci.), **110**, (2000), 263-292.

[**M:Kr1**]
Krishna, M. and Sinha, K.B.*
Spectral properties of Anderson type operators with decaying interactions.
Proc. Ind. Acad. Sciences (Math. Sci), 111(2), 179-201 (2001).

[**M:Kr2**]
Hislop, P.*, Kirsch, W.* and Krishna, M.
Random Schrödinger operators with wavelet interactions.
Wavelets and Allied Topics. P. K Jain et. al. eds, Narosa (2001).

[**M:Kr3**]
Babu, G.V.R.* and Krishna, M.
Improved convergence rate estimate of Ishikawa iteration process for Lipschitz strongly pseudocontractive maps in a Banach space.
Preprint. imsc/2001/07/40.

[**M:Kr4**]
Babu, G.V.R.* and Krishna, M.
Convergence of Mann and Ishikawa iteration schemes for ϕ- contractive maps in a Banach space.
Preprint. imsc/2001/07/41.

[**M:Kr5**]
Krishna, M.
Smoothness of the density of states for random decaying interactions.
Preprint. imsc/2001/07/42.

[**M:Kr6**]
Hislop, P.*, Kirsch, W.* and Krishna, M.
Spectral properties of random singular interaction models.
Preprint. imsc/2001/07/43.

[**M:Kr7**]
Krishna, M. and Shanthi, S.K.*
Value at risk in the Indian markets.
To appear in the *Indian Jour. of Applied Finance.*

[**M:P**]
Biswas I.* and Paranjape K. H.
The Hodge conjecture for a general Prym variety.
To appear in *Journal of Algebraic Geometry.*

[**M:S**]
Srinivas, K.
Distinct zeros of functions in the Selberg class
To appear in *Acta Arith.*

[**M:Sa**]
Sankaran, Parameswaran.
A coincidence theorem for holomorphic maps to G/P.
Preprint. imsc/2001/06/31.

[**M:Su1**]
Srinivasan, R.*, Sunder, V.S. and Wildberger, N.J.*
Discrete series of fusion algebras.
To appear in *J. of Aust. Math. Soc.*

[**M:Su2**]
Landau, Z.* and Sunder, V.S.
Some remarks on planar subalgebras.
Submitted to *J. of Functional Analysis.*

[**M:T1**]
Thangadurai, R.
On a conjecture of Kemnitz.
C. R. Math. Rep. Acad. Sci., Canada., **23 (2)** (2001), 39-45.

[**M:T2**]
Thangadurai, R.
A note on a conjecture of Borwein and Choi.
To appear in *Arch. der. Math.*

[**M:T3**]
Thangadurai, R.
Interplay between four conjectures on certain zero-sum problems.
To appear in *Expostiones Mathematicae.*

[**M:T4**]
Thangadurai, R.
Classical cryptosystems.
To appear in *Bona Mathematica.*

[**M:T5**]
Thangadurai, R.
Non canonical extensions of Erdos-Ginzburg-Ziv theorem.
Preprint, imsc/2001/07/35.

[**M:T6**]
Thangadurai, R.
Equivalent criteria for Fermat and Mersenne primes.
Preprint, imsc/2001/07/36.

[**M:T7**]
Thangadurai, R.
Magic squares of squares and arithmetic progressions in the integral points on the elliptic curve $y^2 = x(x^2 - n^2)$.
Preprint, imsc/2001/07/37.

[**M:T8**]
Sury, B.* and Thangadurai, R.
Some combinatorial problems on zero-sums in finite Abelian groups.
Preprint, imsc/2001/07/38.

Books/Monographs

[**M:Mono1**]
Jain, P.K.*, Mhaskar, H.N.*, Krishna, M, Prestin, J.* and Singh, D.*
Wavelets and Allied Topics.
Narosa Publishing House, New Delhi.

[**M:Mono2**]
Kodiyalam, Vijay and Sunder, V.S.
Topological quantum field theories from subfactors.
Chapman and Hall/CRC Research Notes in Mathematics 423, 2001.

2.2 Physics

2.2.1 Research Summary

Nonlinear Dynamics, Solitons and Chaos

Heisenberg ferromagnetic spins are considered on a variety of curved magnetic surfaces such as a sphere, circular and elliptic cylinders etc, and seek solutions with certain symmetries. It is shown explicitly that the minimum energy configurations satisfy a sine-Gordon equation with a parameter that depends on the geometry of the surface concerned. A topological transition of the spin textures is shown to occur at the one-soliton point [**P:Balak1**].

Lamb has identified a certain class of space curve evolution with soliton equations. It is shown that there are two other classes of curve evolution that may be so identified. Hence *three* distinct classes of curve evolution are associated with a given integrable equation. The nonlinear Schrödinger equation is used to illustrate this explicitly [**P:Balak2**].

Two distinct low-energy sectors are identified in the classical isotropic antiferromagnetic Heisenberg spin-S chain. In the continuum limit, it is shown that *two* types of rotation generators arise for the field in each sector. Using these, the Lagrangian for sector I is shown to be that of the nonlinear sigma model. Sector II has a null Lagrangian; Its Hamiltonian density is just the Pontryagin term. Exact solutions are found in the form of magnons and precessing pulses in I and moving kinks in II [**P:Balak3**].

The issue of why the internal degrees of a black hole (purportedly giving a microscopic string theoretic description of black holes) should appear to be thermal or ergodic had been discussed previously. While it is true that if one traces over unobserved degrees of freedom of a pure-state density matrix, the result is a mixed state density matrix, it is not clear why it should look thermal. It was argued that self thermalization via chaos is a possible mechanism for this. This is known to happen in Yang Mills, which by AdS/CFT duality, is dual to a black hole.

This issue motivated the study of this phenomenon in a general way and to use this to justify or at least understand better the basic postulate "ergodicity" of Quantum Statistical Mechanics. The crucial point is that to obtain ergodization one needs a quantum version of the Gibbbsian coarse graining that is used in classical statistical mechanics. This can, possibly, be done and the attempt is on to show that in simple cases one can obtain a mathematical description of the self thermalization of a pure state.

This is a foundational problem in Quantum Statistical Mechanics of how pure quantum states evolve into states looking very much like the ensembles of Quantum statistical mechanics. The picture that is emerging is that of quantum coarse graining that makes such an evolution plausible.

It is shown how threshold mechanisms can be effectively employed to control chaotic systems onto stable fixed points and limit cycles. The success of the mechanism is demonstrated on three prototypical systems, ranging in complexity from a one-dimensional chaotic map, to a continuous time multi-dimensional system. Also demonstrated is the success of threshold control in an extended system relevant to 'smart matter' applications, namely an unstable

elastic array modeling the buckling of beams. It is found that very few threshold controlled sites are necessary for controlling the entire array, with the added advantage that no information exchange between sites is required to implement the control [**P:Sinhas1**].

It is shown further how stroboscopic threshold mechanisms can be effectively employed to obtain a wide range of stable cyclic behavior from chaotic systems, by simply varying the frequency of control. The success of the scheme is again demonstrated in a prototypical one-dimensional map, as well as in a three-dimensional system modeling lasers where the threshold action is implemented on any one of the variables. It was evident that thresholding is capable of yielding exact limit cycles of varying periods and geometries when implemented at different intervals (even when very infrequent). This suggests a simple and potent mechanism for selecting different regular temporal patterns from chaotic dynamics [**P:Sinhas2**].

Two control strategies are proposed for achieving desired firing patterns in neuronal systems. The techniques were powerful, efficient and robust, and are applied successfully to obtain a range of targeted spiking behaviors in the physiologically realistic Pinsky-Rinzel model neuron. The methods complement each other: one involves the manipulation of only a parameter and the other involves the manipulation of only a state variable. Both have the advantage that they can be implemented without explicit knowledge of the system's governing equations. Further the schemes are not measurement intensive, as they entail monitoring only a single variable [**P:Sinhas3**].

It was observed in earlier studies, that the mean field of globally coupled maps evolving under synchronous updating rules violated the law of large numbers, and this remarkable result generated widespread research interest. It is demonstrated that incorporating increasing degrees of asynchronicity in the updating rules rapidly restores the statistical behaviour of the mean field. This is clear from the decay of the mean square deviation of the mean field with respect to lattice size N, for varying degrees of asynchronicity, which shows $1/N$ behaviour up to very large N even when the updating is far from fully asynchronous. This was also evidenced through increasing $1/f^2$ behaviour regimes in the power spectrum of the mean field under increasing asynchronicity [**P:Sinhas4**].

Mathematical Methods

Quantum algebras are special cases of a wider class of nonlinearly deformed Lie algebras. Particularly, polynomially deformed Lie algebras occur in several physical problems as invariance or dynamical algebras. In this connection, representations and physical applications of some quadratic algebras have been studied [**P:J3**].

By considering the enlarged system of free bosons and fermions, including the heat bath, it is shown that this system has supersymmetry which is not broken at finite temperature.The super algebra is constructed and the Hamiltonian is expressed as the anticommutator of two kinds of supercharges. With this Hamiltonian and the thermal vacuum, this supersymmetry is found to be preserved [**P:P1**].

New Continued Fraction representations involving the ratios of hypergeometric functions ${}_2F_1$ and ${}_3F_2$ with general arguments were established. Two of the continued fractions obtained [**P:Sr3**] are of special interest because of the presence of x and $4x(1-x)$ as the arguments of the ${}_2F_1$s. All the continued fraction results in literature involving ${}_3F_2$ functions are with

unit argument, whereas our new continued fraction result contains the genernal argument x. Continued fractions for the ratio of ${}_3F_2(1)$s have been established corresponding to a transformation for non-terminating ${}_3F_2(1)$ by Denis and Singh. This transformation is one belonging to a group of 120 transformations. Work on obtaining the family of continued fractions from this group of transformations is in progress.

Using the beta integral method and the computer algebra codes – Mathematica with Hyp.m and Hyp.q developed by C. Krattenthaler – some interesting and new results were obtained for the transformations of hypergeometric functions.

Optics

It has been found that quantum corrections can substantially affect the classical results of tracking for trajectories close to charged particle separatrix. Thus the computation of exact quantum maps is important for studies on long-term stability of any charged-particle beam optical system. In view of this, a systematic method for obtaining the quantum maps for charged-particle beam optical systems has been outlined [**P:J1**].

The Foldy-Wouthuysen (FW) iterative diagonalization technique is applied to the Helmholtz equation to obtain a Hamiltonian description of the propagation of a quasiparaxial light beam through a system in which the refractive index $n(\mathbf{r})$ varies about a background value n_0 such that $|\, n(\mathbf{r}) - n_0 \,| << n_0$. This technique is presented as an alternative to the conventional method of series expansion of the radical. Besides reproducing all the traditional quasiparaxial terms, this method leads to certain interesting new terms in the optical Hamiltonian.

A comprehensive study of the geometric phases and the Bargmann invariants associated with a multi-level quantum system is undertaken. It is shown that a full set of 'gauge-invariant' objects for an n-level system consists of n geometric phases and $\frac{1}{2}(n-1)(n-2)$ algebraically independent 4-vertex Bargmann invariants. In the process of establishing this result a canonical form for $U(n)$ matrices, which is useful in its own right, is developed. It is shown, in particular, that the recently discovered 'off-diagonal' geometric phases [N. Manini and F. Pistolesi, Phys. Rev. Lett. **8**, 3067 (2000)] can be completely analysed in terms of the basic building blocks developed in this work. This result liberates the off-diagonal phases from the assumption of adiabaticity used in arriving at them.

Superposition of quantum states is studied through interference in phase space rather than in the configuration space. While conventional interference is determined by considerations of optical path lengths, interference in phase space is governed by considerations of phase space area or geometric phase. The connection between geometric phase and Bohr-Sommerfeld quantization is brought out. An integral representation for state vectors, based on the corresponding orbits in classical phase space, is developed and this leads to asymptotic expressions for matrix elements and for classical orthogonal polynomials.

The *entanglement of formation* (EoF) is among the most popular of the several candidate measures available to quantify entanglement as a resource in quantum information processing. Analytic computation of EoF for mixed states of a bipartite system has proved extremely difficult, but Wootters has succeeded in obtaining a closed form expression for the EoF of an arbitrary (mixed) state of a pair of qubits (a qubit being a quantum system with two-dimensional Hilbert space). Generalization of Wootter's result to bipartite systems of

higher Hilbert space dimensions remains evasive. On the other hand, in the case of canonical systems corresponding to infinite Hilbert space dimensions, Gaussian states continue to be singularly important from the point of view of experiments. We have computed in closed form the EoF of an arbitrary Gaussian mixed state of a bipartite canonical system.

Hilbert showed in 1888 that a positive semi-definite (psd) polynomial in several real variables need not be sum of squares (sos) of polynomials; but explicit example of such polynomials had to wait for nearly 80 years until the works of Motzkin and Robinson. Choi subsequently produced examples of biquadratic forms which are psd but not sos. Inspired by recent developments in quantum information theory, we employ linear maps which are positive but not completely positive to construct large families of biquadratic forms which are psd but not sos. The principal result may be stated as follows:

- Let Δ_0 and $\Delta_{\mathbf{R}}$ be a pair of concentric regular unit $(n-1)$-simplexes in $\mathcal{R}^{n-1}$, $\Delta_{\mathbf{R}}$ being the image of Δ_0 under some proper/improper rotation $\mathbf{R} \in O(n-1)$, the orthogonal group. Let the $(n-1)$-dimensional unit vectors $\hat{\mathbf{r}}^{(k)}(0)$, $\hat{\mathbf{r}}^{(k)}(\mathbf{R})$, $k = 1, 2, \ldots, n$ describe the corresponding vertices of the two simplexes. The biquadratic form

$$B_{\mathbf{R}}(x,y) \;=\; \sum_{i,\,j=1}^{n} \left(1 \,+\, \hat{\mathbf{r}}^{(i)}(0) \cdot \hat{\mathbf{r}}^{(j)}(\mathbf{R}) \right) x_i^2 y_j^2 \;-\; \frac{n}{n-1} \sum_{i \neq j=1}^{n} x_i x_j y_i y_j \,,$$

  is psd for every $\mathbf{R} \in O(n-1)$. But $B_{\mathbf{R}}(x,y)$ can be written as a sum of squares of bilinear forms if and only if the pair of simplexes meets the symmetry requirement $\hat{\mathbf{r}}^{(i)}(0) \cdot \hat{\mathbf{r}}^{(j)}(\mathbf{R}) \;=\; \hat{\mathbf{r}}^{(j)}(0) \cdot \hat{\mathbf{r}}^{(i)}(\mathbf{R})$ for every $i \neq j$ or, equivalently, if and only if the orthogonal matrix $\mathbf{R} \in O(n-1)$ is *symmetric*.

Since symmetric orthogonal matrices constitute a small fraction of $O(n)$, this family of psd but not sos biquadratic forms is nearly as large as $O(n)$, for every $n \geq 2$ [**P:Sim1 - Sim10**].

Condensed Matter Physics

Gauge theory description of Mott insulators and high temperature superconductors was initiated in an early work by G. Baskaran and P.W. Anderson. Starting from an apparently different approach and using different classes of models, in a series of papers Senthil and Fisher proposed an allegedly new Z_2 gauge theory for cuprates. In [**P:Bas7**] it is shown clearly how the Z_2 gauge theory of Senthil and Fisher are different description of the old gauge theory developed by Baskaran and Anderson. This paper also puts on stringent conditions on the modes of quantum number fractionization.

Spinon excitation is all too familiar in spin liquids or RVB states. In [**P:Bas8**] it is shown that the well known ordered 2d quantum Heisenberg antiferromagnets also exhibit deconfined spinon excitations above a particular energy gap, contrary to naive expectations. It was also shown that 'Skyrmion' of the non linear sigma model of this system is in fact made of two unbound spinons.

In a remarkable discovery Akimitsu and collaborators found high temperature superconductivity in MgB_2, a very old and known system. In [**P:Bas11**] it is shown that this system

is electronically equivalent to 'graphite under chemical pressure' and that a major contribution to superconductivity arises from an electronic RVB mechanism. The large isotope effect seen in MgB_2 has been also shown to be compatible with a purely electronic mechanism in [**P:Bas12**].

It has been found experimentally that in the layered material $RuSr_2GdCu_2O_8$ both high temperature superconductivity and ferromagnetism co-exist, but in different layers in a staggered fashion. It was suggested in [**P:Bas13**] that such a co-existence is possible only if there is 'confinement' of carriers in the CuO_2 plane because of the failure of Fermi liquid theory.

An extensive numerical study that uses supercomputers by Jain and collaborators confirms an early suspicion that the lowest energy zero momentum magneto phonon excitations in the major fractional quantum Hall states are two roton bound states. It has been shown in [**P:Bas9**] that if one models the inner structure of magneto rotons and quantize the 'momentum dependent' dipole interaction, one gets a two roton binding and binding energy with a 10 % accuracy compared to Jain's extensive numerical studies. This purely analytical approach has the great advantage of being useful to analyze more complex quantum Hall states.

The physics of quantum cascade laser is studied that includes the quantum-dot cascade laser and cascade laser in a magnetic field [**P:C1 - P:C9**].

Recent experiments have shown that it is indeed possible to devise approximately one dimensional Bose systems and study their properties. A one dimensional Bose system with quintic attractive or repulsive interaction is analysed using the density functional approach. The existence of soliton solutions is shown. Also, a general treatment of the stationary solutions for both attractive and repulsive interactions is provided [**P:G2**].

After the observations of vortices in rotating Bose condensed systems, similar experiments are planned in the case of Fermionic atom-vapours in two dimensions. An exactly solvable model of an interacting two-component Fermi vapour is proposed within the Thomas-Fermi approach. The interaction is given by the screened Coulomb interaction which is relevant to the experiments and is analytically tractable. The system is also analysed in the limit when the rotating frequency is close to the trapping frequency, when the Thomas-Fermi approximation is not valid. Here, a variational approach is used where the local density approximation may be applied after projecting the system on to the lowest degenerate level [**P:G1, P:G2**].

Topological Excitations in Quantum Hall Systems and Bose Einstein Condensation are studied.

After the discovery of Bose-Einstein condensates (BEC) in alkali atomic gas, the reduction in dimension is the subject of extensive studies in trapped Bose systems. Recently, the low-dimensional BEC has also been observed in MIT. An analytic expression is derived for the low-lying excitation frequencies of a two dimensional deformed trapped Bose gas above the critical temperature and at zero temperature. The universality of monopole mode and time evolution of a D- dimensional trapped interacting Bose gas are also shown [**P:Gtk4, P:Gtk5**].

Recently, a new kind of BEC has been proposed where a particular configuration of intense off-resonant laser beams gives rise to an effective gravity-like $1/r$ interatomic attraction between neutral atoms. For strong induced gravity-like potential, the BEC becomes stable even without the trap potential. There are two new regimes, gravity regime (G) and Thomas-Fermi gravity (TF-G) regime arising from the competition between gravity-like potential either with kinetic energy or two-body short range pseudo potential. The ground state properties, monopole and quadrupole mode frequencies of the above mentioned various regimes in this system have been studied [**P:Gtk1**].

The pioneering work of Girvin, Macdonald and Platzman (GMP) brought out non-trivial inner structure of neutral excitations of the fractional quantum Hall effect systems. This inner structure is very transparent for the magneto roton, the minimum energy neutral excitations at finite wave vector for the $\nu = 1/3$ quantum Hall state. They are well approximated by a Laughlin quasi-hole-quasi-particle bound state. It was observed by GMP that the zero momentum neutral excitation, as observed by numerical experiment was in disagreement with their result at zero momentum. Since the numerically observed results was slightly less than the sum of the two roton energy, they speculate that the minimum energy excitation could be a two-roton bound state. This two-roton bound state problem is modeled and solved variationally to find a two roton bound state with binding energy which is within a percent of the numerical results [**P:Gtk3**].

Experimentalists are able to create and detect a vortex lattice structure in a dilute trapped rotating Bose condensates. At present, vortex stabilization in a rotating asymmetric BEC is being studied.

The steady state of a model of hard-core particles driven by gravity and sliding on a fluctuating *rough* surface is studied. For specific examples such as the KPZ and EW surfaces, it is shown both analytically a nd numerically that the the particles and the surface undergo phase separation in the steady state. The pair correlation function has a cusp near the origin while the RMS fluctuation in the order parameter appears to converge to a finite limit as $L \to \infty$. These features make the steady state very different from conventional ordered states.

The description of phase behaviour in disordered type-II superconductors is studied. The issues here are the following: (i) What is the origin of the "peak effect", the ubiquitous increase followed by a sharp decrease in critical currents in a type-II superconductor in its mixed phase, close to the upper critical field? (ii) Why is the regime [in (H, T) space] where this peak occurs so dynamically anomalous? (iii) What is the relation between peak effects in low and high-T_c superconductors? (iv) What is the connection to the so-called "fishtail effect", a relatively slower and smoother increase in critical currents in isothermal measurements when the field is varied? and, (v) How can these phenomena be understood in the context of a universal phase diagram for disordered type-II superconductors?

A complete and consistent approach to answering the questions above is provided [**P:Me1**]. In later work [**P:Me2 - P:Me4**], these ideas have been generalized to high-T_c materials and a detailed analysis performed including obtaining analytic expressions for the phase boundaries.

A theory has been developed for (i) mode structure and static and dynamic correlations in two-component membranes at thermal equilibrium (ii) such mode structure and correlations when the membrane is subjected to non-thermal noise, as arises in a biological context due to the presence of ion pumps and active channels, (iii) the modification of the above results when the membrane is placed near a wall. The principal difficulty with the formulation of (ii) and (iii) is that the membrane is in a non-equilibrium steady state and theoretical tools for the characterization of such states are still in their infancy.

A calculation is done which provides an exact solution to the problem of the persistence exponent in a one-dimensional Ising model with parallel dynamics. It is pointed out that the exponent with parallel dynamics is half the exponent obtained with serial dynamics. This exponent is derived through a mapping onto a two-species diffusion-annihilation model and exact results are provided for spatial correlations in the distribution of persistent sites, showing that persistent sites do not form a fractal [**P:Me5**].

Two electrons with opposite spins cannot occupy a single orbital state when the intra-orbital Coulomb repulsion U between them tends to infinity. Under this condition, the electrons may not satisfy the usual antisymmetry property associated with the simultaneous exchange of space and spin coordinates. Instead, the wavefunction is antisymmetric with respect to the permutation of spatial coordinates only. Consequently, the charge and spin degrees of freedom are decoupled, and the system obeys a new form of quantum statistics *viz*. orthofermi statistics. Currently Gutzwiller projection technique and Nested Bethe Ansatz are two main methods used to handle the U infinity limit. It is demonstrated how these two approaches describe two distinct physical systems; and it is the Nested Bethe ansatz solutions which are compatible with the orthofermi statistics [**P:Mi1**].

Tsallis has proposed a generalisation of the standard entropy, which has since been applied to a variety of physical systems. In the canonical ensemble approach that is mostly used, average energy is given by an unnormalised, or normalised, q-expectation value. A Lagrange multiplier β enforces the energy constraint whose physical interpretation, however, is lacking. Using a microcanonical ensemble approach, it is found that consistency requires that only normalised q-expectation values are to be used. A physical interpretation of β is then presented, relating it to a physical temperature. This interpretation is derived by a different method also [**P:Ram1**].

Neutrino Physics and CP Violation

The current neutrino data indicates possibilities for massive neutrinos with large flavour mixings. The idea of large lepton mixings is discussed in two cases; case (i) quasi-degenerate spectrum and case (ii) hierarchical spectrum. For case (i), the renormalization group evolution equation for two neutrino mixing is known to exhibit nontrivial fixed point structure corresponding to maximal mixing at the weak scale. The presence of the fixed point provides a natural explanation of the observed maximal mixing of $\nu_\mu - \nu_\tau$ if the ν_μ and ν_τ are assumed to be quasi-degenerate at the seesaw scale without constraining on the mixing angles at that scale. In particular, it allows them to be similar to the quark mixings as in generic grand unified theories. The implementation of this program in the case of MSSM is discussed and it is found that the predicted mixing remains stable and close to its maximal value, for all energies below the O(TeV) SUSY scale. Also discussed is how a particular realization of this idea can be tested in neutrinoless double beta decay experiments.

In case (ii), it is assumed that the mass matrix of active neutrinos has hierarchical form with small mixings, similar to quark mass matrix. It is shown that the large mixings between ν_μ and ν_τ as well as between ν_e and certain combination of ν_μ and ν_τ required by the present data can appear due to the presence of a sterile neutrino state. Two realizations of this possibility are considered: (i) Large flavor mixing appears as a result of sterile neutrino "decoupling" ($m_{ss} \gg m_a$), so that the active-sterile mixings are negligible. Here, m_{ss} and m_a are the sterile and active masses respectively. (ii) Sterile neutrino has a mass of $O(1)$ eV and its mixing with active neutrinos can be observable. In the second case, the (3+1) scheme of neutrino mass, which also accommodates the LSND result, can be reproduced, provided the hierarchy of the mass matrix of active neutrinos is not strong (the ratio of largest to smallest elements is about two orders of magnitude). The enhancement of lepton mixing via coupling with sterile neutrino can be realized in Grand Unified theories with the see-saw mechanism of neutrino mass generation.

As a model example, the neutrino mass matrix in the version of Zee model where both Higgs doublets couple to the leptons is examined. It is shown that in this case one can accommodate the large mixing angle (LMA) MSW solution of the solar neutrino problem, while avoiding maximal solar mixing and conflicts with constraints on lepton family number-violating interactions. In the simplified scenario considered, the neutrino mass spectrum is characterized by mass eigenvalues, $m_1 \simeq m_2 \simeq \sqrt{\Delta m^2_{atm}}/\sin 2\theta$ and $m_3/m_1 \simeq \cos 2\theta$, where θ is the solar mixing angle [**P:Balaj1 - P:Balaj3**].

The phenomenological analysis of the effect of flavour mixing and neutrino oscillations in three and four flavour scenarios on the detection of neutrinos from stellar collapse was extended further. A comparison of the signatures of stellar collapse through neutrino(antineutrino) detection in water and heavy water detectors is now completed [**P:Du1, P:Du2**]. While no one experiment can completely sort out the dependence on both theoretical models of neutrino oscillation, and the mechanism of stellar collapse, a simultaneous observation of the stellar collapse in water and heavy water detectors has the ability to rule out some theoretical scenarios. Especially of interest is the fact that one may be able to distinguish the consequences of adiabatic and non-adiabatic propagation of neutrinos through the stellar core.

The work on neutrinos from supernovae that was begun the year before has been taken forward to include studies at both water and heavy water detectors. Substantially more information (including that of the issue of adiabatic vs. non-adiabatic propagation of neutrinos in the stellar core) can be obtained by a comparison of results from different kinds of detectors.

A model for neutrinos of quasidegenerate masses is constructed using the tetrahedral symmetry A_4. This is a nontrivial problem since the neutrinos couple to charged leptons whose masses are widely different. Phenomenological consequences at and below the TeV scale are studied [**P:Raj2**].

If the LSND result is to be explained in addition to the present data on solar and atmospheric neutrino oscillations, a sterile or singlet neutrino has to exist, in addition to the three active or doublet neutrinos. A specific model is proposed with the spontaneous and soft breaking of a new global $U(1)$ symmetry so that the sterile neutrino decays into an active antineutrino

and a nearly massless pseudo-Majoron [**P:Raj3**].

Lepton number violating supersymmetric interactions are studied with the aim of explaining the possibly large value of $(g-2)$ of the muon while at the same time generating viable neutrino masses. Both $(g-2)$ of muon and small nonvanishing neutrino masses can arise if the scalar neutrino is light (of the order of 100 GeV) [**P:Raj4**].

From the large class of L-violating SUSY models, one specific model is picked out as being particularly relevant for the twin problems of the muonic and neutrino mass. The resulting neutrino mass matrix and mixing matrix are worked out and are found to describe the data on neutrino oscillations very well.

The possibility that 3 active (doublet) neutrinos acquire nearly degenerate masses through the usual seesaw mechanism from 3 sterile (singlet) neutrinos is explored. In contrast to the usual scenarios where the 3 singlet neutrinos are superheavy, the unconventional view that all of them are light is taken. The phenomenological consequences of this 3 + 3 model with 6-neutrino oscillations are very interesting and novel. In particular a connection between the LSND data and solar neutrino oscillations is found.

A new method is discovered for extracting weak, CP-violating phase information, with no hadronic uncertainties, from an angular analysis of $B \to V_1 V_2$ decays, where V_1 and V_2 are vector mesons. The quantity $\sin^2(2\beta+\gamma)$ can be cleanly obtained from the study of decays such as $B^0_d(t) \to D^{*\pm}\rho^{\mp}$, $D^{*\pm}a_1^{\mp}$, $D^{*0}K^{*0}$, etc. Similarly, one can use $B^0_s(t) \to D^{*\pm}_s K^{*\mp}$ to extract $\sin^2\gamma$. All the experimental groups involved in B factories worldwide are currently preparing for data accumulation and simulating data analysis techniques to measure $\sin^2(2\beta+\gamma)$ by this method. It is possible that this will be the second function of CP phases, after $\sin 2\beta$, to be measured at B-factories. This work has subsequently been extended to show that one has a clean signal of Time-reversal-violation and also CPT violation using similar analysis [**P:Sinhar1**].

A method is presented to search for new physics using the decay $B \to \pi\pi$, commonly known as the mode to measure the CP-violating phase α. This is done by comparing two weak phases which are equal in the standard model: the phase of the t-quark contribution to the $b \to d$ penguin amplitude, and the phase of $B_d - \bar{B}_d$ mixing [**P:Sinhar2**].

Assuming only isospin, it is shown that the size of the penguin "pollution" in the measurement of α is bounded, by the branching ratios $BR(B^+ \to \pi^+\pi^0)$ and an upper bound on $B^{00} \equiv BR(B^0 \to \pi^0\pi^0) + BR(\bar{B}^0 \to \pi^0\pi^0)$. This bound is stronger than previously obtained ones and is strongest possible bound that can be derived. A model independent lower bound on B^{00} is also derived. Current data suggests that it is not very small, in which case complete isospin analysis may be possible [**P:Sinhar3**].

The decays of B mesons to two vector mesons ($B \to VV$) are studied in a perturbative QCD approach. In this approach, certain nonfactorizable contributions are included in addition to the usual factorizable ones. The helicity amplitudes are calculated and it is shown that experimental data requires that non leading higher twist contributions be included. D^* meson is treated in the heavy quark limit and twist-3 contributions to the ρ meson wavefunction are included. Color suppressed mode $B \to J/\psi K^*$ is also considered [**P:Sinhar4**].

QCD: Lattice, Theoretical, Phenomenological

Excess dimuon production with invariant mass in the range 1.5 – 2.5 GeV in nucleus-nucleus collisions is explained on the basis of η_c production. This appears to be consistent with all the peripheral and central collision data with various nuclei such as S-U at 200 GeV/nucleon except for the central collision data on Pb-Pb at 158 GeV/nucleon. Some explanations based on glueball production for Pb-Pb data are discussed [**P:A1**].

Single particle forward production in Deep Inelastic Scattering (as at HERA) provides a clear test of the distinction between DGLAP and BFKL evolution. In this connection, a next to leading order calculation is being carried out (upto $O(\alpha_s^2)$) after careful regularisation and absorption of Infra Red divergences.

The problem of the Ginsparg-Wilson fermions in the Hamiltonian formulation was solved for coupling to Abelian gauge fields.In particular, the mechanism by which GW fermions avoid the Nielsen-Ninomiya theorem was clarified using the lattice Dirac sea picture [**P:H1**].

The earlier investigations into laying the foundations for numerical simulations based on the dual formalism were continued with vigour. A thorough investigation was made about the negative weight problem. The problem is not fully resolved yet. New algorithms for updating were also investigated [**P:H2, P:H3**].

Studies of J/ψ production at future photon colliders will be able to help corroborate results from current $e\,p$ and hadron-hadron colliders such as HERA and Tevatron. This will be a useful tool in settling the issue of colour octet contributions to cross-sections from the relevant non-relativistic QCD (NRQCD) calculations [**P:I**].

QFT, Quantum Gravity, Black hole, String Theory

The causal structure of spacetime is studied near naked singularities in gravitational collapse from the point of view of classical relativity and it is attempted to characterize nakedness indirectly i.e. without one needing to check explicitly for emergence of causal curves from the singularity [**P:Bar1**].

An attempt is on to generalize the result that the quantum stress tensor diverges on the Cauchy horizon, from the particular case of spherical dust collapse. The premise for this work is quantum field theory on a classical curved background spacetime.

A small program for solving elliptic equations was needed as a part of a program for numerical solution of Einstein field equations. Some modifications involved in the former were completed and the code was tested.

The research work has mainly focused on a generalization of Killing horizons to the so called 'isolated horizons'. An analysis based on field equations as distinct from one based on an action principle is developed and relations among Killing horizons, event horizons and isolated horizons is elaborated [**P:D1, P:D2**].

Complete partition function of a three dimensional black hole is given using the known studies of CS theories on solid torus. The asymptotic behaviour of this partition function is

computed and, in addition to the leading 'area' behaviour of entropy, the logarithmic corrections are obtained exactly. The study of AdS black holes and quasi normal modes gave a new method of computation of these frequencies. Also this helped computing for the first time the exact quasi normal modes of 3-dimensional black holes [**P:Gtr1 - P:Gtr4**].

A simplified method was proposed for calculating trace anomalies in $D = 6$ and $D = 4$ dimensions.Instead of the standard way of calculating which involves a $d/2+1$-loop calculation on an arbitrary geometry, it is shown that a $d/2$-loop calculation on an arbitrary geometry supplemented by the much easier $d/2 + 1$-loop calculation on a maximally symmetric space gives the same information [**P:H4**].

The vacuum polarisation induced coupling between external Maxwell and Kalb-Ramond fields were calculated to one loop order by the techniques introduced by Schwinger in his classic paper on Gauge invariance and vacuum polarisation [**P:H5**].

D-branes in Calabi-Yau (CY) manifolds continued to be studied intensively.

Utilising the intuition provided by the GLSM constructions a systematic procedure was found to construct a large variety of D-branes on smooth CY manifolds by constructing D-branes in an ambient variety and then restricting them to the CY hypersurface. These branes in the ambient variety can be systematically constructed from a few building blocks consisting of D-branes with no moduli with the other branes being realised as building blocks of these D-branes. Restricting these to the CY hypersurface provides an important sub-class of the D-branes on CY manifolds. Using this method one can also identify which of these D-branes do not decay when the Kahler moduli of the CY are varied to describe the CY string compactification at the Landau-Ginzburg orbifold point or Gepner point, where there is an appropriate conformal field theory description of these branes. Important conjectures have also been developed on the generalisation of these techniques so that a large sub-class of D-branes can be described on a wide variety of Calabi-Yau manifolds and in various "phases" of the Calabi-Yau manifold.

In a further extension of the gauged linear sigma model description of D-branes on CY manifolds, boundary fermions were introduced in the description. This enables the construction of a very large class of multiple D-branes wrapped on holomorphic cycles of the CY manifold. In particular the D-brane configurations, that are generically sheaves, that arise as the cohomology of complexes involving line bundles on the CY manifold, can be readily constructed in this formalism. It is noteworthy that in this case, unlike that of similar constructions in the heterotic string, complexes of arbitrary length can be realised in the physical field-theoretic construction [**P:Jay1 - P:Jay3**].

The issue of black hole entropy is reexamined within a finite lattice framework along the lines of Wheeler, 't Hooft and Susskind, with an additional criterion to identify physical horizon states contributing to the entropy. As a consequence, the degeneracy of physical states is lower than that attributed normally to black holes. This results in corrections to the Bekenstein-Hawking area law that are logarithmic in the horizon area. The implications of this result for the holographic entropy bound are shown to be identical to that found by us earlier. The theoretical underpinnings of the above general picture are shown to emerge very naturally from the framework of non-perturbative quantum gravity [**P:K, P:M1, P:M2**].

A variant of an earlier proposal by the author and Sengupta, to describe four dimensional Maxwell electrodynamics in Einstein-Cartan spacetimes through a Kalb-Ramond field as an intermediary, is shown to lead to a new Maxwell-Kalb-Ramond coupling that violates spatial parity, even when the KR gauge field has its standard parity assignment. One consequence of this coupling seems to be a modulation, independent of wavelength but dependent on the KR field strength, of the intensity of synchrotron radiation observed from distant galactic sources. Other consequences related to the anisotropy of the Cosmic Microwave Background Radiation are also described [**P:M3**].

In studying confinement in QCD, it has been conjectured by Polyakov that the confining rigid string action will result from a gauge theory. He proved this conjecture by considering compact $U(1)$ gauge theory. Since the gauge group of QCD is $SU(3)$, it will be important to prove his conjecture with this gauge group. As a first step in this direction, a gauge theory of $GL(2)$ gauge group is considered on a complex manifold and the hermitian connections of holomorphic vector bundles of rank 2 over a compact complex manifold M are abelianized using *monoidal transformations*. The abelianized connections of the line bundle over a manifold $\tilde{M}$ as P^1 fibre over M are constructed explicitly. The Wilson loop of the $GL(2,C)$ gauge theory is abelianized to those of C^* gauge theories. By this procedure, Polyakov's conjecture is verified for a $GL(2)$ gauge theory on a complex manifold. Extension of this to $SU(3)$ gauge group is under investigation [**P:P2 - P:P4**].

$(n+m+1)$ dimensional bulk spacetime, containing flat $(n+m-1)$ dimensional parallel branes, with topology $R^{n-1} \times T^m$ is considered. It is assumed that the graviton and an m-form field are the only bulk fields and that the m-form field has non vanishing components along the T^m directions only. It is found that the m-form field, with suitable bulk and brane potentials, can stabilise the radion modulus at the required value with no fine tuning. Self tuning solutions are also found [**P:Ram2**].

In the $D = (n+m+1)$ dimensional brane world scenario with m compact dimensions, the radion modulus can be stabilised by a massive bulk m-form antisymmetric field. Some of the phenomenological aspects of this scenario are analysed. It is found that the radion mass is smaller than the TeV scale, but larger than that in the case where the radion modulus is stabilised by a bulk scalar field. From the macroscopic n dimensional spacetime point of view, the m-form field mimics a set of p-form fields. The mass spectrum of these fields is analysed. The lowest mass is $\gtrsim TeV$ whereas, for any bulk or brane field, the excitations in the compact space have Planckian mass and are likely to reintroduce the hierarchy problem. Also, the couplings of the m-form field to the matter fields living on a brane are analysed. The present results are applicable to more general cases also [**P:Ram3**].

A topic that has generated interest recently is field theories in non-commutative space-times. Non-commutative geometry has been studied for many years. However with the discovery that they arise in the low energy limit of string theories when a massless antisymmetric tensor background is turned on, has made them extremely interesting for many theoretical physicists. A particularly simple example that has been studied is (non commutative) ϕ^4 field theory and an intriguing result that emerged is the transmutation of ultraviolet into infrared divergences.

The renormalizability of these theories is studied. An O(2) scalar field theory in non-commutative space-time with spontaneously broken symmetry is studied. It has been studied

by others and the conclusion seemed to be that this theory is not renormalizable. The reason given for this is that the Ward Identities are not separately satisfied (for the broken theory) for the planar and non-planar graphs since the non-planar graphs become infrared divergent in some cases and not in others. It is shown that this could be remedied by modifying the prescription to keep an infrared regulator while the continuum limit is being taken. In this prescription the Ward Identities are always satisfied. The theory is thus renormalizable (at least at one loop) [**P:S1**].

In the last year some progress has been made in further developing the loop variable approach to gauge invariant string interactions. This is an approach that attempts to provide some understanding of the underlying symmetries of string theory and also providing a convenient tool for doing computations.

The basic idea for describing string interactions was outlined in the Puri Workshop in 1996. In [**P:Sa1**] these interactions are described in some detail and it is also explained how gauge invariance can be defined for space time fields.

The second part of this work is completed. In the loop variable formalism the theory is written in one higher dimension where all the fields are massless. In order to make contact with string theory one has to dimensionally reduce and obtain the mass spectrum of string theory. One has to further show that this procedure preserves the gauge invariance and also reproduces string scattering amplitudes. This was done in [**P:Sa2**].

While the above two works give the basic prescription of how to do calculations there are many issues that remain to be understood properly. One is the use of a wave-functional with certain properties that was repeatedly used in this approach. An explicit expression for this object was needed. This has since been done. Furthermore while a formal argument for gauge invariance was given, it was not clear how the infinite number of massive modes of the string contribute terms in any equation to make it gauge invariant to all orders. A specific example of a massive mode interacting with electromagnetism was worked out in detail to clarify this issue. Finally in order to make contact with standard sigma model approach, and also to understand how non-perturbative (in fields) issues were to be dealt with, the case of equations of motion for electromagnetism was worked out in the limit of constant electromagnetic field strength. This is the well known Born-Infeld equation. This was derived in this approach. These constitute the contents of [**P:Sa3**].

2.2.2 List of Publications

The following conventions have been adopted in the list of publications: firstly, names of (co)authors who are not members of the Institute have been marked with a superscript *; secondly, in order to facilitate cross-referencing between this list and the 'summary of research' above, all entries in this list have been given a label and finally, the entries are listed according to alphabetical order of their labels.

[**P:A1**]
Anishetty, R. and Basu, Rahul.
Dileptons from η_c in Nucleus-Nucleus collisions
Published in *Phys.Lett.* B495 (2000) 295.

[**P:A2**]
Anishetty, R. and Parthasarathy, R.
Spontaneous Time Asymmetry due to horizon.
To Appear in *Mod.Phys.Lett.A* .

[**P:B**]
Bal, Subrata and Sathiapalan, B.
High Temperature Limit of the N=2 IIA Matrix Model.
Published in *Nucl. Phys. Proc. Suppl.94 (2001) 693.*

[**P:Balaj1**]
Balaji, K.R.S., Mohapatra, R.N.*, Parida, M.K.*, and Paschos, E.A.*
Large Neutrino Mixing from Renormalization Group Evolution.
Published in *Phys. Rev.* **D63***, 113002 (2001).*

[**P:Balaj2**]
Balaji, K.R.S, Prez-Lorenzana, A.*, and Smirnov, A. Yu.*
Large Lepton Mixings Induced by Sterile Neutrino.
Published in *Phys. Lett.* **B509***, 111 (2001).*

[**P:Balaj3**]
Balaji, K.R.S., Grimus, W.*, and Schwetz, T.*
The solar LMA neutrino oscillation solution in the Zee model.
Published in *Phys. Lett.* **B508***, 301 (2001).*

[**P:Balak1**]
Balakrishnan, Radha
Two-branch energy of magnetic surfaces and connection with anholonomy.
Published in *Int. Journ. of Mod. Phys B* **14***, 2083-2091 (2000).*

[**P:Balak2**]
Murugesh, S and Balakrishnan, Radha
New connections between moving curves and soliton equations.
Preprint nlin.PS/0104066.
To appear in *Phys. Lett. A.*

[**P:Balak3**]
Balakrishnan, Radha and Dandoloff, Rossen*
Nonlinear dynamics of the classical isotropic Heisenberg antiferromagnetic chain: The sigma model sector and the kink sector.
Preprint imsc/2001/06/28.

[**P:Bar1**]
Barve, Sukratu
Conformal Transformations near Naked Singularities.
Submitted to *Classical and Quantum Gravity* .

[**P:Bas1**]
Baskaran, G.
Competition between charge stripe order and high temperature superconductivity in cuprates.
Published in *Mod. Phys. Lett.* **B 14** 377 (2000).

[**P:Bas2**]
Baskaran, G.
The principle of Valence Bond Amplitude Maximization in Cuprates: How it breeds superconductivity, charge and spin stripes.
To appear in *Phys. Rev.* B August 2001.

[**P:Bas3**]
Baskaran, G.
New Developments in the theory of high T_c superconductivity.
Published in *Magnetic and Superconducting Materials* (MSM-99), (Ed. M. Akhavan, J. Jensen and K. Kitazawa), Volume A, pp. 53 (2000) (World Scientific).

[**P:Bas4**]
Baskaran, G.
On the origin of spin stripes in Superconducting Cuprates.
Published in *Magnetic and Superconducting Materials* (MSM-99), (Eds. M. Akhavan, J. Jensen and K. Kitazawa), Volume A, pp. 99 (World Scientific, 2000).

[**P:Bas5**]
Baskaran, G.
Anderson's Theory of Superconductivity and Beyond.
Published in '*More is Different* ', Eds. N.P. Ong and R. N. Bhatt (Princeton University Press, NJ, 2001).

[**P:Bas6**]
Baskaran, G.
Anderson's Electronic Mechanism of Superconductivity in high T_c Cuprates.
Published in *Physics in Canada*, **56** 236 (2000).

[**P:Bas7**]
Baskaran, G.
Quantum Number Fractionization in Cuprates: U(1) RVB Gauge Theory and Senthil Fisher Constructions.
Preprint cond-mat/0008324.

[**P:Bas8**]
Baskaran, G.
Spinon de-confinement above a finite energy gap in 2d Quantum Heisenberg Antiferromagnets.
Preprint cond-mat/0010041.

[**P:Bas9**]
Ghosh, Tarun Kanti and Baskaran, G ,
Modeling Two-Roton Bound State Formation in Fractional Quantum Hall System.
Preprint cond-mat/0012241.
Submitted to *Phys. Rev. Lett.*

[**P:Bas10**]
Baskaran, G.
Brain Dynamics: neural correlates of mental phenomenon.
Published in *Current Science*, xx (2001).

[**P:Bas11**]
Baskaran, G.
RVB Contribution to Superconductivity in MgB_2.
Preprint cond-mat/0103308.
Submitted to *Phys. Rev. Lett.*

[**P:Bas12**]
Anisimov, V.I.*, Dasgupta, I.*, Saha-Dasgupta, T.* and Baskaran, G.
LDA tight-bonding parameter for $RuSr_2GdCu_2O_8$ and the problem of coexistence of ferromagnetism and superconductivity.
Submitted to *Phys. Rev. Lett.*

[**P:Bas13**]
Baskaran, G.
Zero-Point Motion and the Isotope Effect in MgB_2 Superconductor.
Submitted to *Phys. Rev. Lett.*

[**P:C1**]
Chakraborty, T.
Electron Spin Transitions in Quantum Hall Systems.
Published in *Advances in Physics* **49***, 959 (2000).*

[**P:C2**]
Apalkov, V.M.* and Chakraborty, T.
Influence of Disorder & a Parallel Magnetic Field on a Quantum Cascade Laser.
Published in *Appl. Phys. Lett.* **78**, *697 (2000).*

[**P:C3**]
Apalkov, V.M.* and Chakraborty, T.
Magnetic Field Induced Luminescence Spectra in a Quantum Cascade Laser.
Published in *Appl. Phys. Lett.* **78**, *1973 (2001).*

[**P:C4**]
Apalkov, V.M.* and Chakraborty, T.
Luminescence Spectra of a Quantum-Dot Cascade Laser.
Published in *Appl. Phys. Lett.* **78**, *1820 (2001).*

[**P:C5**]
Apalkov, V.M.* and Chakraborty, T., Pietiläinen, P.* and Niemelä, K.*
Half-Polarized Quantum Hall States.
Published in *Phys. Rev. Lett.* **86**, *1311 (2001).*

[**P:C6**]
Niemelä, K.*, Pietiläinen, P.* and Chakraborty, T.
Spin Transitions in the Fractional Quantum Hall Systems.
Published in *Physica B* **284-288**, *1716 (2000).*

[**P:C7**]
Smirnov, D.*, Drachenko, O.*, Leotin, J.*, Page, H.*, Becker, C.*, Sirtori, C.*, Apalkov, V.M.*, and Chakraborty, T.
Intersubband Magnetophonon Resonance in Quantum Cascade Structure.
Submitted to *Phys. Rev. Lett.*

[**P:C8**]
Apalkov, V.M.* and Chakraborty, T.
Interaction of a quantum dot with an incompressible two-dimensional electron gas
Preprint cond-mat/0106519.

[**P:C9**]
Apalkov, V.M.* and Chakraborty, T.
Optical properties of a Quantum-Dot Cascade Structure
Preprint cond-mat/0106338.

[**P:D1**]
Date, G.
Notes on Isolated Horizons
Published in *Class. Quant. Grav.* **17**, 5025, (2000).

[**P:D2**]
Date, G.
Isolated Horizon, Killing Horizon and Event Horizon
Preprint IMSc/2001/06/30, gr-qc/0107039.
Submitted to *Class. Quant. Grav.*

[**P:Du1**]
Dutta, G., Indumathi, D., Murthy, M.V.N. and Rajasekaran, G
Neutrinos from stellar collapse: Comparison of the effects of three and four flavour mixings.
Published in *Phys. Rev. D,***62**, 093014 (2000).

[**P:Du2**]
Dutta, Gautam, Indumathi, D., Murthy, M.V.N., Rajasekaran, G.
Neutrinos from Stellar Collapse: Comparison of signatures in water and heavy water detectors.
Preprint hep-ph/0101093.
To appear in *Phys.Rev. D.*

[**P:G1**]
Ghosh, Sankalpa, Murthy, M.V.N., Sinha, Subhasis*
Rotating Fermions in two dimension-Thomas Fermi approach.
To Appear in a special issue of *Int. Jl. Mod. Phys.* **B**, World Scientific as a proceeding of SCES-Y2K held in SINP, Calcutta,October 23-28th, 200.

[**P:G2**]
Ghosh, Sankalpa, Murthy, M.V.N., and Sinha, Subhasis*
Two component Fermi vapour in a 2D rotating trap.
Preprint cond-mat/0105252.
To appear in *Phys. Rev. A.*

[**P:G3**]
Bhaduri, R.K.***, Ghosh, Sankalpa, Murthy, M.V.N. and Sen, Diptiman*****.**
Solitons in a one-dimensional interacting Bose-Einstein System.
To appear in *J. Phys. A.*

[**P:G4**]
Ghosh, Sankalpa and Rajaraman, R.*
Quantum Hall Solitons with Intertwined Spin and Pseudospin at $\nu = 1$.
Published in *Phys. Rev.* **B 63**, *035304 (2001).*

[**P:Gtk1**]
Ghosh, Tarun Kanti,
Collective excitation frequencies of a gravitationally self-bound Bose condensed state.
Preprint cond-mat/0104370.
Submitted to *Phys. Rev. A.*

[**P:Gtk2**]
Ghosh, Tarun Kanti and Sinha, Subhasis *
Splitting between quadrupole modes of dilute quantum gas in a two dimensional anisotropic trap.
Preprint cond-mat/0102258.
Submitted to *Phys. Rev. A*.

[**P:Gtk3**]
Ghosh, Tarun Kanti and Baskaran, G ,
Modeling Two-Roton Bound State Formation in Fractional Quantum Hall System.
Preprint cond-mat/0012241.
Submitted to *Phys. Rev. Lett.*

[**P:Gtk4**]
Ghosh, Tarun Kanti ,
Universality of monopole mode and time evolution of a d-dimensional trapped interacting Bose gas.
Published in *Phys. Lett. A* **285**, 222, (2001).

[**P:Gtk5**]
Ghosh, Tarun Kanti ,
Collective excitation frequencies and damping rates of a two dimensional deformed trapped Bose gas above the critical temperature.
Published in *Phys. Rev. A* **63**, 013603 (2001).

[**P:Gtr1**]
Balachandran, A. P*, Govindarajan, T. R. and Ydri, B*.
The Fermion Doubling Problem and Noncommutative Geometry
Published in *Mod.Phys.Lett.* A15 (2000) 1279.

[**P:Gtr2**]
Govindarajan, T. R, Suneeta, V and Vaidya, S.*
Horizon States for AdS Black Holes
Published in *Nucl.Phys.* B583 (2000) 291.

[**P:Gtr3**]
Govindarajan, T.R., and Suneeta, V.
Quasi-normal modes of AdS black holes : A superpotential approach
Published in *Class. Quant. Grav.* 18 (2001) 265.

[**P:Gtr4**]
Govindarajan, T. R, Kaul, R. K, and Suneeta, V.
Logarithmic correction to the Bekenstein-Hawking entropy of the BTZ black hole
Published in *Class. Quant. Grav.* 18 (2001) 2877.

[**P:H1**]
Cheluvaraja, S.* **and Haridass, N.D.**
Axial anomaly and Ginsparg-Wilson fermions in the lattice Dirac sea picture.
Published in *Nucl. Phy.* **B598**, 134 (2001).

[**P:H2**]
Haridass, N.D.
Quasi-local update algorithms for numerical simulations of D=3 SU(2) LGT in the dual formulation.
Published in *Nucl.Phy.Proc.Suppl.* **94**, 665 (2001).

[**P:H3**]
Haridass, N.D. and Dong-Shin Shin*
Current status of the numerical simulations of D=3 SU(2) Lattice gauge theory in the dual formulation.
Published in *Nucl.Phy.Proc.Suppl.* **94**, 670 (2001).

[**P:H4**]
Bastianelli, Fiorenzo* **and Haridass, N.D.**
Simplified method for trace anomaly calculations in D=6 and D=4.
Published in *Phys.Rev.D.* **64**, 047701, (2001).

[**P:H5**]
Haridass, N.D. and Shajesh, K.V.
Vacuum polarisation induced coupling between Maxwell and Kalb-Ramond Fields.
Preprint hep-th/0107006.

[**P:I**]
Godbole, R.M.*, Indumathi, D., Krämer, M*
J/ψ production through resolved photon processes at e^+ e^- colliders.
Published in *The ECFA-DESY Linear Collider notes (LC-notes) number LC-TH-2001-019, 2001.*

[**P:J1**]
Jaganathan, R.
Quantum mechanics of Dirac particle beam optics: Single-particle theory.
Preprint physics/0101060.
To appear in *Proceedings of the Advanced ICFA Beam Dynamics Workshop on "Quantum Aspects of Beam Physics"*, Capri, Italy, Oct. 2000.

[**P:J2**]
Jaganathan, R.
Some introductory notes on quantum groups, quantum algebras, and their applications.
To appear in *Proceedings of the Institutional and Instructional Programme on Quantum Groups and Their Applications*, Ramanujan Institute for Advanced Study in Mathematics, University of Madras, March 2001.

[**P:J3**]
Sunilkumar, V.*, Bambah, B. A.* and Jagannathan, R.
Quadratic algebras: Three-mode bosonic realizations and applications.
Preprint math-ph/0010017.

[**P:Jay1**]
Govindarajan, Suresh* and Jayaraman, T.
D-branes, Exceptional Sheaves and Quivers on Calabi-Yau Manifolds: From Mukai to Mackay.
Published in *Nucl. Phys.* **B600** (2001) 457.

[**P:Jay2**]
Govindarajan, Suresh* and Jayaraman, T.
Boundary Fermions, Coherent Sheaves and D-branes on Calabi-Yau Manifolds.
Preprint hep-th/0104126.

[**P:Jay3**]
Govindarajan, Suresh* and Jayaraman, T.
D-branes and Vector Bundles on Calabi-Yau manifolds: A view from the helix.
Preprint hep-th/0105216.
To appear in *The proceedings of Strings 2001.*

[**P:K**]
Das, Saurya*, Kaul, Romesh and Majumdar, Parthasarathi
A new holographic bound from quantum geometry.
Published in *Physical Review*, D63, 044019, (2001).

[**P:M1**]
Majumdar, Parthasarathi
Quantum aspects of black hole entropy.
Published in *Pramana (Special Issue)*, 55, 511, (2000).

[**P:M2**]
Majumdar, Parthasarathi
Black hole entropy: certain quantum features.
Published in *Proceedings of IX Marcel Grossmann Conference, 2001.*

[**P:M3**]
Majumdar, Parthasarathi
New parity-violating photon-axion coupling.
Preprint hep-th/0105122.
Submitted for publication.

[**P:Me1**]
Banerjee*, S.S., Rao* T.V.C., Grover* A.K., Higgins* M.J., Menon, Gautam I., Mishra*, P.K. Pal*, D., Ramakrishnan *, S., Ravikumar*, G., Sahni* V.C., Sarkar*, S., Tomy*, C.V.
Disordered Type-II Superconductors: A Universal Phase Diagram for Low-T_c Systems.
Published in *Physica C*, **355**, 39, (2001).

[**P:Me2**]
Menon, Gautam I
Structure and freezing of a disordered flux-line system.
To appear in *Phase Transitions*.

[**P:Me3**]
Menon, Gautam I.
A New Phenomenology for the Disordered Mixed Phase.
Preprint cond-mat/0102168.

[**P:Me4**]
Menon, Gautam I.
On the Phase Behaviour of Disordered Type-II Superconductors.
Preprint cond-mat/0103013.

[**P:Me5**]
Menon, Gautam I., Ray, P., Shukla*, P.
Persistence in Ising Models with Parallel Dynamics.
To appear in *Phys. Rev. E*.

[**P:Mi1**]
Mishra, A. K.
Spin-Charge Decoupling and Orthofermi Quantum Statistics.
Published in *Physical Review B* **63** 132405 (2001).

[**P:Mi2**]
Mishra, A. K. and Rajasekaran, G.
Generalized Fock Spaces and New Forms of Quantum Statistics.
Published in *Spin-Statistics Connection and Commutation Relations*, Eds. R.C. Hilborn, and G.M. Tino, (American Institute of Physics, New York, 2000) p. 162.

[**P:Mi3**]
Mishra, A. K. and Rajasekaran, G.
Quantum Field Theory for Orthofermions and Orthobosons.
Published in *Spin-Statistics Connection and Commutation Relations*, Eds. R.C. Hilborn, and G.M. Tino, (American Institute of Physics, New York, 2000) p. 169.

[**P:Mi4**]
Mishra, A. K.
A Copper Layer Chemisorbed at A Gold Electrode: Electronic Structure and STM Studies.
Published in *Electroanalytical Chemistry and Allied Topics*, Eds. S.K. Aggarwal, H.S. Sharma, N. Gopinath and D.S.C. Purushotham, (Bhabha Atomic Research Centre, Mumbai, 2000) p. 48.

[**P:Mi5**]
Mishra, A. K.
Fock Spaces and Quantum Statistics.
Preprint IMSc/2001/04/19.

[**P:Mu1**]
Sinha, Subhasis*, Murthy, M. V. N. and Shankar, R.
Shell effects in quantum dots: A semiclassical approach.
Published in *Phys. Rev. B.***62**, 10896 (2000).

[**P:Mu2**]
Tran, Muoi N.*, Murthy, M.V.N. and Bhaduri, R.K.*
Ground-State fluctuations in finite fermi systems.
Published in *Phys. Rev. B.***63**, 031105 (2001).

[**P:P1**]
Parthasarathy, R. and Sridhar, R.
Supersymmetry in Thermofield Dynamics.
Published in *Phys.Lett* **A279** (2001) 17.

[**P:P2**]
Parthasarathy, R.
Dual Meissner Effect in the infrared region of QCD with quarks.
Published in *Mod.Phys.Lett* **A15** (2001) 2037.

[**P:P3**]
Parthasarathy, R.
Confining configurations in QCD and relation to rigid string.
Published in *Nucl.Phys. Proc.Suppl.* **94** (2001) 562.

[**P:P4**]
Parthasarathy, R. and Suzuki, O.*
Abelianization of Wilson loop of non-Abelian gauge theory on complex manifold and Polyakov's conjecture.
Nihon University Preprint 01-006; June 26, 2001.

[**P:Raj1**]
Ma, E.*, Rajasekaran, G. and Sarkar, U.*
Light sterile neutrinos from large extra dimensions.
Published in *Phys. Lett.* **B 495**, (2000), 363.

[**P:Raj2**]
Ma, E.* and Rajasekaran, G.
Softly broken A_4 symmetry for nearly degenerate neutrinos masses.
Preprint hep-ph/0106291.

[**P:Raj3**]
Ma, E.* and Rajasekaran, G.
Light unstable sterile neutrino.
Preprint, hep-ph/0107203.

[**P:Raj4**]
Adhikari, R.* **and Rajasekaran, G.**
Anomalous magnetic moment of muon and L-violating supersymmetric models.
Preprint hep-ph/0107279.

[**P:Ram1**]
Kalyana Rama, S.
Tsallis Statistics: Averages and a Physical Interpretation of the Lagrange Multiplier β.
Published in *Phys.Lett. A276 (2000) 103.*

[**P:Ram2**]
Kalyana Rama, S.
Brane World Scenario with m-form field: Stabilisation of Radion Modulus and Self Tuning Solutions.
Published in *Phys.Lett. B495 (2000) 176.*

[**P:Ram3**]
Kalyana Rama, S.
Some Phenomenological Aspects of the $(n+m+1)$ dimensional Brane World Scenario with an m-form Field.
Published in *Phys.Lett. B507 (2001) 287.*

[**P:S1**]
Sarkar, S. and Sathiapalan, B.
Comments on the Renormalizability of the Broken Symmetry Phase in Non-Commutative Scalar Field Theory.
Published in *Jl. of High Energy Phys. 0105 (2001) 049.*

[**P:Sa1**]
Sathiapalan, B.
Loop Variables and Gauge Invariant Interactions-I.
Published in *Int J. Mod. Phys. A15(2000)4761.*

[**P:Sa2**]
Sathiapalan, B.
Loop Variables and Gauge Invariant Interactions-II.
Published in *Int. J. Mod. Phys A16 (2001)1679.*

[**P:Sa3**]
Sathiapalan, B.
Wave Functionals, Gauge Invariant Equations for Massive Modes and the Born-Infeld Equation in the Loop Variable Approach to String Theory.
Published in *Jl. of High Energy Phys. 0103(2001)029.*

[**P:Sim1**]
Simon, R. and Agarwal, G.S.*
Wigner representation for the Laguerre-Gaussian beams.
Published in *Opt. Lett.* **25**, 1313 (2000).

[P:Sim2]
Agarwal, G.S.* and Simon, R.
Reconstruction of the Wigner transform of a rotationally symmetric two-dimensional beam from the Wigner transform of its one-dimensional sample.
Published in *Opt. Lett.* **25**, 1379 (2000).

[P:Sim3]
Simon, R. and Wolf, K.B. *
Fractional Fourier transforms in two dimensions.
Published in *J. Opt. Soc. Am.* A **17**, 2368 (2000).

[P:Sim4]
Simon, R. and Mukunda, N.*
Optical phase space, Wigner representation, and invariant quality parameters.
Published in *J. Opt. Soc. Am. A* **17**, 2440 (2000).

[P:Sim5]
Gori, F.*, Santarsiero, M.*, Piquero, G.*, Borghi, R.*, Mondello, A.* and Simon, R.
Partially polarized Gaussian Schell-model beams.
Published in *J. Opt. A: Pure and Appl. Opt.* **3**, 1 (2001).

[P:Sim6]
Khan, S.A.*, Jagannathan, R., and Simon, R.
Quasiparaxial approximations in the scalar wave theory of light beams.
Submitted to *J. Opt. Soc. Am. A.*

[P:Sim7]
Mukunda, N.*, Arvind*, Chaturvedi, S.*, and Simon, R.
Bargmann invariants and off-diagonal geometric phases for multilevel quantum systems: A unitary group approach.
Preprint quant-ph/0107006.
Submitted to *Phys. Rev. A.*

[P:Sim8]
Simon, R.
Interference in phase space, geometric phase, and asymptotic expressions for classical orthogonal polynomials.
Preprint IMSc/2001/07/44.

[P:Sim9]
Simon, R.
Entanglement of Formation for Gaussian States.
Preprint IMSc/2001/07/45.

[**P:Sim10**]
Simon, R.
Positive semidefinite biquadratic forms which are not sums of squares of bilinear forms.
Preprint IMSc/2001/07/46.

[**P:Sinhan1**]
Gronau, M.*, London, D.*, Sinha, N. and Sinha, R.
Improving bounds on penguin pollution in $B \to \pi\pi$.
Published in *Phys. Lett. B* **514**, 315 (2001).

[**P:Sinhan2**]
Sinha, N.
CP Violation.
Invited talk, to appear in *The Proceedings of the* XIV *DAE Symposium in High Energy Physics*, Hyderabad.

[**P:Sinhar1**]
London, D.*, Sinha, N.* and Sinha, R.
Extracting weak phase information from $B \to V(1)V(2)$ decays.
Phys. Rev. Lett. **85**, 1807 (2000).

[**P:Sinhar2**]
London, D.*, Sinha, N.* and Sinha, R.
Searching for new physics via CP violation in $B \to \pi\pi$.
Published in *Phys. Rev. D* **63**, 054015 (2001).

[**P:Sinhar3**]
Sinha, R.
New physics with beauty.
Published in *Pramana* **55**, 219 (2000).

[**P:Sinhar4**]
Choudhuri, D.* and Sinha, R.
B and collider physics: Working group report.
Published in *Pramana* **55**, 335 (2000).

[**P:Sinhar5**]
London, D.*, Sinha, N.* and Sinha, R.
Searching for new physics via CP violation in $B \to \pi\pi$.
To appear in the *Proceedings of 4th International Conference on B Physics and CP Violation (BCP 4)*, Ago Town, Mie Prefecture, Japan, 19-23 Feb 2001.

[**P:Sinhar6**]
London, D.*, Sinha, N.* and Sinha, R.
Extracting weak phase information from $B \to V(1)V(2)$ decays.
To appear in the *Proceedings of 4th International Conference on B Physics and CP Violation (BCP 4)*, Ago Town, Mie Prefecture, Japan, 19-23 Feb 2001.

[P:Sinhar7]
Sanda, A. I.*, Sinha, N.*, Sinha, R. and Ukai, K.*
PQCD study of $B \to VV$.
To appear in the *Proceedings of 4th International Conference on B Physics and CP Violation (BCP 4)*, Ago Town, Mie Prefecture, Japan, 19-23 Feb 2001.

[P:Sinhas1]
Mehta, M.* and Sinha, S.
Asynchronous Updating of Coupled Maps leads to Synchronisation.
Published in *Chaos* **10** (2000) 350-358.

[P:Sinhas2]
Sinha, S.
Using Thresholding at Varying Intervals to obtain different Temporal Patterns.
Published in *Phys. Rev. E* **63** (2001) 036212.

[P:Sinhas3]
Sinha, S. and Ditto, W.L.*
Controlling Neuronal Spikes.
Published in *Phys. Rev. E* **63** (2001) 056209.

[P:Sinhas4]
Sinha, S.
Asynchronous Updating Restores the Law of Large Numbers in Globally Coupled Systems.
To appear in *Int. J. Bif. and Chaos.*

[P:Sinhas5]
Sinha, S. and Gupte, N.*
Targeting Spatiotemporal Patterns in Extended Systems with Multiple Coexisting Attractors.
Published in *Phys. Rev. E* **64** (2001) Rapid Communication 015203.

[P:Sinhas6]
Sinha, S.
Controlling Chaos with Threshold Mechanisms.
To appear in Proceedings of the VIII Ramanujan Symposium on "Recent Developments in Nonlinear Systems" (Narosa).

[P:Sinhas7]
Munakata, T.*, Sinha, S. and Ditto, W.L.*
Chaos Computing: Implementation of Fundamental Logical and Arithmetic Operations and Memory by Chaotic Elements.
Submitted to IEEE *Trans. on Circuits and Systems.*

[P:Sr1]
Srinivasa Rao, K, Doebner, H.-D.* and Nattermann, P*
Generalized hypergeometric series and the symmetries of $3-j$ and $6-j$ coefficients
Submitted to *Int. J. Math. Math. Sci.*.

[**P:Sr2**]
Srinivasa Rao, K.
Generalized Hypergeometric Series and Quantum Theory of Angular Momentum
in *Selected Topics in Special Functions*, Eds.: R.P. Agarwal, H.L. Manocha and K. Srinivasa Rao, Allied Publishers Pvt. Ltd. (2001) 93 - 134.

[**P:Sr3**]
Srinivasa Rao, K., Denis, R.Y.* and Singh, S.N.*
On Certain Continued Fractions involving hypergeometric functions with general arguments
To appear in *Ind. J. Math.* .

[**P:Sr4**]
Srinivasa Rao, K.
Indian Astronomy: a sketch
To appear in *Ancient Indian Astronomy and contributions of Samanta Chandra Sekhar*, Ed. L.S. Satpathy, Narosa Publishing House, New Delhi.

[**P:Sr5**]
Srinivasa Rao, K.
Carl Friedrich Gauss: the versatile virtuoso
To appear in *Ancient Indian Astronomy and contributions of Samanta Chandra Sekhar*, Ed. L.S. Satpathy, Narosa Publishing House, New Delhi.

[**P:Sr6**]
K. Srinivasa Rao
Hypergeometric Sums and Transformations
Lecture Notes in Special Functions and Functions of Matrix Argument, Center for Mathematical Sciences, Kariavattam, Trivandrum, India,
CMS Publication No. **31** July 2000, p.87 - 130.

[**P:Sr7**]
Srinivasa Rao, K. and Agarwal, A.K.*
On a Generalized Composition Function
J. Ind. Math. Soc. **66** No.4 (2000).

[**P:Sr8**]
Srinivasa Rao, K.
On the Hypergeometric ${}_3F_2(1)$ Series
Proc. of the Int. Conf. on the Works of Srinivasa Ramanujan, Eds. Chandrashekar Adiga and D.D. Somashekara Department of Studies in Mathematics, University of Mysore (2000) 129 - 136.

2.3 Theoretical Computer Science

2.3.1 Research Summary

Temporal Logic and Automata

An investigation of interval temporal logic has been undertaken. A sound axiomatization for an augmentation with a parallel operator has been given [**T:L2**]. Further work led to a sharpening of the basic undecidability result of ITL: even the logic with the two unary modalities "beginning subinterval" and "ending subinterval" is undecidable [**T:L3**].

Over the last few years, work is being done on languages over series-parallel posets and series Σ-algebras. This resulted in an Indo-French project to develop this work with other colleagues, which began in August 00 .

The problem of model-checking classes of Message Sequence Charts (MSCs) presented as Message Sequence Graphs (MSGs) was studied. While model-checking the linearizations of these is known to be undecidable, it was shown that model-checking against a powerful structural specification language — monadic second-order (MSO) logic over the MSC — is decidable. This suggests that local or structural logics are more amenable to analysis than global ones [**T:M2**]. In an extension to this work, we studied a class of extended MSGs, which is strictly more expressive than MSGs as well as regular MSC languages. Model-checking for this class against MSO specifications was also shown to be decidable, which unifies earlier methods to show MSO decidability for the weaker classes [**T:M3**].

Logics for knowledge

Compositional design and verification of finite state distributed protocols is studied using an assumption - commitment framework. Components are finite state automata that make assumptions at local states about other components, and the system behaviour as a whole is determined by compatible products. Situations where one designs components locally assuming an infinite number of assumptions first and then folding them to obtain finite state systems are studied. [**T:R1**].

A notion of information based abstraction for the logical study of security protocols and study how protocol actions update agents' information is proposed. It is shown that interesting security properties of Needham-Schroeder like protocols can be verified automatically [**T:R2**].

Data Structures

Succinct representation of various dynamic data structures are explored. Some of the succinct data structures developed include structures to represent

- a sequence of values to support *partial sum*, *select* and *update* (changing values) [**T:Ra5**],
- a dynamic array consisting of a sequence of elements which supports *insertion*, *deletion* and *access* of an element at any given index [**T:Ra5**].
- a binary tree on n nodes [**T:Ra1**].

Our structures use space within lower order terms of the information theoretically optimum. For the first two structures the operations take a constant factor of their optimum. For binary trees, the basic navigations can be done in constant time, and updates can be done in $O(\lg^2 n)$ amortized time.

The following static membership problem is studied. Given a subset S of up to n keys drawn from a universe of size m, store it so that queries of the form "Is x in S?" can be answered quickly. We study this problem in the bit-probe model where space is counted as the number of bits used to store the data structure and time as the number of bits of the data structure looked at in answering a query. Improved deterministic upper bounds for the problem using explicit constructions are given, particularly for small values of t. For sets of size at most 2, a scheme that uses $O(m^{2/3})$ bits of space and answers queries using 2 probes is given. This improves the earlier bound of $O(m^{3/4})$ bits shown using probabilistic arguments. This space bound is also shown to be optimal for a restricted two probe scheme. This scheme is then generalized to a $\lceil \lg \lg n \rceil + 2$ probe scheme for storing sets of size at most n, using $o(m)$ bits of space. This is the best known constructive scheme (in terms of the number of bit probes used) for general n that uses $o(m)$ bits of space, though it is known (using probabilistic arguments) that there exists a scheme using $o(m)$ bits of space where queries can be answered using a constant number of bit probes. [**T:Ra3**]

It is shown that in any comparison based dictionary if the update time is a constant then the search time is $\Omega(n)$. This strengthens the earlier bound of $\Omega(n^\epsilon)$ which was also proved only for dictionaries with no pointers [**T:Ra4**].

Algorithms

The work on k-coloring random k-colorable graphs was expanded into a full-version journal paper with more details and extensions to other random models. This work describes an approach based on growing BFS (Breadth-First-Search) trees and also shows that it succeeds in k-coloring random graphs, almost surely, for a large class of distributions [**T:S1**].

Recently, the BFS approach was also shown to succeed in solving a host of NP-hard partitioning problems on random instances. This class of problems generally ask for a partitioning of the vertices of input G into k parts with the edge densities (the ratio of actual number of edges to the maximum allowed) of each part (or pair of parts) satisfying specified lower or upper bounds on them. k-coloring is a special case in which each part is required to have a 0-density. The random instance has a planted partition of the required type and the algorithm retrieves either this or a similar partition [**T:S2**].

The problem of counting and sampling the k-colorings of a graph are related to each other and have applications in several areas. It is known that counting k-colorings ($k \geq 3$) of a given G is computationally very hard even if G is assumed to be bipartite. It has been observed that randomized approximate counting reduces to almost uniform sampling in the case of k-colorings of bipartite G for any k. For arbitrary G, this is known to be true only for k above the maximum degree. It is shown that, even for large values of k (not necessarily fixed), any markov chain from a large class of powerful chains cannot be used as an efficient sampler for most of the bipartite graphs. This class includes some well-known chains [**T:B1**].

A new parameterized version of the vertex cover (VC) problem is being looked at. This is a work in progress, but the work done so far has led to an algorithm which finds (if any exists) a VC of required size much faster than the best known algorithm, for values of k relatively smaller than m, i.e., $k \leq m/X$ for some absolute positive constant X.

Computational Complexity

Given a matrix with integer or rational entries, all coefficients of the characteristic polynomial can be computed in the complexity class GapL. Furthermore, computing the determinant is also hard for GapL, whereas computing the leading coefficients is trivial/easy. The transition between hardness and ease of computing these coefficients was explored and some partial results regarding the threshold were obtained [**T:Ma1**].

The complexity of "symmetry breaking" in graphs by vertex coloring is studied. An undirected graph G is said to be *d-distinguishable* if there is a d-coloring of its vertex set $V(G)$ such that no nontrivial automorphism of G preserves the coloring. The *distinguishing number* of a graph G is the minimum d for which it is d-distinguishable. We have designed efficient algorithms for computing the distinguishing numbers of trees and planar graphs. Some observations on the complexity of the problem for general graphs are also made [**T:A2**]. There is work in progress on some other complexity theory questions. Some new results on instance complexity has been obtained. There is ongoing work on the parametrized complexity of counting.

2.3.2 List of Publications

The following conventions have been adopted in the list of publications: firstly, names of (co)authors who are not members of the Institute have been marked with a superscript *; secondly, in order to facilitate cross-referencing between this list and the 'summary of research' above, all entries in this list have been given a label and finally, the entries are listed according to alphabetical order of their labels.

[**T:A1**]
Arvind, V., Beigel, R., and Lozano, A.
The complexity of modular graph automorphism
SIAM Journal of Computing, vol. 30(4), 1253–1298, 2000, electronic edition (print edition, to appear).

[**T:A2**]
Arvind, V. and Nikhil, D.R.
Symmetry Breaking in Trees and Planar Graphs by Vertex Coloring,
Submitted.

[**T:B1**]
Balasubramanian, R. and Subramanian, C.R.
Sampling and Counting Colorings of Bipartite Graphs,
Manuscript submitted.

[**T:L1**]
Lodaya, K. and Ramanujam, R.
An automaton model of user-controlled navigation on the web,
Proc CIAA (London, Ontario, Canada), LNCS (S. Yu, ed), Springer (2001), to appear.

[**T:L2**]
Lodaya, K. and Roy, S*.
Lines, a while, and intervals, manuscript, 10 pp.
Presented at the Workshop on Many-dimensional logical systems, European Summer School on Logic, Language and Information, Birmingham (2000).

[**T:L3**]
Lodaya, K.
Sharpening the undecidability of interval temporal logic,
Proc Asian (Penang, Malaysia), LNCS 1961 (J. He and M. Sato, eds), Springer (2000).

[**T:M1**]
Madhusudan, P., Thiagarajan, P.S.
Distributed control and synthesis for local specifications
In Proc., ICALP '01, 28th Int. Coll., LNCS 2076, Crete, Greece, July 2001.

[**T:M2**]
Madhusudan, P.
Reasoning about sequential and branching behaviours of Message Sequence Graphs,
In Proc., ICALP '01, 28th Int. Coll., Vol. 2076 of *LNCS*, Crete, Greece, July 2001.

[**T:M3**]
Madhusudan, P. and Meenakshi, B.
Beyond Message Sequence Graphs,
To appear in the proceedings of the *FST & TCS conference, 2001.*

[**T:Ma1**]
Mahajan, M. and Vinay, V*.
A note on the hardness of the characteristic polynomial,
Technical Report of the Electronic Colloquium in Computational Complexity,
ECCC TR00-088, 2001.

[**T:R1**]
Mohalik, S*. and Ramanujam, R.
Distributed automata in an Assumption - Commitment framework,
(to appear in) *Special issue on Formal Methods in Verification*, **Sādhana**.

[**T:R2**]
Ramanujam, R. and Suresh, S.P.
Information based reasoning for security protocols,
Logical aspects of Cryptographic Protocol Verification, France, July 2001 (Proceedings in ENTCS series).

[**T:Ra1**]
Munro, I*, Raman, V. and Storm, A.*
Representing Dynamic Trees Succinctly,
Proceedings of the ACM-SIAM Symposium on Discrete Algorithms (2001) 529-536.

[**T:Ra2**]
Munro, I*. Raman, V. and Srinivasa Rao, S.
Space Efficient Suffix Trees,
Journal of Algorithms **39 (2)** (2001) 205-222.

[**T:Ra3**]
Radhakrishnan, J.*, Raman, V. and Srinivasa Rao, S.
Explicit Deterministic Construction for Membership in the Bitprobe Model,
published in the Proceedings of the 9th Annual European Symposium on Algorithms (ESA) 2001, Denmark, Lecture Notes in Computer Science, Springer Verlag **2161** pages 290-299.

[**T:Ra4**]
Radhakrishnan, J.* and Raman, V.
A Tradeoff between Search and Update in Dictionaries,
Information Processing Letters, to appear.

[**T:Ra5**]
Raman, R.*, Raman, V. and Srinivasa Rao, S.
Succinct Dynamic Data Structures,
published in the Proceedings of the 7th International Workshop on Algorithms and Data Structures (WADS) 2001, Providence, USA, Lecture Notes in Computer Science, Springer Verlag **2125** pages 426-437.

[**T:S1**]
Subramanian, C.R.
Coloring Sparse Random Graphs in Polynomial Average Time,
Proceedings of 8th Annual European Symposium on Algorithms (ESA'00), 2000, 415-426.
Also submitted to a journal.

[**T:S2**]
Subramanian, C.R. and Veni Madhavan, C.E.
General Partitioning on Random Graphs,
To appear in *Jour. of Algorithms*.

2.4 Conferences/ Workshops Held at IMSc

2.4.1 Workshop on Mathematica and Hypergeometric Series

The workshop on Mathematica and Hypergeometric Series was convened and conducted by Prof. K. Srinivasa Rao and Prof. C. Krattenthaler (Austria), at the Institute of Mathematical Sciences, from Sep. 18 – 22, 2000. The participants were restricted to a small group of 15, due to the availability of Mathematica on only 5 terminals of the Institute. The morning sessions from 9.30 to 10.45 a.m. and 11.15 a.m. to 12.45 p.m. were devoted to lectures, while the afternoons were meant for learning Mathematica and the software packages HYP and HYP-q developed by Prof. Krattenthaler.

The workshop started with 2 lectures on *Hypergeometric series - summations and transformations* by Prof. K. Srinivasa Rao. These were followed by an introduction to Mathematica on the first day, also by Prof. K. Srinivasa Rao. HYP and HYP-q packages were introduced through a live on-line lecture demonstration by Prof. Krattenthaler, who is the creator of these packages. Prof. R. Jagannathan gave 2 lectures on *q-series: summations and transformations* on the second day. On the remaining three days of the workshop Prof. Krattenthaler presented through his lecture-cum-computer-demonstration the *Sister Celine, Gosper, Wilf and Zeilberger algorithms*.

Prof. Krattenthaler, in particular, Prof. Jagannathan and Prof. Srinivasa Rao were available on all the five afternoons to help the participants learn the use of Mathematica, HYP and HYP-q packages. The participants considered this workshop a rewarding experience. The concluding lecture was by Prof. K. Alladi, on Sep. 22, and it was entitled: *Understanding the Göllnitz theorem and going beyond it*.

2.4.2 Workshop for Mathematics Teachers

On October 14 and 15, 2000, a mini-workshop was held at IMSc for mathematics teachers from high schools in Chennai. The aim was to discuss the possible use of discrete mathematics at high school level, with a view to attracting children to some exciting mathematics. More than 30 teachers participated in the workshop. Professors Mike Fellows and Fran Rosamund, who were then visiting the TCS group from the University of Victoria, British Columbia, Canada, acted as resource persons, with some IMSc faculty members providing additional input as well.

The workshop had sessions on sorting networks, graph colouring problems, minimum weight spanning trees, routing in networks, cryptography and regular expressions. It was organized by Tamil Nadu Science Forum and supported partly by IMSc and partly by National Science and Engineering Research Council of Canada.

2.4.3 School on Algorithmic Techniques for Hard Problems and Workshop on Parameterized Complexity

Parameterized Complexity is a rapidly developing direction in the area of Algorithms and Complexity. It seems to give a promising approach to deal with computationally hard problems. The key idea of the theory is to isolate some aspect(s) or part(s) of the input as the *parameter*, and to confine the seemingly inevitable combinatorial explosion of computational

difficulty to an additive function of the parameter, with other costs being polynomial.

IMSc has an active research group in this area, and one of the founders of the area, Mike Fellows from University of Victoria, B.C. Canada and Victoria University of New Zealand, Wellington (the other person is Rod Downey) visited IMSc for almost three months during Sep-Dec 2000. Combined with his visit, a series of lectures by Mike Fellows and some researchers of IMSc was organized at IMSc. This series culminated in an international workshop on Parameterized Complexity, the first such meeting in this research area, from 7th to 9th December 2000 at IMSc. Given below is the list of speakers and talks in the workshop.

- **Mike Fellows**, University of Victoria, Canada and Victoria University of Wellington, New Zealand
  Parameterized Complexity: The Basics.
- **Jochen Alber**, University of Tuebingen, Germany
  Planar graph problems: fixed parameter tractability with sublinear exponents.
- **Jens Lagergren**, KTH, Sweden
  Parameterization in computational biology.
- **Venkatesh Raman**, IMSc Chennai, India
  Parametric Duality.
- **Jianer Chen**, Texas A & M University, USA
  Simpler computation and deeper theory: on development of efficient parameterized algorithms.
- **Marco Cesati**, University of Rome, Italy
  The Turing way to parameterized intractability.
- **Leizhen Cai**, The Chinese University of Hong Kong, Hong Kong
  On the parameterized complexity of graph coloring.
- **Catherine McCartin**, Victoria U, Wellington, NZ
  Scheduling to minimize tardy tasks is doubly W-hard.
- **Peter Rossmanith**, TU Muenchen, Germany
  Weighted vertex cover is efficiently FPT.

The workshop also had sessions on 'work in progress' and on open problems. The concluding hour had a feedback session and a discussion on the future of the area including some future events.

Prior to the workshop, there was a preparatory school on 'Algorithmic Techniques for Hard Problems', targeted at college and university teachers. The preparatory school was attended by about 40 college and university teachers and some senior PhD students. Almost all of the school participants stayed on for the workshop. The workshop had about 20 additional participants from research institutes in India and abroad.

Part of the workshop (a lunch and a dinner) was supported by an NSERC Canada grant of Mike Fellows, and the rest of the workshop and the preparatory school was supported by

the Institute of Mathematical Sciences.

The preparatory school, the first of its kind prior to a research level workshop, started with the basics of the notion of computational hardness and NP-completeness. Then it went on to describe various approaches to obtain efficient algorithms (either exact or approximate) for such hard problems. It ended with an introduction to techniques useful in fixed parameter tractability.

The lectures (and the tutorials) in the school were given by researchers from IMSc (including the visitors Mike Fellows and Fran Rosemond), from Chennai Mathematical Institute and from the Tata Institute of Fundamental Research. The school ended with a discussion on various problems faced by college and university teachers in teaching Algorithms and in curriculum development, and on ways of improving interaction between research institutes like IMSc and universities.

The list of talks at the school is given below.

- **Mike Fellows**, University of Victoria, Canada and Victoria University, NZ
  Computational Intractability; An Overview
- **Venkatesh Raman**, IMSc, Chennai
  NP-Completeness
- **K.V. Subrahmanyam**, Chennai Mathematical Institute, Chennai
  Dynamic Programming
- **V. Arvind**, IMSc, Chennai
  The Greedy Method
- **Meena Mahajan**, IMSc, Chennai
  Backtracking, Branch and Bound (2 talks)
- **Frances A. Rosamond**, Victoria University, Wellington, NZ
  The Kernelization Technique
- **C.R. Subramanian**, IMSc, Chennai
  Randomization Techniques (2 talks)
- **Jaikumar Radhakrishnan**, TIFR, Mumbai
  Approximation Algorithms (2 talks)
- **Mike Fellows**, University of Victoria, Canada
  Techniques for FPT Algorithms

2.4.4 Preparatory School and Workshop on Automata, Concurrency and Logic

During the last decade, the areas of automata, concurrency and logic have been brought closer together thanks to their interaction in the areas of verification and model checking. The Workshop, held at IMSc, discussed some recent research in the area (for example, on starfree languages, message-passing languages, timed automata, discrete controllers).

IMSc has an active research group in this area, and the Workshop was organized to coincide with the visit of French scientists under the Indo-French project 2102-A.

Preceding the Workshop IMSc hosted a *Preparatory School* for the workshop, aimed towards university and college teachers and senior research students, who have some basic background in Automata theory but may not be fully conversant with recent research in the area. An attempt was made in the School to provide the technical preliminaries necessary to follow the Workshop. The talks are listed below.

The School and Workshop were well-liked by the participants. One should specially note that January 26–28 were not working days, yet the Institute administration ensured smooth running of the meeting.

Preparatory School: January 26 – 28, 2001.

- **Kamal Lodaya**, IMSc
  Basic automata theory
- **Swarup Mohalik**, *Sasken*
  Products of automata
- **Madhavan Mukund**, *CMI*
  Petri nets
- **K Narayan Kumar**, *CMI*
  Traces
- **Deepak D'Souza**, *CMI*
  Automata on infinite words
- **P Madhusudan**, *IMSc*
  Complementation on infinite words
- **Kamal Lodaya**, *IMSc*
  Büchi's theorem
- **R Ramanujam**, *IMSc*
  Temporal logic
- **Kamal Lodaya**, *IMSc*
  Algebraic automata theory
- **Deepak D'Souza**, *CMI*
  Timed automata
- **R Ramanujam**, *IMSc*
  Temporal logic and concurrency
- **Madhavan Mukund**, *CMI*
  Semantics of nets
- **Rani Siromoney**, *MCC (Chair)*
  Discussion: Teaching automata theory

Workshop: January 29 – 31, 2001.

- **Pascal Weil**, Bordeaux
  Starfree languages
- **Kamal Lodaya**, *IMSc*
  Poset languages
- **Jean-Michel Couvreur**, *Bordeaux*
  Detection of illegal behaviours based on unfoldings
- **K. Gopinath and Vivek Shanbhag**, *IISc*
  Integrating model checking and ASN.1
- **R Ramanujam**, *IMSc*
  Modal logic using quantified propositions
- **Paul Gastin**, *Paris*
  LTL is expressively complete for Mazurkiewicz traces
- **Madhavan Mukund**, *CMI*
  Regular collections of message sequence charts
- **Swarup Mohalik**, *Sasken*
  Modelling protocol specifications through FSA - a case study with the Bluetooth standard
- **Antoine Petit**, *Cachan*
  Updatable timed automata
- **Deepak D'Souza**, *CMI*
  Logical characterisations of timed languages
- **P Madhusudan**, *IMSc*
  Distributed synchronous systems: control and synthesis

2.4.5 Neutrino 2001

A meeting on neutrino physics, Neutrino 2001, was held in the Institute for three days from 19-21 February. This meeting is the second such meeting after the one held in Mount Abu during 1999 and it is expected that it will continue to be held every alternate year. The meeting brought together about forty five (from outside) active particle physicists working in the area of neutrino physics, astroparticle physics and associated phenomenology. An important aspect of the meeting was the participation of many active experimentalists involved in major on-going neutrino projects worldwide. The review talks covered almost equally the experimental as well as the phenomenological aspects of neutrino physics and astrophysics.

The experimental reviews covered the on-going efforts at Sudbury Neutrino Observatory(SNO), Gransasso laboratories including the Borexino as well as the gamut of older experimental results from the KGF laboratory. The Indian initiative towards building a neutrino observatory was also discussed extensively and covered in review talks. The phenomenological reviews covered several topics in neutrino astrophysics such as supernova neutrinos, ultra high energy neutrinos etc. The reviews included a status update on direct mass measurements of

neutrinos, reactor and accelerator neutrinos, physics with long-baseline neutrino experiments and the analysis of solar and atmospheric neutrino experimental results. Theoretical reviews included aspects of neutrino-nucleus interactions and phenomenological models of neutrino masses and mixings. There were also two specific discussions on the Indian initiative towards building a neutrino detector apart from several short talks and discussions.

2.4.6 Rajaji Symposium

The neutrino meeting was followed by a one-day symposium on February 22, 2001 to honour Prof. G. Rajasekaran on his 65th birthday. Prof. Rajasekaran has contributed extensively to the field of neutrino physics and several other fields. Nearly all the participants of the neutrino meeting, apart from the members of the Institute, attended the symposium as well as several other close collaborators and associates of Prof. Rajasekaran. The meeting consisted of about fifteen technical talks and a few talks of a more general nature. The symposium concluded with an evening session chaired by Prof. R. Balasubramanian in which many of Prof. Rajasekaran's associates recalled their association with him and his influence on their work.

2.4.7 NBHM Nurture Programme 2000 - 2001

The National Board for Higher Mathematics conducts the Nurture Programme for those bright students who are trained for the International Mathematical Olympiad after being selected from amongst the best performers in the Indian National Mathematical Olympiad (INMO). The aim of this programme is to nurture the mathematical talents of these youngsters while they pursue studies in disciplines of their choice. Each batch of INMO awardees are put in charge of a faculty drawn from one of the centres of mathematical excellence in the country and, for four years, the faculty trains these students in advanced mathematics by correspondence. Each year, in summer, the students attend a Contact Programme, where they get to personally interact with the faculty and other working mathematicians.

The Nurture Programme for the INMO Awardees of 1999-2000 was put in charge of the faculty comprising of Drs. V. Balaji, R. Balasubramanian, S. Kesavan (Convener), K. Paranjape, P. Sankaran and V. S. Sunder of the Institute of Mathematical Sciences, Chennai. The syllabus for the first year was the study of Analysis (W. Rudin, Principles of Mathematical Analysis, Chapters 1 - 6), Algebra (M. Artin, Algebra, Chapters 1 - 4), Linear Algebra (H. Helson, Linear Algebra) and Number Theory (V. S. Varadarajan, Algebra in Ancient and Modern Times).

The first Contact Programme was conducted at the IMSc from Tuesday, June 19 to Saturday, July 7, 2001. Out of the 22 registered participants, 13 attended the programme completely.

During the first three days of the camp, the above subjects were revised by members of the faculty. Dr. S. Kesavan (Analysis, 3 lectures), Dr. P. Sankaran (Algebra, 3 lectures) and Dr. R. Balasubramanian (Number Theory, 3 lectures) were in charge of this. The rest of the camp consisted of lectures on various topics of interest. Dr. V. Sunder gave lectures on Set Theory (2 lectures) and Metric Spaces (3 lectures). Dr. P. Sankaran gave a series of lectures on Group Theory (3 lectures). Dr. V. Balaji gave two series of lectures on Multilinear Algebra (3 lectures) and Rings and Fields (4 lectures). Dr. Balasubramanian gave lectures on Number Theory and Cryptology (3 lectures) and Dr. A. Tripathi (IIT, Delhi, visiting

the IMSc) gave a set of lectures on Continued Fractions (4 lectures). Dr. S. Kesavan gave a set of lectures on Calculus in Normed Spaces (4 lectures) and Dr. K. Paranjape delivered a series of lectures on Combinatorial Topology (4 lectures). The programme concluded with a special lecture by Prof. R. Sridharan (CMI) on 'Kummer's work on Brahmagupta quadrilaterals'.

During the last week, all the participants were interviewed to evaluate their progress and their understanding of the subject.

2.4.8 Refresher Courses for College Teachers

Two Refresher Courses in Physics for teachers at the college and university level were organized at IMSc. by T.R. Govindarajan, R. Shankar and Gautam I. Menon, as part of an IMSc. program to improve and extend academic interactions with non-DAE institutions. Several faculty members from IMSc. gave courses of lectures on specified topics while other lecturers were drawn from Madras University and IGCAR, Kalpakkam. The details of these refresher courses are given below:

Refresher Course in Quantum Mechanics and Mathematical Methods : This was held in the period Nov. 14 - 28, 2000. About 25 teachers from the Chennai area attended this course. The lecturers were (i) Prof. R. Jagannathan, IMSc. *Mathematical Methods* (ii) Prof. R. Parthasarathy, IMSc. *Quantum Mechanics* (iii) Prof. K. Raghunathan, University of Madras *Mathematical Methods* and (iv) Prof. G. Rajasekaran, IMSc. *Quantum Mechanics*. A special lecture was also given by Prof. R. Simon of IMSc.

Refresher Course in Statistical Mechanics, Condensed Matter Physics and Computational Physics : This was held in the period May 25 - June 14, 2001. Participants (about 40 in number) were drawn from all over India. The lecturers were (i) Prof. R. Sridhar, IMSc. *Statistical Mechanics*, (ii) Prof. K. Raghunathan, Madras University *Statistical Mechanics*, (iii) Prof. H.S. Sharatchandra, IMSc. *Statistical Mechanics*, (iv) Prof. G. Baskaran, IMSc. *Condensed Matter Physics*, (v) Dr. A.M. Tiwari, IGCAR *Condensed Matter Physics*, (vi) Prof. S. Balasubramanian *Condensed Matter Physics*, (vii) Dr. R. Shankar, IMSc. *Computational Physics* and (viii) Dr. Gautam I. Menon, IMSc. *Computational Physics*. Prof. N.D. Hari Dass of IMSc. gave a special lecture to the participants. A formal discussion session on the framing of a syllabus for "Computational Physics" was organized, in which several participants spoke of their experiences with similar courses.

Participants were allowed access to the library for extended hours as well as provided computer accounts for their use. Both refresher courses had a strong problem solving component, involving at least one tutorial session per two class hours.

The response to these refresher courses was overwhelmingly positive. Several participants have expressed an interest in combining research work in parallel with their teaching duties. These participants were encouraged to interact with IMSc. members who worked in their fields of interest to formulate research problems. It is planned to hold such refresher courses on a regular basis.

2.4.9 Institute Seminar Week

The Institute Seminar Week was held in the week of 12-16 February, 2001 from 10:10 to 12:55 each day with a half hour tea break at 11:00. There were five talks each day, each of 25 minutes duration. The list of speakers and the title of their talks is given below:

- **H.S. Sharatchandra**
  Phase space wave functions: Geometric quantization as a practical tool.
- **P. Majumdar**
  Cosmological optical activity
- **S.P. Suresh**
  Issues in Security Protocols
- **Sukratu Barve**
  Divergence of quantum stress tensor in spherical dust collapse
- **R. Jaganathan**
  Quantum Aspects of Beam Physics: An Introduction to a New Subject
- **D.S. Nagaraj**
  Parabolic principal bundles
- **S. Kalyana Rama**
  Radius stabilisation in the Brane Worlds
- **T. Jayaraman**
  D-branes on Calabi-Yau manifolds
- **K. Lodaya**
  Interval temporal logics
- **G. Baskaran**
  MgB_2: Yet another high temperature superconductor
- **Sumithra Sankararaman**
  Spiral orientational order in quantum Hall skyrmion lattices
- **G.I. Menon**
  Ising Persistence with Parallel Dynamics: Exact Results for a Probabilistic Cellular Automaton
- **C.R. Subramanian**
  Efficiently solving hard problems over random instances
- **K. Paranjape**
  Rigidity of Arithmetic varieties
- **V. Suneeta**
  Black hole music
- **R. Thangadurai**
  Erdös-Ginzburg-Ziv theorem and its extensions

- **G. V. Ravindra**
  Can cycles be detected using cohomology
- **V. Arvind**
  Lowness as a tool in classifying problems in complexity classes
- **G. Manoj**
  'Long valleys' in rough surfaces
- **G. Date**
  Isolated horizons and black hole thermodynamics
- **S. Ghosh**
  Irreducible paragroups
- **P. Das**
  Hopf algebras arising from paragroup theory
- **P. Sankaran**
  Quantum groups and standard monomial theory
- **R. Basu**
  New results on (g-2) of the muon
- **N.D. Hari Dass**
  The anomalous magnetic moment of muons and possible new physics

2.4.10 National Science Day

February 28th of each year is celebrated as National Science Day. This year, the activities of the Science Day was coordinated by Parameswaran Sankaran. The programme was attended by about 12 students from about half a dozen colleges in the city and some members of the Institute.

The activities of the day began with a welcome address by the Director. This was followed by lectures on *Cryptography* by Prof. Kapil Paranjape, and on *The Power of Physics* by Prof. G. Baskaran in the forenoon.

The afternoon session started with a lecture by Professor V. Arvind on *Computing with coin flips*. There was a demonstration on the use of computers by Shri G. Subramonium.

The day concluded with a special lecture by Professor R. Balasubramanian on *Research avenues for mathematics in India*.

2.5 Other Conferences/ Workshops Organized by IMSc

2.5.1 Conference on Spectral and Inverse Spectral Theories of Schrödinger Operators

This conference was held as part of a joint DST-NSF project in Mathematical Physics of which one of the members of the Institute is a principal investigator.

The conference was held during 14-20 December 2000 at the University of Goa. The participants include M Ashbaugh, E Balslev, S Baretto, R Bhat, H Bhate, J M Combes, W Craig M Demuth, S Dey, V Enss, S George, B Helffer, A M Hinz, P D Hislop, T Ichinose, A Jensen, Y Karpechina, W Kirsch, F Klopp, S Kotani, M Krishna, A N Mohapatra, S Nakamura, M N N Namboodiri, Y S Prahalad, M Rajesh, Barry Simon, K B Sinha, E Skibsted, G Stolz, D Yafaev, K Yajima.

The conference was funded in part, in addition to the DST and NSF, by The International Mathematical Union, The National Board for Higher Mathematics, The Institute of Mathematical Sciences and the University of Goa.

The proceedings of the conference is expected to come out as a special issue of the Proceedings of the Indian Academy of Sciences (Mathematical Sciences).

2.6 Seminars

Seminars held at IMSc during 2000-2001

Date	Speaker Affiliation	Title
3-8-2000	Srinath Cheluvaraja Louisiana State University	Z_2 vortices in gauge theories
7-8-2000	R Simon IMSc, Chennai	Gain-Assisted superluminal light propagation
14-8-2000	Uri Maor Tel Aviv University, Israel	Gluon saturation in DIS and photo production
17-8-2000	Urmie Ray Universite de Reims, France	Generalized Kac-Moody Algebras, Moonshine Conjecture and modular functions
23-8-2000	Ram Kishore. INPE, Sao Paolo, Brazil.	An Overview of the Isotope Effect on Superconducting T_c
23-8-2000	Gautami Bhowmik Universite Lille 1, France	Convolution of arithmetic functions of matrices.
24-8-2000	Urs Heller Florida State University, USA	Chiral symmetry on the Lattice: Recent progress
25-8-2000	E. Seiler Max Planck Inst, Munich, Germany	Percolation, universality and asymptotic freedom in two dimensional spin models.
29-8-2000	Maarten Golterman. Washington State University, St. Louis, USA.	Chiral Gauge Theories on the Lattice.
30-8-2000	A. J. Parameswaran TIFR, Mumbai	Affine Surfaces with Euler characteristic equal to one
30-8-2000	Arifa Ali Khan. Tsukuba University, Japan.	B-Physics from CP-PACS

30-8-2000	B. Nestmann University of Bonn	Resonances formation in electron-molecule scattering
31-8-2000	Mladen Dimitrov Ecole Normale Superieure, Paris	Residual image of Galois representations associated to Hilbert modular forms and torsion of cohomology module
6-9-2000	S. Ramanan TIFR, Mumbai	Clifford Algebras and Spin Groups
6-9-2000	Aravind Srinivasan Bell Labs, USA	On the approximability of Clique and related maximization problems
6-9-2000	Sudhakar Panda MRI, Allahabad	T-duality invariant World-volume action of Non-BPS brane
11-9-2000	Ramesh Narayan Harvard University	The Search for Astrophysical Black Holes
12-9-2000	Jaikumar Radhakrishnan TIFR, Mumbai	Maintaining the minimum
12-9-2000	R. Parthasarathy TIFR, Mumbai	Some C^*-algebras
12-9-2000	Bernard Leong Cambridge University	Spin Torsion effects on Gravity for a self consistent Dirac Field
13-9-2000	S. Ramanan TIFR, Mumbai	Clifford Algebras and Spin Groups
15-9-2000	R. Parthasarathy TIFR, Mumbai	Some C^*-algebras
19-9-2000	Pol Vanhaecke University of Poitiers, France	Algebraic geometric aspects of integrable system
19-9-2000	R. Parthasarathy TIFR, Mumbai	Some C^*-algebras
20-9-2000	S. Ramanan TIFR, Mumbai	Clifford Algebras and Spin Groups

21-9-2000	R. Karandikar ISI, Delhi	On the behaviour of eigenvectors under the perturbation of stochastic matrices and application to evolutionary game theory
22-9-2000	Tapash Chakraborty IMSc, Chennai	Nanotechnology today: The Quantum Cascade Laser
27-9-2000	P. Madhusudan IMSc, Chennai	Synthesizing distributed controllers for local specifications
28-9-2000	G. Ananthakrishna IISc, Bangalore	Enhancement of escape rate due to barrier subdivision and Landauers blow torch
29-9-2000	Bruce C.Berndt University of Illinois, Urbana-Champaigne	Flowers which we cannot yet see growing in Ramanujan's garden of hypergeometric series, elliptic functions and q's
29-9-2000	K.B. Sinha ISI, Calcutta	Some non-commutative manifolds and spectral geometry
9-10-2000	M. Fellows, V. Raman, et al	Parameterized complexity lecture series
11-10-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups
11-10-2000	V.S. Sunder IMSc, Chennai	K-Theory and KK-theory for operator algebras.
12-10-2000	David Sinnou University of Paris VI	Heights on group varieties-I
13-10-2000	David Sinnou University of Paris-VI	Heights on group varieties-II
13-10-2000	V.S. Sunder IMSc, Chennai	K-theory and KK-theory for operator algebras
17-10-2000	R. Shankar Yale University	Hamiltonian Theory of the Fractional Quantum Hall Effect
18-10-2000	Michel Waldschmid University of Paris-VI	Multiple Polylogarithms

23-10-2000	Bhabani Prasad Mandal S.N. Bose Center for Basic Sciences, Kolkata	Finite BRST Transformations
24-10-2000	M. Waldschmidt University of Paris-VI	Multiple polylogarithm
25-10-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups
25-10-2000	V.S. Sunder IMSc, Chennai	K-theory and KK-theory for operator algebras
30-10-2000	Vijay Kodiyalam IMSc, Chennai	Paragroups and Hopf algebras
1-11-2000	M. Waldschmidt Universite Paris-VI	Multiple Polylogarithms
2-11-2000	Tejinder S. Neelon California State University, San Marcos	On C^∞ and formal solutions to power series equations
3-11-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups
3-11-2000	M. Waldschmidt University of Paris-VI	Multiple Polylogarithms
3-11-2000	T. Padmanabhan IUCAA, Pune	Understanding the Intergalactic Medium
8-11-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups
10-11-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups
10-11-2000	M. C. Sinha Indian Meteorological Service	Weather forecasting
17-11-2000	S. Ramanan TIFR, Mumbai	Clifford algebras and spin groups

22-11-2000	S. Ramanan TIFR, Mumbai	Clifford Algebras and spin groups
22-11-2000	R. Shankar IMSc, Chennai	Visual Quantum Mechanics
23-11-2000	R. Shankar IMSc, Chennai	Visual Quantum Mechanics
24-11-2000	Sukratu Barve IMSc, Chennai	Cosmic Censorship: Introduction and a New Idea.
27-11-2000	M. K. Parida North Eastern Hill University, Shillong.	Large Neutrino Mixing from Renormalisation Group Evolution
28-11-2000	R. Simon IMSc, Chennai	Quantum Teleportation
29-11-2000	Martin Leucker University of Technology, Aachen	Deciding LTL over traces by Alternating Buchi Automata
30-11-2000	Manindra Agrawal IIT, Kanpur	Towards uniform AC^0 isomorphisms
1-12-2000	Michael Fellows Univ of Victoria, BC, Canada	Ising Models, Protein Folding and Parameterized Complexity
4-12-2000	N. Panchpakesan Delhi University	Gravitational Lensing and Cosmology
5-12-2000	S. B. Santra IIT, Kanpur	The problem of storing Nuclear Waste in Glass
6-12-2000	N. Panchapakesan Delhi University	Nature of the transition from Quantum tunneling to Thermal hopping
11-12-2000	Marcus Schaefer DePaul University, Chicago	Graph Ramsey Theory and the Polynomial Time Hierarchy
12-12-2000	Prabodh Shukla North Eastern Hill University, Shillong	Hysteresis and Barkhausen noise in an exactly solvable case of the random field Ising model.

12-12-2000	Kavita Ramanan Bell Labs, USA	On a variational problem that characterizes the tail probabilities of reflected Brownian motion
13-12-2000	Mrinal Dasgupta DESY, Germany	Renormalon effects in QCD hard processes
13-12-2000	Supriya Kar Goteborg, Sweden	Strings, D-Branes and Noncommutative Geometry
14-12-2000	Sandip Chakrabarti S. N. Bose Center for Basic Sciences, Kolkata	GRS1915+105: A strange microquasar in our galaxy
14-12-2000	Mrinal Dasgupta DESY, Germany	Theoretical predictions for jet shape variables at HERA
15-12-2000	Sandip Chakrabarti S. N. Bose Institute of Basic Sciences, Kolkata	Can DNA and Amino Acids form during collapse of interstellar clouds
15-12-2000	Y. Ohrn University of Florida, Gainesville	Energy loss and charge exchange effects in ion-atom collision
19-12-2000	Sujata Tarafdar Jadavpur University,	Simulating Porous Media by Ballistic Deposition
26-12-2000	Subodh Shenoy ICTP	BEC tunneling and the momentum shortened oscillator
26-12-2000	Gerard Berry Ecole des Mines and INRIA	Circuits and 2-adic numbers
26-12-2000	V. Sreedhar University of Dublin, Ireland.	Explosion-Implosion Duality.
3-1-2001	M.S. Srikanth REC, Jalandhar	DNA Computing
9-1-2001	Jeff Edmonds York University, Toronto	Non-clairvoyant Multiprocessor Scheduling of Jobs with Arbitrary Arrival Times and Changing Execution Characteristics
10-1-2001	C. Hayat-Legrand University of Toulouse	The geometry of hyperbolic spaces

11-1-2001	Michael Douglas Rutgers University, USA	Dirichlet branes in string theory
11-1-2001	M. Herzlich University of Montipellier	The Penrose Inequality: Black holes and Riemannian Geometry
12-1-2001	M.R. Douglas Rutgers University	The mathematics of branes
12-1-2001	F.A. Bais University of Amsterdam	Topological interactions and their quantisation
15-1-2001	M. P. Das Australian National University, Canberra	Can one measure the fractional charge in the FQHE experiment?
16-1-2001	Narayanan Menon University of Massachusetts, Amherst	Velocity fluctuations in a shaken granular medium
17-1-2001	Fiorenzo Bastianelli University of Bologna ,Italy	Quantum Mechanical Path Integrals for 1D Nonlinear Sigma Models and Trace Anomalies.
18-1-2001	Daniela Biggati INFN, Italy	Gauge Theory on a Fuzzy Torus
19-1-2001	Paul Gastin LIAFA, Paris	Fast LTL to Automata Translation
19-1-2001	A.Legrand University of Toulouse	Quasicrystal: an example of interaction between K-theory of C^*-algebra and physics
24-1-2001	Govindan Rajesh Institute for Advanced Studies, Princeton	Noncommutative solitons and tachyons
29-1-2001	Harvinder Kaur Jassal HRI, Allahabad	Null strings near a higher dimensional black hole
5-2-2001	M.R. Srinivasan Former Chairman, AEC & Former Member, Planning Commission	Energy Scenario in India

6-2-2001	Vinod Gaur IIA, Bangalore	The Gujarat earthquake - what can we learn from it ?
6-2-2001	S. Kanemitsu University of Kinki, Japan	A mean value theorem for Dirichlet series and a general divisor problem
8-2-2001	K. R. S. Balaji IMSc, Chennai	Model independent methods of neutrino mixing
8-2-2001	P. Zvengrowski University of Calgary	Cohomology of Seifert manifolds and applications to physics and topology
9-2-2001	J.Van der Jeugt University of Ghent, Belgium	Symmetry groups and hypergeometric series
15-2-2001	K. Ravishankar SUNY at New Paltz	A constructive approach to hydrodynamics for asymmetric attractive processes with nonconvex non convace flux
21-2-2001	Wolfgang Nolting Humboldt-University at Berlin	Metallic Ferromagnetism of Strongly Correlated Electrons
23-2-2001	Srinivas Krishnagopal Centre for Advanced Technology, Indore.	Free Electron Lasers
23-2-2001	Naba K Mondal TIFR, Mumbai	Physics Prospect with the Upgraded D0 experiment
26-2-2001	Sayan Kar IIT, Kharagpur	Kinematics of flows in diverse contexts
26-2-2001	Vikram Soni NPL, New Delhi	The Nucleon and the Neutron Star
27-2-2001	Sayan Kar IIT, Kharagpur	The Kalb-Ramond field and optical activity
5-3-2001	S. Venkadesan IGCAR, Kalpakkam	Development of Digital Resources at IGCAR Library
5-3-2001	Arun Paramakanti TIFR, Mumbai	The low temperature superconducting state of the cuprates

7-3-2001	David J. E. Callaway The Picower Institute for Medical Research, New York	Molecular Lycanthropy: A theoretical physicist looks at Alzheimer's disease
8-3-2001	G. Baskaran IMSc, Chennai	New Superconductors
13-3-2001	O. Suzuki Nihon University, Tokyo	An operator formalism to abelianized field theory and the SU(2) quark confinement
16-3-2001	S. Thangavelu ISI, Bangalore	Oscillating multipliers for some eigenfunctions expansions
22-3-2001	Uma Iyer HRI, Allahabad	Differential Operators on Hopf Algebras
30-3-2001	Uma Iyer HRI, Allahabad	Quantum differential operators-I
2-4-2001	Uma Iyer HRI, Allahabad	Quantum differential operators-II
3-4-2001	K. Sridhar TIFR, Mumbai	J/ψ production in NRQCD.
4-4-2001	J. Pashupathy CTS, IISc, Bangalaore	Renormalisation group, relation between standard model couplings and Higgs mass
5-4-2001	Suresh Nayak HRI, Allahabad	Residues and duality
12-4-2001	R. Srinivasan ISI, Bangalore	Product system of Hilbert spaces
17-4-2001	P. K. Manoharan TIFR Radio Astronomy Center, Udhagamandalam	Mass ejection from the sun
18-4-2001	Chitra Rangan University of Michigan.	Performing a quantum algorithm on a Rydberg atom through optimally shaped terahertz pulses

19-4-2001	Gautam I. Menon IMSc, Chennai	Statistical Physics and Biological Information: The ITP Workshop
19-4-2001	V.S. Sunder IMSc, Chennai	Planar algebras
20-4-2001	K.L. Sebastian IISc, Bangalore	Barrier Crossing by a long chain molecule - an infinite dimensional Kramers problem
21-4-2001	P. K. Manoharan TIFR Radio Astronomy Center, Udhagamandalam	Sooriya Sooraavali (in Tamil)
25-4-2001	Rahul Siddharthan Ecole Normale Superieure, Paris, France	Frustrated quantum antiferromagnetism: insights from the "square kagome" lattice in the large N limit
25-4-2001	Debashis Ghoshal HRI, Allahabad.	Some Exact Results in Non-perturbative String Theory
26-4-2001	Riddhi Shah TIFR, Mumbai	Levy's measures and self-decomposable measures on the group of upper triangular matrices
2-5-2001	Sanjay Jain CTS, IISc, Bangalore	Origin and evolution of complexity in dynamical networks
8-5-2001	Swarnendu Sarkar IMSc, Chennai	Spontaneous Symmetry Breaking in Non-Commutative Scalar Field Theory
15-5-2001	J. V. Yakhmi BARC, Mumbai.	Molecular Magnets - the current scene
16-5-2001	Tanmay Vachaspati Case Western Reserve University, USA	Estimate of the primordial magnetic field helicity.
17-5-2001	Mustansir Barma TIFR, Mumbai	Phases and transitions in models of aggregation and fragmentation
17-5-2001	P.K. Aravind Worcester Polytechnic, Worcester, MA, USA	Quantum state estimation: Some recent results.

18-5-2001	Tanmay Vachaspati Case Western Reserve University, USA	Topology from fermions
21-5-2001	Vijay Chandru IISc, Bangalore	The Simputer story: Radical simplicity for universal access
24-5-2001	Santhosh George Government College, Sanquelim	The use of monotonicity for choosing the regularization parameter in ill-posed problems
7-6-2001	V. Balaji IMSc, Chennai	Semistable principal bundle
8-6-2001	Joseph Samuel RRI, Bangalore	Remarks on the Geometric Phase
8-6-2001	S. V. Subramanyam IISc, Bangalore	Rich Physics of Carbon Based Materials
11-6-2001	Arun K. Pati BARC, Mumbai	Concepts in Quantum Computation and Quantum Information
14-6-2001	Parameswaran Sankaran IMSc, Chennai	A coincidence theorem for holomorphic maps
15-6-2001	Sankalpa Ghosh IMSc, Chennai	Two component Fermi vapour in a 2D rotating trap
22-6-2001	Vishvajit V S Gautam Apeejay College of Engineering, Sohna,	Braided tensor categories
18-7-2001	G. Manoj, Suneeta Varadarajan and K. R. S. Balaji IMSc, Chennai	Nobel Laurates meet Students
19-7-2001	Roy Joshua Ohio State University, Columbus, Ohio, USA	Equivariant Intersection Cohomology
23-7-2001	Priti Shankar IISc, Bangalore	Tail-biting trellises for linear block codes

24-7-2001	T.P. Das SUNY, Albany	Electronic Structure of Chemical Ferromagnets
24-7-2001	I V Ramakrishnan SUNY at Stony Brook	The promise of logic programming: realized at last?
25-7-2001	Roy Joshua Ohio State University, Columbus	Applications of the strong Künneth decomposition of the diagonal
26-7-2001	Andreas Rosenschon Duke University	Examples in arithmetic mixed Hodge structures

2.7 Student Programmes

2.7.1 Institute JRFs

Students who received Ph.D. degree during 2000-2001.

Mathematics

Name : **R. Srinivasan**
Thesis Title : Connections on Small Vertex Models
Thesis Advisor : V.S. Sunder
University : Indian Statistical Institute

Name: **N. Sabu**
Thesis Title : Eigenvalue Problems in Shell Theory
Thesis Advisor : S. Kesavan
University :Madras University

Name : **M. Rajesh**
Thesis Title : Some Problems in homogenization
Thesis Advisor : S. Kesavan
University : Indian Statistical Institute

Physics

Name: **Arundhati Dasgupta**
Thesis Title : Aspects of Black Hole Thermodynamics
Thesis Advisor : P. Majumdar
University :Madras University

Name : **Pushan Majumdar**
Thesis Title : Duality Transformations of Non-Abelian Gauge Theories
Thesis Advisor : H.S. Sharatchandra
University : Madras University

Name : **Tapobrata Sarkar**
Thesis Title : Aspects of D-branes and Quantum Gravity
Thesis Advisor : T. Jayaraman
University : Madras University

Students who submitted Ph.D. thesis during 2000-2001.

Physics

Name : **K.R.S. Balaji**
Thesis Title : Phenomenology of Neutrino Masses and Large Mixings
Thesis Advisor : Rahul Sinha
University : Madras University

Name : **Suneetha Varadarajan**
Thesis Title : Aspects of black holes in Anti-de Sitter space
Thesis Advisor : T.R. Govindarajan
University : Madras University

The following **lecture courses** were offered during 2000-2001.

Course Title	Period	Lecturer
Mathematics		
Real Analysis	Aug.-Dec. 2000	S. Kesavan
Algebra I	Aug.-Dec. 2000	V. Balaji
Topology I	Aug.-Dec. 2000	D.S. Nagaraj
Functional Analysis I	Jan.-May 2001	V. Kodiyalam
Topology II	Jan.-May 2001	P. Sankaran
Complex Analysis I	Jan.-May 2001	M. Krishna
Geometry	Jan.-May 2001	K.H. Paranjape
Physics		
Classical Mechanics	Aug.-Dec. 2000	R. Sridhar
Quantum Mechanics	Aug.-Dec. 2000	T.R. Govindrajan
Electrodynamics	Aug.-Dec. 2000	G.I. Menon
Mathematical Physics	Aug.-Dec. 2000	R. Jaganathan
Statistical Mechanics	Jan.-May 2001	Ramesh Anishetty
Particle Physics	Jan.-May 2001	N.D. Hari Dass
Intro. Cond. Matter Phys.	Jan.-May 2001	G. Baskaran
Intro. QFT	Jan.-May 2001	H.S. Sharatchandra
General Relativity	Aug.-Dec. 2000	Partha Majumdar
Adv. QFT	Aug.-Dec. 2000	R. Basu
Intro. String Theory	Aug.-Dec. 2000	T. Jayaraman
String Theory	Jan.-May 2001	B. Sathiapalan
Theoretical Computer Science		
Discrete Mathematics	Aug.-Dec. 2000	V. Arvind
Algorithms and Data Structures	Aug.-Dec. 2000	Venkatesh Raman
Principles of Programming Languages	Aug.-Dec. 2000	Kamal Lodaya
Introduction to Logic	Jan.-May 2001	R Ramanujam
Introduction to Computational Complexity	Jan.-May 2001	Meena Mahajan
Randomized Computation	Jan.-May 2001	V. Arvind, Venkatesh Raman, C.R. Subramanian
Semantics	Jan.-May 2001	Kamal Lodaya

In addition the following **lecture courses** were offered during 2000-2001 by IMSc faculty in the National Undergraduate Programme of the Chennai Mathematical Institute.

Course Title	Period	Lecturer
Algebraic Number Theory and Cryptology	Aug.-Dec. 2000	R. Balasubramanian
Algebra I	Aug.-Dec. 2000	Vijay Kodiyalam
Analysis II	Aug.-Dec. 2000	M. Krishna
Calculus III	Aug.-Dec. 2000	Parameswaran Sankaran
Calculus I	Aug.-Dec. 2000	K.H. Paranajape
Algorithms	Aug.-Dec. 2000	V. Raman
Measure Theory	Aug.-Dec. 2000	V.S. Sunder
Topology	Jan.-May 2001	V. Balaji
Calculus II	Jan.-May 2001	S. Kesavan
Field Theory and Galois Theory	Jan.-May 2001	D.S. Nagaraj

2.7.2 Summer Students

Every summer, a small number of students from various institutes/universities come to our institute and work on some learning/research projects with some faculty member for a period of four to six weeks. The following students visited the institute during May - July, 2001.

Student	Faculty
Mathematics	
P. Naushad Pasha, IIT, Madras	R. Balasubramaniam
Arindam Bose, University of Pune	D.S. Nagaraj
Debashis Bose, IIT, Kanpur	Parameswaran Sankaran
Physics	
Tuhin Subhra Roy, IIT, Kanpur	N.D. Hari Dass
Bindusar Sahoo, IIT, Kharagpur	G. Date
N. Vasumathi, Anna University	G. Baskaran
R. Premalatha, Anna University	K. Srinivasa Rao
G. Kavitha, American College, Madurai	Purusattam Ray
E. Sunitha, (IMSc Appalat Fellow)	R. Parthasarathy
B.S. Gouthaman, Pondicherry University	R. Sridhar
Somnath Bandopadhyay, Univ. of Lucknow	M.V.N. Murthy
Arvind Ayyer, IIT, Kanpur	Romesh K. Kaul
S.K. Karthick Kumar, The American College	R. Simon
Theoretical Computer Science	
Suman Sanyal, IIT, Kharagpur	Meena Mahajan
Saket Sautabh, CMI	Venkatesh Raman
Saptorshi Kar, IIT, Kharagpur	R. Ramanujam
Ajai Nair, Calcutta	Meena Mahajan
Saurav Pandit, IIT, Kharagpur	V. Arvind

2.7.3 Apalat Fellowship

In order to encourage bright students to take up Mathematics or Physics for their higher studies, the Institute is offering two Fellowships, one in Mathematics and the other 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. The awardee is encouraged to attend Institute seminars and during summer vacation, is expected to work under the guidance of a faculty member.

Heads of departments of Mathematics and Physics of various city colleges are contacted to suggest five bright final year B.Sc. students who are likely to join the M.Sc. programme in an institution in Chennai. Out of these, one student in each subject is selected for the award of the scholarship through a written test and/or interview. The scholarship is extendable to the second year of M. Sc. programme in case of promising awardees.

2.8 Institute Associateships

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

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

Associates who visited the institute during the period 01.8.00 to 31.7.01 are :

Name: **Ramakalyan Ayyagiri**
Affiliation : Dept. of ICE, Regional Engg. College, Trichy
Period : 27.5.2001 to 6.7.2001

Name: **A. Tripathi**
Affiliation : Dept. of Maths, IIT, Delhi
Period : 7.6.2001 to 6.7.2001

Name: **J. Segar**
Affiliation : RKM Vivekananda College, Chennai
Period : 7.5.2001 to 6.6.2001

Name: **G. Gangadhar Reddy**
Affiliation : Dept. of Physics, Kakatiya University
Period : 14.5.2001 to 14.6.2001

Name: **Santhosh George**
Affiliation : Govt. College Sanquelim, Goa
Period :7.5.2001 to 31.5.2001

Name: **T.C. Vasudevan**
Affiliation : RKM Vivekananda College
Period : 23.4.2001 to 2.6.2001

Name: **M.K. Parida**
Affiliation : Phys. Dept., North Eastern Hill Univ, Shillong
Period : 3.2.2001 to 1.3.2001

Name: **S.K. Basu**
Affiliation : Dept. of Comp. Science, BHU, Varanasi
Period :6.10.2000 to 28.10.2000

Name: **A.R. Usha Devi**
Affiliation : Dept. of Phys, Bangalore University
Period :05.09.2000 to 07.10.2000

Name: **Prabodh Shukla**
Affiliation : Phys, Dept., North Eastern Hill Univ
Period : 21.11.2000 to 17.12.2000

Name: **Ranabir Chakrabarti**
Affiliation: Dept. of Theoretical Physics, University of Madras
Period : 01.05.2001 to 30.06.2001

2.9 Visits to Other Institutions

(including participation in conferences and workshops)

Arvind, V.

Visited IISc, Bangalore to take part in a workshop on Mathematical Tools and Techniques in Computer Science IISc, Bangalore from 24 July – 4 August, 2000. Delivered four lectures in the workshop.

Visited REC, Tiruchi to take part in a workshop on Randomized Algorithms from September 6–8, 2000. Delivered two lectures in the workshop.

Balaji, K.R.S.

Visited Saha Institute of Nuclear Physics as a part of Golden Jubilee celebrations. Gave an invited talk titled *Radiative Magnification of Flavor Mixings*, August, 2000.

Visited Syracuse University, Oklahoma State University, Argonne National Laboratory and Oregon University for presenting a seminar on neutrino physics,September,2000.

Visited the Abdus Salam ICTP for a period of three months (from October,2000) to work in neutrino physics. Also presented a seminar in neutrino physics

Visited the University of Helsinki for a month in January,2001. Presented a seminar on neutrino physics (January, 2001).

Attended the Lindau meeting of Nobel Laureates, Lindau, Germany from 24th June to 8th July, 2001 as a part of the DST Indian team.

Visited the particle theory group, Fermi National Accelerator Laboratory, Batavia, Chicago, U.S.A.

Balaji, V

In October 2000, attended the CAAG Conference at IISc, Bangalore.

In January and February 2001, was invited to UK. Gave a series of lectures at the Universities of Liverpool, Warwick, Durham and also gave the Cambridge-Oxford-Warwick (COW) seminar at the University of Bath on my work in the moduli spaces of principal bundles.

Balakrishnan, Radha

Visited Universite de Cergy-Pontoise, France as CNRS Visiting Professor, from October 1, 2000 to January 31, 2001 and Department Visiting Professor from February 1 to March 31, 2001. Presented a seminar entitled *The Schrodinger equation as a moving curve.*

Co-organizer, International Conference on Geometry, Integrability and Nonlinearity in Condensed Matter and Soft Condensed Matter Physics, Bansko, Bulgaria, July 15-20, 2001.

Balasubramanian, R.

Visited HRI in November 2000 to participate and lecture in the conference on Elliptic curves and cryptology held during Nov.26 - 29.

Visited ISI Calcutta to participate the international conference Indocrypt 2000. I was the general Co-chair of the conference.

Delivered three lectures in the Combinatorial Number theory conference in ISI Bangalore on 14th and 15th May 2001.

Delivered Key Note address at Stella Maris College, Chennai in a programme organized by Forum D' Analystes on 17.10.2000.

Barve, Sukratu

Attended Discussion Meeting on Quantum Gravity, Raman Research Institute, Bangalore, January 1-10, 2001

Presented a paper titled *Apparent horizon and Naked Singularities in Spherical Dust Collapse.* in International Symposium in Mathematical Sciences, Dept. of Mathematics, University of Nagpur, Nagpur, India, March 1-5, 2001.

Baskaran, G

Attended the 'Workshop on High Temperature Superconductivity' on invitation at The Institute for Theoretical Physics, University of California, Santa Barbara, California, USA, during September 13 till December 15 2000.

Delivered a talk at ITP, Santa Barbara on *Deconfined spinons in ordered quantum Heisenberg Antiferromagnet in 2 dimensions* on November 27, 2000 (video and audio available at http://online.itp.ucsb.edu/online/hightc00/baskaran/)

Delivered a talk at the discussion meeting on 'Gauge Theories and Fractionization in High Temperature Superconductors', ITP, Santa Barbara on October 3, 2000.

Delivered a talk at the discussion meeting on 'How well do the Hubbard and t-J models describe the high temperature superconductors ?' at ITP, Santa Barbara on October 4, 2000.

Delivered a talk at the discussion meeting on *Are stripes important in high Tc superconductors ?* at ITP, Santa Barbara on November 9, 2000.

Visited the Department of Physics, Princeton University, NJ, USA during October 30, November 3, 2001 and gave a talk on *Skyrmions and spinon deconfinement in ordered quantum Heisenberg Antiferromagnet in 2 dimensions* on November 1, 2000.

Participated in the 'International Discussion Meeting on Mesoscopic and Disordered Systems' at the Indian Institute of Science, Bangalore, during December 18-20, 2000 and delivered a talk on *Novel Exciton Dynamics in Light Harvesting Antenna Complex LH2 in Purple*

Bacteria.

Participated in the meeting 'India and Abroad: Condensed Matter Physics' at the S.N Bose Institute, Calcutta during January 2-4, 2001.

Participated in a meeting on 'Current Trends in Condensed Matter Physics' at Kakatiya University, Warangal, February 5-6, 2001 and delivered a talk on *Condensed Matter Physics and Biology.*

Participated in a meeting on 'New Developments in Materials: Nanomaterials and Magnetism' and during March 2-3, 2001 at Jawaharlal Nehru University, New Delhi and delivered a talk on *High Temperature Ferromagnetism in* SrB_6*: A New Theory.*

Visited IGCAR, Kalpakkam and delivered a talk on MgB_2*: a broad band RVB Superconductor* on March 23, 2001.

Visited Indian Institute of Science, Bangalore, and delivered a talk on MgB_2*: a broad band RVB Superconductor* on March 23, 2001.

Delivered 3 lectures at the 'Refresher Course for M.Sc. Physics Students' at Nuclear Physics Department, University of Madras, during June 18-20, 2001.

Basu, Rahul

Attended DAE Symposium on High Energy Physics, Hyderabad, December 2000.

Visited LAPTH (Laboratoire d'Annecy-Le-Vieux de Physique Theorique), Annecy, June 17, 2001 to July 28, 2001 for collaborative work.

Chakraborty, T.

Visited the Max-Planck Institute for Physics of Complex Systems, Dresden, Germany, May 7, 2001 to Sept. 4, 2001.

Date, G.

Visited IUCAA, Pune during Oct 2, 2000 - Dec 31, 2000

Attended 'Topics in Classical and Quantum Gravity' meeting at IUCAA, 12 - 20 Oct, 2000 and gave a talk on *isolated horizons.*

Attended "Discussion meeting on Quantum Gravity", Raman Research Institute, Bangalore, Jan 2, - Jan 9, 2001.

Presented invited talk on *Isolated Horizons* at the 21st meeting of the IAGRG, Nagpur, Jan 30 - Feb 1, 2001.

Delivered a set of 10 lectures on *Quantum Field Theory in Curved Space-time* at 'Summer School on Gravity and Field theory' organized by IUCAA, Pune and St. Thomas College,

Kozhenchery, Kerala, May 12 - 22, 2001.

Presented a talk on *Isolated Horizons and their Properties* at the International Conference, GR16, held at Durban, South Africa,during July 15 - 21, 2001.

Ghosh, Sankalpa

Gave a seminar in HRI, Allahabad on*Topological excitations in double layer Quantum Hall systems.*

Attended the workshop on "Flux, Charge Topology and Statistics" in Amsterdam (24th June -30th June,2001) and gave talk *Two components Fermi vapours in 2D rotating trap.*

Attended SCES-Y2K, held in Saha Institute of Nuclear Physics, Calcutta from 23rd to 28th October ,2000.

Hari Dass, N.D.

Visited Raman Research Institute, Bangalore, during August 2000. Delivered a colloquium on "Matrix model of strings: a popular account" as well as a seminar on *Some conceptual issues in classical and quantum statistics.*

Attended the International Symposium on Lattice Field Theory, August 17-22, Bangalore. Presented two poster sessions on *Quasi-local update algorithms for numerical simulations of* $D = 3$ $SU(2)$ *LGT in the dual formulation* and *Current status of the numerical simulations of* $D = 3$ $SU(2)$ *Lattice gauge theory in the dual formulation.*

Visited Indian Institute of Technology Kharagpur during March 2001 and delivered a seminar on *Protective measurements in Quantum Mechanics.*

Visited SNBOSE Centre, Kolkata during 12-22 March 2001 and delivered seminars on *Some conceptual issues in classical and quantum statistical mechanics* and *Measurement problem in Quantum Mechanics.*

Visited Viswabharathi University, Shantiniketan during March 2001 and delivered a seminar on *Some conceptual issues in classical and quantum statistical mechanics.*

Delivered a talk on *Stellar Evolution* at Vivekanand College, Chennai in April 2001.

Delivered a talk on *Total Solar Eclipse* at D.G.P. Vaishnav College, Chennai, in April 2001.

Delivered a talk *Stellar Evolution* to high school students at Children's Club Society in May 2001.

Delivered a set of 9 lectures on *Quantum Mechanics* at the Kodaikanal Summer School on Physics organised by the Indian Institute of Astrophysics.

Indumathi, D.

Presented an invited talk on *polarised structure functions* at the Univ. Dortmund and at DESY, Zeuthen, June 2000.

Presented an invited talk on *polarised structure functions* in the e-RHIC Summer Workshop, BNL, U.S.A, June 26–July 14th 2000.

Presented an invited talk on *neutrinos from supernovae* at Univ. Hawaii, July 2000.

Presented an invited parallel talk on *neutrinos from supernovae* at the International Conference on high energy physics, ICHEP2000, Osaka, Japan, July 27 to Aug 2nd, 2000.

Presented an invited talk on *neutrinos from supernovae* at the Kamiokande Lab., Mozumi, Japan, Aug 2000.

Visited Prof. W. Zhu, East China Normal University, Shanghai, Aug, 2000.

Presented two talks at the parallel session on Neutrino Physics at the DAE Symposium, Hyderabad, Dec 2000.

Presented an invited parallel talk on *long base-line neutrinos* at the Neutrino2000 meeting at the Institute of Mathematical Sciences, Madras, Feb 2001.

Jagannathan, R.

Delivered a course of lectures on *An Introduction to q-Series* in the SERC-sponsored "School on Special Functions and Functions of Matrix Arguments" organized by the Centre for Mathematical Sciences, Thiruvananthapuram, in June 2000.

Visited the Instituto Nazionale di Fisica Nucleare (INFN), Naples, Italy during 10-15 October 2000, and gave a seminar on *Dirac Particle Beam Optics*.

Delivered a talk on *Quantum mechanics of Dirac particle beam optics: Single-particle theory*, and chaired a session, in the International Workshop on "Quantum Aspects of Beam Physics" organized by the International Committee for Future Accelerators (ICFA) during 16-20 October 2000, at Capri, Italy.

Visited the Department of Physics, University of Salerno, Salerno, Italy, during 21-29 October 2000 and gave two lectures on *Algebraic methods in physics*.

Delivered a talk on *Quantum Beam Dynamics* in a Workshop on *Quantum Methodologies in Beam Physics*, held on 23 October 2000, at the University of Salerno, Salerno, Italy.

Delivered a course of lectures on *Physics of Waves* in the Refresher Course on Theoretical Physics for College Teachers organized by the Indian Academy of Sciences in November 2000, at Mavelikara, Kerala.

Delivered a course of lectures on *Linear Differential Equations* in the UGC-sponsored Refresher Course on Mathematical Methods and Applications in Physics for College Teachers organized by the Department of Physics, University of Madras, in February 2001.

Delivered a talk on *Introduction to Quantum Groups* at the "Institutional and Instructional Programme on Quantum Groups and Their Applications" organized by the Ramanujan Institute for Advanced Study in Mathematics, University Madras, in March 2001.

Delivered a talk on *Quantum Mechanics of Particle Beam Optics* in a Meeting on "Geometric Phases in Physics and Foundations of Quantum Mechanics" organized by the Centre for Theoretical Studies - Indian Institute of Science and Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, in honour of Professor N. Mukunda, during 28-29 March 2001.

Jayaraman, T.

Attended Strings 2001 held at TIFR, Mumbai, January 5-10, 2001.

Delivered invited talk on *Boundary fermions, coherent sheaves and D-branes on Calabi-Yau manifolds* at the Crete Regional Meeting on String theory, June 9-19, 2001.

Delivered talks on *D-branes on Calabi-Yau manifolds* at International Centre for Theoretical Physics, Trieste while visiting there June-July 2001.

Kalyan Rama, S.

Attended the conference on STRINGS 2001, held during the second week of January 2001 at Tata Institute of Fundamental Research, Mumbai.

Visited Harishchandra Research Institute, Allahabad during the last week of April 2001. Presented a seminar and an informal talk there.

Kesavan, S.

Delivered an invited talk at the 'One day Conference on Analysis and its Teaching', IIT, Chennai, August, 2000.

Delivered an invited talk at the 'Seminar on Mathematical Career Openings in Research and Teaching, Management and Industry', Vivekananda College, Chennai, September, 2000.

Delivered an invited talk at the 'International Conference on Analysis and its Applications', Meenakshi College and Forum d'Analystes, Chennai, December, 2000.

Gave a series of 4 lectures on *Vector Fields* in the 'Refresher Course in Topology', Ramanujan Institute, Chennai, December, 2000.

Delivered an invited talk at the 'VI Annual Conference of the ISIAM and First International Conference on Industrial and Applied Mathematics in the Indian Subcontinent', Amritsar,

January, 2001.

Visited the department of Mathematics, Université de Metz, Metz, France, from May 1 - 31, 2001.

Participated in the workshop of the Indo-French Cyber University e- math Project (FICUS), at the Université Paul sabatier, Toulouse, from May 21 - 23, 2001.

Kodiyalam, Vijay

Attended the workshop on 'Subfactors and Algebraic aspects of Quantum Field Theories' organized by MSRI, Berkeley in Dec 2000 and gave a talk on *Hopf algebras and paragroups.*

Visited the University of Kansas, Lawrence in Dec 2000 - Jan 2001 and gave a colloquium talk on *The algebra of subfactors.*

Delivered six lectures for the Instructional Conference on *Quantum Groups* organised by Ramanujan Institute for Advanced Study in Mathematics in March 2001.

Krishna, M.

Visited the Department of Mathematics, University of Kentucky, Lexington during the first two weeks of February 2001 for collaborative work as part of the DST-NSF joint research project in Schrödinger operators.

Visited the Department of Mathematics, Ruhr-Universitat Bochum, Germany during 14-22 June 2001 for collaborative work.

Visited the Department of Mathematics, Technical University of Clausthal, Germany on 23 June 2001, gave a talk on *Random Schrödinger operators with singular interactions.*

Lodaya, Kamal

Attended the European Summer School on Logic, Language and Information, Birmingham, UK, 8–18 Aug 2000. Presented a paper at the Workshop on Many-dimensional logical systems held during ESSLLI.

Visited LaBRI, Universit/'e Bordeaux 1, 21 Aug–12 Sep 2000, under the Indo-French project IFCPAR 2102-1. Gave a talk on *An automaton model of user-controlled navigation on the web.*

Attended the Workshop on Logic and Algebra in Concurrency, Dresden, Germany, 13–16 Sep 2000. Gave an invited talk on *A non-monoidal view of Petri nets.*

Attended the 6th International FTRTFT Symposium, held at Pune, 20–22 Sep 2000.

Attended the Workshop on Advances in Programming Languages, held at IIT Delhi, 11–12 Dec 2000.

Attended the 20th FSTTCS Conference, held at IIT Delhi, 13–15 Dec 2000.

Organized the School and Workshop on Automata, Logic and Concurrency, held at IMSc, 26–31 Jan 2001. Gave three talks in the School and one in the Workshop.

Attended the Seminar on Pure Mathematics, Calcutta University, Feb 01 2001. Gave an invited talk on *Frame problems*.

Attended the Summer Seminar on Logic, Automata and Modeling, Calcutta Logic Circle, 18–22 June 2001. Gave three lectures on *Parsing as deduction*.

Visited the Department of Computer Science and Engineering, IIT Delhi, 25–28 June 2001. Gave a talk on *Language from logic*.

Madhusudan, P.

Attended the '20th FST-TCS Conference' at IIT-Delhi, December 13–15, 2000

Attended the 'Workshop on Automata, Concurrency and Logic', IMSc, January 29–31, 2001.

Mahajan, Meena

Visited the Department of Computer Science and Engineering at the Indian Institute of Technology, Bombay, from 8 March to 24 April 2000. Gave a talk *A New NC-algorithm for Finding a Perfect Matching in Bipartite Planar and Small Genus Graphs* on 14th July 2000.

Participated in the Workshop on Mathematical Methods and Tools in Computer Science, held at the Indian Institute of Science, Bangalore, from 24 July to 4th August 2000. Presented the paper of Linial, Mansour and Nisan on *Constant Depth Circuits, Fourier Transform, and Learnability*.

Participated in the Workshop on Parameterized Complexity, held at IMSc during 7–9 December 2000.

Majumdar, Parthasarathi

Presented two lectures on *Quantum black hole entropy* and *Cosmological optical activity* at the Workshop on Field Theoretic Aspects of Gravity at IUCAA, Pune during October, 2000.

Presented two contributed papers on the same topics as item 1 at the HEP Symposium at the University of Hyderabad, in December, 2000.

Gave a lecture on *Quantum black hole entropy* at the Quantum Gravity Discussion Meeting at RRI, Bangalore, January, 2001.

Presented colloquia on *Black hole entropy* at Jadavpur University, S N Bose National Centre for Basic Sciences, Saha Institute of Nuclear Physics, Kolkata during March-April, 2001.

Lectured on *Quantum aspects of black hole entropy* at the First Workshop on Black Hole Astrophysics in Kolkata during April, 2001.

Presented a contributed paper on *Quantum black hole entropy* at Black Holes III Conference at Kannanaskis, Canada, during May, 2001.

Presented a contributed paper on *Cosmological Optical Activity* at the IX Canadian Conference on General Relativity and Relativistic Astrophysics at Edmonton, Canada, in May 2001.

Presented seminars on *Quantum aspects of black hole entropy* at McMaster University, Hamilton, Canada and University of Waterloo, Waterloo, Canada.

Presented a seminar on *Cosmological optical activity* at the University of Manitoba, Winnipeg, Canada in June, 2001.

Manoj, G

Visited TIFR, Mumbai during the period March 18- April 30 2001 and delivered a seminar.

Attended the 51st meeting of Nobel Laureates in Lindau, Germany during the period June 25-29, 2001.

Meenakshi, B

Attended the conference on Formal Techniques for Real-time and Fault Tolerant Systems (FTRTFT 2000) and the associated School held at TRDDC, Pune from September 18 to 22, 2000.

Attended the 20th FST & TCS conference and the pre-conference workshop on Programming Languages held at IIT, Delhi from December 11-15, 2000.

Attended the workshop on Automata, Concurrency and Logic and the preparatory school held at IMSc, Chennai from January 26-31, 2001.

Attended the workshop on Formal Methods for Design of Safety Critical Systems: Synchronous Approaches held at IISc, Bangalore from February 19-20, 2001.

Menon, Gautam I.

Delivered an invited talk, *Current Issues in Vortex State Physics: Theory Confronts Experiments*, at the one day Seminar on 'Frontier Areas of Condensed Matter Physics' held to commemorate the decennial year of IUC-DAEF, Mumbai, August 3, 2000.

Gave a seminar at the 'Centre for Condensed Matter Theory', Department of Physics, IISc., Bangalore on Oct 6, 2000 on *Phase Behavior of Disordered Superconductors.*

Attended the 'Conference on Current Trends in Theoretical Physics', held at the Harish-Chandra Research Institute, Allahabad on October 29-31, 2000.

Gave a TPSC Seminar at the Institute of Physics, Bhubaneshwar, on Oct 12, 2000 on *Phase Behavior of Disordered Superconductors.*

Gave a TPSC Seminar at Jawaharlal Nehru University, New Delhi on *Strange Solids, Exotic Liquids, Novel Glasses: Phase Behaviour of Type-II Superconductors*, October 16, 2000.

Gave a TPSC Seminar at Delhi University, New Delhi on *Phase Behaviour of Type-II Superconductors*, October 18, 2000.

Presented a series of 4 lectures on *Computational Physics* under the T.S. Ramadorai Endowment Programme at Vivekanda College, Chennai between November 6th and 9th. 2000.

Delivered an invited talk at 'Research Perspectives and Projections in Condensed Matter Physics', SNBCBS, January 2-4, (2001) on *A New Phenomenology for Disordered Type-II Superconductors.*

Delivered a set of 2 lectures at the L.A. Meera Meeting on 'Physics of Biological Systems', Dhvanyaloka, Mysore in February 2001 on *Physics of the Cytoskeleton and Motor Proteins.*

Attended the Workshop on 'Statistical Physics of Biological Information' at the Institute of Theoretical Physics, University of Santa Barbara, U.S.A, March 5-31, 2001.

Mishra, A. K.

Visited Central Electrochemical Research Institute, Karaikudi from November 12 to 16, 2000.

Visited Regional Research Laboratory, Bhopal from December 18 - 20, 2000. Presented a talk on *Chemisorption and STM studies of a copper layer on gold electrode.*

Participated in Discussion Meeting on Theoretical Chemistry at IIT, Kanpur from December 22 - 24, 2000. Delivered a talk on *Theory of chemisorption and STM at a metallic electrode.*

Visited Harish Chandra Research Institute, Allahabad from January 25 to February 9, 2001. Delivered a seminar on *Fock spaces and generalized quantum statistics.*

Murugesh. S

Participated in the International Conference on Geometry, Nonlinearity and Integrability in Condensed Matter & Soft Condensed Matter Physics, July 15 - 20, 2001, Bansko, Bulgaria.

Nagaraj, D.S.

Attended the Third National Discussion meeting on Commutative Algebra and Algebraic Geometry, held at IISc/JNC, Bangalore, during the period October 16 to 21, 2000. Delivered a talk titled *Complete Intersection and Cohomology of Line bundle.*

Attended the Advanced Instructional Workshop on Algebraic Number Theory and Cryptography, held at the Harish-Chandra Research Institute, Allahabad, from November 8 to 25, 2000. Delivered three lectures on *ℓ-adic representation attached to an elliptic curve over a*

Number field.

Delivered three lectures on *connectedness* as a Resource person, for the Refresher course in 'Topology' for college/University teachers at the Ramanujan Institute of advanced study in Mathematics university of Madras, held during December 2000.

Attended the International Conference on 'Number Theory' held at H.R.I, Allahabad, during the period December 26 to 29, 2000. Delivered a talk titled *Higher Circular ℓ-units of Anderson and Ihara.* Also, Chaired a session.

Visited TIFR, Mumbai, February 2001 to participate in a mini-conference organised around the visit by Professor G. Faltings of the Max-Planck Institute, Bonn, Germany.

As a Resource person, gave a series of 3 lectures on *Quasi-bialgebras* at the Institutional and Instructional Programme on Quantum Groups and their Applications held at the Ramanujan Institute of advanced study in Mathematics university of Madras, during March 2001.

Attended the National meeting on 'Combinatorial Methods in Group Theory and Number Theory' held at ISI Bangalore during the period May 14 to 20, 2001. Delivered a talk titled *A result of Anderson and Ihara.*

Paranjape, K.H

Visited IIT, Mumbai, during the month of December 2000. Taught a course on Algebraic Geometry in the NBHM Workshop on Cohomological Methods in Commutative Algebra.

Visited TIFR, Mumbai, February 2001 to participate in a mini-conference organised around the visit by Professor G. Faltings of the Max-Planck Institute, Bonn, Germany.

Visited California Institute of Technology, Pasadena, USA from 1st May 2001 to 31st May 2001. Delivered a lecture *Arithmetic objects are Geometrically rigid* on 23rd May 2001.

Visited the University of Chicago and delivered a lecture *A Weak Generalisation of Belyi's Theorem* on 17th June, 2001.

Rajasekaran.G

Participated in the conference on Neutrino 2000 at SINP, Calcutta during 8 - 11 August 2000 and gave a talk on*A synthesis of all the results from neutrino experiments and its implications for neutrino models.*

Participated in the meeting held at Visva-Bharati University, Shantiniketan on 12 August 2000 to discuss ways to foster High Energy Physics research in Universitites.

Gave the Dr.T.S. Ramadurai Endowment lecture on *Physics at the Turn of the Century* at Vivekananda College, Madras on 23 October 2000.

Participated in the Symposium on 'Current Trends in Theoretical Physics' at HRI, Allahabad during 29-31 October 2000.

Visited North Eastern Hill University, Shillong on 11 December 2000.

Attended the XIV Symposium on High Energy Physics at University of Hyderabad during 18 - 22, December 2000 and gave an invited talk on *Indian contributions to High Energy Physics in the Twentieth Century.*

Attended the International Strings 2001 conference at TIFR, Mumbai during 4 - 10 January 2001.

Attended the International Meeting on Theoretical Physics and Nonlinear Dynamics at PRL, Ahmedabad during 11 - 12 January 2001 and gave a talk on*Electroweak Theory without Higgs.*

Participated in the Conference on Neutrino 2001 at IMSc., Madras during 19 - 21 February 2001 and gave the talk on the *conference summary.*

Attended the symposium on 'Geometrical Phases, Quantum Optics and Foundation of Quantum Mechanics' held at IISc, Bangalore during 29 - 31 March 2001 and gave a talk on*Beyond Bose-Einstein and Fermi-Dirac Statistics.*

Participated in the Annual meetings of INSA at Delhi during 11 - 13 March 2001.

Visited University of California, Riverside, USA during May - July 2001 for collaborative research.

Visited Mc Master University, Hamilton, Canada on 23 May 2001.

Raman, Venkatesh

Delivered two lectures on *Randomized Approximation Algorithms* in the Randomization Workshop held at REC Tiruchi during 8-10 September.

Delivered three lectures on *Heaps: Binary, Binomial and Fibonacci* at a seminar series organized by Bharathidasan University, Tiruchi from 29th September to 1st October.

Delivered a talk on *Introduction to Algorithms* at the Department of Mathematics of IIT Madras on October 19, 2000, and at the 'Mathematics in the new Millennium' conference at Anna University on December 23, 2000.

Delivered a set of four lectures on *Graph Algorithms* at Sri Venkateswara College of Engineering, Sriperumbudur, during November 27th and November 29th 2000.

Visited the University of Leicester, UK, from May 31st to June 11th and delivered a lecture on *Introduction to Parameterized Complexity* on June 8th, 2001.

Ramanujam, R

Visited the International Institute for Software Technology, United Nations University, Macau, from August 3 to 7, 2000. Gave 2 talks there: *Finite state message passing systems* (August 4, 2000) and *Automata on the Web* (August 5, 2000).

Visited the Department of Computer and Information Science at the University of New South Wales, Sydney, Australia from November 18, 2000 to January 14, 2001. Gave a talk on *Temporal logic and message passing systems* (December 7, 2000).

Participated in the Australasian Conference on Parallel and Real-Time Systems, 28 November - 1 December, 2000, Sydney.

Ravindra, G.V.

Attended the CAAG conference at IISc. Bangalore.

Visited ISI Bangalore during the month of May. Lectured on a paper *Absolute Hodge cycles* by P. Deligne.

Sankaran, Parameswaran

Gave four lectures on *Surfaces* at the Academic Staff College, held at Ramanujan Institute for Advanced Studies in Mathematics, University of Madras, Chennai.

Gave two lectures on *Combinatorial group theory* at the National Instructional Conference on Low-Dimensional Topology, held at Allahabad University and Harish-Chandra Research Institute, Allahabad, during from 18/12/00 to 31/12/2000.

Gave four lectures on *Knots, links, and tangles,* and two on *Knizhnik- Zamolodchikov equations and quantum groups* in the 'Instructional and Institutional Conference on Quantum groups' held at Ramanujan Institute for Advanced Studies in Mathematics, Chennai during March 2001.

Sathiapalan, Balachandran

Attended the Strings-2001 Conference held at Mumbai in January 4-11th 2001.

Gave lectures at the SERC school held at HRI between February 24- March 6th, 2001, on *Introduction to String Theory.*

Sharatchandra, H.S.

Delivered an Invited Talk:*Reformulating Yang-Mills theory in terms of local gauge invariant variables* , at Lattice2000, Bangalore, Aug 2000.

Gave an Invited Talk :*Quantum gravity as a theory of quantized area bits fitting together* , at Conference on Current Topics in Theoretical Physics, HRI, Allahabad, Oct 29-31, 2000.

Delivered an Invited Talk: *Phase Space Wave Functions: Geometric Quantization as a practical tool* at Workshop on Geometric Phases and Foundations of Quantum Mechanics, CTS, IISc, Bangalore in March 2001.

Simon, R.

Visited Prof. Samuel L. Braunstein at the University of Wales, Bangor during the period 25th September - 11th October 2000 and gave a seminar on *Positive Maps* and a colloquium on *Entanglement in Continuous Variable Gaussian States*.

Visited Prof. Franco Gori at Universita' Roma Tre during the period 12th October - 3rd November 2000 and gave a seminar on *Fourier Optics of Vector Beams*, and one on *Symmetry and Group Structures in Classical Optics*.

Presented a Seminar on *Entanglement and the Geometry of tate Space in Quantum Theory*, at the University of Salerno on October 26, 2000.

Presented a Seminar on *Positive Maps and Quantum Entanglement*, at the University of Naples on October 27, 2000.

Delivered a course of lectures on *Quantum Theory* in the Refresher Course in Theoretical Physics sponsored by the Indian Academy of Sciences at the Bishop Moore College, Mavelikara, Kerala during November 6-20,2000.

Delivered a set of Rev. (Prof.) K.C. Mathew Endowment Lectures on *Unified Approach to Optics, Quantum Mechanics, and Quantum Information Processing* at the Bishop Moore College, Mavelikara, Kerala during January 24–25, 2001.

Attended the meeting on 'Emerging Trends in Theoretical Computing', March 14-15, 2001, held at the Bharathidasan University, Trichi and gave a talk on *Quantum Computing*.

Attended the meeting on 'Geometric Phases in Physics and Foundations of Quantum Mechanics', March 28–29, 2001, held at the Centre for Theoretical Studies, Indian Institute of Science, Bangalore and gave a talk on *Interference in phase space, geometric phase, and asymptotic expressions for classical orthogonal polynomials*.

Delivered a seminar on *Real biquadratic forms which are definite, but cannot be realized as sums of squares of bilinears*, at the Chennai Mathematical Institute on May 31, 2001.

Attended the meeting on 'Current Issues in Theoretical Physics', July 30–31, 2001, held at the Cochin University of Science and Technology, Cochin and gave a talk on *Quantum Information Processing*.

Sinha, Nita

Visited Université de Montréal, Montréal, Canada, 4, May 2001 to 4, June 2001.

Delivered an invited talk at the 'International workshop on B Physics and CP Violation, Taipei, Taiwan, June 8-10, 2001'.

Visited National Center for Theoretical Sciences in Taiwan, from 11, June to 17, June 2001. Presented a seminar at the Center.

Sinha, Rahul

Delivered a talk at the 'XIV DAE Symposium in High Energy Physics, Hyderabad'.

Visited Nagoya University, Nagoya, Japan, from 3, January 2001 to 17, January 2001.

Attended the 'Sapporo Winter School - Niseko 2001', Sapporo, Japan from 7, January 2001 to 11, January 2001.

Visited Nagoya University, Nagoya, Japan, from 13, February 2001, to 19, February 2001.

Attended the '$\mathcal{BCP}$-4, The Fourth International Conference on B physics and CP violation', Ise Shima, Japan, Feb 19-23, 2001.

Visited Université de Montréal, Montréal, Canada, 4, May 2001 to 4, June 2001.

Delivered an invited talk at the 'International workshop on B Physics and CP Violation, Taipei, Taiwan, June 8-10, 2001'.

Visited National Center for Theoretical Sciences in Taiwan, from 11, June to 17, June 2001.

Sinha, Sudeshna

Invited speaker at the Symposium on 'Synchronisation of Chaotic Systems' held in Trieste, 3-5 July 2000.

Invited Speaker at the International Conference on 'Perspectives in Theoretical Physics', Ahmedabad, January 8-12 2001.

Invited Speaker at the VIII Ramanujan Symposium on 'Recent Developments in Nonlinear Systems', Feb 14-16 2001.

Chairperson of a session at the VIII Ramanujan Symposium on 'Recent Developments in Nonlinear Systems' on Feb 16 2001.

Invited Speaker at the Workshop on 'Recent Theoretical Advances on Computation', Tiruchirapalli, March 14 2001 (supported by INSA Madurai Local Chapter).

Gave a series of lectures at the SERC School on *Chemical Dynamics*, IIT Madras, March 21-23 2001.

Gave a talk at the Physics Department of Cal Tech on 9 May 2001.

Gave a Theoretical Engineering Series Seminar at Bell Labs on 4 June 2001.

Visited the Bio Medical Engineering Department of Georgia Tech/Emory in Atlanta (June 2001).

Visited the Physics/Electrical Engineering Department of the University of Maryland (June 2001).

Sridhar, R

Visited School of Physics, University of Hyderabad, Hyderabad, May 21, 2001.

Srinivas, K

Visited Queen' University, Kingston, Canada for one year from July, 2000 and gave talks on *Introduction to cryptography and primality testing, On a lattice point problem for triangles, Distinct zeros of functions in the Selberg class* on Nov 8, Nov 24, 2000 and June 20, 2001 respectively.

Delivered a course of 36 lectures on *Linear Algebra* and *Calculus* each to the first year Engineering students at Queen's University, Kingston, Canada in the Winter term, 2001. Gave a Invited talk titled *On the Uniform distribution of certain sequences* in the Number Theory Seminar in Concordia Univeristy, Montreal, Canada on 10th May, 01

Attended Seaway Number Theory Conference in Carleton University, Ottawa, Canada and gave a talk titled *On the distinct zeroes of functions in the Selberg class* on May 23, 2001

Visited the Department of Mathematics, Univeristy of Toronto from 7-9th June 2001 and gave a talk titled *On the uniform distribution modulo 1 of certain sequences.*

Srinivasa Rao, K.

Delivered two lectures on *Ramanujan* in the 'Meet the Scientist' Programme organised by Anna University for students of schools on May 19 and 20, 2000.

Visited the Center for Mathematical Sciences, Trivandrum, from June 12 to June 23, 2000. Gave a series of 15 lectures on *Hypergeometric Sums and Transformations* in the Second SERC School on Special Functions of Matrix Argument, sponsored by the DST. Also Introduced Mathematica and packages of Hyp and Hyp-q developed by Prof. C. Krattenthaler to the participants. Gave two special lectures on the *life and work of Srinivasa Ramanujan* also during this period.

Gave an Invited Special Lecture on the *Life and Work of Srinivasa Ramanujan*, at the ADE, DRDO, Bangalore, on July 10, 2000.

Participated and gave an Invited talk: *On the Hypergeometric* ${}_3F_2(1)$ *series*, at the International Conference on the Works of Srinivasa Ramanujan, at the University of Mysore, July 1 and 2, 2000.

Gave a Guest Lecture on *the Works of Srinivasa Ramanujan* at Numera 2000, conducted by the Department of Mathematics, Ethiraj College, on Sep. 8, 2000.

Addressed the students of SRM College, Ramapuram as the Chief Guest at their 'Vibrants 2K' Culturals, on Sept. 8, 2000.

Gave an invited lecture on *Mathematics Career Openings in Teaching and Research* at a two-day meeting on the same theme at the Ramakrishna Mission Vivekananda College, Chennai on Sept. 11 and 12, 2000.

Gave an invited talk on *Hypergeoemteric Functions and Multiplicative Diophantine Equations*, in the International Conference on Number Theory and Combinatorics, held at the Panjab University, Chandigarh, form Oct. 2 to 4, 2000.

Delivered a lecture on Ramanujan at the Inter-Disciplinary Center, Cochin University of Science and Technology, Cochin, on Nov. 6, 2000.

Delivered the 'Professor K. Lakshminarayanan Memorial Lecture' entitled: *Twentieth Century Physics: an Overview* at the Ramakrishna Mission Vivekananda College, Chennai, on Jan. 30, 2001.

Invited to Inaugurate a Mathematics Workshop at the St. John's International Research School and to unveil a portrait of Ramanujan on the occasion, at the Residential School's premises, on Jan. 8, 2001.

Invited to address the students Assembly on Mathematics at the St. John's School, Villivakkam, on Jan. 10, 2001.

Invited to deliver a lecture on Ramanujan on the Science Day at Presidency College, Chennai, Feb. 28, 2001.

Invited to deliver a lecture on the *Life and Work of Srinivasa Ramanujan* at the Hindustan College of Engineering, on March 23, 2001.

Invited to address the students on the 'Remembrance Day' of Ramanujan, April 26, 2001, at the Savithri Ammal Oriental Higher Secondary School, Chennai, organised by the Nehru Children's Cultural Association.

Invited Participant to the International Conference on *Science and Metaphysics*, organized by the National Institute of Advanced Study, Bangalore, from June 24 - 27, 2001.

Visiting Scholar, at the Institute for Advanced Study, Shimla, from May 24 - 31, 2001. During this period delivered a lecture on *Complexity in Science and the Science of Complexity* on May 30, 2001.

Gave an invited lecture on the *Life and Work of Srinivasa Ramanujan*, at the Department of Applied Mathematics, Andhra University, Waltair, on July 6, 2001.

Gave a special lecture on *The Brain, the Computer and Artificial Intelligence* at the SSN College of Engineering, Kalavakkam, July 14, 2001.

Srinivasa Rao, S.

Attended the 20th FST & TCS conference, workshop on Recent Advances in Programming Languages and workshop on Computational Geometry held at IIT Delhi during December 11th to 17th, 2000.

Subramanian, C.R.

Presented a talk on *k-coloring* at the 8th Annual European Symposium on Algorithms (ESA'00), September 2000, held at Saarbrücken, Germany. The Symposium was organized by the Max-Planck Institute für Informatik (MPI), Saarbrucken, Germany.

Visited Professor C.E. Veni Madhavan of the Department of Computer Science and Automation, IISc, Bangalore, during August-October 2000.

Sunder, V.S.

Visited the Mathematical Sciences Research Institute, Berkeley as a Research Professor for four months, from mid-November 2000 to mid-March 2001, and participated in the activities held in that period as part of the year-long program they had on Operator Algebras. Delievered a lecture on *Flatness and fusion coefficients* (on November 30th) in their weekly seminar, and a lecture on *Spectra of principal graphs* (on December 6th) in the week-long workshop on 'Subfactors and algebraic aspects of quantum field theory'.

Visited the University of British Columbia, Vancouver for a few days and gave a Colloquium lecture titled *Principal graphs of subfactors* on February 2nd.

Visited the University of California at Riverside for a few days and gave a Colloquium lecture titled *Planar algebras: some examples* on February 28th.

Visited the University of Wales at Cardiff for a few days and gave a Colloquium lecture titled *On planar subalgebras* on March 20th.

Visited the University of Nottingham for a few days and gave a Colloquium lecture titled *Planar algebras: some examples* on March 21st.

Visited the Indian Statistical Institute, Bangalore for a few days in and gave a lecture on *Planar algebras* on May 2, 2001.

Gave six lectures on *metric spaces* (during May 21-26, 2001) in the MTTS Programme conducted at Pondicherry University.

Lectured on *Topological quantum field theories* at the 'Conference on Functional Analysis and its applications' held at the Indian Statistical Institute, Calcutta during June 13-15, 2001.

Suresh, S.P.

Attended the Workshop on 'Automata, Concurrency and Logic' at The Institute of Mathematical Sciences, Chennai, from January 29 to January 31, 2001.

Attended the Summer Seminar on 'Automata, Logic and Modeling' organised by the Calcutta Logic Circle at Calcutta University, Calcutta, from June 15 to June 22, 2001.

Presented the paper entitled *Information based reasoning about security protocols* at the 1st Workshop on 'Logical Aspects of Cryptographic Protocol Verification', on July 23, 2001 at Paris, France.

Attended the International Summer School 2001 on 'Proof and System- Reliability' from July 25, 2001 to August 4, 2001 at Marktoberdorf, Germany.

Thangadurai, R

Attended a workshop on Elliptic curves and Cryptography from Nov 9-21, 2000 held at Harish-Chandra Research Institute, Allahabad. Also, delivered two talks about *classical cryptosystems*.

Attended an International conference on Number Theory from Nov. 22-26, 2000 held at Harish-Chandra Research Institute, Allahabad. Also delivered a talk on *lattice point problem*.

Visited Harish-Chandra Research Institute, Allahabad from March 18, 2001 to April 18, 2001.

Attended a workshop on Combinatorial methods in Group theory and Number theory from May 14, 2001 to May 21, 2001 held at Indian Statistical Institute, Bangalore. Also, presented a survey about *zero-sum problems*.

Visited the John Knopfmacher institute of Applicable analysis and Number theory, University of Witwatersrand, Johannesburg, South Africa from 17th June to 17th July 2001.

Attended a workshop on Elliptic curves at Bhaskaracharya Pradistana, Pune from July 18-19, 2001.

Uma, V.

Attended the winter school on 'Cohomological Methods in Commutative Algebra' organised by the Department of Mathematics, IIT Mumbai,during the period, November 27 – December 13, 2000.

2.10 Collaborative Projects with Other Institutes

2.10.1 Project on Electrochemical Interface

A DST-DAAD joint research project on 'Metal Insulator Transition in an adsorbate layer at an Electrochemical Interface', involving Institute of Mathematical Sciences (India) and University of Ulm (Germany), has been approved. Tarun K. Ghosh (IMSc) and A. K. Mishra (IMSc) are the project members from Indian side, and Prof. W. Schmickler (University of Ulm) is the German participant. The project duration is for two years, and it commences from June 2001.

2.10.2 Project on Syntactic Methods for Verification

This a project supported by the Indo-French Centre for Promotion of Advanced Research. The general purpose of this project is to extend the methods of automata theory to be able to handle concurrent processes, towards the construction of efficient verification tools. The duration of this project is August 2000 – August 2003. The researchers involved in the project are K. Lodaya, R. Ramanujam from IMSc, and M. Mukund and N. Kumar from CMI in the Indian side and P. Weil, P. Gastin, J.-M. Couvreur, A. Petit and J.-E. Pin from the French side.

K. Lodaya visited France in Aug–Sep 00 under the project. He also participated in a Summer School in Birmingham, and a Workshop in Dresden. P. Weil, P. Gastin, J.-M. Couvreur, A. Petit visited Chennai in Jan–Feb 01 under the project. They participated in the Workshop on Automata, Concurrency and Logic held here.

2.10.3 Project on Highly Efficient Data Structures

This is a project approved under the UK-India Science and Technology Research Fund of DST. The principal investigators are Rajeev Raman from University of Leicester, U.K and Venkatesh Raman and S. Srinivasa Rao from IMSc.

In this project, data structuring problems which involve maintaining dynamically changing data are considered, such as sets of integer or floating-point keys.

Under this project, in the year 2001, Rajeev Raman visited IMSc from March 25th to April 15th and Venkatesh Raman visited University of Leicester from May 31st to June 12th.

Some research on succinct dynamic data structures has been already done as part of this project.

2.10.4 Indo-Russian Integrated Longterm Programme in S & T

Advisory Committee: R Ramachandran, A Belavin, A Morozov, P Kulish and V Rubakov.

Organizing Committee: A Filippov, A Isaev, T R Govindarajan, D Kazakov and S Pakuliak.

This is a three year (1998-2000) project. Under this programme a Russian-Indian workshop on Topological and Integrable field theories was organized at the Bogoliubov Laboratory for

Theoretical Physics, Joint Institute for Nuclear research (Dubna), Russia duiring August 11-14, 1998. The lectures and reports at the workshop covered Integrable models, Quantum Symmetries, Topological Field theories and New developments in String theory. R Ramachandran, T R Govindarajan, R Jagannathan from IMSc, Anjan Kundu from Saha Institute of Nuclear Physics, Sunil Mukhi from the Tata Institute of Fundamental Research, Jnanadev Maharana from the Institute of Physics and Dileep Jatkar from Mehta Research Institute participated in the workshop from India.

2.10.5 Project in Parametrized Complexity

This project comes under the DST-DAAD Personnel Exchange Programme-99 for the period April 1999-March 2001, and has now been extended until May 2002. The project is titled "Complexity and Algorithmic Issues in Fixed Parameter (In)tractability". The researchers involved in the project are V Arvind, M. Mahajan, V. Raman and S. S. Rao of IMSc, and K. V. Subramanyam of CMI on the Indian side. From the German side J. Koebler, W. Lindner, and O. Beyersdorff of Humboldt University at Berlin, and R. Schuler of Ulm University. The following research visits were made in 2000–2001 as part of the project by W. Lindner in December 2000, and by W. Lindner, J. Köbler, R. Schuler, and O. Beyersdorff in March 2001, and V. Raman (to Ulm) in July 2001.

2.10.6 DST-NSF exchange programme in Mathematical Physics

This project is a three year exchange programme under which visits are under taken by some scientists in the USA to India and vice versa to work in the area of Spectral and Inverse spectral theories of Schroedinger Operators. The scientists involved in the project are P Hislop, University of Kentucky, W Craig, Brown University and F Gesztesy, University of Missouri and M Krishna, IMSc, K B Sinha, Indian Statistical Institute and A Mohapatra, University of Goa. In addition to joint research work a conference on the above subject was held at the University of Goa during 14-20 December 2000. The proceedings of this conference is expected to come out as a special issue of the Proceedings of the Indian Academy of Sciences (Mathematical Sciences).

2.10.7 Federation agreement with Abdus Salam ICTP

Federation arrangement with Abdus Salam ICTP, Trieste has been renewed for three years from 1999. Under this scientists from IMSc can visit ICTP with expenses paid for a minimum period of 3 weeks. It has become a convention that the younger colleagues make use of funds under this arrangement for the visits.

2.11 Other Professional Activities

Balasubramanian, R.

Member, Fellowship Scrutiny Committee, The National Academy of Sciences, Allahabad.

Convener, Sectional Committee, Indian National Science Academy, Delhi.

Member, Governing Council, Chennai Mathematical Institute.

One of the Managers of the NBHM, CNRS Agreement for the Indo-French Cooperation.

Member, Executive Committee for the School of Mathematics, Anna University.

Barve, Sukratu

Conducted tutorials for the course in quantum mechanics by Prof. N.D. Hari Dass in a school for undergraduate students held by the Indian Institute of Astrophysics at the observatory at Kodaikanal, India (June 2001).

Baskaran, G

Member of the *Shanti Swarup Bhatnagar Award* Committee for Physics - 2000.

Member of the *Professor Y.T. Thathachari Prestigious Research Award* Committee for Science - 2001.

Scientific Council Member of *International Center for Condensed Matter Physics*, Brasilia, Brazil.

Basu, Rahul

Member of National Organising Committee of WHEPP-7, to be held in January 2001.

Chakraborty, Tapas

Wrote a two part article on *A Novel Light Source in Nanostructures* for 'The Hindu'. It appeared on April 26 and May 3, 2001.

Hari Dass, N.D.

Secretary to the Organising Committee for the *International Symposium on Lattice Field Theory,* Aug. 17-22, 2000 at Bangalore.

Kesavan, S.

Conducted Mathematics Quiz, Sri Sankara Senior Secondary School, Adyar, August, 2000.

Judge, Millennium Mathe Day, Expository Talks, Padma Seshadri Bala Bhavan Senior Secondary School, October, 2000.

Member, Curriculum Development Committee, UGC, New Delhi, 2001.

Member, National Board for Higher Mathematics, DAE, Government of India.

Member, Editorial Board, *Mathematics Newsletter of the Ramanujan Mathematical Society.*

Organized the contact programme of the Nurture Programme (NBHM), June 19 - July 7, 2001.

Krishna, M.

Attended a few review meetings of the DST math committee.

Lodaya, Kamal

Member, Programme Committee, 20th FSTTCS Conference, Dec. 13-15, 2000.

Treasurer, Indian Association for Research in Computing Science, 2000-01.

Mahajan, Meena

One of the organizers of the *Workshop on Parameterized Complexity,* held at IMSc during Dec. 7-9, 2000.

Menon, Gautam I.

Organizing Committee of *India and Abroad: A Conference on Condensed Matter Physics*, to be held in Bangalore between Jan 2-4, 2002.

Rajasekaran, G.

Member of the Physics Sectional Committee, INSA, New Delhi.

Member, Governing Council of HRI, Allahabad.

Chaired the National Advisory Committee for the *Symposium on Current Trends in Theoretical Physics,* HRI, Allahabad held in October 2000.

Actively involved in the promotion of the *Indian Neutrino Observatory*, a joint project that is being undertaken by various institutions in the country.

Raman, Venkatesh

Joint organizer, Workshop on Randomized Algorithms at REC Tiruchi, Sept. 8-10, 2000.

One of the organizers of the *School on Algorithmic Techniques for Hard problems,* and the *Workshop on Parameterized Complexity* held at IMSc during Dec. 4-6, 2000 and Dec. 7-9, 2000 respectively.

Simon, R.

Member, Editorial Board, *Pramana.*

Member, Programme Advisory Committee (PAC) of the Department of Science and Technology on *Lasers, Optics, and Atomic & Molecular Physics.*

Co-Editor for the December 2000 Feature Issue of Journal of the Optical Society of America A on *Wigner Distributions and Phase Space in Optics.*

Sinha, Rahul

Member, National organizing committee for XIV *DAE Symposium in High Energy Physics*, held at University of Hyderabad, December 2000.

Sinha, Sudeshna

Member of the Advisory Editorial Board of the AIP journal *Chaos.*

Sridhar, R.

Member, Local Organising Committee, *National Meet on Advances in Magnetic Materials and Applications,* at Department of Nuclear Physics, University of Madras, Guindy Campus, Chennai. Also chaired a session.

Member, Local Organising Committee, *Symposium on Current trends in Magnetism,* Department of Nuclear Physics,University of Madras, Guindy Campus, Chennai, Feb. 19-22, 2001.

Srinivasa Rao, K.

Editor for Newsletter & Librarian, Society for Special Functions and their Applications.

Organizing Committee Member and one of the Resource persons for the Second SERC School on Special Functions of Matrix Argument, sponsored by the DST and conducted by the Center for Mathematical Sciences, Trivandrum from June 12 to 23, 2000.

Convened and conducted a Workshop on *Mathematica and hypergeometric series*, at the Institute of Mathematical Sciences, Chennai (Sep. 18-22, 2000) for a group of 16 selected participants.

Convened and Conducted the Second Annual conference of the Society for Special Functions and their Applications, at Lucknow, (Feb. 2-4, 2001).

Convened and Conducted a two-day meeting on *Facets of Consciousness*, at the CLRI, Chennai, on March 9 and 10, 2001. This conference was sponsored by the National Brain Research Center, the DST and the Chennai Chapter of CSI.

A CD-ROM Project to produce two CDs on the life and work of Srinivasa Ramanujan has been approved by the Department of Science and Technology. Contents for the CDs will be provided by the IMSc (under the supervision of Dr. K. Srinivasa Rao) and the Master Copy of the CDs will be produced by the National Multi-media Research Center of C-DAC, Pune (under the supervision of Mr. D. Katre). This is expected to be a project for 2 years for which the first instalment of 3.38 lakh Rupees has been released in July 2001 by the DST.

Authored the article *Remembering a Wizard*, published in the Metroplus, the Hindu, dated Dec. 22, 2001.

Authored the article *Unravelling the Brain* published in the Metroplus, the Hindu, dated march 8, 2001.

Sunder, V. S.

Member, Editorial Board for the *Journal of the Ramanujan Mathematics Society.*

Member, Editorial Board of the *Proceedings of the Indian Academy of Sciences (Math. Sci.).*

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

Member of the *Technical Advisory Committee* of the Indian Statistical Institute.

Member of the NBHM Committee to *Examine possible initiatives for promoting mathematical activities among women.*

Member of the CSIR Mathematical Sciences Research Committee to assess *various proposals.*

2.12 Visitors

Name	Affiliation	Period of Visit
U. Ray	Univ. De. Reims, France	01.08.00 - 19.08.00
Srinath Cheluvaraja	Lousiana State University, Batou Rouge	01.08.00 - 08.08.00
Pushan Majumdar	IISc, Bangalore	08.08.00 - 12.08.00
Uri Maor	Tel Aviv University, Israel	10.08.00 - 21.08.00
Ram Kishore	INPE, S.J. Campos, Brazil	16.08.00 - 25.08.00
Kamales Kar	SINP, Calcutta	16.08.00 - 25.08.00
Gautami Bhowmik	Universite de Lille 1, France	17.08.00 - 24.08.00
A.J. Parameswaran	Tata Institute of Fundamental Research, Mumbai	21.08.00 - 01.09.00
Arundhati Dasgupta	Max Planck-Institute for Gravitation, Germany	27.08.00 - 31.08.00
Arifa Alikhan	Center for Computational Physics, University of Tsuruba, Japan.	28.08.00 - 30.08.00
Rajat K. Bhaduri	McMaster University, Hamilton, Ontario, Canada	03.09.00 - 08.09.00
S.P. Chokalingam	The American College, Madurai	05.09.00 - 09.09.00
Christian Krattentaaler	Institut Fur Mathematik, Universitat Wien	06.09.00 - 23.09.00
Leong Chung Wei Bernard	University of Cambridge, Cavendish Laboratory	07.09.00 - 13.09.00

S. Srinivasan	Radio Astronomy Centre, TIFR, Ooty	10.09.00 - 22.09.00
V. Sunil Kumar	University of Hyderabad, Central Univ., Hyderabad	17.09.00 - 06.10.00
Michael R. Fellows	Univ. of Victoria, BC Canada	22.09.00 - 09.12.00
David Sinnou	Univ. Paris VI, Paris, France	07.10.00 - 14.10.00
M. Waldschmidt	Institut De Mathematiques, Universite P.Et.M. Curie, France	15.10.00 - 04.11.00
N.V. Vinodchandran	NEC Research Institute, Princeton, NJ, USA	18.10.00 - 21.10.00
G. Ananthakrishna	IISc, Bangalore	27.10.00 - 29.10.00
T.M. Janaki	Triplicane, Chennai	01.11.00 - 31.12.00
P. Ramadevi	IIT, Mumbai	27.11.00 - 26.12.00
Martin Leucker	RWTH Aachen, Germany	29.11.00 - 03.12.00
N. Panchapakesan	Univ. of Delhi, Delhi	03.12.00 - 09.12.00
Rohini Godbole	IISc, Bangalore	04.12.00 - 04.12.00
Abhishek Srivastava	IIT, Kanpur	10.12.00 - 22.12.00
Mrinal Dasgupta	DESY, Hamburg	12.12.00 - 15.12.00
Supriya Kar	Institute of Theoretical Physics, Chalmers Univ. of Technology,	13.12.00 - 15.12.00
N. Yngne Ohrn	University of Florida, Gainesville, USA	15.12.00 - 18.12.00
Sujata Tarafdar	Jadavpur University, Calcutta	18.12.00 - 19.12.00
S. Kotani	Osaka University, Japan	21.12.00 - 24.12.00

Arindam Bose	University of Pune, Pune	24.12.00 - 06.01.01
C.V.K. Baba	Nuclear Science Centre, New Delhi	26.12.00 - 30.12.00
Hayat Legrand	University of Toulouse, France	03.01.01 - 19.03.01
Ruby Salestina M	University of Mysore, Manasagangotri, Mysore	04.01.01 - 20.01.01
Michael R Douglas	Roteers University Piscataway, USA	10.01.01 - 12.01.01
Alexandet Bais	Inst. for Theo. Physics, University of Amsterdam, Netherlands	11.01.01 - 15.01.01
Biswaroop Mukherjee	IISc, Bangalore	12.01.01 - 26.01.01
Bigatti Daniela	Weiemann Institute for Physics, Israel	13.01.01 - 18.01.01
Jeff Edmonds	York University, Canada	16.01.01 - 20.01.01
F. Bastianelli	University of Bologne, Italy	16.01.01 - 22.01.01
Shigeru Kanemitsu	Grad. School of Adv. Techn. University of Kiruki	27.01.01 - 07.02.01
Peter Zvengrowski	University of Calgary, Canada	03.02.01 - 26.02.01
Vander Jegut Joris	University of Ghent, Belgium, Gent	05.02.01 - 11.02.01
V K Gaur	IIA, Bangalore	06.02.01 - 06.02.01
Debasis Dan	Institute of Physics, Bhubaneswar	11.02.01 - 14.02.01
Kamales Kar	SINP, Calcutta	12.02.01 - 23.02.01
Uma Iyer	HRI, Allahabad	12.02.01 - 05.04.01
W. Nolting	Institut for Theoretical Physics, Humboldt University, Germany	20.02.01 - 21.02.01

Rathin Adhikari	Jadavpur University, Calcutta	20.02.01 - 01.03.01
Osamu Suzuki	Nihon University, Tokyo, Japan	26.02.01 - 14.03.01
Arun Paramakanti	TIFR, Mumbai	05.03.01 - 06.03.01
Suresh Nayak	HRI, Allahabad	04.04.01 - 05.04.01
K. V. Shajesh	PRL, Ahmedabad	02.01.01 - 31.03.01
R. Srinivasan	ISI, Bangalore	19.03.01 - 19.04.01
Tapobrata Sarkar	TIFR, Mumbai	22.03.01 - 03.05.01
P.K. Manoharan	TIFR, Radio Astronomy Centre, Ooty	16.04.01 - 23.04.01
K.L. Sebastian	IISc, Bangalore	20.04.01 - 22.04.01
Riddhi Shah	TIFR, Mumbai	23.04.01 - 28.04.01
Debashis Ghoshal	HRI, Allahabad	23.04.01 - 28.04.01
Pushan Majumdar	TIFR, Mumbai	01.05.01 - 05.05.01
J. Yakhmi	BARC, Mumbai	15.05.01 - 16.05.01
Tanmay Vachaspati	TIFR, Mumbai	16.05.01 - 23.05.01
Vijay Chandru	IISc, Bangalore	21.05.01 - 21.05.01
Vishvajit V S Gautam	Apeejay College of Engg., Sohna Vill. Silaji, Haryana	22.05.01 - 23.06.01
Pushan Majumdar	TIFR, Mumbai	30.05.01 - 10.06.01
Aalok Pandya	University of Rajasthan, Jaipur	14.06.01 - 29.06.01
Kamales Kar	SINP, Calcutta	20.06.01 - 05.04.01

C.V.K. Baba	Nuclear Science Centre, New Delhi	01.07.01 - 14.07.01
Srinath Baba	Queens University, Kingston, Canada	01.07.01 - 14.07.01
Roy Joshua	Ohio State University	11.07.01 - 30.07.01
Andreas Rosenschon	Duke University, USA	18.07.01 - 08.08.01

2.13 Honours and Awards

Balakrishnan, Radha was awarded the Tamil Nadu Scientists Award(TANSA) for Physical Sciences, for 1999, by the Tamil Nadu State Council for Science and Technology.

Balasubramanian, R. was awarded the Srinivasa Ramanujan Birth Centenary Award, for 2000-2001, by the Indian Science Congress Association.

Menon, Gautam I. was awarded the Fast Track Fellowship, for 2000-2001, under SERC Fast Track Proposals for Young Scientists.

Srinivasa Rao, K. was awarded *Popularisation of Science* Award for the year 2000, instituted by the Tamil Nadu Council for Science and Technology, for the *πie Pavilion*, the *Ramanujan Gallery* and the *Ramanujan Photo Gallery* designed and created for the ISCE 99 and now housed in the Periyar Science & Technology Center, Kotturpuram.

Chapter 3

Computer Facilities

The following is a list of acquisitions and upgrades made for the computer facility of the Institute.

- All the old access stations (Pentium 166/200MHz) have been replaced with Pentium III, Multimedia, 17" flat screen systems and are loaded with Mandrake 7.2 Linux O/S
- Office and Administration network systems have also been replaced with Pentium III systems working under the WIN-NT O/S.
- Separate internet link through radio/leased line has been established at a speed of 2Mbps band width and it has been integrated with the existing LAN through a Linux firewall.
- LAN is extended to the new guest house complex through the fiber backbone.
- Two multimedia systems have been added to the library network.

Dr. S. Arun Kumar resigned from his post as ERNET Project staff on November 28, 2000 and Dr. A. V. Ashokan was appointed in his place.

Chapter 4

The Library

The Institute library holds a total collection of 44996 books and bound periodicals as on 31.3.2001 including 2540 volumes added during the year. The library subscribes to 260 national and international journals covering Theoretical Physics, Mathematics and Theoretical Computer Science. The library is well developed in these areas both in books and international journals (including back volumes) and is a resource for research workers of the entire southern region. The NBHM has recognised this Institute library as the Regional Library for Mathematics.

The library has access to the following **ONLINE JOURNALS**.

1. AMS

Conformal Geometry and Dynamics
Journal of the AMS
Mathematics and Computation
MathSciNet
Proceedings of the AMS
Representation Theory
Transactions of the AMS

2. APS (PROLA)

Reviews of Modern Physics
Physical Review A
Physical Review B
Physical Review C
Physical Review D
Physical Review E
Physical Review Letters

3. SPRINGER VERLAG

Inventiones Mathematicae
Numerische Mathematik
Mathematische Annalen
Mathematische Zeitschrift

European Physical Journal A
Europena Physical Journal B
European Physical Journal C
European Physical Journal D
Communications in Mathematical Physics
Acta Informatica
Archive for Rational Mechanics and Analysis

4. WORLD SCIENTIFIC

Communications in Contemporary Mathematics (CCM)
Fractals
Int'l Journal of Foundations of Computer Science (IJFCS)
Int'l Journal of Modern Physics A (IJMPA)
Int'l Journal of Modern Physics B (IJMPB)
Int'l Journal of Modern Physics C (IJMPC)
Int'l Journal of Modern Physics D (IJMPD)
Int'l Journal of Modern Physics E (IJMPE)
Journal of Knot Theory and Its Ramifications (JKTR)
Modern Physics Letters A (MPLA)
Modern Physics Letters B (MPLB)
Reviews in Mathematical Physics (RMP)

5. SCIENCE DIRECT

Annals of Pure and Applied Logic
Astroparticle Physics
Chaos, Solitons, and Fractals
Comptes Rendus de l'Acadmie des Sciences - Series I - Mathematics
Information Processing Letters
Journal of Geometry and Physics
The Journal of Logic Programming
Nuclear Physics A
Nuclear Physics B
Nuclear Physics B - Proceedings Supplements
Optics Communications
Physica A: Statistical Mechanics and its Applications
Physica B: Condensed Matter
Physica C: Superconductivity
Physica D: Nonlinear Phenomena
Physica E: Low-dimensional Systems and Nanostructures
Physics Letters A
Physics Letters B
Physics Reports
Reports on Mathematical Physics
Science of Computer Programming
Theoretical Computer Science
Topology

6. IOP

Journal of Physics A: Mathematical and General
Journal of Physics B: Atomic, Molecular and Optical Physics
Journal of Physics: Condensed Matter
Journal of Physics C: Solid State Physics
Journal of Physics G: Nuclear and Particle Physics
Classical and Quantum Gravity
Inverse Problems
Journal of Optics A: Pure and Applied Optics
Journal of Optics B: Quantum and Semiclassical Optics
Nonlinearity
Physics Education
Reports on Progress in Physics

In addition, online access is available for the journals 'Nature' and 'Science' .

The online access is restricted to Institute Members only.

SERVICES:

Apart from acquiring the books recommended by the users, library offers , reprographic and inter library borrowing services. Using LIBSYS software, the library catalogue has been computerized and is now available online to the readers both within and outside the Institute.

Currently efforts are on to establish Digital Inter Library Loan (DILL) facility among various institutions under the DAE.

ACKNOWLEDGMENT

The library gratefully acknowledges the donation of valuable books and journals received during the current year from the persons and organisations mentioned below:-

Balakrishnan, Radha, IMSc
G. Baskaran, IMSc
Purusattam Ray, IMSc
Pushan Majumdar, IMSc
R. Simon, IMSc
Tapash Chakraborthy, IMSc
Venkatesh Raman, IMSc
Mrs. Sutapa Nag
TCS Group, IMSc
Kamal Lodaya, IMSc
Ramaswamy, V

NBHM
Door Programme
International Mathematical Union
Mathematical Society of Japan
Prentice Hall
Princeton University press
Researchco Periodicals organisation
Springer Verlag