The Institute of Mathematical Sciences

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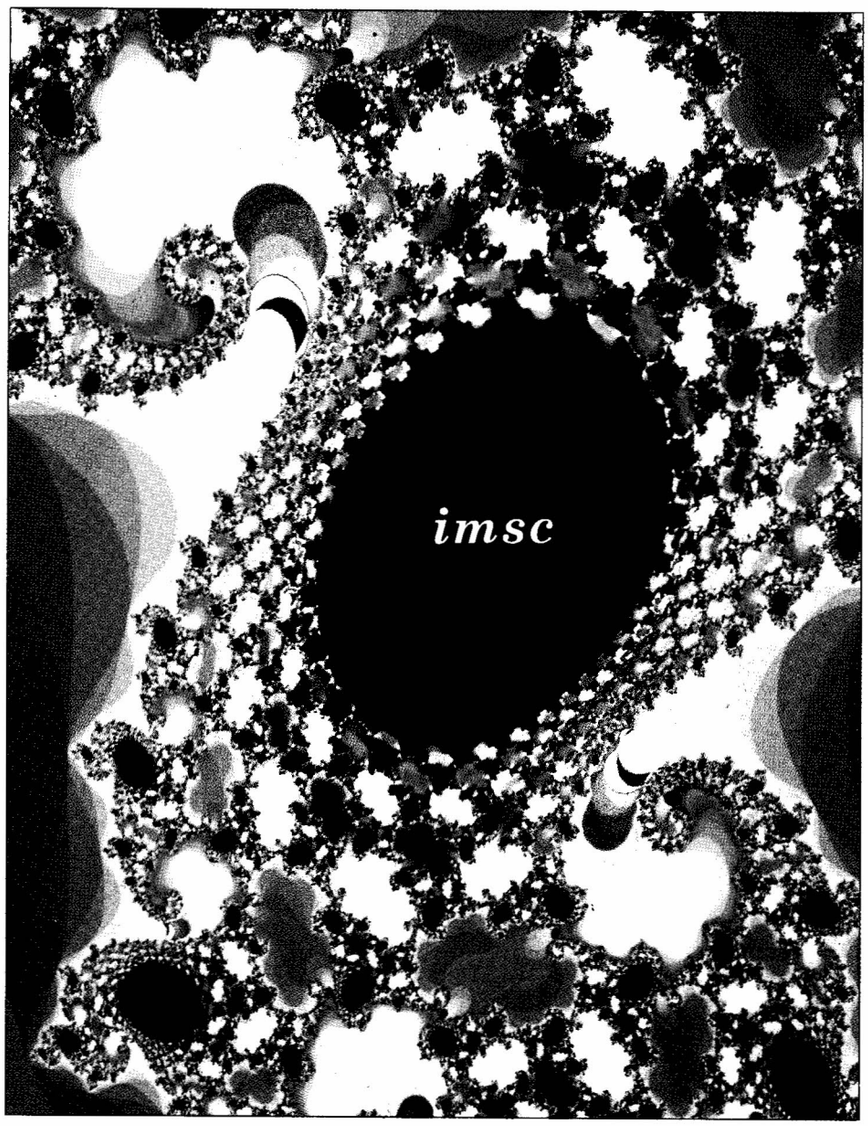

ANNUAL REPORT

1995 - 96

THE INSTITUTE OF MATHEMATICAL SCIENCES

C.I.T. Campus, Taramani

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ANNUAL REPORT

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FOREWORD

I am honoured to present the Annual Report of the Institute of Mathematical Sciences for the year 1995-96. The report lists the academic activities of the Institute and highlights the achievements of both the individual members of the Institute as well as the various collective programmes.

Dr.R.Chidambaram, Chairman of the Executive Council of the Institute initiated discussions on what should be the Vision of the Department of Atomic Energy, its various units and allied Institutions for the next 25 years. The Institute took this opportunity to think about our own Vision for the Institute. A one day seminar Vision 2020 was organised on 19.4.96 to bring to focus our views on the shape of research in the Institute for the next few decades. It is planned that this focus will be further sharpened and emerge as the action plan for the Institute. We hope that the faculty of the Institute and the Executive Council will deliberate on this master plan and take appropriate decisions to enable the Institute play its role in the growth of national research in Mathematical Sciences.

The strong academic tradition of the Institute continues with active collaboration with the Universities and the IIT in Madras. Efforts are on to enter into a memorandum of understanding with IIT Madras for strong academic collaboration in disciplines of mutual interest. We expect to play in the coming years greater role in the teaching component of higher education to supplement and augment our research efforts.

During the year under review, the Indian Academy of Sciences(Bangalore) had its Annual meeting at Madras, from November 10-12,1995 and the Institute in association with other Institutions in Madras, such as IIT, Anna University, CLRI, SPIC Science Foundation and IGCAR Kalpakkam played the role of the local host to a galaxy of distinguished visitors. The Institute organised a symposium in Memory of Professor S.Chandrasekhar on Nov.17,1995 to recall his many faceted contributions. The Institute hosted a workshop on 'Spectral theories of Schrödinger Operators' during December 4-14, 1995, in which there were about 25 participants including a few from abroad. The Institute cohosted the 18th Conference of the Indian Association of General Relativity and Gravitation(IAGRG) held during Feb.15-17,1996.

Further, on January 3, 1996, the Foundation day of the Institute, the main lecture hall of the Institute was formally named as **CHANDRASEKHAR HALL**, recalling the fact that Professor Chandrasekhar inaugurated the Institute on this day 34 years ago.

This annual report has been completed through the efforts of a committee consisting of Profs. S.Nag, H.S.Sharatchandra, R.Sridhar, Dr.V.Arvind and Mr.K.S.Santhanagopalan; Mr.G.Venkatesan provided the necessary support. Mr.T.V.Vasudevan assisted in typesetting the annual report using LaTeX and to all of them I owe my gratitude.

We look forward to achievements that sets us apart as we approach the next millennium.

July 1996

R.Ramachandran
Director

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* *tenure at IMSc is over*

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* *tenure at IMSc is over*

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Summary of Research Work

Mathematics

Algebra:
The study of integrally closed modules over two-dimensional regular local rings was initiated. This is motivated by classical results of Zariski on complete ideals which have applications to the geometry of curves and surfaces. The main results, which are higher rank versions of theorems of Zariski, Huneke-Sally, Lipman and others, assert that the tensor product mod torsion of integrally closed modules is integrally closed, that the symmetric algebra mod torsion of an integrally closed module is a normal, Cohen-Macaulay domain and that the first Fitting ideal of an integrally closed module is a complete ideal. Possible applications of these results in understanding the local Riemann-Roch theorem are currently being studied.

Explicitly determined the core of a torsion-free, integrally closed module over a two dimensional regular local ring generalizing a recent result of Huneke-Swanson. The main result asserts that the core of a finitely generated, torsion-free, integrally closed module over a two dimensional regular local ring is the product of the module and a certain Fitting ideal of the module. The technical tools used are quadratic transforms and Buchsbaum-Rim multiplicity. It is shown that the Rees valuation rings, of a finitely generated, torsion-free module M over a two-dimensional regular local ring are precisely the Rees valuation rings of the rank(M)-th Fitting invariant of M.

A question of Nori for smooth local algebras over perfect fields that are localizations of affine algebras has been settled. An elementary proof of the fact that a line bundle has cancellation property has been found. A manuscript that covers all the developments till the recent past in the area of projective modules and complete intersections has been written for publication.

Algebraic geometry:
Work is continued on the moduli of rank two torsion free sheaves on a reducible curve with two smooth curves meeting at one node. To such a sheaf is associated a vector bundle on each of the components and it is proved that such a sheaf is semi-stable implies that the each of the associated vector bundles are themselves semi-stable on each curve.

Analytic and Differential geometry:
By working on the universal direct system of the classical finite genus Teichmüller spaces, a definitive and genus-independent form of the Mumford isomorphisms between determinant bundles has been obtained. The entire construction has been shown to be equivariant with respect to the natural action on the limit space T_∞ of the universal commensurability mapping class group MC_∞. This group is a new genus-independent modular group; rather surprisingly, it turns out to be closely related to the absolute Galois group "$Gal(\bar{Q}/Q)$" of number theory. That relationship is being actively investigated.

It was shown that the direct limit construction mentioned above can also be carried out at the level of the classical moduli spaces $\mathcal{M}_g$ themselves, by utilizing the cofinal tower of characteristic covers. Weil-Petersson geometry has been studied on this direct limit $\mathcal{M}_\infty$ to prove the validity of the corresponding fundamental Mumford isomorphisms. This matter is connected to a non-perturbative description of the Polyakov measure on moduli.

Number theory:
An old conjecture of Sydney Graham regarding the maximum of a suffix i divided by the gcd of a suffix i and a suffix j was completely settled. A conjecture of Erdos on the cardinality of a subset having distinct divisor property was settled in a stronger form. The work on the zeroes of a generalised Dirichlet series was continued

Partial differential equations:
A system of semilinear equations in a bounded domain has been considered.For a given nonnegative nonlinearity,an isoperimetric inequality of the Payne-Rayner type is established for a positive solution vector.If the space dimension is two, it is shown that if the domain is a ball, this inequality is exactly the reverse of a Pohozaev type of inequality, which is also established. Hence deduced equality in the isoperimetric inequality and we deduce the radial symmetry of the solution vector in a ball.

Quasiregular maps:
The construction of quasiregular maps $F : R^3 \to R^3$ of order zero but whose growth is $\log M(r) = O((\log r)^p)$, where $p \geq 1$ is shown. These are analogues of entire maps $f : C \to C$, which can be written as $f(z) = C.z^m.\Pi(1 - z/a_n)$, where $|a_n| \to \infty$ very rapidly. It is shown that F is the extention to R^3 of an entire function which has the same growth as F, yielding thus an interesting class of examples of quasiregular maps in R^3. One may also consider the map F composed with the Zorich map to obtain quasiregular maps of any order $p \geq 1$.

Spectra of operators:
Work on identifying the iso-spectral sets for Jacobi operators having countable spectrum. This result is in contrast to the case of reflectionless absolutely continuous spectra where the iso-spectral sets can be identified as compact tori giving rise to almost periodic potentials.

In continuation of the above theme, work is carried out to identify the possible singular spectra that can occur for one dimensional Schrödinger operators. In this area research is in progress on two fronts, one to study the inverse spectral theory for the harmonic oscillator, and the other to study inverse theory for general singular spectra. Also ongoing the study of some problems in the theory of resonances of Schrödinger operators.

Von Neumann algebras:
A set of lecture notes on Subfactors is being put together (collaborative effort). The notes contain some new material (on the diagrammatic nature of the computations that go into the determination of the principal graph invariants of a subfactor arising from a 'finite commuting square'), and also some simplified versions of one of the first non-trivial explicit computations of the principal graph invariants of subfactors associated with some vertex models. Collaborative work is being carried on regarding finite hypergroups, their actions on sets, and the relation between these notions and association schemes, etc..

Physics

Mathematical Physics

It is shown that higher order corrections to the lowest order semiclassical quantization rule vanish in the case of three known shape invariant potentials with broken supersymmetry thereby establishing that the lowest order formula is indeed exact for these shape invariant potentials with broken supersymmetry.

Research work in the area of summation theorems and multiple - hypergeometric series is being carried out. The work on obtaining transformations of multiple - hypergeometric series from the new summation theorems for the Kampe de Feriet (double) hypergeometric series obtained earlier is in progress. Results have been obtained for "q-connection coefficients" for Laguerre and Hermite Polynomials. Algorithms have been found for generating 'restricted' compositions and results which generalize those of George E. Andrews on compositions have been obtained.

New integral representations have been found for the 3-j coefficient.

Nonlinear Dynamics

Using methods of classical differential geometry of surfaces and moving curves,a connection has been established between the Belavin-Polyakov equation (which occurs in various physical applications)and the elliptic Liouville equation, whose general solution is known.A surface-embeddability approach is used to identify the class of inhomogeneities for which the spin evolution equation in an inhomogeneous classical Heisenberg chain is exactly solvable.Explicit solutions are found for certain physically interesting examples. Starting with a general formalism for moving space curves,it is shown that large classes of evolution get mapped to variants of the Belavin-Polyakov equation.Physical applications are identified.Nonlinear excitations for an anisotropic antiferromagnet are found and contrasted with the isotropic case.

Quantum Groups, Generalised Statistics

A complete Fock space representation of the covariant differential calculus on the noncommuting quantum space has been constructed. The consistency criteria for the ensuing algebraic structure, mapping to the canonical fermions and bosons and the consequences of the new algebra for the statistics of quanta are analyzed. The concept of statistical transmutation between bosons and fermions is introduced.

Dynamics has been generalized to noncommuting phase space. The noncommuting phase space is taken to be invariant under the quantum group $GL_q(2)$. Both the Hamiltonian and Lagrangian forms of the dynamics have been constructed.

A class of polynomial deformations of $osp(1/2)$ algebra has been considered. The representation theory of these algebras, interpreted as generalized paraboson algebras, has been discussed.

The dually conjugate Hopf algebras $Fun_{p,q}(R)$ and $U_{p,q}(R)$ associated with the two-parametric (p,q)-Alexander-Conway solution R of the Yang-Baxter equation have been studied. The corresponding universal $\mathcal{T}$-matrix, expressing the exponential relationship between the quantum algebra and the quantum group, has been derived.

Using the universal $\mathcal{T}$-matrix approach, and the example of $U_q(sl(2))$-$SL_q(2)$ pair, it has been shown how to construct the comodules of the quantum algebra by exponentiating the modules of the quantum group.

A class of knots and links called mutants has been studied from the Chern-Simons field theory approach. It is shown that none of the polynomial invariants from Chern-Simons theory based on any compact semi-simple gauge group can distinguish mutant knots/links. In an attempt to distinguish them, we developed representation theory of composite braids has been developed. It is shown that some mutant links can be distinguished but not the mutant knots.

Yangian symmetry is respected by some of the integrable models (Heisenberg spin chain, Calogero Sutherland and Haldane Sastry model). A multiparameter deformed Yangian algebra $Y_m(gl_N)$ and a realisation of these generators in terms of the generators of standard Yangian algebra are obtained. A general 'symmetry transformation' of a particle conserving R-matrix resulting in multiparametric R-matrix dependent on spectral and colour parameter which obeys Yang-Baxter equation has been studied.

Such symmetry transformations of the Yang-Baxter equation have been used to derive the multiparametric and coloured extensions of the quantum group $GL_q(N)$ and the Yangian algebra $Y(gl_N)$. The explicit realizations of these extensions have also been discussed.

A simple problem of determining the disconnection number of a link is studied. Disconnection number is defined as the minimum number of scissor cuts required to completely disentangle the link. This is a weak invariant compared to polynomial invariants for knots and links. It has been shown that the 3SAT problem is reducible to the disconnection number problem. This implies that determining disconnection number is at least as hard as the satisfiability problem. Hence computing even this weak invariant is computationally intractable.

Optics and Particle Beams

Quantum mechanics of the optics of charged particle beams through electromagnetic optical systems (of importance in electron beam devices like electron microscopes, accelerators, etc.) is being investigated thoroughly, using essentially an algebraic approach. The basic quantum mechanical equation of motion (Schrödinger/Klein-Gordon/Dirac equation) is converted into a beam optical form describing the evolution of the wavefunction (or density matrix) of the beam along the optical axis. This formalism helps the computation of the transfer maps for the phase-space and spin components across an optical system up to any desired order of accuracy (paraxial and aberration properties) using a systematic perturbation technique. Based on the Dirac equation, a unified description of the orbital and spin dynamics of a spin-1/2 particle beam in an accelerator, including the Stern-Gerlach and the Thomas-Bargmann-Michel-Telegdi effects, has been achieved.

Classical and Quantum Gravity

The issue of Hawking radiation from Black holes and the problem of information loss associated with it in the context of fermions, elementary constituents of matter has been addressed. By studying the effect of the fermions on the geometry of the black hole we find a non-trivial interaction between the in and the out fields after a certain critical time is found. This points to the existence of an S-matrix and the fact that the fermions support complementarity, or

the observables outside the black hole and those inside are not simultaneously present in the same Hilbert space. Also the nature of interaction is very similar to that of scalars due to the geometric optics limit of the calculations, valid near the horizon.

Pathologies in eikonal Planckian scattering in dilaton gravity have been detected by a number of approaches and traced to a curvature singularity in the geometry due to a generic charged dilatonic black hole taken to model the scattering particles. All pathologies disappear in the extremal limit of the black hole metric.

An approach to compute two-particle scattering amplitudes for spinless light particles colliding at Planckian centre-of-mass energies, with increasing momentum transfer away from the eikonal limit has been discussed. For massless charged particles, the electromagnetic and gravitational interactions decouple in the eikonal limit, but mix non-trivially for the leading order corrections.

Planckian scattering of two bodies to produce blackholes is being studied using equivalent graviton approximation.

Quantum gravity effects come into play at the Planck scale which are in general difficult to compute because of the absence of a renormalisable theory of quantum gravity. However, in the eikonal approximation, exact scattering amplitudes can be calculated using well known techniques of quantum field theory in curved space time. It has been shown in this approximation, **(1)** For scattering of point particles in the eikonal limit, electromagnetism and gravitation interactions decouple from each other and act independently. Consequently, the scattering amplitude is proportional tio the 'effective' coupling constant $Gs - \alpha$, which is simply and algebraic sum of the gravitational (Gs) and electromagnetic (α) coupling constants.
(2) Although at Planckian centre of mass energies, electromagnetic interactions are usually much weaker compared to gravity, the two can become equally important if the scattering particles carry magnetic charge. This is a consequence of the Dirac quantisation condition.
(3) If the particles carry angular momenta, the scattering amplitude does not change significantly.
(4) If we analyse eikonal scattering in the context of string theory (by replacing Einstein's equations with low energy string equations of motion), then finite scattering amplitudes are obtained only when the masses and charges of the particles satisfy the extremality condition. This supports the conjecture that extremal black holes can be identified with elementary particles.

Particle Physics

The many novel phenomena arising from matter-induced neutrino oscillations during the passage of solar neutrinos through the moon and the earth are studied. It is found that, due to the oscillations the observed solar neutrino rate in the terrestial neutrino detectors may even be enhanced during a solar eclipse.

Cosmic-ray produced atmospheric neutrinos also undergo oscillations during their passage through the earth. A complete analysis with three flavours of neutrinos has been performed for both the sub-Gev and multi-Gev energies.

The Equivalent Photon Approximation of Weiszacker and Williams is known to fail for the production of massive charged spin-1 particles such as $W^{\pm}$. Hence, for the process $e^+e^- \longrightarrow e^+e^-W^+W^-$, a full-fledged calculation including Higgs boson in the intermediate state is

required. Such a calculation involving 98 Feynman diagrams and 36 helicity amplitudes is near completion.

The interface between the Regge region (fixed momentum transferQ^2) and the low x $(= (Q^2)/(2q.p))$ domain has become an area of much speculation. Attempts are being made to look for the class of diagrams that contribute to the diffraction processes and their relationship to k_T ordering is studied with a view to get a deeper insight into BFKL and GLAP evolutions.

It has been a challenge to use the large number of B's produced in hadron colliders to detect and measure CP violation in B mesons. It is found that the unique signal for detecting CP violation is via modes like $B \to K^* e^+ e^-$. Time reversal violation leads to a dependence on the sine of the angle $(\sin\phi)$ between the plane of the decay products $K\pi$ of K^* and the plane of the leptons. Such a term arises from the interference of the S-wave and P-wave amplitudes. Consequently, it is found that any asymmetry constructed by adding B and $\bar{B}$ events *e.g.* the difference in the number of both B and $\bar{B}$ events with $(0 \leq \phi \leq \pi/2) + (\pi \leq \phi \leq 3\pi/2)$ and $(\pi/2 \leq \phi \leq \pi) + (3\pi/2 \leq \phi \leq 2\pi)$ depends purely on the weak phase being nonzero. One hence has a clean signal of CP violation.The other interesting thing is that the same argument is applicable to $B_s \to \phi e^+ e^-$. At B factories B_s means running at $\Upsilon(5S)$ and then separating B_s from B_d. So CP violation in B_s is regarded as a difficult prospect at B factories. The methodology above is easily applicable to B_s

It is important to test the electroweak vector boson self interactions . Of particular significance are anomalous CP violating (CPV) gauge boson self interactions. If CPV is to originate through the symmetry breaking sector, it would give rise to electric dipole/magnetic quadrupole moment of the W boson. Traditionally, each of the two CPV moments have been constrained by the neutron dipole moment. In e^+e^- collider like LEP-II or NLC the process $e^+e^- \to l_1^- \bar{\nu}_{l_1} l_2^+ \nu_{l_2}$, where l_1, l_2 are either of the three leptons e, μ or τ, has been examined with regard to measuring the internal properties of the W boson, and estimating the two CP violating terms and their effects. A similar study is also done for CP conserving operators.

Quantum Field Theory

Generically coupled neutral scalar bosons and fermions have been shown, in the eikonal kinematical limit, to be described by a reduced (free field) theory with $N = 1$ *on-shell* supersymmetry. *Charged* scalars and spinors turn out to be described in the eikonal limit by a reduced interacting theory with a modified and restricted on-shell $N = 1$ supersymmetry. Consequences of such a symmetry are explored.

The study of Planckian scattering of particles with spin is being studied. This extends our earlier work to include neutrinoes. In particular, our earlier claim of spin decoupling at Planckian energies exhibiting the dominance of gravity, is critically examined with neutrinoes.

Simulations of SO(3) lattice gauge theories has shown that there are metastable states with distint and unrelated values of the expectation value of the Polyakov variable in the defining representation.Evidence that one of these is related to the high temperature deconfining phase and the other to the bulk confining phase is provided.Implications for the phase diagram at non-zero temperatures and the finite temperature transition in the continuum theory are discussed. Theory of the high temperature phase of the Yang-Mills field is developed.It is argued that the phase can be described in a Higgs language and that there are

two scales.Also the relevance of fractional counting statistics is pointed out.

A general solution of the non-abelian Gauss law has been obtained.This is relevant for obtaining the dual formulation and also for Ashtekar formulation of gravity.Using lattice regularization it is shown that any generic vector field which is an isospin triplet can be expressed in terms of a SO(3) non-abelian potential in contrast to the abelian case where the field has to be divergence free.This also implies that any dreibein has a spin connection with respect to which it is torsion free.Duality transformations are obtained as canonical transformations.In particular, transformations to a dual vector potential conjugate to the non-abelian magnetic field and to gauge invariant degrees of freedom are achieved.

String Theory

Intrinsic and extrinsic geometric properties of string world sheets in curved spacetime background are explored. In this approach, the only dynamical degrees of freedom of the string are its immersion coordinates. Classical equations of motion for the Nambu-Goto action picks out minimal surfaces while those for extrinsic curvature action, admits a wider class of surfaces. One loop divergent terms are calculated using the background field method. Finite contributions are under study.

Condensed Matter, Statistical Mechanics

Molecular dynamical simulation of a two dimensional lattice model has been used for the development of fractures. Suitable parameters are identified to point out occurence of spatial scaling in fracture development.

A microscopic derivation of the Ginzburg Landau free energy functional starting from a non-Fermi liquid ground state has been presented. Assuming a BCS like pairing interaction, an analytical expression for the Ginzburg Landau coefficient a(Γ) and b as a function of the scaling exponent α(α is the exponent which appears in the single particle propagator, characterising the non-Fermi liquid ground state, α==0 corresponds to that of Fermi liquid) has been obtained. It has been shown that the non vanishing value of the exponent α which leads to the breakdown of the Fermi liquid theory in the normal state gives rise to qualitatively and quantitatively different results in the superconducting state.

The effect of non-magnetic impurities in one dimensional large U Hubbard model has been studied. It is known that the 1-d large U Hubbard model away from half filling gives rise to a metallic phase, where spin charge separation exists. For a single non-magnetic scatterer, it is shown that a local moment gets formed at the impurity site which interacts with the spin excitations of the metallic state. The strength of the local moment is enhanced when the Coulomb correlation U is less than the impurity site energy and slowly it decreases when U increases and ultimately it vanishes as U tends to infinity. This might be having some relevence to the observed Curie behaviour in the magnetic susceptibility measurement of the substitutional Zn doped high Tc oxides.

The dirty boson problem has drawn a great deal of attention in the past decade as it represents a veriety of physical situations. This is being studied using a model, namely the Bose Hubbard model with random hopping energy, that can be shown to have phase excitations as the low energy mode, within the framework of a mean-field theory for filling $\rho = 0.5$. Numerical solution of the mean-field self consistency equations to calculate the various exponents at the disorder driven superfluid - Bose glass transition is in progress.

The problem of a scalar impurity in an one-dimensional Luttinger liquid: When the high temperature superconductor La_2CuO_4 is doped with a nonmagnetic impurity like zinc, it is found from NMR and ESR experiments that local moments are formed close to the impurity site. It is believed that a Luttinger liquid in one dimension with a scalar impurity has a similar behaviour. We are trying to understand this by using Bosonisation techniques on a one dimensional Luttinger liquid with s spinless impurity.

Quantum Antiferromagnets in two dimensions have been widely studied ,especially as candidates for novel ground states . In this category , the Heisenberg Antiferromagnet on a Kagome lattice presents a very interesting puzzle . This system is all the more interesting as there is a compound $SrCr_8Ga_4O_{19}$, in which the magnetic ion forms a Kagome lattice and hence offers an opportunity for experimental studies . A field theoretic description of this system is begin made. As a prelimnary step towards this, a model that smoothly interpolates from the Triangular to the Kagome lattice is studied by doing a spinwave analysis and looking at the behaviour of various order parameters such as the neel magnetization , chiral and nematic order parameters. The results indicate that there should exist a different type of description near the Kagome end as compared to the triangular end. It has also been possible to identify the modes that would play an important role in describing the low energy physics at the Kagome end . Futher work , showing renormalization group studies on a field theory that describes the behaviour of the goldstone modes has been carried out and is to be written out . Work on the complete theory described earier is in progress .

A novel Monte carlo scheme is developed to study dynamics of fluids in two dimentions. This is used to study phase ordering kinetics of binary fluids. It is established that a late-time scaling regime, where the domain size $R(t)$ grows as $t^{1/2}$ for high viscosity fluids with a crossover to $t^{2/3}$ for low viscosity fluids.

Using the above algorithm, now for a two dimensional surface embeded in three dimension phase separation on membranes made of two types of lipids is studied. When the shape of the membrane is coupled to concentration of the lipids this phase separation induces shape transformations and results in local 'budding' under favorable conditions. This study indicates that membranes with high biscosity, buckle on account of phase segregation. The relation between this dynamical buckling and the phenomenon of 'capping' seen in biological membranes is discussed.

Ground State of a Quantum dot system was studied using the Thomas-Fermi approximation. A method was developed to analyse the case of a class of inter-electron interactions and the results compared to experiment. It was found that the presence of a logarithmic component in the interaction was important to explain the experimental data.

The skyrmion picture of spin excitations about the $\nu = 1$ Quantum Hall state was studied. Starting from the microscopic theory in terms of electrons and using the bosonization in 2 dimensions, a semiclassical method to analyse the spin excitations was developed. The skyrmion solutions were found at the classical level and the results compared to experiment.

The conditions under which a two dimensional electron gas may behave like a Fractional Exclusion Statistics system is derived using mean-field methods.

A new many-body Hamiltonian with novel correlations in two dimensions was constructed. This Hamiltonian, even though has many body interactions, is exactly solvable for the ground state and a class of excited states for arbitrary number of particles.

It was shown that the condensed bosons in a trap with short-range repulsive interactions

can be mapped on to a fermion-like system with features resembling exclusion statistics systems in three dimensions. This mapping then allows calculation of excitations of the condensed bosons in a simple way.

The growth and development of breakdown in disordered system can be viewed as a growth of interface in the disordered medium driven by an external field. The growth morphology is then very much dependent on the strength of the disorder as has been observed in the interface growth in random field Ising model for example. We have studied the kinetics and the growth morphology in various breakdown models to see the effect of disorder. This can have direct application in the very important phenomena like the fracture growth in porous media, in earthquake problem or in breakdown in random electrical networks etc.

Theoretical Computer Science

Algorithms/Data Structures:

The self-adjusting binary search tree is a data structure that allows efficient search, find, and update operations to be performed dynamically. But unlike the earlier data structures for this purpose like the AVL tree, for example, the self-adjusting search tree maintains no explicit balancing information. We analyze the amortized complexity of a particular heuristic for path balancing in a self-adjusting search tree. We show that in a self-adjusting search tree, if after every access, the entire search path is restructured to a balanced binary search tree on those nodes, with the other subtrees placed in their proper positions, the amortized complexity is $O(loglogloglogn/logloglogn)$.

We investigate the parametrized complexity of the vertex cover search problem, where the parameter is the size of the vertex cover. We show that to find a vertex cover of size k in a graph having n vertices, $O(kn + (4/3)^k k^2)$ time is sufficient improving upon the earlier best upper bound of $O(kn + 2^k k^2)$.

We design an efficient combinatorial algorithm for computing the determinant. All earlier algorithms for computing the determinant are based on linear algebra. In contrast, our algorithm and its proof of correctness are combinatorial. This algorithm requires no division and hence works on commutative rings with 1 (like Chistov's algorithm). It also lends itself to efficient parallel implementations.

We analyze the behaviour of algorithms to test if a given number is a perfect power.

Complexity Theory:

The computational complexity of several group-theoretic problems is an intriguing problem. It is a long-standing open question whether they have polynomial-time algorithms. They are not intractable in the usual sense either. Some years ago, using Arthur-Merlin games, it was shown that these problems are powerless as oracles for Σ_2^p machines. Thus they cannot be NP-complete unless the polynomial hierarchy collapses to the second level. We consider these problems for solvable black-box groups and show that these problems are powerless as oracles for the hard counting class PP. These results complement the already known lowness results for Σ_2^p.

The relative complexity of decision versus search for NP problems is a classical subject in complexity theory. For NP-complete problems, there is a general result – using the self-reducibility of natural NP-complete languages – proving that decision and search are polynomial-time equivalent. However, this reduction of search to decision is sequential and can be made parallel only with randomization. We show that search (deterministically) reduces to decision with parallel queries for the Graph Automorphism problem: k solutions can be computed with $O(n^{\log k})$ parallel queries to the decision problem. This and related results imply new consequences concerning program checkers for the Graph Automorphism and related problem.

If a language A polynomial-time reduces to a sparse set S via a reduction f (of some type), then, relative to A how hard is it to compute a sparse set S' such that A still reduces via f to S'? (The sparse set S' is called a small description for A.) We address this question for various polynomial-time reduction types, and prove upper bounds on the complexity of computing small descriptions. If, additionally, A is a self-reducible language

we derive stronger upper bounds. These upper bounds have applications in the form of new collapse consequence results assuming that intractable complexity classes are reducible (via the considered reduction types) to sparse sets.

Interactive proof systems were initially introduced as a model of cryptographic protocols. As a model of computation, interactive proof systems have provided interesting new characterizations of various computational complexity classes. We study the power of interactive proof systems, where the verifier is restricted to use logarithmic space. We obtain a new characterization of the parallel complexity class NC in terms of such interactive proof systems running in polylogarithmic time.

We investigate depth-reduction in commutative and non-commutative arithmetic circuits. In the context of parallel computation, circuit depth corresponds to time and circuit size corresponds to the number of processors required. Depth-reduction of arithmetic circuits, therefore, is designing automatic procedures for parallelizing arithmetic computation. In the commutative setting we show that semi-unbounded log depth uniform circuits characterise polynomial degree uniform circuits (for an appropriate notion of uniformity); earlier proofs did not work for uniform circuits. In the non-commutative setting, a characterization of the classes of arithmetic circuits for which optimal depth-reduction is possible is obtained. This class also can be characterized using the AuxPDA model.

Logic/Concurrency/Knowledge:
While logics of knowledge over multi-agent systems have been extensively studied, little work has been done towards logically describing how knowledge changes *due to* actions of agents in the system. This question is of interest in distributed computing as well as mathematical economics. We study a propositional dynamic logic of knowledge over such systems, with positive results regarding decidability and completeness. The frames for the logic offer a knowledge theoretic account of Zielonka's asynchronous automata, and in terms of temporal logic, the knowledge modality corresponds to a present tense modality.

Finding a tractable temporal logic for systems under the partial-order semantics is difficult, as the natural models are directed acyclic graphs rather than trees, and confluence in such models leads to trouble. The solution is to construct a logic where one cannot talk about global states freely, refer only to processes' local states, and yet capture information about global states in indirect ways. We define such a family of propositional linear-time temporal logics, and study the complexity of satisfiability and model checking for these logics.

Finite Model Theory:
We compare two similar definitions of implicit definability in the context of finite model theory. The first definition requires that there is *exactly* one relation in every finite structure satisfying a given formula implicitly defining a query. Whereas the second definition is more liberal and requires *at most* one relation in every finite structure satisfying the given formula implicitly defining a query. These two ways are sometimes referred to as implicit and weak implicit definition respectively, in the literature. For a logical language L, we denote weak implicit closure and implicit closure of L by $WIMP(L)$ and $IMP(L)$, respectively. We find that these two notions give rise to logics that behave quite differently on classes of finite structures. For instance, WIMP(FO) and IMP(FO), capture the complexity classes UP and $UP \cap coUP$ respectively, on ordered structures but there are PTIME queries on

unordered structures in WIMP(FO) which do not appear to be in IMP(FO). Weak implicit definability is much easier to work with. Many results which have easy proofs for weak implicit definability are either very difficult to prove or are not known to hold for implicit definability. For instance, we give an elementary proof of $WIMP(FO) \not\subseteq L^{\omega}_{\infty,\omega}$. As another example, we show that there is no 0-1 law for WIMP(FO) but the question is open for IMP(FO) and even for IMP($L^{\omega}_{\infty,\omega}$).

We strongly suspect that the implicit closure and weak implicit closure of first order logic, (and similarly, of partial fixed point logic or of infinitary logic with finitely many variables) give rise to two different logics. In the absence of auxiliary queries, we can separate these logics. We in fact, show that $WIMP(LFP) \not\subseteq IMP(L^{\omega}_{\infty,\omega})$, *when no auxiliary queries are allowed in the implicit definitions.* However, to show the same separation in the general case appears to be an interesting and intriguing problem. We also consider some other variants of implicit definability and their expressive power on finite structures.

Publications

Mathematics

Agarwal,A.K. * and Balasubramanian, R.
Genaralised gonal Numbers and a new class of partitions
Jour of Ind. Math Soc. **61** (1995) 153-160

Araki, H.*, Sinha, K B.* and Sunder, V.S.
On Boundedness and $\|\cdot\|_p$-Continuity of Second Quantisation
Publ. Res. Inst. of Math. Sci., Kyoto, **31**, 1995, 941-952.
(*preprint*: RIMS-1011)

Arasu, K.T.*, Balasubramanian, R. and Evans, A.B.*
Quadratic starters in GF(q)and a new family of nested row-column designs
(preprint)

Balasubramanian, R., Shorey,T.N.*, and Harita-kohino,R.N.*
Perfect powers in product of terms in an arithmetic progression
(preprint)

Balasubramanian, R., and Koblitz, N.*
The improbablity that an elliptic curve has subexponential
discrete log problem under the Menezes Okamoto Vanstone algorithm. *(preprint)*

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
Monatshefte fur Math.(to appear)

Balasubramanian, R., Ponnusamy, S.* and Vuorinen, M *
Functional inequalities for the quotients of Hypergeometric functions
(preprint)

Balasubramanian, R. and Ramachandra, K.*
On the zeros of a class of generalized Dirichlet Series XV
Indag Math. (1994) 129-144

Balasubramanian, R. and Ramachandra, K.*
Some local convexity theorems for the zeta function like analytical functions -II
(*preprint*)

Balasubramanian, R., and Ramachandra, K.*
On the zeros of a class of generalised Dirichlet Series - XVIII
(preprint)

Balasubramanian, R. and Ramachandra, K.
On Riemann zeta functions and allied questions - III
Hardy Ramanujan Jour. (1995) 10-22

Balasubramanian, R., and Soundararajan, K.*
Maximal sets of divisors with distinct divisors
Electronic Journal of Combinatorics **2** Paper R22

Biswas, I.* and Nag, S.
Weil-Petersson geometry and determinant bundles on the inductive limit of moduli spaces.
IMSc/96/05/15 preprint, submitted for publication

Biswas, I.*, Nag, S. and Sullivan, D.*
Determinant bundles, Quillen Metrics and Mumford Isomorphisms on the Universal Commensurability Teichmüller space,
Acta Mathematica, **176**, no. 2, 1996, 145-169.
(*preprint*: IHES/M/95/43 Paris)

Gesztesy, F.*, Krishna, M. and Teschl, G.*
On isospectral sets of Jacobi operators.
Commun. Math. Phys. (to appear)
preprint No. 96-1 . mp_arc.

Jones, V.F.R.* and Sunder, V.S.
Introduction to Subfactors
Cambridge University Press, book. (to appear)

Katz, D.* and Vijay, K.
Symmetric powers of complete modules over a two-dimensional regular local ring.
Transactions Amer. Math. Soc. (to appear)

Kesavan, S. and Pacella, F.*
Symmetry of Solutions of a System of Semilinear Elliptic Equations
preprint

Krishna, M. and Sunder, V.S.
Schrödinger operators with fairly arbitrary spectral features
preprint No. 295 Schrödinger Institute Vienna.

Krishnan, U.*, Sunder, V.S. and Varughese, C.*
On some subfactors of integer index arising from vertex models
Jour. Functional Anal. (to appear)

Krishnan, U.* and Sunder, V.S.
On biunitary permutation matrices and some subfactors of index 9
Transactions Amer. Math. Soc. (to appear)

Mandal, S. and Varma P. L. N. *
A Question of Nori : The local case
(submitted)

Mandal, S.
Cancellation of Line Bundles : An Elementary Proof
J. of Ramanujan Mathematical Society (to appear)

Mandal, S.
Projective Modules and Complete Intersections
(submitted for consideration as a book)

Mohan, R.
Core of a Module over a Two-dimensional Regular Local Ring
Journal of Algebra (to appear).

Mohan, R.
The Rees Valuations of a Module over a Two-dimensional Regular Local Ring
(submitted).

Nag, S.
Mathematics in and out of String Theory,
Proc. 37th Taniguchi Foundation Symposium
"Topology and Teichmüller spaces", July 1995, Finland
World Scientific, Eds. S.Kojima, et. al., 1996, 1-34.

Nag, S.
Singular Cauchy integrals and conformal welding on Jordan curves,
Annales. Acad. Scient. Fennicae, Math., **21**, 1996, 81-88.

Nag, S.
Shapes of algebraic loci,
Invited lecture, Indian Institute of Technology, Madras
IIT Mathematical Carnival "Forays '96", Math Pamphlet

Nag, S. and Sullivan, D.*
Teichmüller theory and the universal period mapping
via quantum calculus and the $H^{1/2}$ space of the circle
Osaka Journal Math., **32**, No. 1, 1995, 1-34.

Nagaraj, D.S. and Ramanan, S.*
Polarisations of type $(1, 2, \ldots, 2)$ on abelian varieties.
Duke Math. Jour. **80**, No.1, 157 - 194, 1995

Vijay, K.
Integrally closed modules over two-dimensional regular local rings
Transactions Amer. Math. Soc. **347** (1995) 3551.

Wildberger, N.J.* and Sunder, V.S.
Actions of finite hypergroups: some examples
Proceedings of International Conference on Harmonic Analysis (submitted)
Delhi, December 1995

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* External collaborator

Physics

Acharya, M.*, Ray, P. and Chakrabarti, B.K.*
Cluster statistics in dielectric breakdown.
Physica **A 224** (1996) 254.

Balakrishnan, Radha.
C-integrability of the Belavin-Polyakov equation using classical differential geometry.
Phys. Letts. **A 204** (1995) 243.

Balakrishnan, Radha.
Geometry in nonlinear physics.
Proc. First Kum. L.A. Meera Memorial Meeting on Frontier Areas in Physics- 'Geometry and Topology in Physics', Mysore.Feb.96. eds.N.Mukunda and R.Nityananda(to appear).

Balakrishnan, Radha and **Blumenfeld, R.***
Modified Belavin Polyakov dynamics of moving curves.
Preprint IMSc-96/03/10.

Balakrishnan, Radha and **Blumenfeld, R.***
Twist excitations in anisotropic antiferromagnetic spin chains.
Preprint IMSc-96/03/11.

Balakrishnan, Radha and **Guha, Partha***
Surface-embeddability approach to the dynamics of the inhomogeneous Heisenberg chain.
Journ. Math. Phys. (to appear in Aug.96)

Balakrishnan, Radha
Nonlinear dynamics of a classical antiferromagnetic chain and comparison with the ferromagnetic chain
In *Selected Topics in Mathematical Physics* - Prof.R.Vasudevan
Memorial Volume. Eds.R.Sridhar, K.Srinivasa Rao and V.Lakshminarayanan (Allied Publ.,1995) 257.

Baskaran,G., Rahul Basu, Arjunwadkar, M.* and Kanhere, D.G. *
Superconducting Gap Nodal Surface and Fermi surface: their partial overlap in Cuprates
Mod. Phys. Lett. **B9**. 1243 (1995).

Bhaduri, R.K.* Bhalerao, R.S.* and Murthy, M.V.N.
Haldane Exclusion Statistics and the Boltzmann Equation.
Journal of Statistical Physics **82**, 1659(1996).

Bhaduri, R.K.* Murthy, M.V.N. and Srivastava, M.K.*
Fractional exclusion statistics and two dimensional electron systems.
Physical Review Letters **76**. 165(1996).

Bhaduri, R.K.* and Murthy, M.V.N.
A fermion-like description of condensed Bosons in a trap.
Preprint - submitted for publication.

Bhattacharya,A.*, Madan Rao and Chakrabarti,A.*
Kinetics of Phase Ordering of Nematic Liquid Crystals in a Confined Geometry,
Phys. Rev. **E 53** (1996), 4899.

Basu Mallick, B. * and Ramadevi, P.
Construction of multi-parameter dependent Yangian algebra,
Phys. Lett. A (to appear)

Basu-Mallick, B.,* Ramadevi, P. and Jagannathan, R.
Multiparametric and coloured extensions of the quantum group $GL_q(N)$ and the Yangian algebra $Y(gl_N)$ through a symmetry transformation of the Yang-Baxter equation
*Preprint:*IMSc/95/29, TIFR/TH/95-54, q-alg/9511028

Chakrabarti, R.* and Jagannathan, R.
The dual (p,q)-Alexander-Conway Hopf algebras and the associated $\mathcal{T}$-matrix
Z. Phys. C : Particles and Fields (in press).

Chakraborty, T. and P. Pietiläinen*
Thermodynamics and Spin Polarizations of the Fractional Quantum Hall States
Phys. Rev. Lett. **76**, (1996) 4018.

Chakraborty, T. and P. Pietiläinen*
Electron Correlations in Antidot Arrays in a Magnetic Field
Phys. Rev. B **53** (1996) 4664.

Cheluvaraja Srinath and H.S.Sharatchandra
Finite temperature properties of SO(3) lattice gauge theories and their implications for the continuum theory,
Submitted to *Phys. Rev.Lett.*

Conte, M.,* Jagannathan, R., Khan, S.A. and Pusterla, M.*
Beam optics of the Dirac particle with anomalous magnetic moment
Preprint: IMSc/96/03/07, INFN/AE-96/06.

Das, Saurya and Majumdar, Parthasarathi
Eikonal particle scattering and dilaton gravity
Preprint: IMSc-95/25, submitted to *Nuclear Physics B.*

Das, Saurya and Majumdar, Parthasarathi
Aspects of Planckian scattering beyond the eikonal
Preprint: IMSc-95/8 (revised version), submitted to *Physical Review D.*

Das, Saurya and Parthasarathy, R.
Planckian scattering from Kerr black holes: Eikonal and beyond.
Phys.Rev.D (submitted); IMSc-95/34; hep-th/9603007.

V. Halonen*, P. Hyvönen*, P. Pietiläinen*, and Chakraborty, T.
Effects of scattering centers on the energy spectrum of a quantum dot
Phys. Rev. B **53** (1996) 6971.

V. Halonen*, P. Pietiläinen*, and Chakraborty, T.
Optical Absorption Spectra of Quantum Dots and Rings with a Repulsive Scattering Center
Europhys. Lett. **33** (1996) 377.

Jagannathan, R.
$U_{p,q}(gl(2))$, (p,q)-oscillator and applications (Abstract of Short Communication)
Proc. XI International Congress of Mathematical Physics, Paris.1994,
Ed. D. Iagolnitzer (International Press, Boston, 1995) p. 767.

Jagannathan, R. and Khan, S.A.
Wigner functions in charged particle optics
Selected Topics in Mathematical Physics - Professor R. Vasudevan Memorial Volume,
Eds. R. Sridhar, K. Srinivasa Rao and V. Lakshminarayanan
(Allied Publishers, Madras, Delhi, 1995) p.308.

Jagannathan, R. and Khan, S.A.
Quantum theory of the optics of charged particles
Advances in Imaging and Electron Physics,
Eds. P.W. Hawkes, B. Kazan and T. Mulvey
(Academic Press, San Diego) Vol. **97** (in press)

Kalyniak, P.* Madsen, P.* Sinha, N. and Sinha, R.
Probing anomalous triple boson vertices at future e^+e^- colliders
Phys. Rev. **D52** (1995) 3826.

Kaul, R.K.
Theoretical scenarios for 10^3 GeV to 10^{19} GeV.
Preprint: IMSc.96/02/05.

Madan Rao and A. Chakrabarti*
Slow Domain Growth in a System with Competing Interactions.
Phys. Rev. E **52** (1995) R13.

Madan Rao and Surajit Sengupta*
Kinematic Theory for Scale Invariant Patterns in Acicular Martensites.
Physica A **224** (1996) 403.

Madan Rao and Surajit Sengupta*
Droplet Free Energy Functional for the Morphology of Martensites.
To appear in *Defects in Condensed Media*,
Eds. K. Krisha, C.S. Sundar and V. Kumar (Sci. Tech. Publ. Ltd., Switzerland, 1996).

Madan Rao and Surajit Sengupta*
Reply to the Comment on 'Kinematic Scaling and Crossover to Scale Invariance in Martensite Growth'.
Phys. Rev. Lett. **76**, (1996) 3235.

Majumdar, Parthasarathi
Induced on-shell supersymmetry in eikonal scattering
Preprint: IMSc-95/28, submitted to Physical Review D.

Malik R.P.*, Mishra, A.K. and Rajasekaran, G.
Dynamics in non-commutative phase space.
Preprint: IMSc-960309.

Manindra Agrawal *, Vinay, V. * and Ramadevi, P.
New Link Invariant and its complexity.
Preprint : SPIC/TCS-95-2, IMSc 95/17, submitted to Journal of Knot theory and its Ramifications.

Mann, A. and Parthasarathy. R.
Minimum uncertainty states in quantum groups and quantum Wigner d-functions
J.Phys.A:Math.Gen. **29**(1996) 427

Mishra, A.K.
Covarient differential calculus on the quantum vector spacce and statistical transmutation.
(to appear in the *proceedigs of XI DAE sumposium on high energy physics.*)

Mishra, A.K. and Rajasekaran, G.
Generalized Fock spaces, new forms of quantum statistics and their algebras.
Pramana - J. Phys. **45** (1995) 91.

Mishra, A.K. and Rajasekaran, G.
Fock space representation of differential calculus on the noncommutative quantum space
Preprint IMSc: 960101), to appear in Jour. of Math. Phys.

Mishra, A.K. and Rangarajan, S.K.
Scanning tunnelling microscopy currents in the presence of a chemisorbate
J.Mol. Struc.: Theochem.(Special Issue,"Theoretical Chemistry in India: Structure, Reactivity and Transformation") **361** (1996) 101

Mohan Narayan, Murthy, M.V.N., Rajasekaran, G. and Uma Sankar, S*
Solar and atmospheric neutrino oscillations with three flavours.
Phys. Rev. **D53** (1996) 2809.

Mohan Narayan, Rajasekaran, G. and Rahul Sinha
Solar eclipse and neutrinos.
Current Science **70** (1995) 848

Murali, N.R* Govindarajan, T.R. and Khare, A*
On the Exactness of the broken SUSY semiclassical quantization rule.
Phys. Rev. **A52**(1995) 4259.

Murthy,M.V.N. Bhaduri, R.K.* and Diptiman Sen*
Novel correlations in two dimensions: Some exact solutions.
Physical Review Letters **76** 4103(1996).

Muthukumar, V. N.* Sa Debanand and Sardar M.*
Superconductivity from a non-Fermi liquid: A Ginzburg Landau approach.
*Phys. Rev.***B52** (1995) 9647

Niemel, K.ä*, P. Pietiläinen*, P. Hyvönen*, and Chakraborty, T.
Fractional Oscillations of Electronic States in a Quantum Ring
(to be published)

Pari, G. Mathi Jaya, S.* Subramoniam, G. and Asokamani, R.*
Density functional Description of the electronic structure of $LaMO3(M = Sc - NL)^b$
Phys. Rev. **B51** (1995) 16565.

Radhika Vathsan
Remarks on the Quantization of Gauge Theories
Jour.of Math.Phys.,**37** No.4. 1996

Rahul Basu and Parthasarathy, R.
A mechanism for Instanton induced Chiral Symmetry Breaking in QCD
submitted to *Phys. Lett. B.*

Rajasekaran, G.
Generalized Fock spaces and new forms of quantum statistics.
Current Trends in Mathematics and Physics
(A Tribute to Harish-Chandra) Ed : S.D.Adhikari, Narosa Publishing House
(New Delhi)1995, p138.

Ramachandran, R.
Top Quark Discovery.
Resonance **1** (1996) 23.

Ramachandran, R.
Concluding Remarks on the Symposium on High Energy Physics in the 21st Century.
Current Science (to appear)

Ramadevi, P., Govindarajan, T.R. and Kaul, R.K.
Representations of Composite Braids and Invariants for Mutant Knots and Links in Chern-simons field theories.
Mod. Phys. Lett **A10** (1995) 1635.

Rangarajan, S.K. and Rama Kant*
Diffusion to Rough Interfaces: Finite charge
J. Elec. Chem. **396** (1995) 285.

Rangarajan, S.K. and Ramakrishna, S*
Time Resolved Photoluminiscence and Microwave Conductivity at Semi-Conductor Electrodes: Depletion layer effects
J. Phys. Chem. **99** (1995) 12631

Ray, P.
Critical dynamics in fracture propagation in disordered systems
Phys. Rev. Lett. (Submitted)

Ray, P.
Finite size scaling analysis of fracture dynamics in disordered systems
Europhys. Lett. (Submitted)

Ray, P. and Date, G.
Spatial scaling in fracture propagation in dilute systems
Physica A (to appear)

Reimann,S.M,* Brack, M.*,Magner,A.G.*,Blaschke,J* and Murthy, M.V.N.
Circular quantum billiard with a singular magnetic flux line.
Preprint IMSc-94-33; Surface Review and Letters (In Press) Physical Review A **53** (1996) 39.

Sa Debanand and Baskaran G.
Non-magnetic impurities in one dimensional strongly correlated electron systems. to be communicated (1996).

Samuel, M.A.*, Li, G., Sinha, N. and Sinha, R.
Limits on the Magnetic Moment of the W Boson at Fermilab Detectors
International Journal of Theoretical Physics, **34** (1995)895.

Shankar, R. and Murthy, M.V.N.
Exclusion statistics and strongly correlated electron systems.
Physica B (Condensed matter) **212** 1995 315.

Sheshadri. K, Krishnamurthy, H R.*, Pandit, R.*, and Ramakrishnan, T V.*
Percolation-Enhanced Localication in the Disordered Bosonic Hubbard Model
*Phys. Rev. Lett.***75** 1995 4075

Shubashree, D. and Shankar, R.
Quantum Antiferromagnets : from the Triangular to the Kagome Lattice
Preprint: IMSC -96/02/04

Sinha, R.
Testing Electroweak Vector Boson Self Interactions
Invited talk in *proceedings of WHEPP-3. Pramana Proceedings Supplement.* **45**, (1995)318

Sinha, R. Sundaresan, M.K* and Nigam, B.P*
W pair production and the reliability of equivalent photon approximation
"A gift of prophecy" essays in celebration of R. E. Marshak, edited by E. C. G. Sudarshan. World Scientific (1995).

Sridhar, R.
Anyon fluid and the Bogoliubov approximation.
In *Advances in Theoretical Physics*. Ed. A.P. Pathak (Narosa, 1996).

Sridhar, R.
A systematic approximation procedure for the anyon fluid.
In *Selected Topics in Mathematical Physics* - Prof. R. Vasudevan Memorial Volume. Eds. R. Sridhar, K. Srinivasa Rao and V.Lakshminarayanan (Allied Publ.,1995)

Srinivasa Rao, K., Sangita N.Pitre* and Van der Jeugt, J.*
The polynomial zeros of degree 2 of the $9-j$ coefficient.
Rev. Mexicana Fis. **42** No. 2 (1996) 179 - 192.

Srinivasa Rao, K.
Quantum theory of angular momentum and generalized (ordinary and basic) hypergeometric functions.
Proc. of the Int. Conf. on Symmetry Methods in Physics (ICSMP-95). Dubna. (to appear.)

Srinivasa Rao, K.
New integral representations for the 3-j coefficient in *Selected Topics in Mathematical Physics* - Prof.R.Vasudevan Memorial Volume. Eds.R.Sridhar, K.Srinivasa Rao and V.Lakshminarayanan (Allied Publ.,1995)

Srinivasa Rao, K. and Khare, A*.
Report on the 'International Conference on Symmetry Methods in Physics' (ICSMP - 95).
Current Science **69** (1995) 566.

Srinivasa Rao, K.
Relevance of Values to science : the sublime and the ridiculous.
Current Science **70** (1996) 181.

Srinivasa Rao, K. and Van der Jeugt, J.*
Transformations of single and double hypergeometric series from the triple sum series for the $9-j$ coefficient.
J. Phys. A : Math. Gen. (submitted.)

Sunil Kumar, P.B. and Debnarayan Jana*
Imbibition: experiment and simulation.
Physica A **224** (1996) 199.

Sunil Kumar. P.B. and Madan Rao
Kinetics of Phase Ordering of Two-Component Fluid Membranes.
To appear in *Mol. Cryst. Liq. Cryst.* (1996).

Sunil Kumar, P.B. and Madan Rao
A Novel Monte Carlo Approach to the Dynamics of Fluids - Single Particle Diffusion, Correlation Functions and Phase Ordering of Binary Fluids.
To appear in *Phys. Rev. Lett.* June 29(1996).

Viswanathan, K.S* and Parthasarathy, R.
String theory in curved spacetime
Phys.Rev.D (submitted); Preprint: SFU-HEP-04-96.

Yeung,C.*, Madan Rao and Desai,R.C.*
Bounds on the Decay of the Auto-Correlation in Phase Ordering Dynamics.
Phys. Rev. **E 53** (1996) 3073.

Van der Jeugt, J.* and Jagannathan, R.
Polynomial deformations of $osp(1/2)$ and generalized parabosons
J. Math. Phys. **36** (1995) 4507.

Van der Jeugt, J.* and Jagannathan, R.
The exponential map for representations of $U_{p,q}(gl(2))$
Proc. of the 4th International Colloquium on Quantum Groups and Integrable Systems, Prague, 1995 :
Czech. J. Phys. (in press).

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* External collaborator

Theoretical Computer Science

Agrawal, M.* and Arvind, V.
Reductions of self-reducible sets to depth-1 weighted threshold circuit classes. and sparse sets.
Proceedings of the 10*th Annual Structure in Complexity Theory Conference,*
June, 1995 pp. 264-276, IEEE Society.

Agrawal, M.* and Arvind, V.
A note on decision versus search for the graph automorphism problem.
In *Proc. of the* 11*th Annual Structure in Complexity Theory Conf.*
IEEE Society, 1996, to appear

Allender, E.*, Jiao, J.*, Mahajan, M. and Vinay, V.*.
Non-commutative arithmetic circuits: depth reduction and size lower bounds
Technical Report of the Electronic Colloquium in Computational Complexity, ECCC TR95-043

Arvind, V., Köbler, J.*, and Mundhenk, M.*
On reductions to sets that avoid EXPSPACE.
Information Processing Letters. **56** 1995 109-114

Arvind, V., Köbler, J.*, and Mundhenk M.*
Upper bounds on the complexity of sparse and tally descriptions.
Mathematical Systems Theory. **29** (1996) 63-94.

Arvind, V., Köbler, J.*, and Schuler R.*
On helping and interactive proof systems.
Int.Jour.of Foundations of Comp. Sci., **6** 1995 137-153

Arvind, V. and Vinodchandran, N. V.
Solvable black-box group problems are low for PP.
Proceedings of the 13th Annual Symp. on Theor. Aspects of comp.sci.,
Lecture Notes in Comp. Sci., **1046**, 1996 99-112, Springer Verlag

Balasubramanian, R. and Nagaraj, S. V.
Perfect Power Testing,
Information Processing Letters **58** 1996 59-63

Balasubramanian, R. and Nagaraj, S. V.
Density of Carmichael numbers with three prime factors
Math. of Comp. (submitted)

Balasubramanian, R. and Venkatesh Raman
Path Balance Heuristic for Self-Adjusting Binary Search Trees
Proc. of the 15th Conf. on Foundations of Software Technology
and Theor. Computer Science. Springer **LNCS 1026** 338-348

Balasubramanian R. Fellows, Michael R.*, Venkatesh Raman
Improved Fixed Parameter Algorithm for Vertex Cover submitted

Krithivasan, K.* and Mahajan, M.
Nondeterministic, probabilistic and alternating computations on cellular array models.
Theor. Comp. Sci., **143** 1995, 23–49

Mahajan, M.
An Introduction to Computational Complexity
Text of a series of four lectures, delivered at the Depart. of Maths.,
Annamalai Univ., under Prof. G. Sankaranarayanan Endowment Lecture scheme
To appear as a publication of Annamalai University.

Mahajan, M. and Vinay, V.*.
Combinatorial Algorithm for the Determinant.
Manuscript in preparation

Ramanujam, R.
A local presentation of synchronizing systems.
In *Structures in Concurrency Theory*, ed: Jörg Desel, Springer workshops in computing, (1995), 264-278.

Ramanujam, R.
Local knowledge assertions in a changing world.
Theoretical Aspects of Rationality and Knowledge
(Ed: Yoav Shoham), Morgan Kaufmann, (1996), 1-17

Ramanujam, R.
Locally linear time temporal logic.
To appear, *IEEE Logic in Computer Science*, New Jersey, (1996).

Satyanarayana, L V.*, Mahajan, M. and Vinay, V.*.
Logspace verifiers, NC, and NP
Proc. of the Sixth Annual Int. Symp. on Algorithms and Computation
1995.(Cairns, Australia). **LNCS 1004** 52–61

Seth, Anil
Type 2 Polynomial Hierarchies.
LNCS 960 ed. D. Leivant, Springer 1995, pp. 269-280

Seth, Anil
Implicit definability versus weak implicit definability in finite model theory
manuscript

Vinodchandran N.V. and Mahajan, M.
A note on Mod and generalised Mod classes.
Information Processing Letters **55** 1 (1995), pp. 27–31

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* External collaborator

Visits to Institutions

(including conference participation & lectures[1] by institute members)

Arvind, V.

"Solvable black-box group problems are low for PP" paper presented at the *13th Annual Symposium on Theoretical Aspects of Computer Science*, Grenoble, France, February 22-24, 1996.

Abteilung Theoretische Informatik, Universität Ulm, Germany (February 25 - March 10, 1996).

Lehrstuhl IV Informatik, Universität Trier, Germany (March 11 - March 13, 1996).

Department of Computer Science, Universitat Politechnica Catalunya, Barcelona, Spain (March 14 - March 29, 1996).

"The complexity of NP problems over finite groups"(Seminar), *Abteilung Theoretische Informatik, Universität Ulm*, March 8, 1996.

"On the self-witnessing property of computational problems"(Seminar), *Lehrstuhl IV Informatik, Universität Trier*, March 12, 1996.

"Nonadaptive program checkers for Graph Automorphism and Permutation Group Intersection"(Colloquium), *Lehrstuhl IV Informatik, Universität Trier*, March 13, 1996.

"Polynomial time group theory: algorithms and complexity",(Invited talk), *Workshop on Complexity, Logic and Recursion Theory*, Barcelona, Spain, March 24 - 28, 1996.

Balakrishnan, Radha

Visiting Scientist, *Center for Nonlinear Studies, Los Alamos National Laboratory, Los Alamos*, U.S.A., Aug.16-Nov.2, 1995. Colloquium on "Exact multi-twist solutions in the antiferromagnetic chain."

Invited Talk: "C-Integrability of the Belavin-Polyakov equation using classical differential geometry", *Workshop on Spectral Theories of Schrodinger Operators*, IMSc, Madras, Dec. 4-14, 1995.

[1]Seminars at the Institute are also included here

Invited Lectures: "Integrable classical spin systems", *Winter School on Integrable Systems and Low-dimensional Many-body Problems, Bharathidasan University*, Tiruchirapalli, Dec.18-23, 1995.

Invited Seminar: "On the Belavin-Polyakov equation and its connection with the elliptic Liouville equation", CIMPA-UNESCO *Meeting on Nonlinear Systems, Central University, Pondicherry*, Jan 8- 25, 1996.
Also chaired a session at the above Meeting.

Invited Lecture: "Geometry in Nonlinear Physics", *First Kum. L.A. Meera Memorial Meeting on Frontier Areas in Physics- Geometry and Topology in Physics*, Mysore, Feb.4-15, 1996.

Balasubramanian,R
University of Toronto for two weeks in June 1995 Conferences

International conference on Number Theory and Discrete Mathematics arranged by Ramanujan Mathematical Society in Trichy during Jan 1996

Attended the *Number theory conference in the University of Illinois in honour of Prof H.Halberstam* during May 1995.

Visited the *University of Michigan at AnnArbor* one week in May 1995

Basu Rahul
CTS, IISc, Bangalore - *Discussion Meeting on Deep Inelastic Scattering* (November 13-17 1995).Gluon Reggeization, BFKL Pomeron and all that - invited talk given at the above meeting.

CTS, IISc, Bangalore - Visitor from 25th to 29th March 1996.

Das, Saurya
Participated in the *Extended Workshop on String Theory*, Sept. 19-29, 1995.

Gave a talk at IMSc in Dec. 1995 titled *"Eikonal Particle Scattering and Dilaton Gravity"*.

Visited the following institutes as TPSC speaker during Jan.17 - Feb.9, 1996

Tata Institute of Fundamental Research, Bombay.

Mehta Research Institute for Mathematics and Mathematical Physics, Allahabad.

S. N. Bose National Centre for Basic Sciences, Calcutta.

Institute of Physics, Bhubaneswar.

Gave a talk at each of the above Institutes titled "Eikonal as a Probe to Planck Scale Physics".

Gave a Plenary talk at the *XVIII conference of the Indian Association of General Relativity and Gravitation*, IMSc, Madras, 15-17 February, 1996, titled "Eikonal Approach to Plank Scale Physics".

Participated in *"Second Trieste Conference on Statistical Field Theory"*, ICTP, Trieste, 13-15 March, 1996.

Participated in *"Spring School and Workshop on String Theory, Gauge Theory and Quantum Gravity"*, Trieste, 18-29 March, 1996. Presented a poster at the poster session in the workshop.

Visited *University of Pisa* from 1 to 3 April, 1996 and gave a talk there on 2 April with the title above.

Visited *The International Centre for Theoretical Physics*, Trieste from 4 to 19 April, 1996 and gave a talk there on 11 April with the title above.

Dasgupta, Arundhati

Attended *Extended Workshop on String Theory, Conformal Field Theory and Black Hole Physics*, Bhubaneswar, 25th to 29th September 1995.

M.Sc. Project Seminar at The Institute of Mathematical Sciences, 13th December 1995, titled *"Black Hole Complementarity and Fermions"*.

Presented a contributed paper in the *XVIII Conference of IAGRG*, 15-17the February 1996. Title: "Black Hole Complementarity and Fermions", on 15th February 1996.

Date, G.

"Quantization of a Pseudointegrable System" Conference on the *"Spectral Theory of Schrodinger Operators"*, IMSC, Madras, Dec. 4 – 14, 1995.

"The Ashtekar Approach to Quantum Gravity"(Plenary talk) *XVIII Conference of the Indian Association for General Relativity and Gravitation (IAGRG)*, IMSC, Madras, Feb. 15 – 17, 1996.

Member of the local Organizing Committee and the Scientific Organizing Committee for the *XVIII the Conference of the IAGRG* co-hosted by our Institute during Feb. 15 - 17th. 1996.

Debanand Sa
Research Workshop on "Condensed Matter Physics",International Centre for Theoretical Physics, Trieste, Italy (June 28 - July 28, 1995).

Indian Institute of Technology, Kanpur (Feb. 13 - Feb. 22, 1996). Gave a talk on "Potential Scattering in Luttinger Liquid".

Physics Department, Indian institute of Science, Bangalore (13-15, March 96) Gave a talk on "Potential Scattering in Luttinger Liquid".

Fractional Quantum Hall Effect - *IMSc journal club seminar,* 1995.

Govindarajan, T.R
Visit to *ICTP, Trieste,* Italy: June 95- July 5th 95.

Kamal Lodaya
Attended and chaired a session at the *15th Conference on Foundations of Software Technology & Theoretical Computer Science,* Bangalore (Dec 17-19, 1995).

Visited *Indian Institue of Science, Bangalore* (Mar 6-10, 1995).

Kaul, R.K.
Sixty Fifth Annual Meeting of the Indian Academy of Sciences, Madras, November, 1995, invited talk on"Theoretical scenarios for 10^3 GeV to 10^{19} GeV" at the Symposium on "High Energy Physics in 21st Century."

Kesavan, S.
Laboratoire d'Analyse Numérique,Université de Pierre et Marie Curie (Paris VI), Paris, France (Jan. 21 - July 21,1995.) as Visiting Professor

Sambalpur University (Feb.24 - 29,1996.) as Resource Person, Refresher Course in Mathematics.

Seminar Talk, *Ecole Normale Superieure,Paris,* May 16,1995.

Seminar Talk, *Université de Paris VI, Paris,* June 2,1995.

Seminar Talk, *IMSc. weekly colloquium,* October 19,1995.

Seminar Talk, *IIT, Madras*, Jan.4,1996.

Symmetry of Solutions of a Class of Nonlinear Equations, invited talk, *International Conference on "New Directions in Applied Mathematics", University of Hyderabad,Dec.* 19-22,1995.

Was the Coordinator of a minisymposium on Dynamical Systems at this Conference.

Krishna, Maddaly
Department of Mathematics, *Brown University, Providence*, RI (till 31 May 1995).

Department of Mathematics, University of Missouri, Columbia, May 11-12, 1995, gave a colloquium talk on "Random Jacobi operators and inverse spectral theory".

Department of Mathematics, University of Kentucky, Lexington, May 12-13, 1995.

Department of Mathematics, Indian Institute of Technology, Madras, talk on "Schrodinger operators", 26 October, 1995.

IMSc workshop on "Schrödinger operators" gave a talk on "Inverse spectral theories", 4-14 December 1995.

Erwin Schrödinger Institute, Vienna, Jan 25–Feb 17, 1996, gave a talk on "Inverse spectral theory and singular spectra".

Madan Rao
"Condensed Matter and Computational Physics", Invited Talk at the *'Vision 2020' Meet, BARC*, Bombay, August 1995.

"Droplet Fluctuations in Martensites", Invited Talk at the *International Statphys Satellite Meeting on "Dynamics of Complex Systems"*, S. N. Bose Centre, Calcutta, September 1995.

"Kinetics of Phase ordering of Two-Component Fluid Membranes." Invited Talk at the *International Conference on 'Liquid Crystals and Supramolecular Ordering', Bangalore*, January 1996.

"Statics and Dynamics of Shape Transitions in Fluid Membranes", Seminar in the *Department of Physics, IIT-Madras*, February 1996.

Mandal, Satya
Tata Institute, Bombay (June 1995, two weeks)

University of Kansas (January 15-May 15 1996)

Majumdar, Parthasarathi

Physical Research Laboratory, Ahmadabad (April 3-7, 1995)
Two lectures on "Planckian scattering in the eikonal approximation and beyond"

Satyendranath Bose National Centre for Basic Sciences, Calcutta (July 17-28, 1995) Colloquium on "Naturalness, supersymmetry and duality".
Two lectures on "Issues in Planckian scattering of neutral and charged particles".

Institute of Physics, Bhubaneswar (September 23-29, 1995)
Lecture on "Induced on-shell supersymmetry in eikonal scattering".

Workshop on supersymmetry and neutrino physics, Mount Abu, Rajasthan (October 9-14, 1995) Talk on "Induced supersymmetry in high energy scattering".

IMSc seminar (October 1995) "Induced supersymmetry in high energy scattering".

Saha Institute of Nuclear Physics (November 6-10, 1995 – TPSC visit) Seminar on "Induced supersymmetry in high energy scattering".

Satyendranath Bose National Centre for Basic Sciences (November 6-10, 1995 – TPSC) Colloquium on "Black hole complementarity".

Department of Physics, University of Delhi (November 13-16, 1995 – TPSC) Colloquium on "Black hole complementarity" Seminar on "Induced supersymmetry in eikonal scattering".

IAGRG Meeting (February 14-16, 1996), IMSc, Madras.

Meena Mahajan

Probabilistic Computations and Interactive Proofs, three (invited) focal theme talks delivered at *the Tenth Annual Convention of the Ramanujan Mathematical Society*, Rishikesh, India, 25–27 May 1995.

"Probabilistically Checkable and Interactive Proofs," Invited talk delivered at the *Discussion Meeting on Cryptography and Computation*.

Department of Computer Science and Automation, Indian Institute of Science, Bangalore. 31 August – 1 September, 1995

Logspace verifiers, NC and NP, *Theoretical Computer Science Seminar at IMSc*, 13 October 1995.

Logspace verifiers, NC and NP. Seminar at the *Department of Computer Science, James Cook University, Townsville*, Australia, on 30 November 1996.

"Depth reduction in Arithmetic Circuits", Seminar at the *Department of Computer Science, James Cook University, Townsville*, Australia, on 1 December 1996.

Logspace verifiers, NC and NP, *the Sixth Annual International Symposium on Algorithms and Computation*, Dec 1995 (Cairns, Australia).

Logspace verifiers, NC and NP, Seminar at the *Department of Computer Science, National University of Singapore*, on 8 December 1996.

An Introduction to Computational Complexity, A series of four lectures, delivered at the *Department of Mathematics, Annamalai University*, under the Prof. G. Sankaranarayanan Endowment Lectures scheme. 15 - 16 February, 1996.

Visit to *Department of Computer Science and Automation, Indian Institute of Science, Bangalore*, 26 February – 8 March, 1996. Seminar on 29 February 1996."The Varying Power of a Logspace Verifier".

Mishra, A. K.
"The electronic structure of an adsorbate layer at electrochemical interface"(Invited Talk). *National seminar on " Molecular Dynamics and Structure"*. Dept.of Chem. IIT Madras, April 5-6, 1996.

Mohalik, Swarup Kumar
Participated in an intensive course on *"Formal Methods in Software Development" organized by SERC*, IISc, and the UNU/IIST, Macau, in Bangalore during 15-17, April 1995.

Murthy, M.V.N.
Physical Research Laboratory- Ahmedabad (July 8-15, 1995).

Visiting Professor, *Department of Physics and Astronomy, McMaster University, Canada* 18 August 1995-1st July 1996

Atomic Energy of Canada Laboratories (AECL)- Chalk River, Canada 17-18 November, 1995.

Department of Physics, Syracuse University March 18-21, 1996.

Department of Physics, University of Guelph, Canada March 26, 1996.

Joint Annual American Physical Society- American Association of Physics Teachers Meeting: May 2-5, 1996. Invited talk on "Haldane Statistics and its application to physical systems" in the session on Physics without borders.

Physical Research Laboratory, Ahmedabad 10 July 1995.
Colloquium on "Fractional Exclusion Statistics and the Generalised Pauli Principle".

Department of Physics and Astronomy, McMaster University. December 8, 1995 - Colloquium on "Fractional Exclusion Statistics and the Generalised Pauli Principle".

AECL- Canada. Chalk River, 18 November 1995.
Seminar on "Solar and Atmospheric Neutrino problem".

Department of Physics, Syracuse University 18 March 1996.
Seminar on "Fractional Exclusion Statistics".
Department of Physics, University of Guelph 26 March 1996.
Colloquium on "Fractional Exclusion Statistics and the Generalised Pauli Principle".

Nag, S.
Opening lecture: *The 37th Taniguchi Foundation Symposium "Topology and Teichmüller spaces"*, July 24–29, 1995, Katinkulta, Finland. Invited as the Opening speaker; 50 minute talk: "The Universal Direct System of Teichmüller spaces and String Theory".

The 16th Rolf Nevanlinna Colloquium, held in honour of *R.Nevanlinna's Centenary*, August 1–5, 1995, University of Joensuu, Finland. Invited half-hour speaker: "Universal parameter spaces for Riemann surfaces and String Theory".

Visiting Professor: *Universite d' Orleans*, France, (April 2–15, 1995). Two seminars given on "Universal Mumford-Polyakov structure" (April 5th) and "The Teichmüller space of the universal solenoidal surface" (April 14th).

Universite de Paris (Orsay), France: Invited speaker in the Complex Analysis "Sibony Seminar": "The universal period mapping on universal Teichmüller space", April 11th 1995.

Visiting Professor at the *Universidad Autonoma de Madrid* and the *Universidad Nacional de Educacion a Distancia, Departamento de Matematicas Fundamentales*, Madrid, Spain, April 16th to 24th 1995. Gave a series of three invited lectures on: "Universal Parameter Spaces of Riemann surfaces and String Theory"; first two lectures at UNED, third lecture at Univ. Autonoma Madrid.

Universidad Autonoma de Barcelona, Spain, invited speaker at the Centre for Research Math, "Universal period mapping on $T(\Delta)$", April 24th 1995.

CNRS sponsored visitor, *Universite de Montpellier*, France, April 25-26, 1995.

Centre National de Recherche Scientifique (CNRS), Luminy-Marseille, France. Visitor, April 27–30, 1995. Invited talk on "Universal Determinant Bundles and the Polyakov String" (April 28th).

Universite de Nice, France, Visiting Professor, May 1–6 1995. Delivered two lectures: Colloquium de Mathematiques: "Universal Parameter Spaces of Riemann surfaces and String Theory" (May 4th), and Geometrie et Physique Seminar: "Genus independent Mumford-Polyakov structure" (May 5th).

Institut des Hautes Etudes Scientifiques (IHES), Paris, Visiting Member, May 7th to 20th, 1995.

1st Lipman Bers Colloquium, New York, USA, October 19–20, 1995. The first of the Triennial Bers Colloquia. Invited Participant.

Einstein Chair in Mathematics, City University of New York, Chair Visitor, October 20–26, 1995. Gave an invited one and half hour talk in the New York Geometry and Dynamics Seminars: "Universal Mumford isomorphisms over the commensurability Teichmüller space", October 25. *Videotaped 1 & 1/2 hour* for the Einstein Chair Mathematical Video Library.

Visiting Professor: *Universite de Montreal*, Canada, October 26–November 2, 1995. One hour lecture in *McGill University Geometry and Topology Seminar* Oct 27th 1995, on "DiffS^1, period matrices and Teichmüller space: connections via string theory"

Centre de Recherches Mathematiques, Montreal, Mathematical Physics Seminar, Oct 31, 1995:"Polyakov-Mumford Structure on a Universal Parameter Space for Riemann Surfaces".

Invited as a *Principal Speaker* at the *International Conference on Complex Analytic Aspects of Teichmüller Spaces*", "The Clifford Earle Festschrift", November 3–5, 1995, Northampton, Massachusetts, USA. Topic: "The Universal Commensurability Teichmüller space and String Theory".

Duke University, Durham, USA, visited the Mathematics Department from November 5–9, 1995. Gave *Colloquium* lecture on "Universal Determinant Bundles and the Polyakov String"

Invited speaker at the *American Mathematical Society Conference*, Los Angeles, USA, November 11–12, 1995. Half-hour talk: " Universal parameter spaces of Riemann surfaces and String Theory", Nov. 11th.

University of Southern California, Los Angeles, Visiting Professor November 10-11, 1995. *Colloquium* talk:"The Universal Period Mapping" Nov 13th, 1995.

Visited the *Institute of Physics*, Bhubaneswar, February 18-27, 1996. Colloquium lecture: "Universal Parameter Spaces of Riemann surfaces and String Theory" February 19th, 1996.

Resource person for UGC Refresher Course at *Sambalpur University*, Orissa, February 1996. Gave a course of six lectures (Feb 21-25) on "Riemann Surfaces".

Indian Institute of Technology, Madras, Mathematical Carnival "Forays '96" invited talk: "Shapes of algebraic loci" March 10th, 1996.

Institute of Mathematical Sciences, Colloquium talk, Feb. 1996

Nagaraj D.S.
University of Lille, France (May. 1 - 31, 1995).

University of Nancy, France (June. 1 - 30, 1995).

Symposium on Algebra TIFR, Bombay, (July. 22 - 28, 1995). Gave an invited talk titled "Structure of Iwasawa Modules".

Nagaraj S. V.
Participated in *Fifth National Seminar on Theoretical Computer Science, Bhabha Atomic Research Centre*, Bombay (Aug. 1 – 4, 1995).

Participated in *Discussion meeting on Cryptography and Computation, JNCASR, IISC*, Bangalore (Aug. 31 – Sep. 1, 1995).

Participated in *Discussion meeting on Computational Biology, JNCASR, IISC*, Bangalore (Dec. 15 – 16, 1995).

Participated in *Graduate workshop in Theoretical Computer Science, IISC*, Bangalore (Dec. 17, 1995).

Spoke on Density of Carmichael numbers with 3 or 4 prime factors.

Participated in *Fifteenth International Conference on FST and TCS, IISC*, Bangalore, (Dec. 18 – 20 1995).

Participated in *International conference on Discrete Mathematics and Number Theory*, Trichy (Jan. 3 – 6 1996).

Parthasarathy, R.
"Changing Scenes in Particle Physics". Talk given at *IGCAR, Kalpakkam* December 1995.

Radha Mohan
I.M.Sc., October 26, 1995 Colloquium : "Syzygies, Hilbert Functions and Multiplicities".

Rajasekaran, G.
India - CMS Meeting, University of Delhi, April 17,18, 1995.
Talk on "A task force for new methods of particle-acceleration" at Vision 2020 meeting, BARC, Bombay, July 19 – 21, 1995.

Lecture on "Is there a final theory?" at *Loyola College*, Madras, August 24, 1995.

Lecture on "Chandrasekhar and the Stars" at *Children's Club*, Madras, October 14, 1995.

Talk at *DST meeting on "Thrust Areas in High energy Physics" Institute of Physics*, Bhubaneswar, October 20, 1995.

Talk at *IASc Symposium on "High Energy Physics in the 21st Century" Kalpakkam*, November 11, 1995.

Visited Inter-University Consortium for DAE facilities and Centre for Advanced Technology, Indore, Dec. 12 – 15, 1995.

Lecture on "High Energy Physics - Present and Future" at IUC-DAEF, Indore, Dec. 14, 1995.

Participated in *IV Workshop on High Energy Physics Phenomenology, at SN Bose National Centre for Basic Sciences*, Jan. 4 – 12, 1996 and coordinated the Working Group on QCD.

Seminar on "Orthostatistics" at *Tata Institute of Fundamental Research*, Mumbai, Feb. 22, 1996.

Ramachandran, R.
Orissa Bigyan Academy and Inst. of Physics, Bhubhaneswar (Jun. 2, 1995).

Nuclear Science Centre, New Delhi (Aug. 23, 1995).

Indian Institute of Technology, Kanpur, (Sept 19 - 20, 1995)
Colloquium on "New Avatars of Duality, on Sept 19, 1995.

Mehta Research Institute, Allahabad (Sept 21 - 23)

Department of Physics, Delhi University South Campus (Oct 28, 1995).
Discussion Meeting on Recent results from Fermilab and HERA.

Indian Academy of Sciences (Bangalore) Annual Meeting at Madras during Nov 10 - 12, 1995. Co-convenor of the symposium on "High Energy Physics in Twentyfirst Century" held on Nov 11 at Kalpakkam.

Invited Participant on *Workshop in High Energy Particle Physics* (WHEPP4),

S N Bose National Centre for Basic Sciences Calcutta. (Jan. 2 - 14, 1996). Chaired one of the plenary sessions.

Participant. *XVIII Conf. of the Indian Association for General Relativity and Gravitation* (dedicated to S Chandrasekhar) held at the IMSc, Madras. (Feb. 15 - 17, 1996)

Ramadevi, P.
Visiting Scientist, *Tata Institute of Fundamental Research, Mumbai* (Aug. 1 – Oct. 31, 1995); during this period gave a talk on "Knot Invariants and Vertex models" in the Mathematical Physics Journal club.

Gave a seminar on " Fun with Knots" at the *Physics Department, Indian Institute of Technology,* Mumbai-400 076 (Nov 9, 1995).

Ramanujam, R.
Institut für Informatik und Praktische Mathematik, Universität Kiel, Germany (Nov. 1, 1995 - March 31, 1996).

Course of lectures on "Partial order models of concurrency and their temporal logics", Nov. 14, 1995 – February 6, 1996.

Seminar, "Knowledge and distributed systems", February 1, 1996.

Seminar, "An introduction to quantum computation", March 14, 1996.

"Axiomatizing trace consistency." (invited talk), *REACT, Institut Montefiore, Liège, Belgium,* November 25-27, 1995.

"A temporal logic with local modalities." *BRICS seminar, Aarhus Universiteit, Denmark*, 27 January 1996.

Locally linear time temporal logic. *Oberseminar, Universität Hildesheim*. 13 February 1996.

Local knowledge assertions in a changing world. (contributed paper). TARK, Rennesse, Netherlands. March 1996.

P. Ray
"Fracture propagtaion in disordered systems". IMSC seminar. (22.5.95).

S. N. Bose National Centre for Basic Sciences, Calcutta (May. 24 –31, 1995).(TPSC visit) gave a seminar on "Breakdown in percolating systems". (28.5.95)

Saha Institute of Nuclear Physics, Calcutta (June 1–14, 1995), gave a seminar on "Cluster dynamics in fracture propagation", (9.6.95)

Saha Institute of Nuclear Physics, Calcutta (August 15– Sept.14, 1995)

"Critical dynamics in correlated cluster growth models".(invited speaker) (19.2.96) in Discussion meeting on Computational Condensed Matter Physics. *BARC*, Bombay (Feb. 19–20, 1996)

Physical Research Laboratory, Ahmedabad (Feb. 21–22, 1996), gave a seminar "Dynamics in correlated cluster growth models". (22.2.96)

TIFR, Bombay (Feb. 23–24, 1996)

Visiting Scientist, *ICTP*, Trieste, Italy (March 15– April 30, 1996)

Visiting Faculty, *Boston Univ.*, Boston, U.S.A., (May 1 – June 30, 1996); gave a seminar on "Fully frustrated XY model in 3 dimensions" (13.5.96)

Seth, Anil
Attended Martoberdorf summer school on logic and computation, in Martoberdorf, Germany.(July 23 Aug 6, 1995).

Attended a *discussion meeting, cryptography and computation*, in Jawaharlal Nehru center for advanced studies, IISc Bangalore, July 31-Aug 1).

Attended *FST-TCS*, December 1995 in Bangalore.

Shankar, R.
"Exclusion Statistics and Strongly Correlated Fermion Systems" (Invited talk), DAE Solid State Physics Symposium, IACS, Calcutta December, 1995.

Shubashree, D.
Quantum Antiferromagnets : from the Triangular to the Kagome Lattice. Oral presentation and Poster at the *D.A.E Symposium on Solid State Physics*. At I.A.C.S Calcutta, Dec 27th-31st.

Sinha, R.
Department of Physics and Astronomy, University of Delhi, Delhi (May18 -19, 1995). Seminar title "CP violation the physics of beauty".

Mehta Research Institute, Allahabad, May 7 - 10.13 -17, 1995. Seminar title "CP violation the physics of beauty".

Indian Institute of Technology, Kanpur May 11 -12, 1995. Seminar title "CP violation the physics of beauty".

Srinivasa Rao, K.
Visited *Department of Mathematics of the Roorkee Univ.*, from 24 - 26. May 1995 and delivered a lecture on "Srinivasa Ramanujan : Life and Work", May 25, 1995.

Invited talk on "Quantum theory of angular momentum and generalize (ordinary and basic) hypergeometric functions", on July 13, 1995, at a Plenary Session of the *Int. Conf. on Symmetry Methods in Physics* (ICSMP - 95), at Dubna, Russia, from July 10 - 16, 1995. Chairman of a session on July 13, 1995, at above conference.

Visiting Professor at *Joint Institute of Nuclear Research, Dubna*, Russia, from July 18 - 22, 1995. lecture on "The Life and Work of Srinivasa Ramanujan", on July 20. 1995.

Lecture on "The Life and Work of Srinivasa Ramanujan", at the *Department of Mathematics, Gorakhpur University*, July 25, 1995.

Lecture on "The life and Work of Srinivasa Ramanujan", at the *Nuclear Science Division, Indian Agricultural Research Institute*. Pusa Campus, New Delhi, July 26, 1995.

Lecture on "Relevance of Values to Science: the Sublime and the Ridiculous", in the Seminar on Value Education, held at the *Hindu Senior Secondary School*, Madras on July 28, 1995.

Keynote address, at the *Ramanujan Museum of the Avvai Kalai Kazhagam, Royapuram*, in a workshop on "Incorporating Ramanujan's Creativity in School Curricula", on Aug 30, 1995.

Lectures on "Generalized hypergeometric series"; "Life and work of Srinivasa Ramanujan" and "What is Science ?", at the *Kuvempu University, Shimoga*, September 30, 1995.

Visited the *University of Southampton, Southampton*, England, Oct. 9 - 13, 1995; lecture on the Life and Work of Ramanujan, on Oct. 13.

Visited the *Wren Library of Trinity College, Cambridge*, on Oct. 16 and 17, 1995.

Visiting Professor, *Department of Applied Mathematics and Computer Science, University of Gent*, Belgium, Oct. 18, 1995 - Jan.14, 1996, during which gave course of seven lectures on "Summation theorems and transformations of generalized hypergeometric series".

Invited lecture on "Quantum theory of angular momentum and hypergeometric series", at the *Groupe de Contact FNRS : Physique Mathematique meeting, at the University of Mons-Hainaut*, Mons, on Oct. 27, 1995.

Lectured on the "Life and Work of Srinivasa Ramanujan", at Shanti Darshan : *Belgo-Indian Association, Gembloux*, on Dec. 3, 1995.

Limburgs University, Diepenbeck , on Dec. 7, 1995.

Universitaires Notre-Dame de la Paix, Namur, in the History of Science seminar of Prof. Dominique Lambert, on Dec. 19, 1995.

University of Leuveen, Leuveen, on Dec. 22, 1995.

Lecture on "Polynomial zeros of angular momentum coefficients", at the *University Libre Bruxelles*, on Dec. 11, 1995.

Visiting Professor, *University of Rome*, Italy, from Jan. 15 - 19, 1996: delivered a lecture on the "Life and Work of Srinivasa Ramanujan", (at Roma III) on Jan. 17, 1996 and a lecture on "Quantum theory of angular momentum and hypergeometric series", on Jan. 18, 1996.

Visited the *Polytechnico and the University of Torino*, delivered a lecture on "$9-j$ coefficient and summation theorems", at the Polytechnico, Jan. 23, 1996 and a lecture on " Clebsch-Gordan coefficients and quantum groups", at the Univ. of Torino, on Jan. 25, 1996.

Lecture: "Generalized hypergeometric series", at the *Vivekananda College*, Feb. 13, 1996.

Srinivasa Rao, S.

Participated in Discussion meeting on *Computational Biology, JNCASR, IISC*, Bangalore (Dec. 15 - 16, 1995).

Participated in *Graduate workshop in Theoretical Computer Science, IISC*, Bangalore (Dec. 17, 1995).

Participated in *Fifteenth International Conference on FST and TCS, IISC*, Bangalore, (Dec. 18 - 20 1995).

Subramoniam, G.

Participated in the Workshop on Telematics, ICTP, Trieste and delivered two seminars titled "Integrated LAN connectivity" (Oct. 2-20, 1995)

Sunder, V.S.

Visiting Professor *Univ. of New South Wales, Sydney, Australia* (April 17 - May 26, 1995): During this period delivered following invited lectures: (i) Two lectures on 'Lattice and Spin models' Seminar at the *UNSW* (ii) a lecture on 'Biunitary permutations' at the Mathematics Colloquium conducted jointly by *Sydney University and UNSW*; (iii) a lecture on 'Some subfactors from vertex models' at the *University of Newcastle*; (iv) a lecture on 'From subfactors to knot invariants' at the *University of Melbourne*; (v) a lecture on 'Continuity of second quantisation' at *MacQuarie University*.

Visiting Professor at the *Univ. of Calif. at Berkeley, USA* (May 28 - June 8, 1995); attended a Mini-Conference on Subfactors there, and gave two lectures on 'Permutation vertex models' and one lecture on 'The diagrammatics of arbitrary non-degenerate commuting squares'.

Invited participant in two-week Winter School on *Group Representations and Function theory*, at Indian Statistical Institute, Bangalore (October 2 - 14, 1995); gave a series of lectures on 'Induced representations and the Imprimitivity theorem'.

Organising Committee member of the workshop on *Spectral Theories of Schrödinger operators*, conducted by the I.M.Sc. (December 4 - 14, 1995); gave a lecture on 'Inverse theory and singular spectra'.

Organising Committee member of an *International Conference on Harmonic Analysis held at Delhi University*, December 18 - 23, 1995); also gave a lecture there on 'Actions of hypergroups'.

Sunil Kumar, P.B.

TIFR, Bombay, February 22, 1996.

A Novel Monte Carlo Approach to the Dynamics of Fluids. Meeting on *Computational Con-*

densed Matter Physics, BARC, Bombay, February 19-20, 1996.

Swati Sastry
Talk: "A converse defect relation for quasimeromorphic maps" at the *University of Michigan, Ann Arbor*, Aug 17, 1995, in the Ann Arbor Analysis workshop.

Also attended conference "Quasiregular mappings and Analysis" from Aug 17 to Aug 19, 1995 at the University of Michigan.
Seminar talk at *University of Helsinki*, Finland, Oct 10, 1995

Visiting member *Math dept. Purdue University* from Aug 1 to Sept 15, 1995, and also the *University of Helsinki* from Sept 15 to Oct 14, 1995.

Gave a talk titled "Upper bounds for the value distribution of quasiregular maps", at *IMSc* on Dec 12, 1995 in the conference on Schrodinger operators.

"Quasiregular extensions of some entire functions", at *IMSc* on Feb 22, 1996, as a colloquium talk.

Venkatesh Raman
Presented the contributed paper Tight Bounds for Finding Degrees from the Adjacency matrix in LATIN 95 conference held at Valparaiso, Chile (April 3-7 1995).

University of Victoria, Canada (April 9-11, 1995).

Presented the contributed paper Some Hard Problems in (Weighted) Tournaments in the *Fifth National Seminar on Theoretical Computer Science, Bombay, India* (August 1-4 1995) Also chaired a session.

Tata Institute of Fundamental Research, Bombay (August 5-11 1995)

Participated in the *"Discussion Meeting on Cryptography and Computation"*, at IISc, Bangalore (Aug. 31 - Sep 1)

Fixed Parameter Tractability, *IMSc seminar* (Sep 28, 1995)
Path Balance Heuristic for Self-Adjusting Binary Search Trees, *IMSc seminar* (Dec 13, 1995)

Participated in the "Discussion Meeting on Computational Biology" at *IISc Bangalore*, India (Dec. 15-16 1995)

Presented the contributed paper "Path Balance Heuristic for Self-Adjusting Binary Search Trees" in the *15th Foundations of Software Technology and Theoretical Computer Science*

Conference at Bangalore, India Dec. 17-19 1995.

Participated at the "*International Conference on Discrete Mathematics and Number Theory*" at Tiruchirapalli, India (Jan. 3-6 1996).

Vijay Kodiyalam
Intersection Theory, *I.M.Sc. Colloquium*, October 12, 1995.

Professional Activities

Arvind, V.
Member, Program Committee, 15th Conference on the Foundations of Software Technology and Theoretical Computer Science,Dec 17-19, 1995, Bangalore.

Govindarajan, T.R
TPSC convenor Madras center.
Secretary, IPA Madras Chapter.
Member, Board of Studies in Physics, Manonmaniam Sundaranar University, Thirunelveli, TN.

Kesavan, S
Member, Advisory Board,Indian Journal of Pure and Applied Mathematics.
Member,Board of Postgraduate Studies,Cochin University of Science and Technology.
Convenor of the Faculty appointed by the NBHM for its Nurture Programme,1995-96.
Was a Judge for the event "Mathemaya" of the "Mirages 96-A Mathematical Fiesta",organized by the Padma Seshadri Bala Bhavan Senior Secondary School, Madras,on Jan. 18,1996.
Member, *American Mathematical Society*
Member, *International Soc. for Interaction of Mechanics and Mathematics*
Member, *Indian Soc. of Industrial and Applicable Math*
Life-member *Indian Mathematical Society.*

Krishna, M
Member, Organizing Committee, workshop on "Spectral theories of Schrödinger operators" at IMSc during 4-14 Dec. 1995.

Lodaya, Kamal
Member, Programme Committee, 6th National Seminar on Theoretical Computer Science, 1996.
Attended 61st Annual Conference of the Indian Academy of Sciences, Madras, December 1995, as invitee of Panel on University Education in Science.

Meena Mahajan
Referee for the FST&TCS95 (Foundations of Software Technology and Theoretical Computer Science), FTS95 (Fault-Tolerant Systems), NSTCS96 (National Seminar on Theoretical Computer Science) conferences.

Mohalik, Swarupkumar
Institute seminars on the thesis work. Presented the work at the graduate students' workshop in the FST and TCS conference in Bangalore, December, '95.

Nag, S

Member, Advisory Board of the Indian Journal of Pure and Applied Mathematics, by election of the Council of the Indian National Science Academy.
Reviewer, *Zentralblatt für Mathematik* and *Mathematical Reviews*.
Resource person, UGC Course, Sambalpur University, February 1996.
Member, *American Mathematical Society*
Life-member *Indian Mathematical Society*.

Rajasekaran, G

Chairman, National Committee of the International Union of Pure and Applied Physics
Member, National Committee of the International Council of Scientific Unions
President, Madras Chapter of the Indian Physics Association
Convener, Madras Chapter of the Indian National Science Academy
Member, Governing Council of the Mehta Research Institute of Mathematics and Mathematical Physics, Allahabad
Member, Apex Committee of the Anna Unviersity, Madras
Member, Special Committee of the School of Physical Sciences, Jawaharlal Nehru University, New Delhi
Member, Editorial Board of Pramana - J. of Physics (upto Dec. 1995)
Member, Editorial Board of Indian Journal of Pure and Applied Mathematics (from Jan. 1996)
Member, Local organizing Committee and the Academic Programme Committee for the 61st Annual Meeting of Indian Academy of Sciences held at Madras, November 10 – 12, 1995
Co-organiser of a Symposium on "High Energy Physics in the 21st Century" at Kalpakkam on Nov. 11, 1995 as a part of the Annual Meeting of IASc
Co-organiser of a Symposium in Memory of Prof. S.Chandrasekhar on Nov. 1, 1995, under the auspices of the Madras Chapters of INSA and IPA.
Member, National Organizing Committee of the IV Workshop on High Energy Physics Phenomenology, Calcutta, Jan 1996.
Chaired a Session of the XVIII Conference of the Indian Association for General Relativity and Gravitation at IMSc, Madras, Feb 15-17, 1996 ; also member of the Organizing Committee.

Ramachandran, R

Senior Associate and Regional Representative of the External Activities, ICTP, Trieste, Italy
Member, Sectional Committee for Physics, Indian Academy of Sciences, Bangalore.
Member, Board of Studies, Indra 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.
Member, Strategic Planning Committee of IIT Madras.
Member, UN COSTED committee
Member, Working Committee of Current Science Association
All India Radio Interview: On the Activities of The Institute of Mathematical Sciences, (Feb 11, 1996 8.30 pm Madras A station)

Ramanujam, R
Member, Programme committee, *Algebraic Methodology and Software Technology*, Montreal, June 1995.
Member, Programme committee, *Foundations of Software Technology and Theoretical Computer Science 15*, Bangalore, Dec. 18-20, 1995.

Seth, Anil
Refreed a paper for JCSS special issue on Structures 95.

Sridhar, R
Life Member, Indian Society for Complex Systems, Bangalore

Srinivasa Rao, K.
The EEC Project between the Institute and the University of Gent, continued this year with a visit to the Univ. of Gent, by K. Srinivasa Rao. Under this project, IMSc acquired Hypersparc 4 System - a parallel computer with four SS20s @ 90 MHz at its four nodes. (Project contribution was US $15,000/-).
A two-week intensive teaching-cum-training program was conducted by K. Srinivasa Rao, with R. Jagannathan and R. Parthasarathy, at the Scientific Publishing Services (P) Ltd., March 17 - 31, 1995. For the course of lectures on TEX delivered to the trainees, a set of Springer-Verlag books was presented to the IMSc Library.

Sunder, V.S
Corresponding Editor of *Resonance* (Indian Academy of Sciences); written an article titled 'Knots' for "*Resonance*"
On the editorial board for the Journal of the Ramanujan Math. Soc.
Participating in conducting the "Nurture" programme (NBHM) at IMSc.
Organising Committee and 'Resource Person' for MTTS programme 1996 (NBHM)

Book Published

Selected Topics in Mathematical Physics : Professor R.Vasudevan Memorial Volume
Editors : R.Sridhar, K.Srinivasa Rao and V.Lakshminarayanan
Allied Publishers Limited, Madras(1995)

Lecture Courses at the Institute

Mathematics

Lecturer	Lecture Course	Duration
Kesavan, S	Functional Analysis	Aug. – Nov. 1995
Krishna, M	Analysis	1995
Nag, S	Riemann Surfaces Course	Jan. – May 1996
Nag, S et.al.	Seminar on the Grothendieck-Riemann-Roch theorem	Jan. – May 1996
Nagaraj, D.S.	Topology II	April 1995
Sunder, V.S.	Functional Analysis	Jan. – April 1996
Vijay Kodaiyalam	Local Cohomology	Jan. – May 1996

Physics

Lecturer	Lecture Course	Duration
Balakrishnan, Radha	Nonlinear Dynamics	Jan. – May 1996
Basu, Rahul	Quantum Field Theory II,	Aug. – Dec. 1995
Date, G.	Advanced Gravitation	Aug. – Dec. 1995
Jagannathan, R.	Quantum Mechanics	Aug. – Dec. 1995
Majumdar, Partha	Quantum Field Theory	January 1996
Mishra, A.K.	Condensed Matter Physics	Jan. – May 1996
Rajasekaran, G.	Gravitation and Cosmology	March – Aug. 1995
Ramachandran, R.	Electrodynamics	Aug. – Dec. 1995
Sharatchandra, H.S.	Mathematical Methods	Aug. – Dec. 1995
Shankar, R.	Many Body Theory	Aug. – Dec. 1995
Srinivasa Rao, K.	Introductory Elementary Particle Physics	Jan. – May 1996

Theoretical Computer Science

Lecturer	Lecture Course	Duration
Arvind, V	Design and Analysis of Algorithms	Jan. - April 1995
Arvind, V. Venkatesh Raman	Randomized Algorithms	Aug. - Nov. 1995
Lodaya, Kamal	Program Correctness	Aug. - Dec. 1995
Lodaya, Kamal Anil Seth	Program Semantics	Jan. - May 1996
Lodaya, Kamal Madhavan Mukund(SPIC)	Distributed Computing	Jan. - May 1996
Mahajan, M Subramoniam, K.V.(SPIC)	Introduction to Complexity Theory	Aug. - Dec. 1995
Anil Seth	Introduction of Mathematical Logic	Aug. - Dec.1995
Anil Seth	Intro. to Programming Language Semantics	Jan. - May 1996
Seth, Anil Lodaya, Kamal	Intro. to Mathematical Logic	Aug. - Dec. 1994
Venkatesh Raman	Approximate Algorithms	May - July 1995
Venkatesh Raman	Data Structures and their Analysis	Aug. - Dec. 1995
Venkatesh Raman Subramanian, K.V.(SPIC)	Design and Analysis of Algorithms	Jan. - May 1996

Conferences / Workshops / Symposia at IMSc.

Workshop on Schrödinger Operators:

The workshop on Schrödinger operators was held at the Institute of Mathematical sciences during 4 -14 December 1995. There were about 25 participants for the workshop including 6 from abroad.

The workshop had lectures mainly in the areas of Spectral theory of Random Schrödinger operators, theory of resonances, inverse spectral theory of Schrödinger operators and micro local analysis of partial differential equations. In addition to these there were talks in related areas. Prof. W Kirsh, Prof P. Hislop and Prof. F Klopp gave lectures on the spectral theory of random Schrödinger operators. Prof R Froese spoke on theory of resonances. Prof W Craig and Prof M Vanninathan discussed partial differential equations. Prof T Ichinose and Prof K B Sinha gave lectures on dynamical semigroups. Prof V S Sunder and Dr M Krishna dealt with inverse spectral theory in one dimension while Dr A Mohapatra discussed trace formulae. Dr Radha Balakrishnan spoke on integrable systems and Dr G Date discussed spectra of Anyons. Prof R Bhatia and Dr T Bhattacharya concentrated on the general theory of operators. In addition there were lectures by Prof N Wildberger on Hypergroups and random walks, Dr T Sengadir on the stability of functional differential equations, Dr R Radha on the multiplier theory of the Weyl tranform and Mr S Padhi on third order differential equations. The proceedings of the workshop will be brought out in the Institute Lecture Notes series by June-July 1996.

Vision 2020:

On 19th April 1995 a discussion meeting on VISION 2020 in order to initiate the long term plans for the activities of the Institute. In the next 25 years, what shall be our role and how the same will enmesh with those of the DAE organisation is an important excercise. Dr Romesh Kaul co-ordinated the brainstorming session that was to generate suitable inputs both to the VISION 2020 of the entire DAE set up, which was taken up in a three day seminar in July 1996, as well as to our own immediate as well as long term plans. Having thus initiated the debate, we hope that we will eventually converge into a focussed picture of our perceptions and perspectives and lead ourselves to a concrete programme for future action.

Annual Conference in Nov 95 of the Indian Academy of Sciences:

The Institute cosponsored the 61st Annual Meeting of the Indian Academy of Sciences, held at Madras during Nov. 10 -12, 1995. As a part of this meeting, the Institute organized a Symposium on "High Energy Physics in the 21st Century". The four themes of the Symposium were : The Standard Model of High Energy Physics, Theoretical scenerios for 10^3 GeV - 10^{19} GeV, Hints of new physics from Cosmology, and New ideas on acceleration to Planckian energies : talks bearing on these themes were given by Prof.D.P.Roy (TIFR, Bombay), Prof.Romesh Kaul, Prof.R.Cowsik (IIA, Bangalore) and Prof.Abhijit Sen (IPR, Gandhinagar) respectively

Under the auspices of the Madras Chapters of INSA and IPA, the Institute organized a symposium in Memory of Prof.S.Chandrasekhar on Nov. 17, 1995. Prof.V.Balakrishnan (IIT, Madras) spoke on "Chandrasekhar's Citation Classic", while Prof.Rajaram Nityananda (RRI, Bangalore) spoke on "Six Faces of Subramanyam Chandrasekhar as an Astrophysicist".

XVIII IAGRG Conference

The Institute co-hosted the XVIII the conference of the Indian Association for General Relativity and Gravitation (IAGRG) during February 15-17, 1996. Apart from playing the role of being a local organising institute (i.e. hosting the conference), and the venue, the Institute sought to expand the scope of the conference to include quantum aspects of gravity. As a result, apart from the traditional IAGRG topics the conference had about a third of the topics devoted to quantum aspects which included talks on scattering at Planckian energies, black holes, string approach, Ashtekar approach and lattice approach to quantum gravity.

The confernece was dedicated to the late Prof. S. Chandrasekhar. There were 17 invited talks including special talks on Prof. Chandrasekhar given by Prof. N. Panchapakesan, Delhi University and Prof. R.H. Dalitz, Oxford University, UK and the Vaidya-Raychoudhuri Endowment lecture by Prof. C.V. Vishveswara, Indian Inst. of Astrophysics, Bangalore. There were 3 sessions for contributed papers including 24 presentations and 1 session on thesis presentation including 2 presentations.

About 44 out station and about 20 local participants from universities and research institutions from all over the country attended the conference. The confernece was funded by the Dept. of Science and Technology, the Inter University Center for Astronomy and Astrophysics (IUCAA) and the Institute of Mathematical Sciences. The total budget for the conference was about Rs. 75,000/- including the cost of proceedings which are to be brought out as an IMSC report (IMSc-Report Number 117) shortly.

Workshop on internet

IMSc conducted a one day workshop on the internet for the benefit of the educational and research institutions in and around the city of Madras on 9 March 1996. About 60 scientists from around 20 Institutions attended the workshop. There were lectures by S. Ramakrishnan, Director ERNET, G. Palaniappan of VSNL, G. Subramoniam, Rahul Basu and Tabish Qureshi of IMSc after a welcome by the Director of the Institute.

Honours and Awards

Balakrishnan, Radha
Fulbright Award (1995),Council for International Exchange of Scholars. Washington D.C.,U.S.A.

Govindarajan, T.R.
Senior Associate, ICTP, Trieste.

Nag, S.
Designated *"Principal Speaker"* at the International Conference: "Complex Analytic Aspects of Teichmüller Spaces", Massachusetts, USA, November 3-5, 1995.

Opening Lecturer at the 37th Taniguchi Foundation Symposium, "Topology and Teichmüller spaces", Katinkulta, Finland, 23-30 July 1995.

Degrees Awarded and Summer Students

Ph.D. Degree Awarded

Varghese John, Ph.D. (Madras University)
Thesis: Some Studies in Noncritical String Theory
Guide : Prof.Anishetty, R.

Padma, R., Ph.D. (Madras University)
Thesis: Mean value theorems of Dirichlet series
Guide : Prof.Balasubramaniam, R.

M.Sc. Degree Awarded

Sarkar, Tapobrata was awarded the M.Sc., degree in Physics, by research, under the joint programme of the Institute with Anna University in March 1996, for his
Thesis : Aspects of High Energy Scattering in abelian and Non-abelian Gauge Theories
Guide : Dr.Jayaraman, T.

Summer Students

Name	Period
Rohit Dhamankar	May 16 - June 16, 1995
Sai Ganesh, S.	May 30 - June 30, 1995
S. Bose	May 31 - July 1, 1995
Manoj Plakal	June 5 - July 5, 1995
Soumen Ghosh	May 16 - July 16, 1995
Sanjay Bose	May 16 - July 16, 1995
Prakash Narayanan	May 16 - July 16, 1995

Visitors to the Institute

including Seminars/Colloquia by Visitors

Name & Address	Period of visit	Title of lecture
Biswadeb Dutta J.N.Centre for Adv. Scientific Research,Bangalore	13,14.4.95	
Ravindran, V. TIFR, Bombay	7–21.4.94	
Rajaram Nityananda Raman Research Institute Bangalore	8-15.5.95	
Ramaswamy, S. Dept. of Maths. Pondicherry University	8–12.5.95	
Subramanian, P.S. TCS Group,T.I.F.R. Bombay	23–25.5.95	Algebraic topology and distributed computation
Suresh V.Vettoor St.Dominics College Kerala	3–29.5.95	
Ramanathan, R. Dept. of Physics, Univ. of Delhi	24.5.-2.6.95	
Umasankar, S. IIT, Bombay	21.5.–8.6.95	Recent Results from LSND on Neutrino Oscillations
Avijit Mukherjee Univ. of Cambridge U.K.	30.5.–16.6.95	2D Gravity Coupled to Topological Minimal Models
Agarwal, A.K. Birla Inst. of Tech. of Sci. Pilani	9-19.6.95	Applications of Special Functions in Number Theory

Sougato Bose IIT, Kharagpur	21.6.95	Standard quantum mechanics versus decoherence versus collapse
Sanjay Kumar, M.	11.3.–24.6.95	
Ravi Kumar,B. Univ. of Rhode Island U.S.A.	29.6.95	A parallel algorithm for the homing sequence problem
Malik, R.P. JINR, Dubna, Moscow	24.3.–30.6.95	
Shaji Anil, J.N.Cen.for Adv.Sci.Res. Bangalore	8.6.–7.8.95	
Pramathanath Sastry School of Mathematics, SPIC Sci.Foundation.	3.7.95	Multi Dimensional Residues in Algebraic Geometry
Balaji, V. School of Mathematics SPIC Sci. Foundation	13.7.95	On the rationality problem in Algebraic Geometry
Stevendale Cutkosky Univ. of Missouri	14.7.95	Local factorization of birational maps
Muthukumar, N Univ. of Dortumund Germany	14.7.95	Non Reciprocal optical effects in Cr_2O_3
Sudeshna Sinha Inst. of Astrophys. Bangalore	16-21.7.95	Chaos and regularity in lattice dynamics
Hema Srinivasan Univ. of Missouri	17.7.95	Finite Determinency of Mappings
Sivaram Narayan Central Michigan Univ.	19.7.95	Schur multiplier norm of matrices and truncation

Rajarama Bhat, B.V. The Fields Institute Waterloo	26–28.7.95	
Balachandran, A.P. Syracuse Univ. USA	24–28.7.95	Topology change and quantum physics
Rajaraman Bhat, B.V. Univ. of Toronto	27.7.95	On the recent classification of purely infinite $C*$ - algebras
Vijay Raghavan Vanderbilt University U.S.A.	28.7.95	How many queries are needed to Learn?
Ananthanarayanan, B. Univ. of Lausanne Switzerland	30.7.–1.8.95	Pions and chiral perturbation theory CP violation in $e^+ + e^-$ rightarrow $\tau^+ + \tau^-$ with longitudinaly polarized beams
Sekhar Chivukula, R. Biston University Boston	6–8.8.95	Dynamical Electroweak symmetry breaking and the top quark
Thangadurai, K.R. Mehta Rese. Inst. Allahabad	12.7.–11.8.95	
Jeeva S.Anandan Univ. of South Carolina	10–13.8.95	Cosmic Strings and Quantum Gravity
Srinivas, K. TIFR, Bombay	14.7.–14.8.95	
Anuradha Narasimhan Univ. of Poona Pune	18.7.–18.8.95	

Adhikari, S.D. Mehta Res. Institute Allahabad	12.7.–21.8.95	
Kalyan Chakraborty Mehta Res. Institute Allahabad	12.7.–21.8.95	
Ramakrishnan, B. Mehta Res. Institute Allahabad	12.7.–21.8.95	On exceptions to quadratic forms
Ravindran, V. TIFR,Bombay	7–20.8.95	
Suvasini, M.B. Madras	24.8.95	Aspects of Density functional theory of Superconductors
Alagar, V.S. Concordia University Canada	28.8.95	An object model for reactive
Neal Koblitz Univ. of Washington	28-30.8.95	Fixed Parameter complexity
Ravi Mehrotra Natl.Physical Lab. New Delhi	10–13.9.95	Voltage Turbulence and Vortex Dynamics in 2D Josephson Junction Arrays
Suresh Govindrajan TIFR, Bombay	4–22.9.95	

Vishwanathan, K.S. Simon Fraser Univ. Burnaby, Canada	21.8.–13.10.95	Planckian energy scattering. Black hole formation and colliding plane waves
Shastry, S. Natl.Inst. of Health Bethesda	5.9.95	Statistical Mechanics of Water
Ghosh, S.* MRI, Allahabad	8.9.95	Consequences of non trivial PPN parameters
Sengupta, S. MSD,IGCAR, Kalpakkam	20.9.95	Kinematic Scaling and Approach to SOC in Martensites
Goutam Mukherjee S.S.F.	21.9.95	2-group actions on manfolds and applications
Madhavan Mukund SPIC Sci. Foundation Madras	22.9.95	Determinizing asynchronous automata
Utpal Sarkar Phys. Rese.Lab. Ahmedabad	22–30.10.95	i)Baryogenesis through lepton number violation ii)Alternative explanations neutrino puzzles
Ponnusamy, S. Univ. of Helsinki Finland	15.9.–28.10.95	
Ghoshal, G.* MRI, Allahabad	4.10.95	Some Universal properties of String Compactification on Calabi-Yau spaces
Ramakrishna, S. IISc, Bangalore	5.10.95	Photocarrier dynamics and charge transfer at semi-conductor-electrolyte interface

Bandyopadhyay, A.* Department of Physics IIT, Kanpur	18.10.95	Squeezing in the interaction of coherent radiation with coherent atomic beams
Sukumar, N. Theorie International Madras	19.10.95	Calcutta staircase to the ozone hole
Pasupathy, J. I.I.Sc, Bangalore	29-31.10.95	Summary of the Beijing conference
Adhikari, S.D. Mehta Rese.Inst. Allahabad	13.10.–6.11.95	
Banhatti, D.G. Madurai Kamaraj Univ. Madurai	30.10.–7.11.95	
Parthasarathy, K.R. ISI, Delhi	10.11.95	Markov Processes with a given Christensen-Evans generator
Roy, D.P. Theory Group, TIFR, Bombay	13.11.95	Susy dark matter
Rajaram Nityananda Raman Research Institute Bangalore	16–18.11.95	Six faces of Subrahmanyam Chandrasekhar as an Astrophysicist
Anubha Rastogi Univ. of Delhi Delhi	19–24.11.95	
Choudam, S.A. Department of Mathematics IIT, Madras	24.11.95	Ordered and canonical Ramsey's Theorems
Anupam Srivastav Suny at Albany U.S.A.	6-28.11.95	Galoi's module structure and Kummer extensions

Abhijeet Das Gawahati University Guwahati	21-28.11.95	
Chakraborty, B. SNBNCBS, Calcutta	28.11.95	Landau Lifshifts model of continuum ferromagnets as gauge fixed version of nonrelativistic CP_1 model
Puri, R.R. BARC, Bombay	30.11.95	Coherent states via minimum uncertainty relations
Varma, P.L.N. Mehta Rese. Institute Allahabad	2.11-2.12.95	
Rahul Pandit Indian Inst. of Science Bangalore	22-26.11.95	Shell models of turbulence
Uyrzakulov, R HEPI, Kazakhstan	8,9.12.95	
Butcher, P.N. U.K.	13.12.95	
Sivakumar, M. University of Hyderabad Hyderabad	13.12.95	Remarks on W algebra in Calagero Sutherland model
Schuler, R. University of Ulm Germany	14.15.12.95	i) The complexity Average Polynomial Time under Ptime computable distributions ii) Truth-table closure and Turing closure of Average Polynomial Time have different measures in EXP.
Paterson, M. University of Warwick.UK	14.12.95	Mean Pay-Off Games

Shiv Dutt Kumar Mehta Rese. Institute Allahabad	22.11-16.12.95	
Mihir Arjunwadkar Univ. of Pune Pune	7-16.12.95	
Joseph Wheatley Camukide Univ. U.K.	5-17.12.95	C-axis couplings in copper-oxides
Asle Subdo Norwegian Univ. of Tech.	8-22.12.95	Pairing fluctuations in copper oxide model: Exact results
Klaus Dieter Rothe Institut fur Theo.Phy.Univ. Heidelberg, Germany	22.11-14.12.95	Recent developments in QCD_2
Balachandran, A.P. Syracuse Univ. N.Y.	19-23.12.95	Quantum groups for quantised geons
Chandar, L. Univ. of Florida U.S.A	15-22.12.95	
Madhavan Varadarajan Univ. of Utah Salt Lake City	20-22.12.95	Dilatonic blackholes
Ramana, M.V. University of Toronto Toronto	26.12.95	New Physics source of hard gluons in top quark production
Mukherjee, P.K.* Calcutta University Calcutta	27.12.95	T_C T^* puzzle in liquid crystals
Ramanan, S. TIFR, Bombay	27.12.95	Abelian Varieties

Runa De Visva Bharati University	28.12.95	Role of supersymmetric quantum mechanics in path integrals
Durganandini, P. Pune University Pune	24.12.95–4.1.96	
Norman Wildberger Univ. of New Southwales	1.12.95–1.1.96	Hypergroups of order three
Basu Mallick, B. TIFR, Bombay	24–29.12.95	Spin dependent generalisation of Calagero-Sutherland model through anyon like permutaion opertor
Ashoke Sen* Mehta Rese. Institute Allahabad	31.12.95–6.1.96	i)Recent developments in string theory ii)U-duality and Dirichlet branes
S.Raghavan Univ. of New Mexico U.S.A.	31.12.95–7.1.96	
Adhikari, S.D. Mehta Research Institute Allahabad	27.12.95-11.1.96	
Sir Hermann Bondi Churchil College Cambridge	31.12.95	
Takahiro Shiota Kyoto Univ. Kyoto	1-10.1.96	Matrix integral solutions to [P,Q] = P
Kirti Joshi TIFR, Bombay	7-13.1.96	Special values of L-functions
Maharana, J.* Institute of Physics Bhubaneswar	9.1.96	Duality in string theories

Singha Deo. P.* Institute of Physics Bhubaneswar	10.1.96	Transport in mesoscopic systems
Narain, K.S. ICTP, Trieste	11.1.96	$N = 2$ type II - heterotic duality
Namiki Mikio Waseda Univ. Tokyo	15.16.1.96	Zeno's paradox in quantum mechanics
Prof.A.Koranyi Univ. of New York U.S.A.	12-17.1.96	Conical limit sets in complex,quaternionic and octonionic hyperbolic spaces
Rajeev. S.G. Univ. of Rochester New York	16.17.1.96	Poisson algebras of loops in Yang-Mills and Chern-Simons theories
Parikh, R. CUNY	18.1.96	Belief and Belief Revision
Dattagupta, S. JNU, Delhi	22.1.96	Quantum glasses
Suresh, V. People's Union for Civil Liberties	23.1.96	A Citizens' Initiative for the Elections
Richard Froese Univ. of British Canada	1-24.1.96	
Gupta, R.K.* Punjab University	25.1.96	Quantum group and their algebra as applied to nuclear physics problems
Jager CEDEX, France	28-31.1.96	Type II matrices and association schemes

Bryan Cain IOWA State Univ. U.S.A.	23-27.1.96	Inertia theorems for Hilbert space operators
Yegnanarayanan, V. Annamalai University	1.11.95-31.1.96	
Avinash Singh* IIT, Kanpur	31.1.96	Gap states, local moments and magnetic dynamics in an impurity-doped Mott-Hubbard
Das, M.P. Australian Nati.Univ.	1,2.2.96	Are the high T_c oxide superconductors truely superconducting
Mohan Nair Univ. of Glazgow U.K.	30.1-13.12.96	
Ramamoorthy, M. Vanderbelt University U.S.A.	6.2.96	Complex diffusive phenomena in semiconductors
Bhattacharjee, J.K.* IACS, Calcutta	7.2.96	Turbulence:Is understanding round the corner
Kruskal, M.D. Rutgers University	8.2.96	In search of Euclidean geometry
Mitra, M.* IOP,Bhubaneswar	9.2.96	Correlated fermion systems in slave boson formalisms
Varghese John, K. Syracuse Univ.	10.12.95-15.2.96	
Dalitz, R.H. Oxford University U.K.	11-18.2.96	i) PAM Dirac: his life ii) Systematics of quarks and leptons today

Sayan Kar* IOP, Bhubaneswar	12.2.96	Evolving Lorentzian wormholes
Sobhana Narasimhan Berlin	19,20.2.96	
Raychaudhuri, A.* Calcutta University Calcutta	19,20.2.96	i)Singlet Higgs signals at hadron colliders ii)Neutrino oscillations
Umasankar, S. I.I.T. Bombay	18-23.2.96	
Divakaran, P.P. TIFR. Bombay	6-15.3.96	Quantum theory as representation theory of symmetries
Mahanti, S.D. Michigan State University Michigan	8.3.96	Quantum particles in microporous channels
Manisha V.Kulkarni Mehta Res. Institute Allahabad	16.2-16.3.96	
Von Gehlen Gunter Univ. of Bonn Germany	13-18.3.96	Integrable chiral potts model
Parwani, R. IOP, Bhubaneswar	20.3.96	Asymptotically free Kac-Moody gauge fields in four dimensions
Mihir Dash I.S.I. Bangalore	26.2-2.3.96	
Decio Levi Universita Di Roma Italy	26-29.3.96	Symmetries of equations on the lattice

* TPSC Visitor

COMPUTER NETWORK at IMSc.

The IMSc Computer services are handled by an up-to-date system of several interconnected SunSPARC Stations. A dual CPU SunSPARC Station-10 system is the file server and Web server, and a SunSPARC station-4 system works as the mail server and domain name server for the Network. Two other SunSPARC station-20s are utilized for running the analytical computation packages like Macsyma and Mathematica in the network under the Solaris 2.5 operating system in the 10Base-T network environment.

The Institute started from the month of May 1995 a World Wide Web server:
http://www.imsc.ernet.in/
Quickly this has become a very widely accessed server providing information about the educational and research institutions of India.

The web service is mainly used to access various academic institutions in the world. We access a variety of preprint servers, electronic journals, and obtain information regarding advances in research in areas in which the Institute members are currently involved.

The reliable INTERNET service was establised in September 1995 by commissioning the Hughes VSAT link through the HUB at STP, Bangalore under the ERNET VSAT project. The already existing leased line link service is now acting for the local link and also as standby INTERNET link through IIT-Madras.

During the current year the institute added to its existing IMSc computer Network the following hardware:
SGI Indy 20 Mflops graphics workstation,
SGI Power Indigo-2 100 Mflops workstation.
HyperSPARC 4 cpu parallel processing workstation with CraySoft Fortran90 compiler,
HP Laserjet 4MV 600 dpi high resolution printer,
HP Scanner 4C colour scanner and five numbers of colour HDS-X-terminals.

This year IMSc further made available the computing services to a few research institutions in the neighbourhood for their research work, through institutional and individual accounts.

Library

During the period ended 31st March 1996, 1128 books and bound volumes of periodicals were added to the Library. About 260 journals were subscribed to for the year 1996. Subscriptions for the following eight new journals have been started by our Library upon recommendation by the faculty:

1. Advances in Applied Clifford Algebras
2. Combinatorica
3. Communications in Algebra
4. Computational Complexity
5. Journal of Logic and Computation
6. Mathematics of Computation
7. Mathematical Structures in Computer Science
8. Resonance

As before we have been getting several journals, Lecture Notes etc. on an exchange basis. About 2200 Preprints have been received during the year from Research Institutions and Universities all over the world. Our Library has lent out, as well as borrowed, a large number of Books/Journals from other libraries on Inter-Library Loan. Likewise a number of xeroxed research articles were sent to other institutions on reciprocal basis. The number of Visitors to the Library for reference work, making use of xerox facilities etc. has increased to about 3000 this year.

During the year the Institute Library received some valuable books gratis from the following; to them we express our gratitude:

1. ICTP, Italy
2. NBHM, Bombay
3. Department of Physics, University of Delhi
4. S.Ponnusamy, SPIC Science Foundation, Madras
5. V.Kumar Moorthy, Canada
6. R.Ramachandran, K.Srinivasa Rao, R.Simon, R.Sridhar, Venkatesh Raman, Anil Seth, Meena Mahajan of our Institute.
7. Scientific Publishing Services (P) Ltd., Elnet building, Madras.