THE INSTITUTE OF MATHEMATICAL SCIENCES

C.I.T. Campus, Taramani

Madras 600 113, India

ANNUAL REPORT

August 1997 – July 1998

Foreword

As decided last year, the Annual Report from now on will cover the academic activities of the Institute during the period August - July. In this way we hope that the concept of academic year will take a more formal root in the Institute. This notion is appropriate for an Institution whose activities are akin to that of a University Department. It further emphasises that ours is not a specific goal oriented pure Research organisation, but instead, endorses the spirit of a University, which is expected to combine in it three distinct interrelated roles: Scholarship generation and its nurturing; Teaching, training and human resource development; and Counselling for the society and the Government. While we are primarily a Research Institute, research in basic sciences inevitably incorporates a significant component of teaching as an ingredient. It is therefore natural that we co-ordinate with the Universities and other Teaching Institutions in augmenting the training potential in disciplines of interest to our Institute.

We are now engaged in identifying research partners from among the University personnel through the programme of Institute Associateship. Under this, we hope to augment research collaborations and build much needed bridges between Universities and Research Institutes. While this should provide the University teachers the research infrastructure, it will give us an opportunity to contact the ever fresh student environment of our universities and colleges.

The golden jubilee of the country's independence was commemorated by us through a sequence of Public Lectures entitled *Swarnajayanti Public Lectures on Frontiers of Science*, with a view to take Science and its excitement to the lay public. This was also an occasion to take an introspective view of the status of research in independant India. Accordingly, we hosted a 3 day seminar on *50 years of Indian Mathematics*, during which significant advancements made in various disciplines of Mathematics were highlighted by the experts. Another feature of the seminar were two very interesting panel discussions, on Mathematics Education, and on Research in the Indian Institutions, and there were numerous interesting suggestions that were generated by the event.

Among the laurels won for the Institute by its faculty, I should like to highlight the recently announced SWARNAJAYANTI Fellowship to Madan Rao, and the Satyendra Nath Bose Medal awarded to G. Rajasekaran. Further I am proud of the election of S. Kesavan and V.S. Sunder as Fellows of the National Academy of Sciences (Allahabad) and the honorary doctorate conferred on Tapash Chakraborty by University of Oulu, Finland. I offer my warm felicitation to K Srinivasa Rao who completed his silver jubilee with the Institute. It is appropriate to take note that the following members of the Institute have completed more than 25 years of service to the Institute: Sarvashri A.R. Balakrishnan, G. Elumalai, R. Ganapathi, R. Jayaraman, S. Krishnan, N.S. Sampath and G. Venkatesan; and their service to the Institute is warmly appreciated.

The annual report has been compiled through the efforts of a committee consisting of V.S. Sunder, T.R. Govindarajan, Venkatesh Raman, P. Ray, K.S. Santhanagopalan and Sudeshna Sinha; further G. Venkatesan provided some support to them, and to all of them I owe my gratitude.

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

R. Ramachandran
Director.

August 1998

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Chapter 1

The Institute

1.1 Board

Thiru **K. Anbazhagan**, Minister for Education, Government of Tamil Nadu, Chennai
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(**Vice Chairman**)

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(**Member**)

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

Prof. **H.S. Mani**, Director, Mehta Research Institute of Mathematics and Mathematical Physics, Allahabad
(**Member**)

Dr. **J. K. Bhattacharjee**, Department of Theoretical Physics, Indian Association for the Cultivation of Science, Calcutta
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(**Member**)

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

1.2 Executive Council

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(**Member**)

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Dr. **J. K. Bhattacharjee**, Department of Theoretical Physics, Indian Association for the Cultivation of Science, Calcutta
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Smt **Sudha Bhave**, I.A.S., Joint Secretary to Government of India, Department of Atomic Energy, Mumbai
(**Member**)

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(**Member**)

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

PATRON
Shri **C. Subramaniam**

1.3   Faculty

email: userid@imsc.ernet.in

MATHEMATICS

Name	*Userid*	*Res. Phone No*
Balasubramanian, R.	balu	245 3926
Inamdar, S.P.	inamdar	492 5715
Kesavan, S.	kesh	641 2839
Kodiyalam, Vijay	vijay	490 2041
Krishna, M.	krishna	492 8499
Nag, S.	nag	
Nagaraj, D.S.	dsn	
Paranjape, Kapil H.	kapil	492 7243
Srinivas, K.	srini	
Sunder, V.S.	sunder	858 3343

PHYSICS

Anishetty, R.	ramesha	496 0586
Balakrishnan, Radha	radha	235 1365 Ext.5060
Baskaran, G.	baskaran	492 7304
Basu, Rahul	rahul	245 4794,245 3297
Chakraborty, Tapash	tapash	
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	401546
Jayaraman, T.	jayaram	492 9527
Kaul, Romesh	kaul	441 3264
Majumdar, Parthasarathi	partha	413254
Mishra, A.K.	mishra	
Murthy, M.V.N.	murthy	235 2652
Parthasarathy, R.	sarathy	442 2201
Rajasekaran, G.	graj	441 3395
Rama, S. Kalyana	krama	
Ramachandran, R. (Director)	rr	442 0387

Name	*Userid*	*Res. Phone No*
Rao, Madan	madan	
Ray, Purusattam	ray	492 8251
Sathiapalan, Balachandran	bala	492 7832
Shankar, R.	shankar	235 0436
Sharatchandra, H.S.	sharat	441 8059
Simon, R.	simon	441 3270
Sinha, Rahul	sinha	
Sinha, Sudeshna	sudeshna	492 7243
Sridhar, R.	sridhar	441 9145
Srinivasa Rao, K.	rao	441 1347

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Arvind, V.	arvind	235 2556
Lodaya, Kamal	kamal	
Mahajan, Meena	meena	441 3403
Raman, Venkatesh	vraman	
Ramanujam, R.	jam	492 8138
Seth, Anil	seth	492 7647

SCIENTIFIC OFFICER

Subramoniam, G.	gsmoni	237 9520

1.4   Post-Doctoral Fellows

Name   *Userid*

MATHEMATICS

Bhattacharyya, Tirthankar*   tirtha
Biswas, Jishnu   jishnu
Chakraborthy, Kalyan   kalyan
Mitra, Mahan*   mahan
Gendron, Tim   gendron

PHYSICS

Adhikari, Rathin   rathin
Ghosh, P.K.   pijush
Kar Gupta, Abhijit   abhi
Mehta, Mitaxi   mitaxi
Ramakrishna, S.*   ramki
Sengupta, Gautam*   gautam
Sinha, Nita   nita

THEORETICAL COMPUTER SCIENCE

Kamakoti, V.   kama

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* *tenure at IMSc is over*

1.5 Ph.D. Students

Name	*Userid*

MATHEMATICS

Bhattacharya, D.*	dakshini
Rajesh, M.	rajesh
Ramana, D. Surya	suri
Ravindra, G.V.	ravindra
Sabu, N.	sabu
Srinivasan, R.	vasanth
Suresh, I.	isuresh

PHYSICS

Babu, Dutta Sreedhar	sbdutta
Bal, Subrata.	subrata
Balaji, K.R.S.	balaji
Chaudhuri, Sarasij Ray	sarasij
Das, Jayajit	jayajit
Das, Saurya	saurya
Dasgupta, Arundhati	dasgupta
Ghosh, Tarun Kanti	tkghosh
Majumdar, Pushan	pushan
Manoj, G.	manoj
Mishra, Anup Kumar	anup
Murugesh, S.	mgesh
Rema, K.	rema
Sarkar, Tapobrata	sarkar
Sinha, Subhasis	subhasis
Sumithra, S.R.	sumithra
Surendran, Naveen	naveen
Varadarajan, Suneetha	suneeta
Vathsan, Radhika	radhika

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* *tenure at IMSc is over*

Name	*Userid*

THEORETICAL COMPUTER SCIENCE

Madhusudan, P.	madhu
Mohalik, Swarup Kumar*	swarup
Nagaraj, S.V.*	svn
Srinivasa Rao, S.	ssrao
Suresh, S.P.	spsuresh
Vinodchandran, N.V	vinod

1.6   Administrative Staff

Sethuraman, G.	Chief Administrative Officer
Jayaraman, R.	Administrative Officer
Krishnan, S.	Accounts Officer
Santhanagopalan, K.S.	Librarian

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

Chapter 2

Academic Activities

2.1 Summary of research

2.1.1 Mathematics

Algebra

The behaviour of the Catelnuovo-Mumford regularity of powers of an ideal has been investigated over the last few years by various people. It has been shown ([M:Ko]) that this behaviour is actually asymptotically linear and the leading constant has been identified.

Algebraic Geometry

One of Jonathan Wahl's conjectures regarding configuration of lines has been proved. Another result of Jonathan Wahl (which was originally proved using representation theory and consequently valid only in characteristic zero) has been given a purely geometric proof, which is valid in all characteristics.

Ongoing collaboration ([M:Nr2]) has led to a sort of generalisation (to higher ranks) of D. Gieseker's work on the compatification of moduli space of vector bundles of rank two and odd degree on a nodal curve; this came about as a result of a nice compatification of moduli space of vector bundles of fixed rank and degree (rank and degree coprime) on a nodal curve.

Also, various aspects of principal G-bundles on projective manifolds have been generalized ([M:Nr3]) to G-bundles on projective manifolds with parabolic structure over a divisor.

Recent work by M. Levine, A. Suslin and A. Voevedsky suggest that the construction of the category of *Motives* which was alluded to in the work of Grothendieck may be quite simple. Yet another construction of this category has been obtained from the directions of homotopical algebra (rather than homological algebra used earlier). This should have the advantage of understanding the motivic structure of the fundamental group. One important unsolved problem is proving the equivalence of the various constructions!

One has also to study this category and demonstrate most of the results which are already known for the singular, étale and other cohomology theories; in particular, the *Hard Lefschetz theorem* is not yet proved.

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Some fundamental results in Algebraic Cycles were studied with an aim to further research on related topics. Some interesting problems have been identified for the Ph.D. research work for the students. The visitors Luca Barbieri Viale, Jishnu Biswas and I. Kimura also lectured on material closely related with this seminar.

A study has been made of the results of O. Mathieu on the relation between certain group theoretic conjectures and the famous Jacobian conjecture. In particular, M. V. Nori's counter-example to one of the group theoretic conjectures was studied. The study also indicated that the remaining conjectures of Mathieu could be false without falsifying the Jacobian conjecture.

Complex Analysis

The Sobolev space $H^{1/2}$ of (half-order differentiable functions on the unit circle) plays an elegant role in the theory of Teichmüller spaces, via consideration of the universal period mapping.

The problem of embedding the universal cover of the Jacobian of an *arbitrary* Riemann surface, X, into the "universal Jacobian" $H^{1/2}$, has been solved ([M:N3]). As the complex structure on X is deformed, a method is given to define a (Teichmüller-parametrized) family of these natural embeddings, such that they provide a holomorphic homomorphism of a vector bundle over the Teichmüller space into the tautological vector bundle over the universal Siegel space. This homomorphism commutes with the universal period map. Further, the above Jacobian variety embeddings are studied with reference to towers of Jacobians arising from towers of finite coverings of Riemann surfaces. It is then possible to pass to inductive limits and see the elegant rôle of the commensurability automorphism groups acting on the limit objects.

What may be called the commensurability automorphism group, ComAut(X), has been associated ([M:N4]) to a compact Riemann surface X. This consists of all the finite holomorphic self-correspondences of X. This interesting new group ComAut(X) is shown to be the stabilizer of the point $[X]$ for the action of the universal commensurability modular group, $CM_\infty(X)$, on the universal direct limit of Teichmüller spaces, $T_\infty(X)$. Moreover, ComAut(X) acts by holomorphic automorphisms on the Riemann surface lamination $H_\infty(X)$. This action has been demonstrated to exhibit the dichotomy that it is *ergodic* precisely when the Fuchsian group uniformizing X is *arithmetic*. The action of $CM_\infty(X)$, and of all its isotropy subgroups, on some natural vector bundles over $T_\infty(X)$ are studied.

William Thurston discovered an intrinsic compactification of the Teichmüller space, $T(X)$, enjoying the property that the action, on $T(X)$, of each element of the modular (= mapping class) group $MCG(X)$, extends continuously as homeomorphisms of the compactification. A natural question that arises is to investigate whether or not the direct limit construction of $T_\infty(X)$, and the action thereon of the universal commensurability modular group, $CM_\infty(X)$, can be carried out in the framework of the *Thurston-compactified* Teichmüller spaces. These queries have been answered ([M:N1]) affirmatively, and various applications are then shown to emerge.

Differential Equations

1. *Homogenization and Optimal Control*:

Homogenization of some optimal control problems were studied ([M:Ke1],[M:Ke3]). In all the cases, the optimal control problem is governed by a second-order elliptic boundary value problem and the cost functional is a Dirchlet type integral of the state function.

Assuming that the coefficients appearing are periodically oscillating and that the domain Ω_ε is periodically perforated with holes of the same size as the period ε a new proof of the homogenization was given ([M:KeR]) using the two-scale convergence method, assuming Neumann condition on the holes.

The problem with Dirichlet condition on holes was considered. The coefficients appearing in the state equation are assumed to be non-oscillatory. Then, the limit of quadratic forms of the gradient of solutions of the state equation is obtained. In this case, when the perforations are of a certain critical size, the limit problem has extra terms in both the state equation and the cost functional and the measures that give these extra terms have been identified.

The problem where the state variable is the solution vector of a system of coupled second order elliptic equations has been studied by extending the H-convergence technique to systems.

An optimal control problem with non-homogeneous Dirichlet boundary condtion on holes is being studied.

Currently, the limiting behaviour of some 'low cost control problems' is being studied . Here, the coefficient of norm of the control in the cost functional goes to zero. This leads to some new kinds of limiting processes not fully covered by homogenization techniques.

Homogenization of an eigenvalue problem for the buckling equation has been done. The domains are periodically perforated with holes of critical size and Dirichlet condition on the holes is assumed. This covers dimensions greater than three. The case of holes whose size is bigger than the critical size and the problem for dimensions less than or equal to three are being considered.

2. *Asymptotic Behaviour of Thin Elastic Structures:*

The study of the limiting behaviour of the spectrum of thin linearly elastic shells in the flexural and membrane cases is in progress. The limiting behaviour of the spectrum of thin rods has been completely studied ([M:KeSb]).

Mathematical Physics

During this academic year the localization and transport for the Anderson Model was addressed and the mobility edge was identified for two distinct class of models [M:Kr1], [M:Kr2]. One with decaying randomness and the other with sparse randomness in 5 or more dimensions. The method employed also gave the results for long range off-diagonal parts.

Number Theory

In the theory of Riemann Zeta function, a lower bound for the L_1-norm of $\frac{\zeta'(s)}{\zeta(s)} - a$ in the interval $[T, T + H]$ was obtained ([M:B10]). Also a simple proof was furnished ([M:B12]) for the result of Jan Moser to the effect that given any integer $k \geq 2$, there are infinitely many zeros of $\zeta(s)$ whose order is not divisible by k.

The investigation as to the conditions under which a general Dirichlet series $\sum_{n \geq 1} \frac{a_n}{n^s}$ will admit lot of zeros in $\frac{1}{2} - \epsilon \leq \sigma \leq \frac{1}{2} + \epsilon$ was continued ([M:B9]).

In transcendental number theory, the analogue of Erdos-Woods conjecture on arithmetical progressions was considered. It was proved ([M:B5]) that under $a\,b\,c$ conjecture of Oesterle, both the original conjecture of Erdos-Woods and its arithmetical anlogue are true.

It is known that if S is a set of cosecutive integers and if we omit a few integers from S and obtain a set T, then the product of integers in T cannot be a perfect power. The analogous result was proved ([M:B14]) if S is a set of consecutive elements in an arithmetical progression.

The study of hypergeometric functions, in particular, analogous to the one considered by Ramanujan, was considered ([M:B7], [M:B8]).

It was observed ([M:B4]) that Menezes-Okamoto-Vanstore algorithm, which works in polynomial time for ordinary discrete log problem, is, in general, does not work in polynomial time for Elliptic curve discrete log problem.

A good estimate for the density of *Charmichael numbers* with three prime factors was obtained ([T:BN]).

The Diophantine equation $r + s + t = rst = 1$, in the ring of S-integers of a quadratic field, was studied ([M:C]) and a simpler proof was obtained for the known result in the ring of integers of quadratic fields. Also some interesting results were obtained about the solutions of an elliptic curve defined over $\mathbb{Q}$ in quadratic fields. Work is in progress on : (i) the same Diophantine equation in totally real Galois cubic fields; (ii) on some arithmetical questions about Hilbert modular forms - for example, the congruence between them and the number of Fourier coefficients which determine a Hecke Hilbert eigen-form; and (iii) the recent work of Kraus and Halberstadt (and previously by Oesterle) on the following question of Mazur, B : writing $\overline{\mathbb{Q}}$ for an algebraic closure of $\mathbb{Q}$, do there exist an integer $n \geq 7$ and two elliptic curves E and E' defined over $\mathbb{Q}$, and non-isogenous over $\mathbb{Q}$, such the Galois representations are isomorphic?

Some work is also in progress on getting good estimations for *exponential sums*; This will improve many well known results in Number theory - e.g., the well known result on the difference between consecutive zeros of zeta functions of a quadratic field can be drastically improved.

Some progress has been made on the problem of estimation of partial sums of the form $\sum_{n \leq x} c^{\Omega(n)}$, where $x > 0$ with $c > 2$.

An elementary proof has been obtained ([M:BSy]) of the following theorem which was first proved by A.O.L. Atkin, and which was previously accessible only through the use of the circle method:

There exists an infinite sequence of positive integers, whose j th term $s(j)$ satisfies $s(j) = j^2 + O(\log(j))$, such that the set of integers representable as a sum of two distinct terms of

this sequence is of positive asymptotic density.

(The interest in this theorem stems from the fact that the set of integers representable as a sum of two squares is known to have zero asymptotic density.)

Operator Algebras

V. Jones noticed that the centraliser of the natural diagonal action of the permutation group S_k on the k-fold tensor power of an n-dimensional vactor space has a basis consisting of equivalence relations on a $2n$-element set; and he used this fact to describe the structure of the tower of these algebras (as n varies), and established some useful consequences for the Potts model. An 'equivariant version' of this 'algebra of equivalence relations' - where there is an auxiliary group to be taken into consideration - has been studied ([M:KoSrnS], and the structure of the resulting towers of algebras has been identified. This tower exhibits the full representation theory of a certain tower of groups which is associated with the auxiliary group G (in the same way that the tower $\{S_n\}_n$ is associated to the trivial group $G = \{1\}$).

An $m \times n$ vertex model is a 'square' $A \subset B, C \subset D$ of four algebras satisfying the following conditions: $A \cong \mathbb{C}, B \cong M_m(\mathbb{C}), C \cong M_n(\mathbb{C}), D \cong M_{mn}(\mathbb{C})$, and B and C are 'independent' in the sense that $tr(bc) = tr(b)tr(c)$ for all $b \in B, c \in C$. Two such vertex models are isomorphic if there is an isomorphism of the corresponding D's under which the subalgebras A, B, C get mapped to their counterparts. It has been shown that there exists a $(3n - 6)$-parameter family of pairwise non-isomorphic $n \times 2$ vertex models, and that this bound is sharp. It has also been shown that using such $n \times 2$ vertex models, it is possible to construct subfactors with any possible principal graph invariant (that an index 4 subfactor can have).

2.1.2   Physics

Classical Mechanics, Quantum Mechanics, Mathematical Physics:

Hamilton in the course of his studies on quaternions came up with an elegant geometric representation for the group $SU(2)$ wherein the group elements are represented by "turns" – equivalence classes of directed great circle arcs on the unit sphere S^2 – in such a manner that the rule for composition of group elements takes the form of the familiar parallellogram law for the Euclidean translation group. This construction has been generalized only recently to the noncompact group $SU(1,1) = Sp(2, R) = SL(2, R)$, the double cover of $SO(2,1)$. The present work develops a theory of turns for $SL(2, C)$, the double and universal cover of $SO(3,1)$, $SO(3,C)$, rendering a geometric representation in the spirit of Hamilton available for all low dimentional semisimple Lie groups of interest in physics. The geometric construction is illustrated through application to polar decomposition to and the composition of Lorentz boosts and the resulting Wigner rotation([P:Si6]).

Coherent states of the hydrogen atom, labeled by classical phase space variables were constructed. The wave packets formed by these states were shown to follow the classical trajectories ([P:MSc1]).

Two-term transformation formulas between basic hypergeometric series have been described by means of invariance groups. For transformations of non-terminating $_3\phi_2$ series and those of terminating balance $_4\phi_3$ series, the invariance groups are the symmetric groups S_5 and S_6, respectively. For the Heine transformation of the $_2\phi_1$ series, the invariance group is the dihedral group of order 12. Transformations of terminating $_3\phi_2$ series correspond to a subgroup of S_6. It is found that the invariance group of transformations of the very-well-poised, non-terminating $_8\phi_7$ series is isomorphic to the Weyl group of a root system of type D_5 ([P:Sr1]).

It has been suggested that the (p, q)-hypergeometric series studied by Burban and Klimyk (1994) can be considered as a special case of a more general (P, Q)-hypergeometric series ([P:J1]). These (P, Q)-hypergeometric series are different from the bibasic hypergeometric series. Work on these two-parameter (P, Q) deformations of the basic hypergeometric series, their summation theorems, and transformation formulas is in progress.

The diagonalizations of certain self-adjoint operators in the positive discrete series representations, and their tensor products, of the Lie algebra $SU(1,1)$ and the quantum algebra $U_q(SU(1,1))$ have been considered and their generalized eigenvectors have been constructed in terms of orthogonal polynomials. Using simple realizations of $SU(1,1)$ and $U_q(SU(1,1))$ these generalized eigenvectors have been shown to coincide with the generating functions for the orthogonal polynomials. The relations valid in the tensor product representations then give rise to new generating functions for the orthogonal polynomials or to their Poisson kernels. In particular, a group theoretical derivation of the Poisson kernels for the Meixner-Pollaczek and the Al-Salam-Chihara polynomials has been obtained. ([P:J3]).

A new differential calculus on a multidimensional noncommutative quantum space, which does not use the Grassmann variables, has been constructed. Correspondingly, the mapping to the Fock space does not involve fermionic variables, but involves only bosonic variables with a new kind of transmutation of indices. ([P:MiRs]).

Recently proposed idea of "protective" measurement of a quantum state has been critically examined, and generalized. Earlier criticisms of the idea and their relevance to the proposal have also been assessed. Several constraints on measuring apparatus required by "protective" measurements have been isolated, with emphasis on how they may restrict their experimental feasibility. Though "protective" measurements result in an unchanged system state and a shift of the pointer proportional to the expectation value of the measured observable in the system state, the actual reading of the pointer position gives rise to several subtleties. It is proposed several schemes for reading pointer position, both when the apparatus is treated as a classical system as well as when its quantum aspects are taken into account, that address these issues. The tiny entanglement which is always present due to deviation from extreme adiabaticity in realistic situations is argued to be the weakest aspect of the proposal. Though this is unlikely to affect practical implementations of the proposal, it is enough to preclude an ontological status for the wave function. Several other conceptual issues have also been clarified([P:H3]).

Nonlinear dynamics and chaos:

Interesting geometric structure of certain nonlinear partial differential equations that appear in various physical problems is reviewed ([P:B1]).

A wide class of curve evolutions is mapped to solvable forms of the Belavin-Polyakov equation, by using a novel transformation of variables ([P:B2]).

A traveling single twist solitary wave solution has been obtained for a classical anisotropic antiferromagnetic chain ([P:B3]).

The nonlinear differential difference equations describing the spin vector evolution in classical ferromagnetic and antiferromagnetic chains have been solved without using the continuum approximation to yield exact nonlinear spinwave solutions ([P:B4]).

The capacity of a lattice of threshold coupled chaotic elements to perform computations has been demonstrated. Such systems are shown to emulate logic gates, encode numbers and perform specific arithmetic operations, such as addition and multiplication, as well as yield more specialised operations such as the calculation of the least common multiplier of a sequence of numbers ([P:Ss8, Ss10]).

Adaptive control algorithms have been found, whereby a spatially extended nonlinear system can be steered to a target state with desired spatio-temporal characteristics (ranging from spatio-temporal fixed points and regular spatial patterns to spatio-temporal chaos). The success of the method was demonstrated for a system of relevance to smart matter applications ([P:Ss9]).

Optics

The recently discovered twist phase has been studied from several viewpoints. It has been shown that the nonnegativity requirement on the cross-spectral density of the light beam demands that the strength of the twist phase be bounded from above by the inverse of the transverse coherence area of the beam. Imposition of the twist phase on an otherwise untwisted beam results in a linear transformation in the optical phase space that preserves the four-dimensional phase space volume, but is not symplectic, and hence alters the Wigner character of a phase space distribution ([P:Si5]).

A complete analysis of the shape-invariant anisotropic Gaussian Schell-model beams has been carried out using Wigner distribution techniques. The set of all shape-invariant Gaussian Schell-model beams forms a six parameter family embedded within the ten parameter family of all anisotropic Gaussian Schell-model beams. These shape invariant beams are generically anisotropic and possess a saddle-like phase front in addition to a twist phase, in such a way that the tendency of the latter to twist the beam in course of propagation is exactly countered by the former. The propagation characteristics of these beams are controlled by a single parameter which plays the role of the Rayleigh range ([P:Si1,Si2,Si3,Si4]).

The standard matrix approach to the dioptric power of an optical system has been generalized utilizing the Lie methods. This generalization helps deal with nonlinear problems (aberrations) in vision optics. The Lie methods are well known in recent studies in light optics and the introduction of such methods in vision optics could prove useful ([P:SriJ]).

Accelerator Optics

The traditional approach to accelerator optics, based mainly on classical mechanics, is working excellently from the practical point of view. However, from the point of view of curiosity, as well as with a view to explore quantitatively the consequences of possible small quantum corrections to the classical theory, a quantum mechanical formalism of accelerator optics for the Dirac particle is being developed recently. It seems that the quantum corrections, particularly those due to the Heisenberg uncertainty, could be important in understanding the nonlinear dynamics of accelerator beams ([P:J2]).

High Temperature Superconductivity

The role played by zero sound in destabilizing a Fermi liquid state was analyzed further during this year ([P:Ba1]).

The relevance of SO(5) symmetry as well as the general notion of quantum critical point to an understanding the anomalous normal state as well as the microscopic mechanism of superconductivity in the high Tc cuprates was critically analyzed. It was concluded that the SO(5) symmetry idea as well as the quantum critical point idea misses the fundamental physics of the doped Mott insulator. Some newer insights in the doped Mott insulating state were brought out ([P:Ba2,Ba3]).

Two experimental results involving the high Tc cuprates, obtained in the University of Maryland, U.S.A were analysed. The first involved a 1.5 eV resonance seen in their femto second laser experiment in YBCO. This was identified with the plasmon excitation. This explanation opens a door of novel plasmon spectroscopy in the cuprates. The second was concerning the unusual charge transport along the C-axis of YBCO which was interpreted as an evidence of interlayer pair tunneling. Further experiments are being done to test this important idea ([P:Ba4, Ba5]).

Colossal Magneto Resistance

Some experimental results on the mangenite Colossal Magneto Resistance (CMR) material obtained in the University of Maryland, U.S.A were analysed. The femto-second laser

induced conductive and resistive transients in CMR manganites, were interpreted in terms of the magnetization relaxation around the hole in the well ordered and poorly ordered ferromagnetic state invoking the Hund's rule coupling. This opens a way to study non trivial spin dynamics by femto second laser methods and also clarifies the mechanism of spin relaxation in the band as well as localized states of the mangenites ([P:Ba6]).

Quantum Hall Effect

An extension of the celebrated theory of Singwi, Tosi, Land and Sjölander (STLS) was extended to a system of Chern-Simons fermions at half-filled Landau level. The dynamical functions like, the dynamic response function, the dynamic structure factor and the longitudinal conductivity were studied. There is a clear improvement of results over the work of Halperin, Lee and Read where the random-phase approximation was used. The result for longitudinal conductivity compares well with available experimental results ([P:C1,C2,C3,C4]).

The effect of spin and impurity on the phase diagram of interacting electrons in a narrow channel in the fractional quantum Hall regime was investigated. This system is particularly interesting to study half-filled Landau level, where, unlike in a two-dimensional system, an incompressible quantum fluid is expected ([P:C5,C6]).

A many-body approach was developed to calculate the ground state properties of the half-filled Landau level using a modified Laughlin state proposed by Read. This approach provides a way to calculate physical quantities in the thermodynamic limit ([P:C7,C8]).

The skyrmion excitations in quantum Hall ferromagnets were investigated. Work was done towards obtaining a quantitatively good descriptions of finite size skyrmions and vortices as soliton solutions in Chern-Simons theory. The vortex solutions solutions of the classical equations were obtained numerically and the parameters of the theory were phenomenologically fitted ([P:RmSh1,RmSh2]).

Bose-Einstien Condensation

Quantum corrections of the thermodynamic quantities of a system of confined Bosons were calculated at finite temperature. the local density approximation for charged bosons in the weak magnetic field was improved by the semiclassical expansion. Diamagnetic susceptibility of a system of confined charged was calculated. The method was applied to calculate analytically the thermodynamic potential of a weakly interacting Bose-gas confined in 3-dimensional harmonic oscillator potential. For large number of particles, quantum corrections become small, and contribute to the finite size corrections to scaling ([P:Ssb]).

Exact results in many body problems

Classical ground states with fixed angular momentum of systems of confined particles in two dimensions were studied. These particles are confined by a parabolic potential and interact via a two body repulsive potential. In the ground state configurations, such clusters of particles organise themselves, approximately, in the form of varying number of concentric shells. The number of shells, their occupancies, ratios of the shell radii etc are independent of strength of the interactions, angular momentum etc but depend on the form of the repulsive

interaction. A transition from single shell to two shells always occurs when the number of particles changes from 5 to 6 and is independent of the exact form of the repulsive interaction. This was shown analytically. The dependence of this first transition on the form of the confinement potential, as well as on a three-body perturbations was also studied. This part and the multi-shell structures were analysed numerically ([P:DMuRv]).

The classical ground state of a D ($\geq$ 2)- dimensional Calogero-Sutherland type model with both two and three body interaction was studied as a function of the strength of the three body interaction. It was shown *exactly* that beyond a critical strength of the three body interaction, the classical ground state of the system is one in which all the particles are on a line. The positions of the particles along the line are uniquely determined by the zeros of the Hermite polynomials. ([P:DGhMu]).

A mapping was estabished (of the spectrum and wavefunctions) between the Calogero-Sutherland model (CSM) with a harmonic and a Coulomb like potential, using an underlying $SU(1, 1)$ symmetry of both of these models. Consequently, a class of new exactly solvable many-body system in one dimension was discovered. Some of these models are isospectral to the CSM. It was shown that the mapping between the oscillator and the Coulomb-like systems is valid even in arbitrary dimensions provided the many-body interaction of these models is homogeneous with degree -2 ([P:Gh]).

Magnetism

The Potts model was studied in two dimensions in presence of external random magnetic field. The study is of utmost important in the context of magnetic transition in anisotropic magnetic systems like $Rb_2Co_{0.85}Mg_{0.15}F_4$ or in phase transition of adsorbed system like CO on grafoil in presence of dilution. In the absence of random field, the transition in Potts model is of second order or first order depending on the the number of states of the spins. The effect of the random field on this transition was investigated, specially at two dimensions which is the lower critical dimension for the transition.

The work on the Kagome lattice antiferromagnet was continued. The field theory about the "q=0" classical ground state was obtained. The order parameter for the novel phase was derived in terms of the spin operators ([P:Sh]).

Statistical Mechanics and Dynamics

Intensive studies were done regarding the defect formation in a two-dimensional Leonard-Jones particle system due to the mismatch in particle sizes. This is very important in the context of melting of a solid in presence of disorder. Types of defects like 'dislocation', 'disclination', 'grain boundary' etc. were catagorized and the effect of these defects in determining the nature of the transiton was determined ([P:R]).

The dynamics of ordering of the nonconserved and conserved Heisenberg magnet was investigated. The dynamics consists of two parts − an irreversible dissipation into a heat bath and a reversible precession induced by a torque due to the local molecular field. For quenches to zero temperature, it was shown, both numerically and analytically that the torque is irrelevant at late times for the nonconserved dynamics but relevant for the conserved

case. The dynamics of the excitations other than Polyakov monopoles and spin waves present in the hard spin Heisenberg model was investigated ([P:DjRm]).

A novel scaling form was obtained in the time development of the 'persistent' spins or particles which arise in any non-equilibrium system evolving in time. The scaling form of the size distribution of these clusters and its evolution with time was found.

The persistence probability in one dimensional Diffusion-Reaction systems was studied ([P:Mg]).

The onset and development of fracture was studied in systems with defects and disorders. It is shown that the fracture development takes place in a scale invariant way similar to that what happens to a system near a spinodal point. These results also suggest that the fracture process is attracted towards a critical point which is then preempted by the first order transition and the spinodal regime.

Artificial and biological membranes

Equilibrium phase diagram of a two-component fluid membrane made up of two different lipid species was investigated. Two ordered phases were identified and their stability against thermal fluctuations was checked. The dynamics of tethered and fluid model membranes with hydrodynamic interactions was investigated. The shape transformations of fluid vesicles of membrane (of spherical topology) with the inclusion of rod-type lipids along with spherical shaped lipids was studied.

Fluorescence microscopy experiments at the National Centre of Biological Sciences, Bangalore vindicate the existence of rafts in cell membranes. A technique was developed to estimate the size of these rafts. Investigations on the physical basis of the formation of the rafts were done. A Landau theory to account for their existence was formulated. Experiments to verify the premises of the theory and also to determine their physical properties are being designed.

Charge transfer kinetics

A central feature of charge transfer kinetics in the condensed phase is the concept of solvent friction which substantially lowers the net barrier crossing rate *vis a vis* the values predicted by the conventional transition state rate theory. The influence of the solvent dynamics on the electron transfer kinetics in polar solvent media was formulated within the framework of the spectral density function approach. The dependence of the reaction system response function on the frequency dependent solvent dielectric constant and associated relaxation time was analysed ([P:Mi]).

Quantum Field theory, Conformal field theory:

The problem of gauge field copies in Yang-Mills theories was resolved in three dimensions. It was shown that the potentials giving rise to the same fields are related by a local SO(3) group of transformations ([P:MSc2]).

A general solution of the non-abelian Gauss law was found in terms of local fields. Non-abelian analogs of the Hodge decomposition were determined ([P:MSc3]).

Duality transformation for 3+1 dimensional Yang-Mills theories was carried out using canonical transformations using the above results for gauge field copies, non-abelian Gauss law and Hodge decomposition ([P:MSc4]).

Analogy with gravity was crucially used to characterize dual gluons and monopoles in terms of gauge invariant variables. Interactions between dual gluons and monopoles were obtained ([P:AsMSc]).

A new way of presenting the classification of compact 2-d complex surfaces was proposed in close analogy to the classification of 2-d real surfaces ([P:M]).

Finite energy monopole solutions of Yang-Mills equations with constraints at isolated points representing the 'centers' of monopoles are analyzed ([P:MSc4]).

New collective coordinates, related to the field at the 'center' of the monopoles are proposed. A systematic computation of the infrared properties of 2+1- and 3+1- dimensional Yang-Mills theory is now possible and is related to solutions of classical equations with constraints at isolated points. For 2+1-dimensional Yang-Mills theory, monopoles of a specific size proportional to g^{-2} dominate and a semiclassical technique is applicable ([P:Sc3]).

The behaviour of conformal field theories interacting at a point has been analysed. The edge states of quantum hall effect give rise to a particular representation of a chiral Kac-Moody current algebra. For intearcting CFTs at a point a twisted representaion of the algebra was obtained. It was found that for the case two discs touching at a point one gets current oscillations between the discs. The frequency of oscillations in terms of an effective parameter characterising the interaction ([P:G2]) was obtained.

It was found that there could be solitons in the shape of knots in nonlinear field theories. Arguments were proposed to substantiate this and look for possible ansatzes which will characterise such knot solitons in O(3) σ model in 3 dimensions ([P:G3]).

Particle Physics:

Nearly two decades ago some simple tests for P and T violations in Gravitation were proposed. Recently, several groups have started looking for these effects using NMR-techniques. The use of laser cooled atom traps for this purpose has been investigated.

Neutrino Physics has been used to constrain R-parity breaking in SUSY models; lepton number violating couplings can be estimated this way. Baryogenesis has also been studied in SUSY models without R-parity and baryon number violating processes (that can possibly generate a baryon number asymmetry in the early Universe) have been identified ([P:Ad]).

An analysis of the recent result of the CHOOZ reactor experiment in the framework of three-flavour neutrino oscillations was done. Within the usual mass-hierarchy, the CHOOZ result can be interpreted as a strong constraint on the allowed values of the (1,3) mixing angle, forcing it to be small. As a consequence, the solar neutrino and atomospheric neutrino problems get approximately decoupled, with the former being solved by two-flavour $\nu_e \leftrightarrow \nu_\mu$ oscillation and the latter by two-flavour $\nu_\mu \leftrightarrow \nu_\tau$ oscillation([P:NRs]).

A study of the one-pion events produced via neutral current and charged current interactions by the atmospheric neutrinos was made. The ratios of these event-rates were analyzed in the framework of oscillations between three neutrino flavours. The ratio of the charged-current event-rate to the neutral current event-rate for ν_e and a similar ratio for ν_μ are shown to provide good diagnostic tools in the investigation of neutrino oscillations[P:BjRs].

The physics prospects of the Borexino neutrino detector in the context of three-flavour neutrino oscillations were analysed. Borexino measurements can zero in on a very small region in the three-flavour parameter space and hence it is a owerful tool to distinguish between the various solutions to the solar neutrino problem([P:NMuRsSr]).

A mechanism for generating massive but naturally light Dirac neutrinos is proposed. It involves composite Higgs within the standard model as well as new interaction beyond the standard model. According to this scenario, a mass of 0.1 eV for neutrino signals new physics at energies of 10-100 TeV or lower ([P:Rs]).

B-decays have been studied, both in order to determine the elements of the CKM mixing matrix and to study CP violation. A method was proposed to determine the CP violating angle $\gamma = arg(V_{ub})$, using the $B \to D^*V$ ($V = K^*, \rho$) modes. The D^* is considered to decay to $D\pi$. An interference of the $B \to D^{*0}V$ and $B \to \overline{D^{*0}}V$ amplitudes is achieved by looking at a common final state f, in the subsequent decays of $D^0/\overline{D^0}$ ([P:SnSr1]).

A technique to determine the CP violating phases as well as the lifetime differences of the mass eigenstates for both B_d and B_s, by considering correlated $B\bar{B}$ pairs produced at the Υ resonances has been proposed([P:SnSr2]). Possible CP violating asymmetries are evaluated through angular distributions for the decay mode $B \to \rho\ell^+\ell^-$.

It is possible that deep inelastic scattering of electrons on protons at HERA at low x is described by the BFKL evolution equation rather than the conventional DGLAP evolution equations. A good way to distinguish the two is afforded by a study of single particle inclusive cross sections at large transverse momenta. While inclusive jet production has already been studied, work (especially involving numerical Monte Carlo programming) is in progress to modify existing Jet Monte Carlos in a manner suitable for studying this problem ([P:StBs]).

Ideas of double scaling have been applied to the Drell Yan process at hadron colliders. Kinematic regions where double scaling can be observed at the Tevatron and the LHC have been identified ([P:Bs]).

It is shown that as far as the scalar-isoscalar channel is concerned, considerable simplifications occur and that the dominant infrared behaviour is governed by chiral symmetry breaking. A simple parametrisation is given for the phenomenologically important intermediate ranges.

A mechanism is proposed for instanton induced chiral symmetry breaking in an extended QCD model with fundamental scalars that may describe the quarks and gluons inside a baryon ([P:BsPs]).

Abelian projected effective theory for QCD is being studied to understand the mechanism of confinement.

An attempt has been made to derive an expression for the structure function of a nucleon in a hybrid model for a nucleon (that has a topological structure; skyrmion) with quarks moving in a background pion field. The idea is to solve for the wavefunction of the resultant Dirac equation. Following Diakonov et al. in such a framework, an attempt is made to generalise to SU(3) flavour and quark structure functions for baryonic states.

Black holes, Quantum Gravity and String theory:

An exact mapping between the problem of the partition function of a bosonic string in arbitrary dimensions regularised by dynamical triangulations and the probability distribution

of the complexity of 3-regular simple graphs has been shown.

An action to study 2+1 dimensional black holes to account for the correct degrees of freedom accounting for the entropy of the black holes, was proposed ([P:G4]). The states of 2+1 dimensional balckholes are being analysed within the context of Regge Ponzano lattice formulation of gravity.

Various aspects of black hole thermodynamics from the point of view of string theory has been probed. The D- brane picture of black holes (at small string coupling) provides a microscopic interpretation of Hawking radiation in terms of open strings colliding on the D-branes producing a closed string in the bulk, which is regarded as the Hawking particle. The string theory amplitude for this process predicts the correct Hawking radiation rate for very low energy outgoing scalar particles. These results were extended to include outgoing particle of very high energies. On the black hole side, the high energy particles modify the Hawking spectrum by back reacting on the black hole. On the D - brane side, the thermodynamics of massless open string modes are now described by a microcanonical ensemble, rather than a canonical one. By taking these effects into account, it was shown that the D - brane decay rate continues to match the Hawking radiation rate from these black holes9([P:DsDgst]).

The emission rate of fermions was calculated by considering the collision of massless bosonic and fermionic modes on the D - branes. This was shown to agree with the fermionic Hawking radiation rate from the corresponding black holes. The above results show that both the bosonic and fermionic Hawking radiation can be successfully modelled by the decay of D - branes into closed string states([P:DsDgMaSt]).

Planckian scattering of point particles in the eikonal limit defines an important quantum gravitational regime where the scattering amplitudes can be calculated exactly. The particles are usually modelled by appropriate black hole metrics and the quantum mechanical wave equation of one of the particles is solved in the curved background of the other particle. If stringy black hole metrics are used for this purpose, the modelling fails when the string coupling g is weak, since for sufficiently small g, the Newton's constant is so small that the string length exceeds the Schwarzschild radius and the black hole solutions of low energy effective actions cease to hold. However, it was shown that Planckian scattering amplitudes can still be calculated by regarding the point particles as wrapped D - branes at weak coupling. The particles interact by the exchange of massless closed string modes at large impact parameters. The scattring amplitude is exactly calculable and agrees with that found previously at large coupling.

Planckian scattering of scalar particles with angular momenta is studied by describing them as source of the Kerr matric. In the shock wave formalism, it is found that the angular momenta do not contribute to the scattering amplitude in eikonal limit. This is confirmed by using the wave equation of the test particle in the Kerr background. It is planned to extend this to charged rotating black-hole ([P:DsPs]).

A close similarity exists between the string equations of motion viewing the world-sheet as a 2-d surface immersed in R^3 and the Chern-Simons system. The self-dual equations are obtained for such surfaces having constant mean curvature. These equations admit rational functions (holomorphic and anti-holomorphic) as solutions and correspond to magnetic vortex configurations ([P:Ps1]).

The strings on the stretched horizon of a black hole have been looked at as bits of

polymers. Then, proposing an interaction between them, the size of the configuration, and thus of the black hole, using the scaling laws, has been obtained. The transition from a typical black hole state to a typical string state has a simple explanation ([P:Kr1]).

It is shown that the transition between black holes to black p-barnes observed recently in matrix theory is the well known black hole to black string transition viewed in a boosted frame. Similarly, the correspondence point between string and black hole is analysed. It is also shown how boosts can be used to relate Hawking radiation rates ([P;Kr2]).

One of the most important discoveries in the recent past that has led to a tremendous advance in the study of Quantum Gravity via string theory has been that of solitonic solutions called D(irichlet)- branes. These hitherto unknown non-perturbative solutions of string theory have been the subject of an enormous amount of research in the last three years. There have been various attempts to understand the role of these objects in flat as well as curved space time. The construction of curved D- branes has been tried out, and work is in progress in this direction. This will help in understanding the geometrical nature of these objects in a more fundamental way. In particular, attempts to construct curved D- branes starting from the so called Linear Sigma Models have been made. It is hoped that these will in particular throw light on the behaviour of D- branes near space time singularities.

Another aspect of D- branes that has been studied is the scattering of these objects. Extremely high energy scattering of two D- branes has been considered and it was found that the scattering amplitude matches exactly with that of black holes which come as solutions of the corresponding low energy theory. This in particular have provided further strong evidence of the so called D- brane - Black Hole correspondence.

Recently there has been a lot of interest in matrix models following a proposal that large N supersymmetric Yang Mills theory is a possible non perturbative description of string theory. There are many outstanding questions that arise immediately. One is the nature of the double scaling limit. Another is the connection with standard perturbative string theory. There is also the hope of understanding duality symmetries better. The nature of the double scaling limit was clarified by looking at the non-planar Feynman diagrams of these matrix models. It was shown how one can reproduce some simple vertex operators in the matrix model description. A proposal was made that the duality symmetry may be related to a symmetry between different choices of matrices as backgrounds about which perturbation is to be done. If this proposal is right then symmetries such as the SL(2,Z) of Type IIB strings can be made much more manifest. Work is under way in clarifying these and other issues.

Work is in progress in looking at fermion Hawking emission rates for BTZ black holes which are asymptotically AdS_3 and would correspond to the same superconformal field theory as the four and five dimensional black holes. It is found that they do reproduce the four dimensional results for minimally coupled fermion emission.

The interaction between F(fundamental) and D(Dirichlet) strings were studied. It was shown that there exists a pole corresponding to a bound state (1,1) string ([P:HSb]). Also the e^{-1/g_s} terms corresponding to soliton loops, which is the hallmark of a non-perturbative effect, could be seen in the potential between the strings. Furthermore S-duality was manifest. The attempts to understand various non- peturbative symmetries (U-duality, Nahm-duality) etc in the context of matrix models are being continued.

One of the mysterious aspects of string theories is the existence of the Hagedorn temper-

ature, which is in the nature of a limiting temperature. In the eighties there were a number of attempts to understand this further. The absence of a non-perturbative formalism made it hard. With the advent of matrix models one can hope for some progress. Recently, it is shown using the matrix model that the Hagedorn temperature should be understood as a phase transition temperature analogous to deconfinement in gauge theories. Below this temperature is the string phase where D-0-branes are spread out and form the string. Above this temperature D-0-branes cluster at one point and there is no string ([P:Sb]).

An exact formula is obtained for the dimensionality of the Hilbert space of the boundary states of level k $SU(2)$ Chern-Simons theory for arbitrary values of k. This generalizes the recent work of Ashtekar *et al* for $k \gg 1$ which yields the semiclassical Bekenstein-Hawking entropy of a four dimensional Schwarzschild black hole. This result stems from the relation between the (boundary) Hilbert space of the Chern-Simons theory and the space of conformal blocks of two dimensional $SU(2)$ WZW model. It is the first attempt to calculate the full quantum entropy of an arbitrary sized black hole using the standard machinery of 2d CFT and Chern-Simons theory ([P:KMa]).

The generic observable sector gaugino mass in the weakly-coupled heterotic string compactified to four dimensions by the Scherk-Schwarz scheme (together with hidden sector gaugino condensation inducing the super-Higgs effect with a vanishing cosmological constant) is shown to be nonzero at tree level, being of the order of the gravitino mass, modulo reasonable assumptions regarding the magnitude of the condensate and the Scherk-Schwarz mass parameters. Previous pitfalls to obtain a similar result within the usual toriodal compactification are thus eliminated by using this scheme of compactification ([P:Ma]).

2.1.3 Theoretical Computer Science

Complexity Theory:

Two fundamental operations used in formal language theory, namely Kleene closure of languages and inversion of formal power series, were considered as tools for the investigation of arithmetic complexity classes. Subclasses of the complexity class GapL (which characterizes the complexity of computing the determinant) were studied in this framework. Several hardness results for inversion and a counting version of Kleene closure were shown. Furthermore, the Kleene closure of finite languages was described in terms of finite monoids and its complexity related to the internal structure of the monoid ([T:AM]).

Motivated by the question of the relative complexities of the Graph Isomorphism and the Graph Automorphism problems, the modular graph automorphism problems were defined and studied. These are the decision problems $\mathrm{Mod}_k\mathrm{GA}$ which consist, for each $k > 1$, of deciding whether the number of automorphisms of a graph is divisible by k. The $\mathrm{Mod}_k\mathrm{GA}$ problems all turn out to be intermediate in difficulty between Graph Automorphism and Graph Isomorphism. An appropriate search version of $\mathrm{Mod}_k\mathrm{GA}$ was defined and an algorithm was designed that polynomial-time reduces the $\mathrm{Mod}_k\mathrm{GA}$ search problem to the decision problem. Combining this algorithm with an IP protocol, a randomized polynomial-time checker for $\mathrm{Mod}_k\mathrm{GA}$, for all $k > 1$, was obtained ([T:A2]).

The existence of disjunctive hard sets for NP was related to other well studied hypotheses in complexity theory showing that if an NP-complete set or a coNP-complete set is polynomial-time disjunctively reducible to a sparse set then $\mathrm{FP}_{||}^{\mathrm{NP}} = \mathrm{FP}^{\mathrm{NP}}[\log]$. Using similar arguments it was also proved that if SAT is $O(\log n)$-approximable then $\mathrm{FP}_{||}^{\mathrm{NP}} = \mathrm{FP}^{\mathrm{NP}}[\log]$. Since it is already known that $\mathrm{FP}_{||}^{\mathrm{NP}} = \mathrm{FP}^{\mathrm{NP}}[\log]$ implies that SAT is $O(\log n)$-approximable, it follows as a consequence of our result that the two hypotheses $\mathrm{FP}_{||}^{\mathrm{NP}} = \mathrm{FP}^{\mathrm{NP}}[\log]$ and SAT is $O(\log n)$-approximable are equivalent. It is also shown as a consequence of the first result that if an NP-complete set or a coNP-complete set is disjunctively reducible to a sparse set of polylogarithmic density then P=NP. Furthermore, it is shown that if $\mathrm{Mod}_k\mathrm{P}$ is disjunctively reducible to a sparse set then RP=NP ([T:A4]).

Algorithms and Data Structures:

An eliminating edge of a polygon is an edge of the polygon which can be translated in parallel inside the polygon such that it eliminates itself or a neighboring edge without violating the simplicity at any instance during the translation. It is proved that there exist at least two eliminating edges in a simple polygon and the lower bound is tight ([T:K2]).

Given a set S of colored points and a query point q, a new data structure was designed to output the nearest point closest to q in S and colored differently from q ([T:K4]).

An optimal algorithm for the visible nearest foreign neighbor among a given set of colored line segments was proposed ([T:K1]).

Given two points p and q in the plane, point p dominates q if and only if q lies in the isothetic rectangle with diagonal points as the origin and p. A data structure to answer

sparse dominance queries for many points in optimal time and space was designed ([T:K3]).

Is it possible to convert a non-simple polygon to a simple one by doing some well-defined transformations? This question has been addressed in our research on untangability of non-simple polygons. Some necessary and sufficient conditions for the untangability of non-simple polygons are given.

A combinatorial analysis of known algorithms for the computation of the determinant was carried out. Certain identities relating structures on the underlying graph follow from the correctness of these algorithms, but now have independent combinatorial proofs. The insights obtained allow a better understanding, in graph-theoretic terms, of why these algorithms work efficiently ([T:M1], [T:M2]).

New upper bounds were obtained for the problem of selecting an item of any given rank (for example, the median element) from a list of elements residing in a read-only memory using limited extra storage. For example, when the given list has n elements, our new algorithm takes $O(n \log^2 n)$ time using $O(\log n)$ extra storage cells whereas the earlier best known algorithm that uses the same space takes $n \lg^{\omega(1)}$ time ([T:V]).

Efficient representation for static binary trees (reported last year) is used to obtain efficient representation for Suffix Trees.

Some empirical work has been performed to find the exact bounds for several splaying heuristics for binary search trees. This work appears in the M.Sc. thesis of G. Srinivasan submitted to Anna University.

Distributed Systems - Automata and Temporal Logics

Regular languages over strings, defined by regular expressions, have a characterization in terms of finite-state automata using Kleene's theorem. Regular languages were considered over series-parallel posets, defined by extending regular expressions with a parallel operator. These are characterized using finite-state automata which allow fork and join transitions ([T:L]).

Axiomatizing partial order based temporal logics requires extending the standard induction principle of linear time temporal logic, principally due to the lack of global next-time modality. Such an axiom system was proposed and a completeness theorem proved for the logic. The axiomatization was presented in a layered manner: one system for each reasoning agent in a distributed environment, and a global one for putting these together ([T:R]).

The assumption - commitment framework was studied automata theoretically. Placing assumptions on synchronization actions, and taking compatible products (whereby commitments match assumptions) led to a class of systems which characterize regular trace languages (of Mazurkiewicz) over an associated independence alphabet. Subsequently, it was shown that allowing assumptions to be made at arbitrary local states adds substantial expressive power: *every* regular language can then be obtained by a decomposition into an assumption compatible system.

These results were shown to generalize to automata over infinite strings as well. A Kleene theorem was proved, offering top-level parallelism ([T:MoR1], [T:MoR2]).

Jointly with Prof. P. S. Thiagarajan of SPIC Mathematical Institute, the problem of automatic controller synthesis for discrete-event systems has been studied. The problem for

branching-time specifications has been studied and some decidability results are obtained. In a fairly simple setting, the synthesis of asynchronous controllers for asynchronous systems is shown to be undecidable ([T:Md]).

Work is underway in studying the controller-synthesis problem for full CTL as well as the problem of synthesizing product controllers for product systems catering to linear-time specifications.

Finite Model Theory:

Let $\mathbf{Q}$ be a finite set of generalized quantifiers, and let $L^k(\mathbf{Q})$ denote the k-variable fragment of FO($\mathbf{Q}$), first order logic extended with $\mathbf{Q}$. It is shown that for each k, there is a PFP($\mathbf{Q}$)-definable linear pre-order whose equivalence classes in any finite structure $\mathfrak{A}$ are the $L^k(\mathbf{Q})$-types in $\mathfrak{A}$. For some special classes of generalized quantifiers $\mathbf{Q}$, it is shown that such an ordering of $L^k(\mathbf{Q})$-types is already definable in IFP($\mathbf{Q}$). As an application of the above results, some generalizations of the Abiteboul-Vianu theorem are proved. For instance, it is shown that for any finite set $\mathbf{Q}$ of modular counting quantifiers, P = PSPACE if, and only if, IFP($\mathbf{Q}$) = PFP($\mathbf{Q}$) over finite structures([T:S]).

2.2 Publications

The following conventions have been adopted in the following list of publications: firstly, names of (co)authors who are not members of IMSc have been decorated with a superscript *; secondly, in order to facilitate cross-referencing between this list and the 'summary of research' in §2.1, all entries in this list have been given a label (which reflects the name of the author(s) from the institute); and finally, the entries are listed according to the alphabetical order of their labels.

2.2.1 Mathematics

[M:B1]
Adhikari, S.D.*, **Balasubramanian, R, and Tangadurai.***
Further remarks on Steinhaus sets
Submitted for publication; preprint IMSc/98/07/49.

[M:B2]
Agarwal, A.K.*, **and Balasubramanian, R.**
n-color partitions with weighted difference equal to minus two.
Published in *Internat J. Math and Math. Sci.***20** (1997) 759-768.

[M:B3]
Agarwal, A.K.*, **and Balasubramanian, R.**
Genaralised Gonal numbers and a new class of partions.
Published in *J. of Indian Math Soc* **61** (1995) 153-160.

[M:B4]
Balasubramanian, R., and Koblitz, N.*
The improbablity that an elliptic curve has subexponential Discrete Log Problem under the Menezes-Okamoto-Vanstone Algorithm,
Published in *J. of Cryptology,* **11**, (1998), 141-145 .

[M:B5]
Balasubramanian, R., Langevin, M.*, **Shorey , T.N***, **and Waldschmidt, M.***
On the maximal length of two sequences of integers in arithmetic progressions with the same prime divisors,
Published in *Monatschaft Math.* **121** (1996) 295-307.

[M:B6]
Balasubramanian, R., and Ponnuswamy, S.*
Application of duality principles and integral transforms,
To appear in *Complex variables, theory and applications.*

[**M:B7**]
Balasubramanian, R., and Ponnusamy, S.[*]
On Ramanujan's asymptotic expansion and inequalities for hypergeometric functions,
Published in *Proc of Indian Acedamy of Sciences*, 108 (1998) vol 2, 1-14.

[**M:B8**]
Balasubramanian, R., Ponnusamy, S. [*], and Vuorinen, M.[*]
Functional inequalities for the quotients of the Hypergeometric functions .
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2.3   Conferences/Workshops held at IMSc

2.3.1   Meeting on Mathematics in independent India

The Institute conducted a meeting on **50 years of Indian mathematics : A critical analysis of mathematics in independent India** during the period November 4th-6th, 1997, as part of the Swarnajayanthi celebrations in this Golden Jubilee year of Indian independence.

The purpose of this meeting was two-fold: firstly, to assemble various eminent Indian mathematicians who would speak on the advances made in independent India in research in their respective areas of specialisation; and secondly, to conduct two panel discussions on the themes *Mathematics Research as a Career in India*, and *Mathematics Education*, respectively, which would aim to review the existing system with a view to arriving at some concrete proposals for possible improvement, where necessary.

The meeting was very well-attended and much appreciated by all who attended. It is proposed to bring out the proceedings of this meeting as an IMSc report; it is hoped that this task would be completed in a few months.

The programme for the meeting was as follows:

<div align="center">

Programme

</div>

4-11-97

10:30 - 10:45	:	**R. Ramachandran**	:	*Director's welcome*
10:45 - 11:45	:	**R. Sridharan**	:	*Algebra*
11:45 - 12:00	:	*COFFEE*		
12:00 - 13:00	:	**C.S. Seshadri**	:	*Algebraic Geometry*
14:00 - 15:00	:	**M.S. Raghunathan**	:	*Lie Groups*
15:00 - 15:30	:	*COFFEE*		
15:30 - 17:30	:	**Panel discussion**	:	*Mathematics Research*

5-11-97

10:00 - 11:00	:	**R.L. Karandikar**	:	*Probability*
11:00 - 11:30	:	*COFFEE*		
11:30 - 12:30	:	**P.N. Srikanth**	:	*Differential Equations*
14:00 - 15:00	:	**N.M. Singhi**	:	*Combinatorics*
15:00 - 15:30	:	*COFFEE*		
15:30 - 17:30	:	**Panel discussion**	:	*Mathematics Education*

6-11-97

10:00 - 11:00	:	**K.B. Sinha**	:	*Operator Algebras & Mathematical Physics*
11:00 - 11:30	:	*COFFEE*		
11:30 - 12:30	:	**S.G. Dani**	:	*Ergodic Theory*
14:00 - 15:00	:	**K.R. Parthasarathy**	:	*Functional/Harmonic Analysis*
15:00 - 15:30	:	*COFFEE*		
15:30 - 16:15	:	**Dipendra Prasad**	:	*Algebraic Number theory*
16:15 - 17:00	:	**R. Balasubramanian**	:	*Analytic Number Theory*

The panel discussions

4-11-97:

Topic : *Mathematics Research as a Career in India*

Aim : To try and identify the various problems faced by a working mathematician in India (eg: limited choices of locations and areas for research, the effect of prevailing views on what constitutes 'good mathematics', etc) and formulate proposals for improved future conditions.

Moderator : Shobha Madan

Panel : Phoolan Prasad, M.S. Rangachari, Ramji Lal, C.S. Seshadri, K.B. Sinha and Satya Deo

5-11-97:

Topic : *Mathematics Education*

Aim : To review attempts made in the past to tackle the problem of the quality of students coming in to mathematics, and to address this problem afresh.

Moderator : Alladi Sitaram

Panel : V. Krishna Kumar, S. Kumaresan, C. Musili, M.S. Raghunathan and S.A. Shirali

2.3.2   Institute Seminar Meeting

As per the many discussions held earlier, an annual seminar meeting involving all the academic members of the Institute was held during November 10-12, 1997. The purpose of such a meeting was to provide a forum where people from all disciplines could get an idea of what their colleagues were working on.

A total of 37 speakers presented their work (TCS-7, Maths-10, Phys-20). To promote greater interaction between disciplines each session had talks from all disciplines.

All the talks were well attended. The schedule and titles of the talks are given below:

<div align="center">

Schedule

</div>

10 November, 1997

09:30 - 11:00	:	Group A
11:00 - 11:30	:	Coffee/Tea Break
11:30 - 13:00	:	Group B
13:00 - 14:00	:	Lunch Break
14:00 - 15:30	:	Group C
15:30 - 16:00	:	Coffee/Tea Break

11 November, 1997

09:30 - 11:20	:	Group D
11:20 - 11:40	:	Coffee/Tea Break
11:40 - 13:10	:	Group E
13:10 - 14:10	:	Lunch Break
14:10 - 15:40	:	Group F
15:40 - 16:00	:	Coffee/Tea Break

12 November, 1997

09:30 - 11:00	:	Group G
11:00 - 11:30	:	Coffee/Tea Break
11:30 - 13:00	:	Group H
13:00 - 14:00	:	Lunch Break
14:00 - 15:30	:	Group I
15:30 - 16:00	:	Coffee/Tea Break

Titles of Talks

Group A

R. Shankar	:	Skyrmions in Quantum Hall Systems
G. Baskaran	:	Failure of Fermi-liquid theory in 2 and 3 dimensions
Anil Seth	:	McColm's Conjectures
K. Maddaly	:	Inverse Spectral Theory in one dimension

Group B

V. Kodiyalam	:	Castelnuovo-Mumford regularity of a sheaf on projective spaces
S.P. Inamdar	:	On the cohomology of square of an ideal sheaf
Radhika Vatsan	:	Reductions of Anyons to one dimension and Calogero-Sutherland type models
M.V.N. Murthy	:	Geometry of many particle clusters in two dimensions

Group C

G. Date	:	Radiating astrophysical objects in equilibrium with cosmic radiation
B. Sathiapalan	:	Matrix models and string theory
P. Majumdar	:	Quantum Black holes
Kapil Paranjape	:	On Rationality Questions

Group D

R. Simon	:	Composition of Lorentz boosts and the concept of Adiabatic Following
Sharatchandra	:	Phase of the quantum oscillator
G. Rajasekaran	:	New Fock spaces and new quantum field theories
Sabu	:	Justification of eigenvalue problem in linear elasticity
Arvind	:	Designing programmes that check their work

Group E

Venkatesh Raman	:	Parametrized Complexity
Jagannathan	:	Quantum theory of charged-particle beam optics
K. Srinivas	:	Goldbach numbers in short intervals
Mohan Narayan	:	Neutrino Physics

Group F

Meena Mahajan	:	The Complexity of the Determinant
Hari Dass	:	Gravity theories meet Graph theory
V.S. Sunder	:	Subgroups and subfactors
T. Bhattacharyya	:	A glimpse of fusion algebras

Group G

Mahan Mitra	:	Coarse Extrinsic Geometry in Negatively Curved Spaces
R. Partasarathy	:	Yang-Mills connections on two-dimensional surfaces
V. Kamakoti	:	On Proximity Problems
T.R. Govindarajan	:	Knot Solitons

Group H

S. Kesavan	:	Homogenisation and Optimal Control
Rajesh	:	Homogenisation in the periodic case
Sudeshna Sinha	:	Lattice dynamical models of complex spatiotemporal phenomena
R. Ramanujam	:	Local reasoning in distributed systems

Group I

Kamal Lodaya	:	Series-parallel languages and branching automata
G. Manoj	:	Ordered Phases in two-component fluid membranes
Nita Sinha	:	CP-violating anomalous trilinear gauge couplings
Shubashree	:	Gapless excitation in frustrated anti-ferromagnet : a new Goldstone mechanism

2.3.3 Swarnajayanthi Public Lectures on Frontiers of Science

The Institute organized a series of public lectures on Frontier areas in Science as part of its celebrations of fifty years of Independence of the Nation. These lectures were spread over the Swarnajayanti year. While teachers and students of the large number of Universities, Colleges, and other scientific institutions in the city naturally exhibited interest in these lectures, we made a special attempt, with a fair amount of success, to reach and attract educated lay public with a keen interest in science, since these lectures were primarily meant for them.

The lectures were intended to cover all frontier areas of science, and not restricted to just the three areas namely Theoretical Physics, Mathematics, and Theoretical Computer Science in which advanced scientific research is being carried out at the Institute. This series, inaugurated by Dr. R. Chidambaram, Chairman, Atomic Energy Commission and Chairman of the Executive Council of the Institute, was well attended with substantial coverage by the print media and Doordarshan.

The lectures in the series were as follows:

Speaker	:	**Dr. R. Chidambaram**
		Chairman, Atomic Energy Commission
Title	:	*NUCLEAR SCIENCE: SPIN-OFFS FOR*
		THE BENEFIT OF THE NATION
Presided over by	:	Professor R. Ramachandran, Director, IMSc.
Date	:	September 6 1997:

<p align="center">*****************************</p>

Speaker	:	**Professor P. Balaram**
		Molecular Biophysics Unit
		Indian Institute of Science, Bangalore
Title	:	*FROM GENES TO PROTEINS:*
		INFORMATION TRANSFER IN BIOLOGY
Presided over by	:	Professor R. Ramachandran, Director, IMSc.
Date	:	October 13 1997

<p align="center">*****************************</p>

Speaker	:	**Professor R. Simon**
		The Institute of Mathematical Sciences
Title	:	*LASER COOLING OF ATOMS*
Presided over by	:	Professor R. Natarajan
		Director, IIT, Chennai
Date	:	3rd November 1997

<p align="center">*****************************</p>

Speaker   :   **Professor M. Vidyasagar**
                       Director, Center for Artificial
                       Intelligence and Robotics, Bangalore
Title   :   *CAN A COMPUTER BE INTELLIGENT ?*
Presided over by   :   Professor R.M. Vasagam
                       Vice Chancellor, Anna University, Chennai
Date   :   28th November 1997

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Speaker   :   **Prof. Dale Rolfsen**
                       University of British Columbia,
                       Vancouver, Canada,
Title   :   *KNOT FOR EVERYONE*
Presided over by   :   Professor C. S. Seshadri, Director, SPIC Math. Inst., Chennai
Date   :   19th December 1997

****

Speaker   :   **Prof. D. Balasubramanian**
                       Director, Center for Cellular
                       and Molecular Biology, Hyderabad
Title   :   *THIS THING CALLED DNA*
Presided over by   :   Professor P. T. Manoharan
                       Vice Chancellor, University of Madras.
Date   :   30th March 1998

****

2.3.4 National Science Day

National Science Day is observed on 28th February. At IMSc, the day was marked by a series of programmes targetted at students pursuing Bachelor's and Master's degrees in any of the science disciplines. The idea was to try and enthuse the younger generation of tomorrow's scientists by bringing alive for them the sheer excitement inherent in the pursuit of science. To this end, an informative and fun-filled scientific programme for the day was planned. The schedule of events was as described below.

9:00– 9:10 Welcome by the Director Dr. R. Ramachandran

9:00–10:00 Quiz Elimination Round (Written Test)

10:00–11:00 Presentations by IMSc students

11:00–11:15 Coffee/Tea Break

11:15–12:00 Computer/Internet Demos

12:00–13:05 Screening of films

13:05–14:00 Lunch Break

14:00–15:30 Quiz Finals

15:30–16:00 Coffee/Tea Break

16:00–16:45 Special Talk by Dr. T. Ramasami, Director, CLRI.

16:45–17:00 Prize Distribution

The programme was attended by about 25 students from science colleges in the city, and by several members of the Institute.

A major highlight of the programme was the **Science Quiz**. This quiz, which has become an annual feature of the National Science Day programme at IMSc, challenges participants to find the scientific explanations behind phenomena we observe routinely in day-to-day life, it also probes their mathematical understanding and examines their appreciation of the biosciences.

Another major event was the screening of two films. **Powers of Ten** is a ten-minute documentary that brings home in a graphically appealing way the differences between different orders of magnitudes. **Professor Hawking's Universe** is a fifty-five minute documentary describing, by filming a typical day in the life of Stephen Hawking, how he rose above his physical handicap to do top-grade physics.

In other sessions, our graduate students described briefly the research work pursued at IMSc, and demonstrated how computers and the Internet provide an exciting and indispensable tool in research and education.

The programme concluded with an excellent talk by Dr. T. Ramasami, the Director of the Central Leather Research Institute (CLRI) in Chennai, on *Challenges in the Design of Shoes.*

2.4 Seminars

Date	Speaker Affiliation	Title
6-8-1997	Reuben Rabi King's College, UK	Elements of Hodge Cohomology
7-8-1997	Krishna Maddaly IMSc	Anderson model with decaying randomness: Mobility edge
8-8-1997	R. Bhaduri McMaster University Canada	An example of a quantum liquid in one dimension
12-8-1997	Niranjan Ramachandran University of Michigan, Ann Arbor, USA	Motives
13-8-1997	Tapobrata Sarkar IMSc	Black hole fermionic radiance and D- brane decay
14-8-1997	Leticia Brambila - Paz Universidad Autonoma Metropolitana, Mexico	On Brill-Noether Theory
18-8-1997	M. Muthukumar University of Massachusetts, Amherst, USA	Collective diffusion of charged polymer: & Ordinary-Extraordinary Transition
20-8-1997	K. S. Viswanathan Simon Fraser Unveristy Canada	p - Branes in diverse dimensions
22-8-1997	Venkatesh Raman IMSc	Finding Matching Bracket in Constant Time and o(n) Space
28-8-1997	J. Saint Jean Paulin University of Metz, France	Homogenization of Elastic-Viscoelastic Problems and the Fading Memory Effect

29-8-1997	Dida Midesko Addis Ababa University, Ethiopia	Computer Assisted Learning (CAL)
3-9-1997	Pragya Shukla JNCAR, Bangalore	Spectral Correlations in Quantum Chaotic systems
10-9-1997	Ranjan Ghosh West Bengal Educational Service	A class of exactly solvable models in arbitrary dimensions
18-9-1997	Samuel Okoya Obafemi Awolowo University, Nigeria	In search of closed-form solutions of some PDEs
19-9-1997	Pierre Dèbes University Lille, France	The regular Inverse Galois Problem over Ample Fields
23-9-1997	S.K. Ghoshal SERC, IISc Bangalore	Recent Trends in Distributed Computing using the Internet: Java and Friends
23-9-1997	R. Jayakumar CLRI, Chennai	Self Assembly of Proteins
24-9-1997	G. Rajasekaran IMSc	Neutrinos from the Sun and the atmosphere - what can we learn from them?
1-10-1997	Vijay Kumar IGCAR, Kalpakkam)	Magic clusters and their interaction with atoms
1-10-1997	V. Srinivas TIFR Mumbai	A characterization of rational singularities using characteristic p methods
8-10-1997	Rahul Sinha IMSc	CP Violation: Beauty with simplicity - I
9-10-1997	S.V.Nagaraj IMSc	Density of Charmichael numbers with three prime factors
15-10-1997	Ramesh Anishetty IMSc	Perturbative QCD with string tension

17-10-1997	Onuttam Narayan Univ. of California at Santa Cruz USA	Depinning Transitions in Disordered Systems
20-10-1997	Peter Jarvis University of Tasmania	Realisation of physical particle states via extended BRST-BFV quantisation
22-10-1997	P. Narayana Swamy Univ. of Southern Illinois USA	Absence of Gellmann-Low eigenvalue in finite QED
28-10-1997	S. V. Nagaraj IMSc	The least witness of a composite number
29-10-1997	Jaikumar Radhakrishnan TIFR Mumbai	Tight bounds for depth-two superconcentrators
7-11-1997	Tirthankar Bhattacharya IMSc	On Fusion Algebras
7-11-1997	P.N. Srikanth TIFR Bangalore	On Lorentz-Dirac Equation
13-11-1997	Samuel Okoya Obafemi Awolowo Univ, Nigeria	Experiences with the development of micro-wave problems
17-11-1997	Silvano Dal-Zillio INRIA, Sophia-Antipolis, France	Representing objects in a process calculus
17-11-1997	Gautam Sengupta IMSc	Introduction to matrix string theory
17-11-1997	Kamal Lodaya IMSc	Series-parallel languages
18-11-1997	Gautam Sengupta IMSc	Oscillating D-strings in IIB matrix theory
19-11-1997	P. N. Swamy University of Southern Illinois USA	Broken chiral symmetry in QCD

25-11-1997	Jorge Zanelli Centro de Estudios Cientificos de Santiago, Chile	New Gauge Supergravities in 7 and 11 Dimensions
26-11-1997	P. N. Swamy Univ of Southern Illinois USA	Thermodynamics of q-oscillators
27-11-1997	Kalyan Chakrabarty IMSc	Congruences between Modular forms
28-11-1997	R. Ramanujam IMSc	Induction rules and local reasoning
28-11-1997	Pascal Weil CNRS, Paris, France	N-free posets: algebra and automata
1-12-1997	T. P. Parik IOP, Bhubaneswar	Dissipative 2 state systems
4-12-1997	Manisha Kulkarni MRI, Allahabad	Solving the Diophantine equation $r + s + t = rst = 1$ in quadratic fields
5-12-1997	Kamakoti IMSc	An optimal parallel algorithm for the All Nearest Foreign Neighbour problem
5-12-1997	Swarup Mohalik IMSc	Assumption and Commitment in Automata
10-12-1997	L. M. Sehgal Inst. for Theoretical Physics, RWTH, Aachen	Helicity–flip paradox and the Chiral Anomaly in QED
11-12-1997	M.F.Vigneras Ecole Normale Suériere,Paris-7.	Modular theory of representations of p-adic groups
12-12-1997	Anil Seth IMSc	Limitations of capturing complexity classes using generalized quantifiers
12-12-1997	Mohan Krishnamoorthy CSIRO, Clayton, Australia	Locating airline hubs: perspectives, problems & reseach challenges

12-12-1997	Devdatt Dubhashi SPIC Mathematical Institute	How tall is a random tree?
12-12-1997	M. F. Vigneras Paris-7	Modular theory of representations of p-adic groups - II
18-12-1997	Kedar Damle Yale University, USA	Spin transport and dynamics in gapped one dimensional antiferromagnetic systems
19-12-1997	Subodh Shenoy ICTP, Trieste, Italy	Ginzburg-Landau approach to Martensitic Transforms
22-12-1997	Deepti Banarjee ISI Calcutta	Topological aspects of Berry Phase in Quantum Hall Effect
26-12-1997	Luca Barbieri Viale University of Genova,Italy	The Picard 1-motive
26-12-1997	D. Ramachandran Cal. State Univ., Sacramento,USA.	The Monge-Kantorovich Duality theorem and its applications
29-12-1997	A. Cianchi University of Florence, Italy	Boundedness of Solutions to Variational Problems
29-12-1997	Aravind Srinivasan National University, Singapore	Randomized rounding
30-12-1997	A. Mukherjee Delhi University	Cosmological compactification of superstrings and scale-factor duality
30-12-1997	Luca Barbieri Viale University of Genoa,Italy	Basics of the Picard 1-motive
5-1-1998	Srikanth Raghavan ICTP, Trieste	Some aspects of Bose Einstein Condensation in laser cooled
9-1-1998	Basudeb Datta IISc Bangalore	Minimal triangulation and complementarity

9-1-1998	Kaustubh Agashe UC Berkeley, USA	Are heavy scalars of the 1st and 2nd generations a solution to the SUSY flavor problem?
19-1-1998	Rajamani Sundar Tiruchy	Efficient data structures for the priority queue with attrition
19-1-1998	Jishnu Biswas Tata Institute, Mumbai	On Lefschetz (1,1) theorem
20-1-1998	Jayanta K Bhattacharya IACS	Interface roughening: What does it have to do with turbulence?
2-2-1998	Jesper Henriksen Aarhus University, Denmark	Dynamic linear time temporal logic
4-2-1998	Shun-ichi Kimura Hiroshima University, Japan	On Bloch's Conjecture
5-2-1998	V. Lakshmibai Northeastern University, Boston, USA	Schubert varieties, Ladder determinantal varieties and Quiver varieties
9-2-1998	Anjan Kundu SINP	Possible extension of quantum integrable systems towards higher dimensions
10-2-1998	K. Srinivas, VHS,Chennai	The Science of Clinical Neurology Revisited
12-2-1998	E. Gutkin U.S.C.,Los Angeles, USA	Geometric aspects of billiard dynamics
13-2-1998	Hari Koduvely Weizmann Institute of Science, Israel	Spontaneous Symmetry Breaking and Long Range Order in 1-d Non Equilibrium Systems
13-2-1998	T.Padmanabhan IUCAA, Pune	Conceptual issues in blackhole entropy
17-2-1998	R. E. Amritkar PRL Ahmedabad	Control of Chaos

18-2-1998	Haridas Banerjee SNBCBS Calcutta	Lattice Fermions and the chiral anomaly
19-2-1998	Alladi Ramakrishnan Alladi Centenary Foundation	Non simultaneity in Lorentz transformation
20-2-1998	M. Revzen Technion, Israel Institute of Technology	Casimir effect - classical limit
23-2-1998	Asok K. Sen Saha Institute of Nuclear Physics, Calcutta	Phase distribution, localization and scaling in disordered chains
23-2-1998	Robert Conte C E A, Saclay, France	Old and new problems in the explicit integration of differential equations
23-2-1998	Matti Vuorinen University of Helsinki, Finland	Role of Hypergeometric function in Function Theory
26-2-1998	Matti Vuoreinen University of Helsinki, Finland	The role of Hypergeometric Functions in Function theory
27-2-1998	Bas Edixhoven University of Rennes, France	On the U_p-operator on modular forms
2-3-1998	Dinakar Ramakrishnan Caltech,USA	Determination of Elliptic Curves by Points
3-3-1998	Rene Schoof University of Rome II, Italy.	On the analogue between function fields and number fields
4-3-1998	Martin Kruskal Rutgers University USA	Story of the Soliton
5-3-1998	Michael Demuth University of Clausthal, Germany	Relation between spectral theory and capacity
5-3-1998	Kiran Kolwankar IISc Bangalore	From fractional differentiability to fractional Fokker-Planck equation

6-3-1998	Martin Kruskal Rutgers University, U S A	Surreal numbers: bigger, better, bolder and more basic
9-3-1998	F. Willig Hahn-Meitner-Institut, Berlin, Germany	Femtosecond Electron transfer from a molecule to a semiconductor in ultra-high v uum
9-3-1998	Rene Schoof University of Rome II, Italy.	Prime divisors of $x^n - 1$ and an elliptic analogue
11-3-1998	Gautam Mandal TIFR Mumbai	Black-hole dynamics and D-branes
12-3-1998	George Gidal Lawrence Berkeley National Laboratory, USA	An Experiment to Search for CP violation in Hyperon Decay
12-3-1998	Rene Schoof University of Rome II, Italy	Counting points of elliptic curves over finite fields
12-3-1998	Deepak D'Souza SPIC Mathematical Institute	The Berthomieu-Diaz method for analyzing Time Petri nets
13-3-1998	Rathin Adhikari IMSc	Matter anti-matter asymmetry of the universe
13-3-1998	Pascal Weil CNRS, Paris, France	A Birkhoff theorem for finite algebras
16-3-1998	Jeeva S. Anandan, Hebrew University of Jerusalem	Global Topology and Local Violation of Discrete Symmetries
18-3-1998	Rohini Godbole IISc Bangalore	Eikonalised minijet model prediction for $\sigma_{\gamma\gamma}^{top}$
19-3-1998	Rene Schoof University of Rome II, Italy	Algebraic curves over finite fields with many points
25-3-1998	Sridhar TIFR Mumbai	Adding colour to hidden charm

26-3-1998	Kumar Gupta SINP, Calcutta	Decays of Heavy Hadrons
13-4-1998	Nandini Chatterjee University of Pune	Spatiotemporal order in coupled sine circle map lattices
15-4-1998	Manu Mathur S. N. Bose	Magnetic monopoles in SU(N) gauge theories: An abelian understanding
15-4-1998	Balakrishnarajan Bharathidasan University, Trichy	An intelligent search system for a class of #P-complete enumeration problems
17-4-1998	R. Shankar IMSc	A Novel Goldstone Mechanism in the Kagome Lattice Antiferromagnet
22-4-1998	N. D. Hari Dass IMSc	Does Nature abhor the individual?
22-4-1998	S.Srinivasan TIFR Mumbai	Well distributed Sequences
23-4-1998	N.Chandramowliswaran SVCE,Pennalur	Automorphisms of free groups
1-5-1998	Madan Rao IMSc	Lipid Domains on Living Cells
6-5-1998	R. P. Malik S. N. Bose National Centre	BRST cohomology in gauge theories
20-5-1998	Graeme L. Cohen University of Technology, Sydney, Australia	On Ore's harmonic numbers
16-6-1998	A. Dharwadkar New Delhi	On four colour problem
19-6-1998	Sagar Pandit University of Pune	Unpredictability and undecidability in dynamical systems

22-6-1998	Kalyan Chakraborty IMSc	Introduction to Elliptic Curves
23-6-1998	S. M. Bhattacharjee IOP Bhubaneshwar	Growth problems and polymers
23-6-1998	Srikanth Iyengar University of Missouri, Columbia	Depth for complexes, and Intersection theorems
24-6-1998	G. Srinivasan Anna University	Self-adjusting binary search trees
24-6-1998	S. M. Bhattacharjee IOP Bhubaneshwar	Quantum criticality in incommensurate Heisenberg chain
24-6-1998	Kalyan Chakraborty IMSc	Introduction to Elliptic Curves
1-7-1998	K. Gopalakrishnan East Carolina University	Some applications of orthogonal arrays to computer science and cryptography
2-7-1998	Ravi Kannan Yale University	Some applications of linear algebra
2-7-1998	P. Madhusudan IMSc	Controllers for Discrete Event Systems via Morphisms
3-7-1998	Mokshay Madimann IIT Bombay	Chaotic Maps under Threshold Mechanism
8-7-1998	T.K. Kar IIT Kharagpur	Coherent States for quons
9-7-1998	Clare D'Cruz TIFR Mumbai	On complete ideals in regular local rings
9-7-1998	D. Indumathi IMSc	Report on DIS98
9-7-1998	V Kamakoti IMSc	Reducing simple polygons to triangles

10-7-1998	V. Sowmya IIT Chennai	Interaction without entanglement
22-7-1998	Deepak Kumar JNU, New Delhi	Quantum theory of optical interference - role of the quantum phase
23-7-1998	V. Kamakoti IMSc	The colored sector search tree: a dynamic data structure
27-7-1998	K.B.Athreya Iowa State University, USA	Random Logistic map
28-7-1998	Balaji Raghavachari Univ. of Texas at Dallas USA	Euler tours, postman tours and mixed graphs
29-7-1998	S.V.M. Satyanarayana MSD, IGCAR, Kalpakkam	Unstable periodic orbits of chaotic maps using order statistics
30-7-1998	R.Srinivasan IMSc	Connections on small vertex models
31-7-1998	Prof Y. Manoussakis Universite Paris XI, Orsay, France	Sequential and Parallel Algorithms for some problems in Tournaments

2.5 Visitors

Name	Affiliation	Period of Visit
Antoni Lozano	Universitat Politecnica de Catalunya, Spain	16.02.97 to 12.08.97
M. Muthukumar	University of Massachusetts, Amherst, USA	12.07.97 to 23.08.97
Dida Midekso	Addis Ababa Univ., Ethiopia	17.07.97 to 08.09.97
Kondayah S. Viswanathan	Simon Fraser Univ., Burnaby, British Columbia	27.07.97 to 20.08.97
A.P. Balachandran	Syracuse University, Syracuse, NY, USA	28.07.97 to 01.08.97
Rajat K. Bhaduri	McMaster University, Canada	28.07.97 to 10.08.97
Okoya Samuel Segun	Obafemi Awolavo University, Nigeria	21.08.97 to 19.11.97
J. Saint Jean Paulin	University of Metz, France	27.08.97 to 02.09.97
Pragya Shukla	IISc Bangalore	03.09.97 to 04.09.97

Ranjan Kumar Ghosh	Haldia Govt. College West Bengal	05.09.97 to 12.09.97
Manisha Kulkarni	MRI Allahabad	22.10.97 to 21.01.98
Mitaxi Mehta	PRL Ahmedabad	27.10.97 to 13.11.97
T.P. Pareek	Institute of Physics Bhubaneswar	08.11.97 to 08.12.97
Jorge Zanelli	Univ. of Santiago and Centro de Estudios Cientificos de Santiago, Casilla, Santiago	23.11.97 to 01.12.97
S. Umasankar	IIT Mumbai	30.11.97 to 5.12.97
Lalit Mohan Sehgal	Institiute of Theoretical Physics, RWTH Academy Germany	03.12.97 to 13.12.97
A.P. Balachandran	Syracuse University, Syracuse, USA	07.12.97 to 12.12.97
Vigneras	Ecole Norm. Super., Paris, France	07.12.97 to 16.12.97
Varghese John	I.C.T.P., Trieste Italy.	09.12.97 to 07.01.98

S.R. Shenoy	I.C.T.P., Trieste Italy.	15.12.97 to 20.12.97
Kedar Damle	Physics Department, Yale University	18.12.97 to 19.12.97
Dale Rolfsen	University of British Columbia, Vancouver, Canada	19.12.97 to 21.12.97
Luca Barbieri Viale	Univ. of Genoa, Italy	26.12.97 to 05.01.98
Anandhan Jayaraman	Univ. of Pittsburg USA	29.12.97 to 30.12.97
Srimanth Raghavan	I.C.T.P., Trieste Italy.	29.12.97 to 06.01.98
A. Vishwanath	Princeton University, Princeton, USA	30.12.97 to 31.12.97
Pascal Weil	Charge de Recherche, CNRS, Liafa, Paris	05.01.98 to 06.01.98
Kaustabh Agashe	IIT Mumbai	08.01.98 to 10.01.98
Indranil Biswas	TIFR Mumbai	09.01.98 to 31.01.98
Pablo Ares Gastesi	TIFR Mumbai	11.01.98 to 22.01.98

Jishnu Biswas	TIFR Mumbai	11.01.98 to 22.01.98
Mitaxi P. Mehta	PRL Ahmedabad	14.01.98 to 16.02.98
Anjan Kundu	Saha Institute of Nuclear Physics, Calcutta	22.01.98 to 10.02.98
Shunichi Kumura	Hiroshima University, East Hiroshima City, Japan	30.01.98 to 07.02.98
E. Gutkin	U.S.C. Los Angeles USA	12.02.98 to 13.02.98
Hari M. Koduvely	Weizmann Institute, Israel	12.02.98 to 13.02.98
T. Padmanabhan	IUCAA Pune	12.02.98 to 16.02.98
Haridas Banerjee	S.N. Bose National Centre for Basic Sciences, Calcutta	17.02.98 to 19.02.98
Conte Robert	CEA Saclay France	17.02.98 to 25.02.98
Matti Vuorinen	Univ. of Helsinki Finland	18.02.98 to 28.02.98

Asok Kumar Sen	Saha Institute of Nuclear Physics Calcutta	22.02.98 to 28.02.98
Bas Edixhoven	Université de Rennes France	23.02.98 to 03.03.98
J. Obermeit	Univ. of Bochum Germany	24.02.98 to 30.06.98
Demuth Michael	Institute of Math. TU Clausthal Germany	28.02.98 to 09.03.98
Martin Kruskal	Rutgers Univ. USA	03.03.98 to 09.03.98
Frank Willig	Hahn Meitnet Institut Berlin, Germany	08.03.98 to 09.03.98
Rene Schoof	Univ. Di Roma 2 Rome, Italy	22.02.98 to 20.03.98
Sumati Surya	IUCAA Pune	09.03.98 to 20.03.98
George Gidal	Lawrence Berkeley National Lab. USA	11.03.98 to 13.03.98
Indranil Biswas	TIFR Mumbai	14.03.98 to 27.03.98
Rohini M. Godbole	IISc Bangalore	15.03.98 to 21.03.98

J. Pasupathy	IISc Bangalore	15.03.98 to 22.03.98
Srinivasan S.	TIFR Mumbai	18.03.98 to 20.03.98
Winfried Bruns	Univ. of Osnabruck Germany	28.03.98 to 31.03.98
Manu Mathur	S.N. Bose National Centre for Basic Sciences, Calcutta	02.04.98 to 02.06.98
Shubashree D.	MRI Allahabad	06.04.98 to 20.04.98
Ramakrishnan B	MRI Allahabad	13.04.98 to 15.05.98
Malik R.P.	S.N. Bose National Centre for Basic Sciences, Calcutta	15.04.98 to 16.05.98
Balakrishnarajan	Bharathidasan University	15.04.98 to 16.04.98
Srinivasan S	TIFR Mumbai	19.04.98 to 25.04.98
Eckhard Giere	Inst. für Mathematik Bochum	25.04.98 to 09.06.98
Krishna Mohan	CMMACS Bangalore	27.04.98 to 29.04.98
Vijayarajan A.K.	IISc Bangalore	17.05.98 to 31.05.98

Srinivasan T.P.	Madurai Kamaraj University Madurai	27.05.98 to 26.06.98
Clare D'Cruz	TIFR Mumbai	05.06.98 to 15.06.98
Umasankar S	IIT Mumbai	14.06.98 to 20.06.98
Sagar A. Pandit	University of Pune	16.06.98 to 20.06.98
S.M. Bhattacharjee	Institute of Physics, Bhubaneswar	18.06.98 to 26.06.98
Y. Manoussakis	Universite Paris XI, Orsay, France	29.07.98 to 02.08.98

2.6   Student Programme

2.6.1   Institute JRFs

The institute selects junior research fellows to work towards their PhD every year in the areas Mathematics, Physics and Theoretical Computer Science. These students are selected after a nationwide entrance test followed by an interview at the Insitute. During the first year, these students go through rigorous course work. Then they register for their PhD usually with the Madras University. Exceptionally bright Bachelor's students are also selected in this process. These students, before registering for PhD, go through a two year M.Sc (by research) programme awarded by the Anna University.

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The following students of the institute were awarded Ph.D. degrees by the Madras University in 1997.

Physics

Name	**S.A. Khan**
Title	Quantum theory of charged-particle beam optics
Guide	R. Jagannathan.

Name	**Srinath Cheluvaraja**
Title	Finite temperature phase transition in non-abelian gauge theories
Guide	H.S. Sharatchandra.

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The following Ph.D. theses have been submitted to Madras University:

Mathematics

Name	**Dakshini Bhattacharyya**
Title	Variational formulae for Fuchsian groups over families of algebraic curves
Guide	S. Nag.

Theoretical Computer Science

Name	**N.V. Vinodchandran**
Title	Counting Complexity and Computational Group Theory
Guide	V. Arvind

Name	**Swarup Kumar Mohalik**
Title	Local presentations for finite state distributed systems
Guide	R. Ramanujam

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The following Ph.D. thesis has been submitted to the Indian Statistical Institute:

Mathematics

Name	**R. Srinivasan**
Title	Connections on small vertex models
Guide	V.S. Sunder

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The following lecture courses were offered during the last academic year.

Course Title	Period	Lecturer
Mathematics		
Analysis	Aug - Nov, 1997	S. Kesavan
Topology	Aug - Nov, 1997	S. Inamdar
Algebra	Aug - Nov, 1997	V. Kodiyalam
Non-Commutative index theorems	Dec 1997 - Feb 1998	T. Gendron
Hyperbolic Geometry	Oct - Dec, 1997	M. Mitra
Complex Analysis	Jan - Apr, 1998	M. Krishna
Number Theory	Jan - Apr, 1998	R. Balasubramanian
Algebra	Jan - Apr, 1998	K. Paranjape
Introduction to Subfactors	Feb - Apr, 1998	V.S. Sunder
Elliptic Curves	Jun - Aug, 1998	K. Chakaraborty
Physics		
Classical Mechanics	Aug–Dec, 1997	M. V. N. Murthy
Classical Electromagnetism	Aug–Dec, 1997	T. R. Govindarajan
Quantum Mechanics	Aug–Dec, 1997	R. Parthasarathy
Mathematical Methods	Aug–Dec, 1997	R. Jagannathan
Advanced Quantum Field Theory	Aug–Dec, 1997	Parthasarathi Majumdar
Advanced Mathematical Physics	Aug–Dec, 1997	G. Date
Introduction to String Theory	Aug–Dec, 1997	T. Jayaraman
Statistical Physics	Jan–May, 1998	Radha Balakrishnan
Quantum Field Theory	Jan-May, 1998	Rahul Basu
Introductory Condensed Matter Physics	Jan–May, 1998	A. K. Mishra
Introductory Particle Physics	Jan–May, 1998	R. Ramachandran
Adnavced Particle Physics	Jan–May, 1998	R. Sinha
Many Body Theory	Jan–May, 1998	R. Shankar

Course Title	Period	Lecturer
Theoretical Computer Science		
Data Structures	Aug–Nov, 1997	V Raman & M Mahajan
Automata Theory	Aug–Nov, 1997	R Ramanujam
Introduction to Logic	Aug–Nov, 1997	M Mukund*
Discrete Mathematics	Aug–Nov, 1997	KV Subrahmanyam*
Data Structures in RAM	Nov–Feb, 1998	V Raman &V Kamakoti
Design and Analysis of Algorithms	Jan–May, 1998	V Arvind
Theory of Computability	Jan–May, 1998	K Lodaya
Logic in Computer Science	Jan-May, 1998	Anil Seth
Concurrency Theory	Jan–May, 1998	PS Thiagarajan*
High Performance Scientific Computing	April-June, 1998	V Kamakoti

Note: Instructors with starred names are members of the SPIC Math. Institute.

2.6.2   Collaborations with Anna University

One of our JRFs Mr. S. Srinivasa Rao was awarded the M.Sc. (by research) degree by Anna University for the thesis he submitted in the last academic year. Apart from the regular joint M.Sc (by research) program between IMSc and Anna University, this year our colloboration with Anna University intensified further. Several of our faculty members in the theoretical computer science group participated in some of the student activities of Anna University.

Mr. G. Srinivasan, an Anna University student, did his M.Sc. thesis on 'Self Adjusting Binary Search Trees' under the supervision of Venkatesh Raman and Meena Mahajan, two of our faculty members in the theoretical computer science group. Also two of our faculty members R. Ramanujam and V. Arvind taught courses to the Anna University students in the M.Sc. (Computer Science) programme run by the Mathematics department of the university. Ramanujam taught the course on "Automata and Formal Language Theory" and Arvind taught the course on "Design and Analysis of Algorithms'.

2.6.3   Summer Students

Every summer, a small number of students from various institutes/universities come to our institute and work on some research projects with some faculty member. During the last summer, the following students visited our institute.

Student	Period	Faculty

Mathematics

A. Ranjekar Pune University	1st May 1998 to 15th June 1998	M. Krishna

As a result of his research here, he has written up the paper "Inverse theory of Schrödinger matrices", (IMSc Preprint No 98/06/28, June 1998), in which he has settled (in the negative) a conjecture due to F. Gesztesy and B. Simon.

Physics

Mokshay M. Madiman IIT Mumbai	June, 1998	Sudeshna Sinha
S. Srividya IIT Chennai	June, 1998	K. Srinivasa Rao
S. Ramee IIT Chennai	June, 1998	R. Simon
V. Sowmya IIT Chennai	June, 1998	N. D. Hari Dass
A. Sudarshan* Loyola College, Chennai	May-June '98	G. Rajasekaran

(*): This was supported by the Summer Research Fellowship Programme of the Jawaharlal Nehru Centre for Advanced Research, Bangalore.

Theoretical Computer Science

Anirban Dasgupta IIT Kharagpur	May–June, 1998	Meena Mahajan
Kumar Saurabh IIT Kharagpur	May–June, 1998	Meena Mahajan
Nikhil Bansal IIT Bombay	May-July 1998	Venkatesh Raman
Nisheet Kumar Voishnoi IIT Bombay	May-July 1998	Venkatesh Raman
Subhas Ajit Khote IIT Bombay	May-July 1998	Venkatesh Raman
Subramanian Iyer IIT Mumbai	May–June, 1998	R Ramanujam
Chintan Amrit IISc Bangalore	May–June, 1998	V. Arvind

2.6.4 Nurture Programme, 1997-1998

The Institute continued to play its role in the ongoing Nurture Programme that is organised and funded by the National Board for Higher Mathematics.

The Contact Programme at the end of the Third Year of the (Madras chapter of the) Nurture Programme was held at the Institute of Mathematical Sciences, Chennai, from Monday, June 29 to Friday, July 17, 1998. All the 13 students who attended the Programme last year were reinvited this year and 11 of them attended the Programme.

These 11 students continued to be under the charge of the Faculty comprising of V. Balaji (SPIC Mathematical Institute-SMI), R. Balasubramanian (IMSc), S. Kesavan (IMSc, Convener), P. Sankaran (SMI), V. S. Sunder (IMSc) and K. N. Raghavan (SMI). In addition, M. Krishna and S. Nag of the IMSc kindly agreed to give some lectures.

The course work assigned for the third year, *i.e.* 1997-98, consisted of Algebraic Number Theory (based on the book by P. Samuel (Hermann)), Complex Analysis (based on the first four chapters of the book by L. Ahlfors), Algebraic Topology (based on the first and second parts of the book by M. Greenberg and J. Harper) and An Introduction to Differential Topology (based on the first chapter of the book by V. Guillemin and A. Polack). Exercises were sent in each of these subjects to the students to solve and return to the Faculty for evaluation.

During the first week of Contact Programme, these subjects were thoroughly reviewed via lectures by the Faculty members. Algebraic Number Theory was reviewed by R. Balasubramanian (5 Lectures), Algebraic Topology was reviewed by K. N. Raghavan and V. Balaji (6 lectures) and Complex Analysis was reviewed by M. Krishna (3 lectures). In addition, Measure Theory was reviewed by S. Kesavan (1 lecture). During the next two weeks,, introductory lecture courses on Elliptic Curves (4 lectures by R. Balasubramanian), Algebraic Geometry (2 lectures by V. Balaji), Differential Topology (5 lectures by P. Sankaran), Riemann Surfaces (5 lectures by S. Nag) and the Theory of Distributions (6 lectures by S. Kesavan) were arranged. All lectures were of 90 minutes duration.

On the last two days, the students were individually interviewed by the Faculty to assess their progress .

2.7 Visits to other institutions

(including conference participation and lectures by institute members)

Adhikari, Rathin

Attended the International Conference on B- physics and Neutrino Physics held at Mehta Research Institute, Allahabad, during 4-8 January, 1998.

Attended the conference on Particle Phenomenology - WHEPP-5 held at IUCAA, Pune during 12-24 January, 1998, and gave a talk on *Baryogenesis in Supersymmetric Models*.

Gave a seminar entitled *Matter Anti-matter asymmetry of the universe* at the Physics Department, Gauhati University, on 16th March, 1998, under the TPSC programme.

Gave a seminar entitled *Matter Anti-matter asymmetry of the universe* at the Physics Department, Dibrugarh University 17th March, 1998 under the TPSC programme.

Visited the Physics Department of North-Eastern Hill University, Shillong from 19-21 March, 1998 under the TPSC programme and gave a seminar entitled *Matter Anti-matter asymmetry of the universe.*

Visited S. N. Bose National Centre, Calcutta, during 23-27 March, 1998 under the TPSC programme, and gave a seminar with the same title as above.

Arvind, V.

Attended the Foundations of Software Technology and Theoretical Computer Science Conference, during the period December 16–19, 1997 and presented a contributed paper (joint work with J. Köbler) titled *Pseudorandomness and resource-bounded measure.*

Balaji, K.R.S.

Visiited TIFR during 21 November '97 - 2 January 1998.

Attened a workshop in B and neutrino physics at MRI, during 4-8 January, 1998.

Attended WHEPP5 at IUCAA, during 11-20 January 1998.

Balakrishnan, Radha

Visited ICTP, Trieste, Italy, as a Senior Associate, from 27 July 1997 to 12 August 1997.

Visited Center for Nonlinear Studies, Los Alamos National Laboratory from 14 August 1997 to 20 October 1997, and gave a colloquium on *Nonlinearity and Geometry: Some Applications in Physics* on 8 October 1997.

Attended the International Conference ' Nonlinear Dynamics: Integrability and Chaos' held at Bharathidasan University, Tiruchirapalli, from 12-16 February, 1998, and gave an invited talk on *General Curve evolution and mapping to the modified Belavin-Polyakov Equation*, and chaired a session.

Balasubramanian, R

Attended the summer school on Elliptic curves at ICTP, Trieste during Aug-Sept 1997, and gave a talk on *Elliptic psuedoprimes.*

Visited University of Ferrara, Italy in Sept. 1997 for a week, and gave a talk on *Cryptography*

Visited University of Genova,Italy in Sept.1997 for a week, and gave a talk on *Carmichael numbers with three prime factors.*

Lectured on *Zeros of an exponential sum* at the Conference on Number Theory and Applications, held at the Vivekananda College, Chennai, on 19th, Feb1997.

Gave two lectures on *Algebraic number theory* at the Academic staff college, Pondicherry, under the QIP programme organised by Dr A.M.S. Ramasamy of Pondicherry University.

Gave two talks *On psuedo-squares* as the Rajan Memorial lecture at Madras University.

Gave two lectures *On Cryptography* at the Indian Institute of Technology, Chennai.

Lectured on *Introduction to Number theory* at a programme organised by the Bharatiya Vidya Bhavan for bright students, during May 4-7, 1998.

Lectured *On Riemann zeta function* at the Indian Institute of Science, Bangalore.

Baskaran, Ganapathy

Visited the International Center for Theoretical Physics, Trieste, Italy during the month of July 1998 and Directed the workshop on 'Open Problems in Strongly Correlated Electrons' during 14 - 25 July 1997.

Delivered an invited talk on *Zero sound fails Fermi liquid state in 2 and 3 dimensions* at 'SNS98', a meeting on recent trends in High Temperature Superconductivity at Cape Cod, Massachusetts, USA during 14 - 17 September 1997.

Visited the Physics Department of the University of Amherst, Massachusetts, USA during 18 - 19 Sept 1998 and delivered a talk *Nature of the non Fermi liquid state* on 20th Sept 1998.

Visited IUCAA, Pune during 24 - 26 November 1997 and gave a Colloquium on *Novel Physics in Quantum Condensed Matter Systems* on 24th November 1998.

Delivered a talk on *Recent Developments in the theory of High Tc Superconductivity* at the Physics Department of Pune University on 25th November 1997.

Delivered a talk on *Breaking electrons in condensed matter* at Central Leather Research Institute, Madras on 30th December 1997 at the 100th anniversary of the discovery of electron.

Visited the Center for Theoretical Studies of the National Tsing Hua University, Hsin Chu, Taiwan during 17 Feb 1998 - 2nd March 1998.

Delivered a talk on *Issues with SO(5) symmetries in layered Cuprates* at the National Tsing Hua University, Hsin Chu, Taiwan on 20 Feb 1998.

Delivered a talk on *Sharpened Version of RVB Theory* at the National Taiwan University, Taipei, on 23 Feb 1998.

Delivered two talks, on *Failure of Fermi liquid theory in 2 and 3 dimensions*, and on *Where are we with respect to the theory of HTSC in cuprates*, respectively, at Ching Tong University, Hsin Chu, Taiwan on 27 Feb 1998.

Visited the Physics Department of the University of Chulalangkorn, Bangkok, Thailand during 3 - 6 March 1998 and gave two talks, on *Introduction to High Temperature Superconductivity*, and on *Composite Fermions*, respectively, on 4th and 6th March 1998.

Visited the Physics Department of the University of Delhi during 19 and 20 March 98 and delivered a talk on *Rich Physics in Complex Materials* on 20 March 1998.

Delivered a talk on the *Physics of Friction* at the Physics Association meeting of the Physics Department of the Anna University, Madras on 22nd April 1998.

Delivered a talk on *Why is Physics Interesting ?* to the Talented Students Summer School organized by the Bharathiya Vidhya Bhavan at IIT, Madras on 5th May 1998.

Basu, Rahul

Attended "Micro-workshop on QCD", TIFR, Mumbai, Nov 17-21, 1997.

Presented Plenary talk on *Structure Functions and Low x physics* at the Fifth Workshop on

High Energy Physics Phenomenology held at IUCAA, Pune, Jan 12-25 1998.

Chakraborty, Kalyan

Participated in Summer School on 'Elliptic Curves' at ICTP, Trieste, Italy, during 11 - 29 August 1997.

Visited Mehta Research Institute, Allahabad, for two weeks in October 1997.

Gave a lecture entitled *On the Diophantine equation $r + s + t = rst = 1$* in a one-day UGC sponsored conference on 'Number Theory' held at Ramakrishna Mission Vivekananda College, Chennai on February 16, 1998.

Visited Indian Institute of Science, Bangalore, during the period 4 - 8 May, 1998.

Visited Mehta Research Institute, Allahabad during July 13-22, 1998, and gave a lecture titled *On the Diophantine equation $r + s + t = rst = 1$*.

Chakraborty, T.

Gave an invited talk at the International Conference on 'Semiconductor Nanostructures' at Pisa, Italy, held during June 14-21, 1998.

Gave an invited talk at the March meeting of the German Physical Society, Regensburg, 1998.

Visited Yale University, during Jan. 11-16, 1998, and presented a condensed matter seminar on Jan. 14.

Visited University of Missouri, Columbia, MO, during Jan. 17 -21, 1998 and presented a condensed matter seminar on Jan. 20.

Visited University of Georgia, Athens, GA, during Jan. 22-24, 1998, and presented a seminar on Jan. 23, 1998.

Visited University of Central Florida, Orlando, during Jan. 24-27, 1998, and presented a seminar on Jan. 26, 1998.

Visited National Magnet Lab., Tallahassee, Florida, during Jan. 28-29, 1998, and presented a seminar on Jan. 28, 1998.

Visited Ohio University, Athens, OH, during Jan. 30 - Feb. 5, 1998, and presented a Colloquium on Feb. 4, 1998.

Visited Massachusetts Institute of Technology, Cambridge, during Feb. 5-7, 1998, and

presented a seminar on Feb. 6, 1998.

Visited Harvard University on Feb. 5.

Visited Bell Laboratories/Lucent Technologies, Murray Hill, N.J., during Feb. 8-10, and presented a seminar on Feb. 9, 1998.

Das, Jayajit

Gave a talk at the Saha Institute Of Nuclear Physics on *Dynamics of Ordering in Isotropic Magnets* on 17th Oct. 1997.

Participated and presented a poster titled *Dynamics of Ordering in Isotropic Magnets* in the Fourth Meeting on 'Structure and Dynamics of Materials in the Mesocopic Domain' organised by Royal Society - Unilever Indo/UK Forum held at National Chemical Laboratory , Pune between 8-12th Dec. 1997.

Attended the DAE Symposium on Solid state physics, Cochin University, Cochin , between 27-31 Dec. 1997 and presented a poster on *Dynamics of Ordering in Isotropic Magnets.*

Participated in the Spring College on 'Statistical Mechanics and Dynamics of Soft Condensed Matter' at ICTP, Trieste, Italy between 4th May to 5th June, 1998, and presented a poster on *Dynamics of Ordering in Isotropic Magnets* in the workshop organised by the college.

Participated in the Adriatico conference 'Complex Fluids far from Equilibrium' between 9-12th June, 1998 at ICTP, Trieste, Italy.

Das, Saurya

Attended the meeting on *Phenomenological Aspects of Superstring Theories* at ICTP, Trieste, during October 2-4, 1997.

Participated in the *Spring School on String theory* at ICTP, Trieste, during March 23-31, 1998.

Attended the *Trieste Conference on Superfivebranes and Physics in $5 + 1$ Dimensions* at ICTP, Trieste during April 1-3, 1998.

Participated in the *Spinoza Meeting on the Quantum Black Hole* at Utrecht, The Netherlands during the period 29 June - 4 July, 1998.

Visited the following institutions in the period 1 Sepetmber - 5 December, 1997 and gave a talk at each place titled *Fermionic Hawking Radiation and its Effective String Description*:
   Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

Service de Physique Theorique, Saclay, France
Ecole Polytechnique, Paris, France
Joseph Henry laboratories, Princeton University, USA
Center for Theoretical Physics, Massachusetts Intitute of Technology, USA
Physics Department, Syracuse University, USA
Center for Gravitational Physics and Geometry, Pennsylvania State University, USA
Physics Department, California Institute of Technology, USA
Physics Department, Stanford University, USA
City College of The City University of New York, USA

Dasgupta, Arundathi

Attended GR15 at IUCAA, Pune, during the period 15 - 21 December, 1997, and presented a paper titled *Black Hole fermionic radiance and it's effective string picture.*

Attended Spinoza Meeting on the Quantum Black Hole at Utrecht, The Netherlands during 29 June - 4 July, 1998.

Visited Tata Institute Of Fundamental Research, Mumbai, during 1st Nov- 1st Dec, 1997, and presented a talk to the Theory group, titled *Planckian Scattering of D-Branes*, as well as a talk to the Astrophysics group, titled *Back-reaction Effects in Hawking Radiation.*

Visited Saha Institute of Nuclear Physics, Calcutta, during 9 - 10 February, 1998. and presented a talk titled *Back-reaction effects in Hawking Radiation.*

Visited CERN, Geneva, Switzerland, during 5 - 21 July, 1998, and presented a talk titled *Fermion Emission from Stringy Black Holes.*

Date, G.

Visited Physical Research Laboratory, Ahmedabad during Aug. 6th - 11th, 1997 to participate in a two day meeting on quantum gravity.

Attended the GR 15 international conference held at IUCAA, Pune during Dec. 16 - Dec. 21, 1997. Gave a talk on *On a Static Solution of Einstein Equation... .*

Ghosh, Pijush K.

Visited Institute of Physics, Bhubaneswar from April 6, 1998 to May 1, 1998

Govindarajan, T. R.

Delivered a set lectures on *Relativistic Quantum Mechanics* at Cochin University as part of a UGC Refresher Course for College teachers 11-15 Feb 1998.

Visited University of Hyderabad during 19-23 Feb 1998, and gave a colloquium on *Chern Simons theory as a theory of knots and links* and a seminar on *Black holes in 2+1 dimensions.*

Visited S. N. Bose Inst, Calcutta and Saha Inst. of Nuclear Physics during 23-26 Feb 1998, and gave 2 talks on *Knot theory* and *2+1 dimensional balck holes*, respectively.
Visited Inst. of Physics, Bhubaneswar during Feb 28 - March 7th 1998, to attend Workshop on M theory, Strings and Dulaity.

Hari Dass, N.D.

Attended the workshops on Black Holes at the Indian Institute of Science, Bangalore and the workshop on Quantum Gravity at the Raman Research Institute, Bangalore during December 1997.

Attended the Symposium on Physics of Cooled Atoms at BARC, Mumbai during 5-7 March 1998 and delivered an invited talk on *Probing fundamental aspects of gravitation through trapped atoms.*

Visited IUCAA, Pune during 9-16 March, 1998 and delivered a colloquium talk on *Many avatars of duality.*

Visited the Institute of Physics, Bhubaneswar during 9-16 April 1998 and delivered a colloquium talk on *Protective measurements in Quantum Mechanics* as well as a group seminar on *Implications of chiral symmetry for nuclear forces.*

Inamdar, S. P.

Visited the Mathematics Department of the University of North Carolina at Chapel Hill, USA during the month of September 1997, and gave a colloquium on *Mathieu's conjectures in Reductive Groups* on Spetember 25, 1997.

Gave a seminar at the Indian Institute of Science, Bangalore in December 1997 on *Equations defining algebraic varieties.*

Gave two lectures on *Vector Spaces* as part of a programme conducted at the Mylapore Children's Club Madras, in May 1998.

Jagannathan, R.

Delivered an invited talk on *Quantum mechanics of accelerator optics* in the Second School on Physics of Beams at the Center for Advanced Technology, at Indore during Dec. 29, 1997 - Jan. 9, 1998.

Participated in the 15th Advanced ICFA (International Committee for Future Accelerators) Beam Dynamics Workshop: Quantum Aspects of Beam Physics, during 5-9 Jan. 1998, at Monterey, California, U.S.A., and gave an invited talk on *Dirac equation approach to spin-1/2 particle beam optics* in the session on Quantum Methodology in Beam Physics.

Visited the Center for Beam Physics, Lawrence Berkeley National Laboratory, Berkeley, U.S.A., for a week during 9-15 Jan., 1998, and gave a seminar on *Dirac spinor beam optics.*

Visited the Stanford Linear Accelerator Center on 16th January 1998 and gave a seminar on *Quantum mechanical approach to accelerator optics.*

Kamakoti, V

Attended the FSTTCS conference held at IIT, Kharagpur during December 1997.

Lodaya, Kamal

Lectured on *Computability*, at a Seminar on Methods in Science, at Shantiniketan, on 27 August 1997.

Gave a lecture on *Finite automata, formal logic and circuit complexity* at ISI Calcutta, on 28 August 1997.

Gave a lecture on *Evam Indrajit, or Automata constructions and propositional connectives* at a Seminar on Philosophy of Science, at IIT Bombay, on 21 Feb 1998.

Kar Gupta, Abhijit

Attended the Royal Society-Unilever INDO/UK Forum Fourth Meeting on Structure and Dynamics of Materials in the Mesoscopic Domain, during 8-12 Dec., 1997, at NCL, Pune, India.

Kesavan, S.

Attended the International Conference on Function Spaces and Applications to Partial Differential Equations, University of Delhi, during 15 - 19 December, 1997, and gave an invited address entitled *Two Dimensional Approximation of Eigenvalue Problems in Thin Shell Theories.*

Visited the University of Science and Technology, Cochin as a Resource Person in their Refresher Course in Mathematics, during 26 - 27 February, 1998, and gave a series of five lectures on *Distribution Theory.*

Visited the University of Metz, Metz, France, during April 28 - May 31, 1998, and gave a

lecture entitled *Sur l'approximation de problèmes de valeurs propres pour les coques minces.*

Participated in the Colloquium held in honour of Prof. J.- L. Lions on the occasion of his 70th Birthday, at CNRS, Paris, during 26-27 May,1998.

Kodiyalam, Vijay

Attended the Conference in Commutative Algebra and Algebraic Geometry held in Kodaikanal during 23 - 27 March, 1998 and delivered a talk entitled *Asymptotic behaviour of Castelnuovo-Mumford regularity.*

Madhusudan, P

Attended the conference of Foundations of Software Technology and Theoretical Computer Science (FST&TCS) '97 at Kharaghpur, India from December 18–20 1997.

Mahajan, Meena

Attended the Workshop on Randomized Algorithms at Kharagpur on 16 - 17 December, 1997.

Attended the Seventeenth Foundations of Software Technology and Theoretical Computer Science (FST&TCS) Conference at Kharagpur from 18 - 20 December 1997.

Attended the Eighth National Seminar on Theoretical Computer Science at Bhubaneshwar during 11 - 14 June, 1998, and delivered two talks on *Computing determinants combinatorially.*

Majumdar, Parthasarathi

Presented an invited lecture entitled *Quantum black holes* at the International Workshop on Observational aspects of Gravitation, Numerical General Relativity and Quantum Gravity, Raman Research Institute, Bangalore, in December 1997.

Attended the XV International Conference on General Relativity, Gravitation and Cosmology, IUCAA, Pune, December 1997.

Visited the Saha Institute of Nuclear Physics, Calcutta from January 12, 1998 to April 7, 1998, and delivered a seminar talk entitled *Quantum black holes* in March 1998, as well as an Institute colloquium entitled *Black holes, entropy and quantum gravity* in April 1998.

Visited the Inter University Consortium on Astronomy and Astrophysics, Pune during April 13-16, 1998, and delivered a colloquium entitled *Black hole entropy and quantum gravity*, as well as a seminar lecture entitled *Canonical quantum gravity approach to black hole entropy.*

Presented an invited lecture entitled *Black hole entropy and quantum gravity* at the National Symposium on Trends and Perspectives in Theoretical Physics, Indian Association for the Cultivation of Science, Calcutta, during April 23-26, 1998.

Majumdar, Pushan

Attended the Yukawa International Seminar (YKIS'97) held at the Yukawa Institute of theoretical physics, Kyoto University, Japan from December 2nd to 12th and presented a talk titled *Monopoles and dual gluons in 2+1Yang-Mills theories.*

Visited KEK, Japan during December 14 - 20, 1997 and gave a talk on *Monopoles and dual gluons in 2+1 Yang-Mills theories.*

Visited the Yukawa Institute of theoretical physics, Kyoto University, Japan during December 21 - 27, 1997 and gave a talk on *Gauge invarint characterization of monopoles and dual gluons in 2+1 Yang-Mills theories.*

Visited Department of Physics, Federal University of Pernambuco, Brasil during June 20 - July 3rd, 1998 and gave a talk on *Coherent states for the hydrogen atom.*

Visited Department of Physics, Federal University of Paraiba, Brasil on July 2nd and 3rd, 1998 , and gave two talks titled *Gauge field Copies* and *Gauge invariant characterization of monopoles and dual gluons in 2+1 dimensional Yang-Mills theory.*

Attended Lattice '98 at the University of Colorado, Denver, USA during July 13 - July 18, 1998, and presented a talk titled *Gauge field copies, general solution of the non-abelian gauss law, non-abelian analogs of the Hodge decompositon and duality transformation of 3+1 dimensional Yang-Mills theory.*

Visited SUNY Fredonia, USA between July 22nd and July 24th and presented a talk titled *Duality transformation for 3+1 dimensional Yang-Mills theories.*

Manoj, G.

Participated in the Fourth meeting on 'Structure and Dynamics of Materials in the Mesoscopic Domain', organised by Royal Society- Unilever Indo/UK Forum, held at National Chemical Laboratory, Pune during 8-12 Dec, 1997 and presented a poster titled *Novel ordered phases in a two-component Fluid Membrane.*

Mishra, A.K.

Participated in a Technical Meeting organized by the Electrochemical Society of India, Bangalore and delivered an invited talk on *Scanning Microscopy Tunnelling Currents in the Presence of Chemisorbates* on July 26, 1997.

Visited ICTP, Trieste, Italy during 1 - 27 Aug. 1997, and participated in the Research Workshop on Condensed Matter Physics.

Attended the Electrochemical Society and the International Society of Electrochemistry Joint International Meeting 1997, held at Paris from Aug 31 - Sep. 5, 1997, and presented a paper on *Chemisorption at Electrode-Electrolyte Interface: Electronic Structure of Copper Adsorbed on Gold Electrode.*

Visited Ecole Polytechnique, France during 6 - 8 Sep., 1997.

Visited the Physical Chemistry department, University of Milan, Italy during 9 - 11 Sep., 1997 and gave a talk on *Chemisorbed Layers at Electrochemical Interfaces: Electronic Structure* on Sep. 9, 1997.

Visited the Max-Planck institute for Physics of Complex Systems, Dresden, Germany from Sep. 11 - Nov. 11, 1997, and gave a talk on *Chemisorption at Electrochemical Interface* on Nov. 6,1997.

Visited the Physics department, Humboldt University, Berlin,Germany during 11 - 20 Nov., 1997, and gave a talk on *Electronic Structure of Copper Layer on Gold Substrate* on Nov. 19,1997.

Murthy, M.V.N.

Visited IGCAR, Kalpakkam in June 1997, and delivered the IPA special address on *Neutrinos from Stellar Collapse - SN1987a.*

Visited the Institute of Physics, Bhubaneswar, under TPSc, during 9 - 16 December, 1997, and delivered a seminar on the *Geometry of Clusters in two dimensions*, as well as a Colloquium on *Fractional exclusion statistics- Generalised Pauli Principle.*

Attended a workshop on "Semiclassics in two-dimensional systems" at Regensburg, Germany during 13-17 April 1998, and delivered an invited talk on *Geometry of clusters in two dimensions - some exact results.*

Visited the Institute of Theoretical Physics, University of Regensburg, Germany during 11 April - 15 May 1998, and delivered two special lectures, on *Fractional exclusion statistics: A generalised Pauli principle* (on 7 May 1998), and on *Fractional exclusion statistics: Physical realisation* (on 14 May 1998).

Murugesh, S.

Attended the 'International Conference on Nonlinear Dynamics: Integrability and Chaos'

held in Bharathidasan University during 12 - 16 February 1998.

Nag, Subhashis

Visiting Professor at Cornell University, Ithaca, New York, from August 24th, 1997, till December 31st, 1997; gave a Dynamics and Geometry Seminar talk on *Direct limit Teichmüller spaces and a new modular action*; also taught a graduate course on *Mathematical Methods for Physics* at Cornell.

Visited Syracuse University, New York, in December 1997, and gave a Colloquium talk on *Universal Polyakov structure and a new modular group*.

Visited the Tata Institute of Fundamental Research, Mumbai from December 29th, 1997 till January 8th 1998; gave an invited talk at the 'International Conference on Complex Analysis and Related Topics', held during 29 - 31 December, 1997 at TIFR; also gave the TIFR Mathematics Colloquium on January 8th 1998 on *Universal Period Matrices and String Theory*.

Gave an invited talk on *New Trends in Mathematics* at the Science Day Celebrations held at IIT, Chennai on February 1998.

Gave the Physics Department Seminar at IIT, Chennai, on "Exotic R^4", in March 1998.

Paranjape, K.H.

Visited ICTP, Trieste, Italy, during Aug-Sep 1997, and attended two very interesting conferences, one on The Arithmetic of Elliptic Curves and the other on K-theory, Cycles and Motives.

Gave two lectures on *The constructions of Levine, Suslin and Voevodsky* at the ICTP, Trieste, Italy in August 1997.

Gave a lecture on *The resolution of singularities* in the Mathematics Seminar of the ICTP in August 1997.

Gave a lecture on *The Jacobian conjecture and group theory* at ISI, Bangalore in March 1998.

Gave a lecture on *Motives* at the first National Conference on Algebraic Geometry at Kodaikanal in April 1998.

Rajasekaran, G.

Participated in the Workshop on Supersymmetry and Unification at TIFR, Bombay during 17-21 December 97.

Participated in the Workshop on B and ν at MRI, Allahabad, during 4-8 January 98 and talked on *KVL Sarma and High Energy Physics*.

Gave a seminar on *Neutrinos* at Jawaharlal Nehru University, New Delhi on 23 February 1998.

Gave a seminar on *Neutrino Physics* at MRI, Allahabad on 25 February 1998.

Gave a Lecture on *Chandrasekhar and the Stars* at the Gifted Student Programme held at IIT, Madras on 11 May 1998.

Gave a Lecture on *Our present view of Matter and Forces* to the Physics Olympiad Students at the Homi Bhabha Centre for Science Education, Mumbai on 12 June 1998.

Rajesh, M.

Visited TIFR Bangalore Centre during 11 - 30 May, 1998.

Rama, S. Kalyana

Visited T.I.F.R, Mumbai, from 6 Oct. to 6 Nov, 1997, and presented a talk there.

Attended the Black hole workshop held in I.I.Sc, Bangalore, in December 1997.

Attended the Quantum Gravity workshop held in R.R.I, Bangalore, in December 1997.

Attended the GR15 conference at IUCAA, Pune, in December 1997; and presented a talk there.

Attended the spring school on Non Perturbative effects in String Theory, at ICTP, Trieste, Italy, in March 1998.

Ramachandran, R.

Attended the Annual Meeting of the Indian Academy of Sciences at Hyderabad, during 1 - 3 Nov., 1997.

Visited Joint Institute of Nuclear Research, Dubna Institutes of Russian Academy of Sciences at Moscow, Russia under Indo Russian Integrated Long Term Co-operation (ILTP) in Science and Technology to foster research collaborations in the field of Mathematical Physics.

Participated in the Abdus Salam Memorial Meeting at Trieste, during 19 -22 November, 1997, and chaired a technical session.

Participated in the Internatonal Conference on General Relativity and Gravitation (GR 15) at IUCAA, Pune, during January 15 - 21, 1998.

Participated in 'Recent Trends in Physics', at the Platinum Jubilee of Department of Physics & Astrophysics, University of Delhi, during March 18 -19, 1998.

Raman, Venkatesh

Visited the University of Waterloo, Canada during September 21 - 30, 1997, and gave a talk on *Parameterized Complexity.*

Visited the University of Victoria, Canada during October 1 - 5, 1997, and gave a talk on *Succinct Representation of Static Binary Trees.*

Attended the 'Conference on Graph Connections' at Cochin during January 28 - 31, 1998 and delivered an invited talk on *Generalized Hamiltonian Paths in Tournaments.*

Attended the Dagstuhl Workshop on Data Structures at Saarbrucken, Germany during March 1 - 5, 1998 and delivered an invited talk on *Improved Upper Bounds for Time-Space Tradeoffs for Selection from Read-Only Memory.*

Visited the Max Planck Institut for Informatik at Saarbrucken, Germany during the month of March and delivered a series of three lectures on *Parameterized Complexity.*

Attended the annual Ramanujan Mathematical Society meeting at Manonmaniam Sundaranar University, Tirunelveli on June 4th '98 and delivered an invited talk on *Randomization in Graph Algorithms.*

Participated in the National Seminar in Theoretical Computer Science, held at Bhubaneswar, during June 11 - 14, 1998.

Visited the Lulea University of Technology, Lulea, Sweden from 5th to 7th July.

Attended the sixth Scandinavian Workshop on Algorithm Technology (SWAT 98) at Stockholm, Sweden between July 8th to 10th and presented the paper titled *Improved Upper Bounds for Time-Space Tradeoffs for Selection with Limited Storage.*

Attended the Ninth SIAM Conference on Discrete Mathematics at Toronto between July 12th to 15th and delivered a talk on *Parametric Tractability Techniques* in the minisymposium on Parameterized Complexity.

Visited the University of Waterloo, Canada between July 16th to 18th.

Ramanujam, R.

Visited Tata Institute of Fundamental Research, Mumbai from August 1 to 15, 1997, and gave two talks related to *Model checking temporal logics.*

Participated in the ASIAN1997 conference at Khatmandu, during December 9 to 12, 1998, and presented a paper titled *Rules for trace consistent reasoning*; also gave a talk titled *Issues in local model checking* in a post-conference workshop.

Gave a Mathematics Colloquium at Mehta Research Institute on February 5, 1998, titled *A provably unsolvable problem.*

Gave a talk titled *A phased temporal logic* at Tata Institute of Fundamental Research, Mumbai on February 13, 1998.

Participated in the Seminar on Philosophy of Science at IIT, Bombay, during February 16 - 22, 1998, and gave a tutorial on *The logical omniscience problem*, and an invited talk on *Knowledge, views and model checking.*

Gave two talks at United Nations University, Macau, on *Communicating automata* (on March 16, 1998), and on *Partial order methods* (on March 17, 1998), respectively.

Gave a talk titled *Speeding up verification in temporal logic*, at the Graduate School of Mathematics, University of Tokyo, on March 20, 1998.

Participated in the Conference on Applications of Concurrency to System Design, Aizu-Wakamatsu, Japan, during March 23 to 26, 1998, and presented a paper titled *A presentation of regular languages in the assumption - commitment framework.*

Gave a talk titled *Local reasoning in distributed systems*, at the National University of Singapore on March 31, 1998.

Visited Indian Institute of Technology, Kanpur, from April 22 to May 9, 1998, and gave a talk titled *Automata-based verification.*

Participated in the National Seminar in Theoretical Computer Science, held at Bhubaneswar, during June 11 - 14, 1998, and gave an invited talk on *Rabin's Tree Theorem.*

Ravindra, G.V.

Attended the first National Conference on Commutative Algebra and Algebraic Geometry at The Indian Institute of Astrophysics, Kodaikanal, during 23 - 27 March, 1998.

Ray, Purusattam

Attended the Workshop on 'Statistical Physics of Frustrated Systems at ICTP, Trieste, Italy from September 3rd to October 3rd, 1997; gave a talk on *Disorder induced melting in two-dimensional system.*

Visited Boston University, Boston, U.S.A. from October 6th to December 23rd, 1997.

Attended '78th Statistical Mechanics Conference' at Rutgers University, U. S. A. during December 14 - 16, 1997, and gave a talk on *How defects can induce melting.*

Visited University of Mainz, Mainz, Germany during July 1 to September 27, 1998.

Attended 'The 20th IUPAP International Conference on Statistical Physics', Paris during July 20 - 24, 1998, and presented two papers, namely *Scaling in the cluster-size distribution of persistent sites* (coauthor G. Manoj), and *Novel phase diagram in size-dispersity induced melting* (coauthors M. R. Sadr-Lahijany and H. E. Stanley).

Sarkar, Tapobrata

Attended 'Mini Workshop on Recent Developments in String Theory' at the Institute of Physics, Bhubaneshwar, during 4th to 9th March, 1998, and gave a talk titled *Planckian Scattering of D- Branes.*

Sathiapalan, Balachandran

Visited CTS Bangalore for a month (October 97), and presented six lectures on *M-Theory.*

Visited CTS for a conference on Quantum Gravity in Dec 1997.

Visited IOP Bubhaneswar to attend workshop on string theory in March 1998; presented two lectures - one was a review talk on Matrix models and the other was on *Interaction between F- and D- strings in the Matrix Model.*

Seth, Anil

Attended the 17th FSTTCS conference, during Dec. 18-20 1997, in Kharagpur and presented a paper titled *Sharper Results on the Expressive Power of Generalized Quantifiers.*

Visited the Indian Statistical Institute, Calcutta, Dec. 21-23, 1997, and delivered two talks on finite model theory.

Simon, R.

Attended the 'Frontier Meeting in Physics: Optics - Modern Trends', at Mysore, during January 31 - February 5, 1998 and gave a course of lectures on *Geometry of Phases in Optics.*

Visited Physical Research Laboratory, Ahmedabad during April 27 - 29, 1998 and gave a seminar on *Congruences and Canonical Forms for Positive Definite Matrices.*

Visited the Centre for Theoretical Studies, Indian Institute of Science, Bangalore during June 10 - 14, 1998.

Sinha, Nita

Attended the Workshop on B and Neutrino Physics, at Mehta Research Institute, Allahabad, during Jan 4-8, 1998.

Sinha, Rahul

Attended the Workshop on B and Neutrino Physics, at Mehta Research Institute, Allahabad, during Jan 4-8, 1998, and presented an invited talk titled *CP violation: Beauty with simplicity.*

Visited Physical Research Laboratory, Ahmedabad, during Mar. 15-18,1998, and delivered a talk titled *CP violation: The Physics of Beauty.*

Visited Tata Institute of Fundamental Research, Mumbai, during Mar. 18-22, 1998 and delivered a talk titled *CP violation: The Physics of Beauty.*

Visited Institute of Physics, Bhubaneshwar, during Mar 22-24, 1998, and delivered a talk titled *CP violation: The Physics of Beauty.*

Sinha, Subhasis

Attended the 'DAE Solid State Physics Symphosium 1997' at Cochin during December 27 - 31, 1997.

Visited the Centre for Theoretical Studies, Bangalore during February 1 - 28, 1998, and gave a talk on *Collective excitations in Bose-Einstein condensate in a trap.*

Sinha, Sudeshna

Gave an invited talk in the 'PRL Golden Jubilee Conference on Nonlinear Dynamics and Computational Physics', at Ahmedabad, in December 1997.

Gave an invited talk in the 'International Conference on Nonlinear Dynamics and Brain Functioning', at Bangalore, in February 1998.

Gave an invited talk in the 'International Conference on Nonlinear Dynamics: Integrability and Chaos', at Tiruchirapalli, in February 1998.

Sridhar, R.

Visited the Department of Physical Sciences, University of Salerno, Salerno, Italy during September 15 - October 11, 1997 and gave a course of lectures on *Methods of Quantum Field Theory in Condensed Matter Physics.*

Visited the Department of Applied Mathematics and Computer Science, University of Ghent, Ghent, Belgium during October 11-25, 1997 and gave a Seminar on *Fractional Statistics and Quantum Mechanics in Non-commutative spaces.*

Visited the International Centre for Theoretical Physics, Trieste, Italy during October 26 - November 15, 1997.

Srinivas, K.

Visited TIFR, Mumbai during Sept. 19 - Oct. 3, 1997.

Participated in the Number theory conference held at Vivekananda College, Chennai on 16th Feb. 1998.

Visited Pondicherry University during 19 - 21 March, 1998, and gave two talks on *Cryptography and Primality testing* at the Academic Staff College, Pondicherry.

Srinivasa Rao, K.

Visited the Arnold Sommerfeld Institute for Mathematical Physics, Technical University of Clausthal, Germany, during Aug. 9 - 25, 1997; participated in the Workshop on Lie Theory and its Applications to Physics, during Aug. 17 - 20, and delivered a special evening lecture on *A glimpse into the life and work of Ramanujan* on Aug. 18.

Participated in the Fifth International Wigner Symposium, held at the University of Vienna, Austria, during 25 - 29 August 1997, chaired a session on Aug. 25 and gave an invited talk on the *Group theory of some transformations of generalized hypergeometric series and symmetries of the 3-j and 6-j coefficients*, on Aug. 26.

Visited and lectured on *Quantum Theory of angular Momentum and Hypergeometric series*, at the University of Vienna, Austria, on Sep. 1, 1997.

Visited the Department of Applied Mathematics and Computer Science, University of Ghent, Belgium, under the European Commission Project (CI1*-CT92-0101), during Sep. 2 - Nov. 28, 1997; gave an invited talk on *Communications in India: the present scenario*, at an International Colloquium on New Technologies based Learning and Employment support, at Ghent and Louvain, during Sept. 17 - 19, 1997.

Gave an invited talk on *q and (P,Q)- hypergeomtric functions*, in the Contact Group in Mathematical Physics meeting at the University of Liege, on Oct. 31, 1997.

Visited the CWI, Amsterdam and gave a two-part lecture on the *Life and Work of Srinivasa Ramanujan*, on Nov. 4, 1997.

Visited the Birla Institute of Technology and Science, Pilani, during February 10 - 14, 1998, and gave two lectures on *Physics of the 21st Century ?!*, and on *Gauss hypergeometric series and its generalizations*, respectively.

Delivered an invited Talk on *Group Theory of some transformations of hypergeometric series*, at the Conference on Number Theory and its Applications, at the Ramakrishna Vivekananda College, Madras, on Feb. 19, 1998.

Participated in the XIII Annual Meeting of the Ramanujan Mathematical Society, at the Manonmaniam Sundaranar University, Tirunelveli, during June 4 - 6, 1998, chaired two sessions, and gave an invited talk on *Group theory of transformations of ordinary and basic hypergeometric series.*

Sunder, V.S.

Lectured on *Knots* at the Maths Association of the Madras Christian College on Sept. 26th, 1997.

Attended a National Symposium on 'Dynamical Systems and Ergodic Theory' at the University of Hyderabad during Dec. 6 - 8, 1997, and gave a lecture titled *From Factor Orbit Equivalence to Subfactors.*

Lectured on *Determinants of +1,-1 matrices* at the 'One Day Symposium on Mathematical Methods and Applications, on the birth anniversary of Ramanujan', at IIT, Chennai, on Dec. 22nd, 1997.

Gave the Eighth Srinivasa Ramanujan Award Lecture at the Annual Conference of the Indian Mathematical Society at Ahmednagar, on Dec. 27th, 1997; the title of the lecture was *Commuting Squares.*

Attended the Conference on 'Complex Analysis and Related Areas' at TIFR, Mumbai during Dec. 29 - 31, 1997, and lectured on *Extended Dynkin diagrams, finite subgroups of SO(3)*

and subfactors of index 4.

Attended the Discussion Meeting on Harmonic Analysis held at the Indian Statistical Institute, Calcutta, during Jan. 22 - 24, 1998, and lectured on *The algebra of relations.*

Visited the Indian Statistical Institute, Bangalore, during the period April 13th-24th, 1998, and gave two lectures, titled *G-Relations* and *Survey of Subfactors*, respectively.

Gave three lectures on *Some aspects of convexity* at a 'Short term Course on aspects of nonlinear functional and Applicable Analysis' in IIT, Chennai, on May 27th and 28th, 1998.

Organised the 'thematic lecture series' on the theme *Complete Positivity*, at the Annual Conference of the Ramanujan Math. Soc., at Manonmaniyam Sundaranar University, Tirunelveli, during the period June 4th-6th, 1998; this 'lecture series' consisted of three lectures by each of Rajarama Bhat, Gadadhar Misra (both of ISI, Bangalore) and V.S. Sunder.

Lectured on *Algebras of G-relations* at the SPIC Math. Inst. on July 29th, 1998.

Surya Ramana, D.

Visited the I.C.T.P., Trieste, Italy in the months of August-September, 1997, under the Federation Agreement scheme, and attended the summer school on Elliptic Curves in August, 1997.

Visited the Department of Mathematics, University of Genoa, Genoa, Italy in September, 1997, and delivered a seminar titled *Additive Complements of Squares.*

Vathsan, Radhika

Attended the Discussion Meeting on Quantum General Relativity, at RRI, Bangalore, on 13th and 14th December 1997.

Presented a poster entitled *Geometry of Clusters in Two Dimensions* at the DAE Symposium on Solid State Physics, at CUSAT, Kochi, during 27 - 31, December 1997.

2.8   Other Professional Activities

Adhikari, Rathin

Selected as speaker for 98-99 session under theoretical physics seminar circuit programme organised by S. N. Bose National Centre for Basic Sciences, Calcutta.

Arvind, V.

Co-chair of the Programme committee of the 18th international conference on Foundations of Software Technology and Theoretical Computer Science, to be held in Chennai in December 1998.

Balasubramanian, R

Member, National Board of Higher Mathematics.
Member, Management Advisory Commitee , D.S.T.
Member, Board of Research, Madras University
Member, Board of Studies in Mathematics (PG), Madras University
Member, Scrutinizing Committee of the National Academy of Sciences, Allahabad
Member, Editorial Board, National Acedemy of Science Letters.
Member, Editorial Board, Indian Journal of Pure and Applied Mathematics.
Member, Programme Advisory Committee, S.N.Bose Center for Basic Sciences .
Member, National Committee (INSA) for International Mathematical Union.

Baskaran, G.

Editor of the Indian Journal of Pure and Applied Physics.
Elected member of the Indian Committee of International Union of Pure and Applied Physics (IUPAP).
Member of the International Scientific Committee of the International Center for Condensed Matter Physics, Brasilia, Brazil.
Staff Associate Consultant to the International Center for Theoretical Physics, Trieste, Italy.

Chakraborty, T.

Editor of the International Journal Physica E: Low-Dimensional Systems and Nanostructures (North-Holland).
Scientific Director of the International Workshop on "Novel Physics in Low-Dimensional Electron Systems" (LOWDES), Dresden, July 28 - August 8, 1997

Dasgupta, Arundathi

Took Tutorials for the course, Electricity and Magnetism, during Aug - Dec, 1997.

Govindarajan, T. R.

Member Board of Studies, Manonmaniam Sundaranar University, Thirunelveli.
Organising Committee member, III Puri Workshop, Dec 10-19, 1998.
Organising committee member, Indo-Russian International Workshop, Dubna, Aug 11-15,98.
Senior Associate, ICTP, Trieste Italy.

Hari Dass, N.D.

Organised the first Institute seminar day involving participation from members of the institute from all disciplines (10-12 Nov '97).
Member, Scientific organising committee for the Meeting on Black Holes held in Bangalore during December 1998.
Member, planning committee for the 1998 SERC school on Theoretical High Energy Physics.
Guided a summer student (V.Sowmya,IIT,Chennai) on a project entitled *Interaction without entanglement.*
Have given many talks in the String theory journal club as well as in the QCD journal club.

Kesavan, S.

Organized the Contact Programme under the Nurture Programme of the NBHM from June 29 - July 17, 1998.

Member, Programme Advisory Committee, National Undergraduate Programme in Mathematical Sciences, SPIC Mathematical Institute, Chennai.

Member, Programme Implementation Committee, National Undergraduate Programme in Mathematical Sciences, SPIC Mathematical Institute, Chennai.

Krishna, M

Member, PAC, Mathematical Sciences (SERC) DST.

Mahajan, Meena

Member, Programme Committee of the 8th National Seminar on Theoretical Computer Science, held in Bhubaneshwar from 11th to 14th June 1998.
Member, Programme Committee of the 18th International Conference on Foundations of Software Technology and Theoretical Computer Science FST&TCS, to be held in Chennai in December 1998.

Nag, Subhashis

Member, Advisory Board, IJPAM, Indian National Science Academy.

Nagaraj, D.S.

As a resource person for the Refresher course in Linear Algebra and Field Theory for college/University teachers at the Ramanujan Institute of advanced study in Mathematics university of Madras, gave three lectures and conducted three problem sessions on Linear Algebra during 27th, 28th of Feb. and 2nd March 1998.

Paranjape, K. H.

Associate Editor for The Proceedings of the Indian Academy of Sciences, (Mathematical Sciences).
Member of the Editorial Board for the Journal of the Ramanujan Mathematics Society.
Member of the Editorial Board for 'Resonance' A Journal of Science Education.

As chairman computer committee a number of computer-related activities were carried out.

1. A proxy http server was configured to reduce the load put on our external bandwidth by repeated access to the same information.

2. The new ERNET-VSNL link based at IMSc was put in operation.

3. An extensive cleaning and organisation operation at the Computer Center is in progress.

4. The work of the computer centre has now been divided into projects, each of which will be managed by various faculty members.

Rajasekaran, G.

Member, Governing Council of the Mehta Research Institute of Mathematics and Mathematical Physics, Allahabad.
Member, Special Committee of the School of Physical Sciences, Jawaharlal Nehru University, New Delhi.
President, Indian Physics Association (Madras Chapter).
Member, Organizing Committee of the Fifth Workshop on High Energy Physics Phenomenology (WHEPP-5) held at IUCAA, Pune during 12-26 January 1998.

Ramachandran, R.

Member, Sectional Committee for Physics, Indian Academy of Science, Bangalore.
Member, Board of Studies, Indira Gandhi National Open University, New Delhi.
Member, School of Physics Board, University of Hyderabad.

Member, Planning Board, Manonmaniam Sundaranar University, Thirunelveli.
Member, Board of Research, University of Madras, Madras.
Member, Strategic Planning Committee at IIT Madras.
Member, Working Committee of Current Science Association.
Area Co-ordinator for Mathematics and Mathematical Sciences of the Indo Russian Integrated Long Term Program (ILTP) of Co-operation in Science and Technology.

Ramanujam, R.

Co-chair of the Programme committee of the 18th international conference on Foundations of Software Technology and Theoretical Computer Science, to be held in Chennai in December 1998.

Ray, Purusattam

Was nominated an Associate Member of The Abdus Salam ICTP, Trieste, Italy from 1 January 1998 until 31 December 2003.

Sarkar, Tapobrata

Delivered a lecture titled 'Unification of Forces in Nature' on the occassion of the National Science Day, to B.Sc and M.Sc students from Chennai at I.M.Sc
Delivered three lectures to standard X and XI students at the Children's Club, Mylapore, on Electricity and Magnetism, as part of the Summer School for school students, and also was part of the organising team for the Physics Quiz for the same students.

Simon, R.

Member, Programme Advisory Committee (PAC) on *Lasers, Optics, Atomic and Molecular Physics*, Department of Science and Technology, Government of India.
Member: Editorial Board, *Pramana – Journal of Physics.*

Sinha, N.

Selected TPSC Speaker for 98-99

Srinivas, K.

Gave a course of 24 lectures on Number Theory in the MTTS programme held at IIT,Chennai during May 18th to June 13th '98.

Srinivasa Rao, K.

Organized for the Institute and the Avvai Academy, Royapuram, the 78th Remembrance Day of Ramanujan at the Ramanujan Museum, Royapuram, on April 26, 1998, at which function his book *Srinivasa Ramanujan: a Mathematical Genius* was released.
Member of the 1998 International Advisory Committee of the XXII International Colloquium on Group Theoretical Methods in Physics, to be held at the University of Tasmania, Hobart, Australia.

Sunder, V.S.

Member, Editorial Board, of the Journal of the Ramanujan Mathematical Society.
Member, Sectional Committee for Mathematics, Indian Academy of Sciences.
Member, Programme Implementation Committee, National Undergraduate Programme in Mathematical Sciences, SPIC Mathematical Institute, Chennai.
Organised the meeting on *50 years of Indian mathematics* at IMSc during November, '97.

2.9   Honours/Awards received

Chakraborty, T. was awarded a Doctor of Philosophy (honoris causa) by the University of Oulu, Finland in May 1998.

Kesavan, S. was elected Fellow of the National Academy of Sciences, Allahabad, in 1997.

Rajasekaran, G. was awarded the Satyendra Nath Bose Medal (1998) of the Indian National Science Academy, New Delhi.

Rao, Madan was one of the few scientists from all over the country selected to receive the prestigious *Swarnajayanthi Fellowships* awarded to exceptional scientists under the age of 40.

Sunder, V.S. was elected Fellow of the National Academy of Sciences, Allahabad, in 1997.

Chapter 3

Computer Facilities

In the current report period, there was further significant strengthening of the Institute computer system in terms of hardware and software, and internet services.

A twin-tower SGI Origin 200 machine with a CrayLink Interconnect has been acquired (with a total of four R10000 CPUS at 175MHz and 256 Mb of RAM). High performance FORTRAN compiler has been installed in the multi CPU systems for high performance computing needs.

The Power Challenge L, acquired 2 years ago, has been upgraded with the addition of two more R8000 CPUs and 128 MB RAMs (with a total of 4 R8000 CPUs and 256 RAM).

A lecture series on High Performance Computing was delivered by Dr. V. Kamakoti at the Institute during April-May 1998. The emphasis was on developing appropriate programming strategies to utilise more efficiently the computing power available through the newer machines. Currently the PVM (parallel virtual machine) is being set up by Dr. V. Kamakoti and Dr. G. Date.

During the current report period, the software capabilities have been considerably expanded. A purchase order for IMSL has been placed, additional licenses for Mathematica have been obtained, FORM and Matlab have been purchased. Numerical Recipes is already installed on one of the machines. With these new purchases, a fairly exhaustive range of computation and symbolic manipulation packages are now available on the IMSc computer network.

Internet services have been functioning regularly through the VSAT and the VSNL radio link network of ERNET. As of last year, the Institute has become a regular ERNET transit node. As an ERNET node, a 64 KBPS radio link to the internet through VSNL, Chennai has been commissioned, and will eventually be upgraded to 2MBPS. The Institute is now in a position to provide uucp and/or Internet connectivity to various other institutions in the region on behalf of ERNET, in accordance with ERNET policies.

A systematic move to upgrade access stations in end-users' offices has been started. About half of the old monochrome xterms have been phased out, and Pentiums and new colour xterminals are now the access stations of choice.

The computer facility used by the office and administration has been upgraded to a Windows-NT network, and an appropriate software package for office automation has been implemented under PowerBuilder. Eight Win-NT clients have been provided to allow staff

members to utilise the software package from their desks. The office automation will be completed in a few months time.

Computer controlled 30KVA UPS with 30 minutes backup time has been installed to support the computer systems distributed in the campus. A generator backup is provided to maintain the IMSc computer network services.

A mirror site (http://xxx.imsc.ernet.in) of the Los Alamos physics and mathematics e-print archives was set up during the previous year. In the last year, after the commissioning of the 64Kbps link to VSNL under ERNET, this project has been thrown open for regular service. This provides users in India an alternate ready access to the vast majority of current literature published in several areas of mathematics and physics. IMSc also hosts the official web-site of the Indian Association for Research in Computer Science (IARCS).

The Institute has a popular web-site at http://www.imsc.ernet.in, with several pages of information about the Institute and its research, on science and popular science, web-sites in India, etc. It continues to be a fairly frequently accessed site.

The system is managed by one full-time system administrator, Dr. G. Subramoniam. The ERNET has provided for a project assistant to help in the network related activities. Dr. Suresh Rao has joined in this capacity from July 1st.

Chapter 4

The Library

During the year 1997-98, two thousand and twenty volumes have been added to the Library, which brings the total number of volumes to 36670. The Library continues to subscribe to about 240 International Journals on Mathematics, Physics, and Theoretical Computer Science. We get Preprints from reputed institutions both from within and outside India. The institute library also receives journals, lecture notes, books, etc., in exchange for IMSc reports. Inter-Library-Loan facilities are available to similar institutions.

The number of visitors and users to the library for reference work and Xeroxing has increased substantialy over the previous years. Over hundred thousand photocopies were made in response to the requests received from institute members, as well as from research scholars working in various colleges and Universities from the Southern States of the country.

The Ninth Five Year Plan (1997-2002) provides opportunities to augment our resources. In the First year of 9th plan, a large number of missing back-volumes and serials as well as books in new areas have been added to the library. The automation sofware LIBSYS is being upgraded. A new xerox machine (CANON - model no.6330) was purchased.

The library gratefully acknowledges the donation of valuable books and journals during the current year from the sources mentioned below:

East West Press, Madras
Indian National Science Academy
Door programme
N.B.H.M, D.A.E, Mumbai
International Joint Conf. on A.I. Inc.
Allied Publishers Subscriptions Agency, Madras
ICTP, Italy
Professor J. Keller
Professors R. Ramachandran, K. Srinivasa Rao, G. Baskaran, V.S. Sunder, S. Kesavan,
R. Sridhar, Kamal Lodaya, V. Arvind and Mr. N.V. Vinodchandran.

The paper 'Emerging Information Scenario at the Institute of Mathematical Sciences Library', by Natarajan, M.* and Venkatesan, G., was published in the *Fifth National Convention CALIBER-98 on Information Management in Academic and Research Libraries*, 4-5 March 1998, pp. 310-311.