Institute of Mathematical Sciences

Annual Report 1986 — 1987

Madras-600 113
India

INSTITUTE OF MATHEMATICAL SCIENCES

Annual Report 1986-87

CENTRAL POLYTECHNIC CAMPUS, THARAMANI

MADRAS - 600 113, INDIA

CONTENTS

INTRODUCTION

This annual report of the academic activities of the Institute of Mathematical Sciences covers the period April 1986 - March 1987. The Institute continued to grow during this period and it has now reached the status of a major centre for Theoretical Physics and Mathematics in the country. The following comparison between the year 1984 (when the present growth and development started) and the current year 1987 is appropriate at this point:-

	1984 January	1987 March
Academic Staff	12	27
Junior Research Fellows and Post Doctoral Fellows	6	31
Administrative and Maintenance Staff	21	31

During these three years, the academic strength (staff and students) has grown from 18 to 58, which is more than a factor of 3. This growth has resulted in a corresponding growth in all the academic activities of the Institute. It is also worth pointing out that such a growth has been achieved with a much more modest increase of the staff strength in the administrative and maintenance wing (from 21 to 31 only).

It is much more important to ensure that the above quantitative expansion leads also to a qualitative change. The Institute is now poised to make outstanding research contributions and this potential must be realised in the next few years.

I would like to express my appreciation to Dr. R. Jagannathan and Mr. G. Sethuraman for their effort and care in bringing out this annual report.

G. RAJASEKARAN
JOINT DIRECTOR

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Sri. C. SUBRAMANIAM

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Government of Tamil Nadu
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Director
Institute of Mathematical Sciences
Madras

Prof. K.R. Unni
Institute of Mathematical Sciences
Madras

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Prof. E.C.G. Sudarshan
Director
Institute of Mathematical Sciences
Madras

Mr. T.A. Lakshminarayanan
Controller
Bhabha Atomic Research Centre
Bombay

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Prof. E.C.G. Sudarshan	(Physics)

Joint Director

Prof. G. Rajasekaran	(Physics)

Senior Professors

Seshadri, C.S.+	(Mathematics)
Vasudevan, R.*	(Physics)

Professors

Hari Dass, N.D.	(Physics)
Ranganathan, N.R.	(Physics)
Santhanam, T.S.	(Physics)
Unni, K.R.	(Mathematics)

Associate Professors

Alladi Krishnaswami §	(Mathematics)
Balasubramanian, R. +	(Mathematics)
Mariwalla, K.H.	(Physics)
Parthasarathy, R.	(Physics)
Radhaskrishnan, V. §	(Physics)
Sridhar, R.	(Physics)
Srinivasa Rao, K.	(Physics)
Thiagarajan, P.S.	(Mathematics - Computer Science)

Readers

Jagannathan, R.	(Physics)
Rindani, S.D.	(Physics)

Assistant Professors

Chaturvedi, S.	(Physics)
Hemant Bhate	(Mathematics)
Joshipura, A.S.	(Physics)
Murthy, M.V.N.	(Physics)
Muthuramalingam, PI.	(Mathematics)
Radha Balakrishnan	(Physics)
Ramesh Anishetty	(Physics)
Sharathchandra, H.S.	(Physics)
Simon, R.	(Physics)

Postal Doctoral Fellows

Adimoolam, C.	(Mathematics)
Chakrabarti, R.	(Physics)
Date, G.	(Physics)
Ghosh, R.K.	(Physics)
Prema, G.	(Mathematics)
Rahul Basu	(Physics)

Junior Research Fellows

Adhikari, S.D.	(Mathematics)
Anthony Anand, J.	(Mathematics)
Biswajit Chakraborty	(Physics)
Debajyoti Choudhury	(Physics)
Gadiyar, G.H.	(Physics)
Indumathi, D.	(Physics)
Lobo, S.J. +	(Mathematics)
Madhavan Mukund	(Mathematics - Computer Science)
Manaskumar Sardar	(Physics)
Raghavendra, N.	(Mathematics)
Salai Dhavakodi, T.	(Mathematics)
Sandhya, K.	(Mathematics)
Shaji, N.	(Physics)
Sumitra, R.	(Physics).
Vanchinathan, R.	(Mathematics)
Velammal, G.	(Mathematics)
Venkataraman, S.	(Mathematics)
Vytheeswaran, A.S.	(Physics)
Yogananda, C.S.	(Mathematics)

N.B.H.M. Research Fellows**

Balaji, V.	(Mathematics)
Padma, R.	(Mathematics)
Srinivasa Rau, S.	(Mathematics)

C.S.I.R.++ Research Fellows

Shanti, A.	(Physics)
Rajeswari, V..	(Physics)
Venkata Satyanarayana, M.	(Physics)

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* On reemployment from 1.12.1986

\+ From Tata Institue of Fundamental Research, Bombay

** National Board for Higher Mathematics

++ Council of Scientific and Industrial Research

§ On Visiting Academic Assignment in U.S.A. with leave of absence from the Institute. This report does not include the details of the academic work of the members who are on such long-term leave.

ADMINISTRATIVE STAFF

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Mr. S. Krishnan	Administrative/Accounts Officer
Mr. K.S. Santhanagopalan	Librarian
Mr. R. Jayaraman	Office Superintendent
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Mr. A.R. Balakrishnan	U.D. Typist
Mr. R. Ganapathi	U.D. Steno
Mr. G. Venkatesan	Jr. Library Assistant
Mr. P. Chellakrishnan	Typist
Mr. T.V. Vasudevan	Typist
Mrs. E. Gayatri	Typist
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Mr. V. Jayaraman	Supervisor
Mr. G. Nithyanandam	Car Driver
Mr. M. Gangan	Attender
Mr. S. Muthusigamani	Attender
Mr. T.R. Narayanan	Caretaker-cum-cook
Mr. G. Elumalai	Gardener
Mr. M. Kanniappan	Gardener
Mr. M. Munuswamy	Peon
Mr. J. Balakrishnan	Library Attender
Mr. V. Parthiban	Attender
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Mr. M. Selvaraj	Sweeper
Mr. C. Rajendran	Cleaner
Mr. E. Moorthy	Watchman
Mr. H. Rizwan Sheriff	Van Driver
Mr. M.G. Radhakrishnan Nair	Personal Attendent to Director
Mr. M. Ravi	Hostel-cum-Guest House Cook
Mr. N. Ravichandran	Helper (Guest House)

* On deputation from Department of Atomic Energy, Bombay

AWARDS AND HONOURS

Prof. E.C.G. Sudarshan received the First Physics Prize of the Third World Academy of Sciences for his fundamental contribution to the understanding of the weak nuclear force, in particular for his part in the formulation of the Universal V-A Theory of Sudarshan and Marshak, on Sunday, October 26, 1986 at the Award Ceremony at the International Centre for Theoretical Physics, Trieste, Italy.

Prof. G. Rajasekaran received the Meghnad Saha Award (for 1984) for Research in Theoretical Sciences (Instituted by the University Grants Commission and Hari Om Ashram Trust) at the award ceremony at New Delhi on 26 February 1987. The citation mentions his role in the discovery of "Shadow Poles", the formulation of the test for elementarity, the determination of neutral-current couplings and the construction of broken-colour gauge theories.

Dr. R. Balasubramanian was elected Fellow of the Indian Academy of Sciences with effect from 1987.

RESEARCH IN MATHEMATICS

The direct and inverse scattering transforms for a class of differential-difference evolution equations have been investigated and it has been shown that for a generic class of initial potentials, the cauchy problem for these equations can be solved (Bhate).

Generalisation to the infinite-dimensional set up of the earlier work on standard monomial theory associated to semisimple algebraic groups has begun (Seshadri with Lakshmibai).

The theorem on the complements of the squares, first raised by Erdos was improved already in 1985-86 and substantial progress in this problem has been made this year. Stolarsky's problem of finding the point on the curve $\sum_{j=1}^{n} e^{z_j} = 0$ nearest to digagonal has been completely solved for all sufficiently large n. The properties of the sum-sequence of two subsets of integers have been obtained, thereby improving a result of Erdos, Sarkozy and Sos (Balasubramanian).

An O-result for the number of square-full integers has been given, improving a result of Suryanarayana. The problem of Erdos about counting integers such that $nd(n) \leq N$ has been settled completely, thereby proving a conjecture of Erdos in the affirmative. The earlier investigation about how large the value of the Riemann zeta function can become on the critical line was continued (Balasubramanian with Ramachandra).

Hitherto unknown Ω results have been proved for the number of k-full integers less than N (Balasubramanian with Ramachandra and Subbarao).

A partial solution has been given to the Erdos-Wòods conjecture on the existence of two sets of consecutive integers having the same prime factors (Balasubramanian with Shorey and Waldschmidt)

RESEARCH IN THEORETICAL COMPUTER SCIENCE

In continuation of the earlier work (Thiagarajan) a new and elementary formulation of the basic system model of net theory has been obtained. The equivalence of four independent notions of when a nonsequential process enforces a finitary (causal) relationship has been shown. A strong relationship between temporal logic and event structures - which provide an attractive model of distributed systems - has been established.

PUBLICATIONS IN MATHEMATICS

H. BHATE
"Discrete scattering theory"
J.Diff. Eqns. 64(1986) 395

C.S. SESHADRI (with V.LAKSHMIBAI)*
"Theories monomiale standard pour SL_2"
to appear in Comptes-Rendus

C. ADIMOOLAM
"Calabi-Yau manifolds"
to appear in the Proc. National Symposium on Recent Developments in Theoretical Physics, Kottayam, Sept. 1986; World Scientific Pub. Singapore.

Papers in the course of publication

R. BALASUBRAMANIAN
- "A note on a theorem of Erdos, Sarkozy and Sos"
- "On the frequency of Titchmarsh's phenomenon for ζ (s)-VI" (with K. RAMACHANDRA)
- "On squarefull integers" (with K. RAMACHANDRA)
- "An Ω - result for the number of k-full integers" (with K. RAMACHANDRA and M.V. SUBBARAO)
- "On the maximal length of two sequences of consecutive integers with the same prime divisors" (with T.N. SHOREY and M. WALDSCHMIDT)

PUBLICATIONS IN THEORETICAL COMPUTER SCIENCE

P.S. THIAGARAJAN
"Elementary net systems"
to appear in the Proceedings of the Advanced Course on Petri nets, Bad Honnof, W.Germany, 1986 (Springer Lecture Notes in Computer Science)

P.S. THIAGARAJAN (with E. BEST)
"Some Classes of live and safe Petri nets"
to appear in Concurrency and Nets (Eds. K. Voss, H.J. Genrich and G.Rozenberg, Springer-Verlag, 1986)

P.S. THIAGARAJAN (with K. LODAYA)
"A modal logic for a subclass of event structures"
Technical Report DAIMI PB-220, (1987) Computer Science Department, Aarhus University, Aarhus, Denmark.

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* Throughout the Report external collaborators are mentioned as (with.....)

RESEARCH IN PHYSICS

Classical and Quantum Mechanics: Foundations

The case of quasi-invariance in Lagrangian systems has been re-examined because of the great interest in quantum theories possessing anomalies. In those theories in their path integral formulation even when the classical action is invariant the quantum action functional is not invariant due to the measure in path space being noninvariant under the symmetry group. The question of the classical dynamics counterpart of the anomalies has been raised and the answer has been found in the need for central extensions of the symmetry groups of the equations of motion. (Sudarshan with Marmo, Morandi and Simoni)

The problem of inequivalent quantizations of a physical system with multiply connected configuration space X has been investigated. For scalar quantum theory it has been shown that state vectors must be single-valued if and only if the first homology group $H_1(X)$ is trivial, or equivalently the fundamental group $\pi_1(X)$ is perfect. The θ - structure of quantum gauge and gravitational theories has been discussed in the light of this result (Sudarshan with Imbo).

The solution of the Schrodinger equation in the eikonal method involves usually the Froman-Froman - JWKB series expansion Based on quasilinearisation it has been shown that the solution of the Schrodinger equation and the energy eigenvalues can be obtained by solving the relevant Riccati equation by a new technique which converges quadratically. In this new method each iteration contains all the terms of the Froman-Froman series with different coefficients representing the summation of different infinite class of diagrams and consequently the centrifugal potential is modified suitably for each approximation converging fast to the actual value (Vasudevan with Raghunathan).

The Wigner phase-space distribution is a useful tool in the description of systems in quantum mechanics and optics. Gaussian Wigner distributions for arbitrary number of degrees of freedom have been completely characterized (Simon and Sudarshan with Mukunda.) Recently there is much interest in describing quantum measurement processes and dynamical systems in terms of nonnegative phase-space distribution functions obtained by the convolution of Wigner functions. In this context a relevant result has been obtained showing that the convolution of two Wigner distributions does not always lead to another Wigner distribution (Jagannathan, Simon, Sudarshan and Vasudevan).

The problem of defining properly s self-adjoint phase operator conjugate to the number operator is an age old one in quantum mechanics. It has been shown that there exists a solution for this problem in the case of a supersymmetric harmonic oscillator (Santhanam with Raghunathan).

Classical and Quantum Optics

Light beams with Gaussian intensity profile have been shown to have a polarization component along the beam axis and also a cross-polarization component in addition to the principal transverse polarization component. Wolf's new theory of partial coherence has been extended and completed and applied to beam propagation problems (Simon and Sudarshan with Mukunda).

It has been shown that a certain matrix condition is essential to test if a given Mueller matrix of an optical system corresponds to a depolarizing system and this condition degenerates into a scalar condition only in the case of completely positive maps (Simon).

It has been shown that description in terms of the Wigner distribution gives a convenient framework for studying problems of squeezed states of light as in the case of many other optical problems (Simon). 'Logarithmic states' of the radiation field have been introduced and their squeezing and antibunching properties have been studied. These states have been shown to exhibit an asymptotic scaling form (Simon and Satyanarayana).

Quantum Statistical Mechanics

Feynman's influence functional formalism has been used to describe a quantum system weakly coupled to a heatbath and approach to thermal equilibrium of the system has been investigated (Chakrabarti with Carlitz). A quantum oscillator injected into a heatbath of boson or fermion type with non-Markovian features, like memory-dependent damping, has been studied. This leads to a set of coupled dispersion relations for the distribution of the modes of the heatbath. Though it is difficult to get an explicit solution, the KMS periodicity condition for the Green's function in the equilibrium limit has been established apart from other interesting observations on the behaviour of the system (Chakrabarti and Vasudevan).

Condensed Matter Physics

The problem of anomalous phonon dispersion in the long wave length limit in liquid Helium-I has been a puzzling one for the past of fifteen years. Though small in magnitude it leads to qualitatively surprising results. Using sum rule arguments with the assumption that single and two-phonon excitations saturate the sum rules several aspects of the anomalous behaviour have been explained (Sridhar). The same arguments have been shown to explain satisfactorily the temperature dependence of the static structure factor for superfluid ^{4}He. ^{3}He-^{4}He mixtures have been the objects of serious study for more than two decades. The experimental data in this area of research have been insufficient so far. With the advent of the latest results relating to X-ray scattering on these mixtures there is renewed interest in theoretial investigations on this topic. In this context, based on random phase approximation (RPA) an excitation spectrum, identical to the spectrum predicted by the binary boson approximation (BBA) has been obtained. The structure factor has also been obtained from sum-rule arguments. These theoretical results have been quite satisfactory compared to the experimental results (Sridhar and Shanthi).

A new nonlinear evolution equation for the order parameter in superfluid ^{4}He has been derived using a pseudospin model which incorporates hard-cores plus attractive nearest-neighbour interactions. An exact solution is shown to yield a nontrivial spatial dependence of the vorticity. A density wave with a velocity-dependent amplitude, and a static domain wall structure have also been predicted as possible solutions (Radha Balakrishnan, Sridhar and Vasudevan).

The spin evolution equation of an isotropic quantum ferromagnetic Heisenberg chain has been analysed in the continum approximation using spin coherent states.

Magnetic solitary wave solutions have been found. The dispersion relation for these nonlinear excitations has been derived for spin values 11/2, 1 and 3/2. It has been shown that the inclusion of quantum effects splits the single branch semiclassical spectrum into two branches. This result has been physically interpreted and a heuristic discussion of the stability of the excitations has been presented (Radha Balakrishnan, with Bishop and Holyst).

Some representative applications of soliton theory in diverse parts of condensed matter physics have been reviewed with examples including continum models in nonlinear lattice dynamics, magnetism and superfluid ^{4}He (Radha Balakrishnan).

Chaos

In recent years there has been much advancement in understanding the chaotic behaviour of classical and quantum dynamical systems. Starting from a one-dimensional Heisenberg Hamiltonian with an external magnetic field term, a new area preserving map associated with planar spin states has been analytically derived. It has been shown then that the spin profiles display a spatially chaotic behaviour when the magnetic field energy is small as compared to the exchange interaction energy. A continum approximation of the map results in a double-sine Gordon equation (Radha Balakrishnan with Ananthakrishna and Hao Bai-lin).

Nuclear Physics

In an attempt to understand the nature of quark degrees of freedom in nuclei the triton and ^{3}He magnetic moments have been analysed. On this topic there has always been a discrepancy between theory and experiment even after all meson exchange corrections are taken into account. It has been shown now that a small six quark bag component in the wave function can significantly contribute and improve the theoretical value to acceptable levels (Murthy with Bhaduri and Tomusiak).

The socalled 'EMC effect' has been analysed in the context of nuclear shell model and a completely nuclear physics explanation of the effect has been attempted without involving quark structure of nucleons at the outset. It has been shown that to a good approximation conventional nuclear physics explanation does indeed lead to the observed ratio of bound nucleon to free nucleon structure functions (Murthy with Bhaduri and Van Dijk).

QCD sum rules have been studied with the aim of getting numerical values for the weak interaction coupling constants of nucleon. The axial vector coupling constant g_A in nuclear medium has been calculated by relating it to the chiral symmetry breaking correlator and nuclear effective mass in a nuclear medium. The results indicate a quenching of g_A as the medium effects (through effective nucleon mass) are switched on. In nuclear matter it is found $g_A \sim 1$ (Parthasarathy with Pasupathy)

Classical Fields, Quantum Fields and Particle Physics

The change in the phase of the wave function when a particle is transported along a cyclic path in a (4+n) dimensional Kaluza-Klein theory has been computed.

While the result unifies the wellknown nonabelian Aharanov-Bohm effect with its gravitational analogue a new constant phase-shift depending on the n-dimensional manifold is also obtained (Parthasarathy and Rajasekaran with Nagarajan). A compactification scheme has been suggested for (4+n)-dimensional Kaluza-Klein theory using a general non-linear sigma model in the extra manifold and it has been shown that the Kaluza-Klein gauge bosons remain massless after dimensional reduction (Parthasarathy). The problem of simultaneously having vanishing physical cosmological constant and Ricci non-flat internal space has been studied without introducing additional gauge fields in the action. It has been shown that this can be realized using a 'warped product' metric and certain topological properties of 'warp factor' have been studied (Parthasarathy with Nagarajan and Lakshmibala).

A study of the Gribov ambiguity using geometric methods has been undertaken. Following closely Singer's geometric proof of the existence of the Gribov ambiguity in non-Abelian gauge theories, it has been demonstrated that there is Gribov ambiguity in Abelian gauge theory at finite temperature where the appropriate manifold is $S^3 \times S^1$. If the gauge fixing and gauge fields are defined on the full space $S^3 \times S^1$ then there will be Gribov ambiguity. However for the coulomb gauge (not manifestly covariant) where the space is simply S^3, there is no ambiguity in fixing the gauge (Parthasarathy).

The gauge-covariant technique of extracting the operator content of propagators in a background field has been discussed and used to find the operator product expansion of current-current correlators (Chakrabarti). Mechanism of decay of unstable 'vacuum' states to the stable vacuum state at zero temperature in gauge theories has been discussed and semiclassical methods of Langer, Callan and Coleman have been implemented (Ramesh Anishetty).

Renormalizability of ϕ^4 theory and scalar electrodynamics in the framework of stochastic quantization method has been established. Several regularization schemes for stochastic quantization have been suggested and a new proof of equivalence of stochastic quantization to field theories has been given (Chaturvedi with Kapoor and Srinivasan).

The phase-structure of the ferimionic system in a non-abelian sigma model has been studied. A discontinuity (finite or infinite) is found in the specific heat at critical temperature at which symmetry is restored. The effect of introducing quantum fluctuations (leading to temperature-dependent scalar and pseudo-scalar masses) on the specific heat has been studied (Rahul Basu with Biswas, Goyal and Soni).

The critical density above which neutron matter would be in the quark phase has been studied where the proposed equation of state for neutron matter at high densities resulted from a solution of various field equations of a chiral sigma model in the mean field approximation (Rahul Basu with Biswas and Soni).

The conditions for residual supersymmetry in compactified 10-dimensional supergravity theories has been investigated. It is found that compactification to d = 4 Minkowski space would allow only purely metric Ricci flat field configurations with constant wave vector (Hari Dass with De Wit and Smit).

An effective action that accounts for the strong, electro-magnetic and weak interactions of pions and vector mesons has been constructed starting from the QCD generating functional (Hari Dass with Golterman) Witten's nonabelian bosonization has been applied to compute the spectrum of two dimensional multi-flavour QCD in the strong coupling limit. Earlier recipes of 'abelian' bosonization are inadequate to study the strong coupling spectrum for more than two flavours and the present analysis is applicable to the case of arbitrary number of flavours and colours (Date with Frishman and Sonnenschein).

An attractive possibility for a fundamental theory unifying all interactions is to presume a composite structure for quarks and leptons. However to make this viable certain major dilemmas have to be explained for the required dynamics. It has been argued that local supersymmetry with guage interactions resolves some of these dilemmas (Sharatchandra with Pati and Cvetic).

The concept of maximal CP nonconservation as the one that mixes the generation maximally has been studied in detail (Santhanam).

The processes $p\bar{p} \to W\gamma x$ and $e^+e^- \to \gamma + 2$ jets have been studied as possible tests of the quark charges. It has been shown that the radiation zero occuring in the former can be used as a clean and distinctive test while in the latter though the angular distribution can be used it is not a very distinctive test (Rajasekaran and Rindani with Lakshmibala, X. - G.He and Pakvasa).

It has been shown that for a Higgs boson of mass less than about 0.6 TeV transverse polarizations of the W and Z in the vector-vector fusion mechanism for Higgs production make a significant contribution. Including these contributions, the equivalent vector boson approximation is found to overestimate the production cross section (Rindani with Godbole).

Following the earlier proposal of a quark model of hadrons for nonstrange baryons the spectra of odd parity strange baryons has been analysed on the basis of the same model. This model incorporates the deformation of the quark mean field in a self-consistent manner. Such a feature seems necessary from a phenomenological point of view and the proposed model is seen to give a good fit to the spectra of non-strange as well as strange baryons (Murthy with Bhaduri and Tabarah).

It has been shown that a puzzle concerning the susceptibility χ of the proton can be solved if one accounts for the vacuum contribution properly. The usual bag model calculations give a theoretical value for χ which is positive while the experiment indicates that it is zero or even negative. It has been shown that the empty bag contribution is nontrivial and negative, sufficient to cancel the valence quark contribution (Murthy with Bhaduri and Jennings).

Astrophysics and Cosmology

1987 brought excitement in the field of Astrophysics and Cosmology with the revelation of a new supernova. The available experimental data on the detection of neutrinos from the recent supernova 'SN 1987 a' have been analysed for their implications on supernova parameters as well as neutrino masses (Hari Dass, Indumathi, Joshipura and Murthy).

Mathematical Physics

Orbits in the Lie algebras of (pseudo)-orthogonal groups O(m,n) with $(m+n) \leq 5$ have been completely classified (Simon and Sudarshan with Mukunda).

A three-term recurrence relation has been derived for the Racah coefficients or 6j symbols based on a set of orthogonal polynomials, called Racah polynomials, that generalize these coefficients. This relation has been shown to be a consequence of the wellknown Biedenharn-Elliott identity (Srinivasa Rao and Santhanam with Gustafson). It has been shown that the complete set of polynomial zeros of degree one of the Racah coefficient can be obtained only from the eight-parameter solution of the multiplicative Diaphontine equation : $x_1x_2x_3 = U_1U_2U_3$ with the constraint $x_3 = x_1+x_2+U_2+U_3$. All the other parametric solutions available in the literature so far have been shown to be subsets of the complete set obtained by the above method (Srinivasa Rao and Rajeswari).

The formulation of quantum mechanics in a finite-dimensional Hilbert space in analogy with the usual infinite dimensional form of quantum mechanics based on the Heisenberg canonical commutation relation for conjugate observables leads to a matrix representation for the differential operator. This has been used to relate the zeros of special functions to the eigenvalues of certain Jacobi-type matrices associated with generating recurrence relations of the Special functions (Santhanam and Jagannathan).

Prabability and Stochastic Processes

An exact expression for the first passage time distribution for a persistent random walk on a line has been derived (Chaturvedi with Balakrishnan).

A collective risk model with incomes like premiums and interests and random claims that constitute depletions of the capital has been studied. With the upper limit of the reserve restricted, the first passage time probabilities for ruin under different barrier conditions have been obtained. The Laplace transforms of these probabilities have been obtained analytically and solved (Vasudevan with Vittal).

Modifications warranted in the fluctuation-dissipation relations in presence of multiplicative noise in addition to additive noise in a classical Langevin equation have been analysed using the concepts of Ito and Stratanovich Calculii. New results have been obtained for the first and second fluctuation theorems (Vasudevan with Parthasarathy).

PUBLICATIONS IN PHYSICS

R. ANISHETTY
"Vacuum decay in gauge theories"
Helvetica Physica Acta 59 (1986) 1337.

R. BASU (with J.D. ANAND, S.N. BISWAS, A. GOYAL and S.K. SONI)
"Phase structure of the fermionic system in the SU(2) x SU(2) Chiral sigma model"
Phys. Rev. D34 (1986) 2133.

R. CHAKRABARTI
"Short distance propagators in a backround field"
Zeit. fur Physik C34 (1987) 233.

R. CHAKRABARTI (with R.D. CARLITZ)
"The approach to equilibrium of a quantum mechanical system"
Phys. Rev. A35 (1987) 3156.

S. CHATURVEDI (with A.K. KAPOOR and V. SRINIVASAN)
"Regularization schemes for stochastic quantization"
Phys. Rev. D34 (1987) 3846.

G. DATE (with Y. FRISHMAN and J. SONNENSCHEIN)
"The spectrum of multiflavour QCD in two dimensions"
Nucl. Phys. B283 (1987) 365.

G. DATE
"Bosonization in two dimensions and its applications"
Proc. of the TIFR Winter School in Theoretical Physics, Panchagni, 1986
(World scientific Pub., Singapore).

N.D. HARI DASS (with MAARTEN P.L. GOLTERMAN)
"On the QCD effective action for pions and vector mesons"
Nucl. Phys. B277 (1986) 739.

N.D. HARI DASS (with B. DE WIT, and D.J. SMIT)
"Residual supersymmetry of compactified d=10 supergravity",
Nucl. Phys. B283 (1987) 165.

N.D. HARI DASS, D. INDUMATHI, A.S. JOSHIPURA and M.V.N. MURTHY
"On the neutrinos from SNI 1987 a"
Current Science 56 (1987) 575.

R. JAGANNATHAN, R. SIMON, E.C.G. SUDARSHAN and R. VASUDEVAN
"Dynamical maps and nonnegative phase-space distribution functions
in quantum mechanics"
Phys. Lett. A120 (1987) 161.

M.V.N. MURTHY (with R.K. BHADURI and E. TABARAH)
"Odd parity spectra of strange baryons in the deformed model"
Z.Phys. C (Particles and fields) 31 (1986) 81.

M.V.N. MURTHY (with R.K. BHADURI and B.K. JENNINGS)
"The vacuum contribution to proton polarizability"
Nucl. Phys. A454 (1986) 629.

M.V.N. MURTHY (with R.K. BHADURI and E.S. THOMUSIAK)
"Six quark bags, exchange currents and trinucleon magnetic moment"
Phys. Lett. B173 (1986) 369.

M.V.N. MURTHY (with R.K. BHADURI and B.K. JENNINGS)
"The vacuum contribution to proton magnetic polarizability"
Current Trends in Physics (Eds. A. Khare and T. Pradhan)
World Scientific Pub. Singapore, p.157.

M.V.N. MURTHY (with R.K. BHADURI and W. VAN DIJK)
"The EMC effect and its explanation in the context of nuclear shell model"
Current Trends in Physics (Eds. A. Khare and T. Pradhan)
World Scientific Pub., Singapore, p.130.

R. PARTHASARATHY
"On space-time compactification induced by a general nonlinear sigma model"
Phys. Lett. B181 (1986) 91.

G. RAJASEKARAN (with S. LAKSHMIBALA, X. - G. HE and S. PAKVASA)

"$\bar{p}p \to W\gamma x$ as a test of the quark charges"
Mod. Phys. Lett. A1 (1986) 277.

G. RAJASEKARAN and S.D. RINDANI (with X. - G.HE and S. PAKVASA)

"$e^+e^- \to \gamma$ + 2 jets as a test of quark charges"
Phys. Lett. B185 (1987) 158.

T.S. SANTHANAM (with K. RAGHUNATHAN)
"Supersymmetric oscillator and the phase problem"
Phys. Rev. D33 (1986) 3790.

H.S. SHARATCHANDRA (with J.C. PATI and M. CVETIC)
"Towards a resolution of certain dilemmas in preon dynamics through local supersymmetry"
Phys. Rev. Lett. 58 (1987) 851.

R. SIMON
"Squeezed states and quadratic Hamiltonians: A Wigner distribution approach"
in Symmetries in Science II (Eds. B. Gruber and R. Lenczewski)
Plenum Pub., New York, 1986.

R. SIMON and E.C.G. SUDARSHAN (with N. MUKUNDA)
"Gaussian Maxwell beams"
J. Opt. Soc. America A3 (1986) 536.

R. SIMON and E.C.G. SUDARSHAN (with N. MUKUNDA)
"Cross Polarization in laser beams"
Appl. Optics 26 (1987) 1589.

R. SRIDHAR and A. SHANTHI
"Temperature dependence of the structure factor of liquid ^{4}He"
Physica A137 (1986) 337.

R. SRIDHAR
"Anomalous phonon dispersion in Helium-II"
Phys. Rep. 146 (1987) 259.

R. SRIDHAR and A. SHANTHI
"Structure factor of ^{3}He - ^{4}He mixtures"
Proc. of the DAE Symposium on Solid State Physics 29C (1986) 37.

R. SRIDHAR and A. SHANTHI
"On the hybridization of single and two-particle spectra in Superfluid Helium-4"
Proc. of the DAE Symposium on Solid State Physics 29C (1986) 38.

R. SRIDHAR
"Superfluidity in outer space"
in Proc. of the Seminar on the Exploration of Space held at Meenakshi College, Madras, Feb. 1987.

K. SRINIVASA RAO and V. RAJESWARI
"An algorithm to generate the polynomial zeros of degree one of the Racah Coefficient"
J. Phys. A (Math and General) 20 (1987) 507.

K. SRINIVASA RAO
"Parallelism in Computer Science"
Proc. of the Workshop on Mathematics of Computer Algorithms,
Institute of Mathematical Sciences, 1986 : I M.Sc. Report No. 111 (1986) E1.

E.C.G. SUDARSHAN
"Light and group theory"
in Symmetries in Science-II (Eds. B. Gruber and R. Lenczewski)
Plenum Pub., New York, 1986.

E.C.G. SUDARSHAN
"Three perspectives on light"
in progress in Quantum Field Theory (Eds. H. Ezawa and S. Kamefuchi)
Elsevier Science Pub., 1986.

E.C.G. SUDARSHAN (with N. MUKUNDA)
"The three faces of Maxwell's equations"
Pramana, 27 (1986) 1.

R. VASUDEVAN (with K. RAGHUNATHAN)
"JWKB method and quasilinearization"
J. Phys. A (Math. and General) 20 (1987) 839.

RADHA BALAKRISHNAN, R. SRIDHAR and R. VASUDEVAN
"Vortices and nonlinear waves in Superfluid Helium-4"
Proc. of the DAE Symposium on Solid State Phys. 29C (1986) 138.

S. CHATURVEDI (with A.K. KAPOOR AND V. SRINIVASAN)
"Equivalence of Stochastic quantisation to field theories from supersymmetry"
to appear in Pramana (1987)

S. CHATURVEDI (with A.K. KAPOOR and V. SRINIVASAN)
"Renormalization of stochastically quantized field theories"
to appear in Internat. J. Mod. Phys. A (1987).

S. CHATURVEDI
"Some theoretical aspects of quantum Hall effect"
to appear in the Proc. of the DAE Symposium on Solid State Physics,
(1986) invited talks volume.

N.D. HARI DASS
"On the interrelationship between, concepts in Elementary Particle Physics and Statistical Mechanics"
to appear in the Proc. of the National Symposium on Recent Developments in Theoretical Physics (George Sudarshan Centre for Physics and Computer Science, Kottayam, 1986); World Scientific Pub., Singapore.

N.D. HARI DASS
"Lattice gauge theories"
to appear in the Proc. of the VIII High Energy Physics Symposium, Calcutta, 1986.

N.D. HARI DASS
"Three lectures on Cosmology"
to appear in the Proc. of the UGC Instructional Conference on Gravitation, Quantum Fields and Superstrings, (I.I.T. Madras) 1986.

R. PARTHASARATHY
"QCD vacuum-bag constant"
to appear in the Proc. International Symposium on Perspectives in Nuclear Physics, Madras, 1987.

R. PARTHASARATHY and G. RAJASEKARAN (with R. NAGARAJAN)
"Quantum interference effects in a generalized (4+n) dimensional Kaluza-Klein theory"
to appear in Classical and Quantum Gravity.

RADHA BALAKRISHNAN (with G. ANANTHAKRISHNA and HAO BAI-LIN)
"Spatially chaotic spin patterns in a field-perturbed Heisenberg chain"
to appear in Phys. Lett. A.

RADHA BALAKRISHNAN
"Solitons: Some applications in condensed matter physics"
to appear in the Proc. of the DAE Symposium on Solid State Physics, (1986), Invited Talks Volume.

S.D. RINDANI (with R.M. GODBOLE)
"Intermediate-mass Higgs boson production and the equivalent vector boson approximation"
to appear in Phys. Lett. B.

K. SRINIVASA RAO and T.S. SANTHANAM (with R.A. GUSTAFSON)
"Racah polynomials and a three term recurrence relation for the Racah coefficients"
to appear in J. Physics. A (Math. and General).

R. SIMON
"Mueller matrices and depolarization criteria"
to appear in J. Mod. Optics.

R. SIMON
"Generalized light rays: Ray dispersion, dark rays and statistical inhomogeneity"
to appear in Optics communications.

R. SIMON
"Laser cavities bounded by crossed cylindrical mirrors"
to appear in J. Opt. Soc. America A.

R. SIMON and E.C.G. SUDARSHAN (with N. MUKUNDA)
"Gaussian Wigner distributions in quantum mechanics and Optics"
to appear in Phys. Rev. A.

R. VASUDEVAN (with K.V. PARATHASARATHY)
"Fluctuation dissipation relations in the presence of multiplicative noise"
to appear in Transport Theory and Stat. Phys. (USA).

R. VASUDEVAN (with P.R. VITTAL)
"Some first passage time problems with restricted reserve and two components of income"
to appear in Scandinavian Actuarial Journal: SCANDIA (Sweden)

G. RAJASEKARAN (with S.F. TUAN)
"Superstrings: Another view"
Physics Today, March 1987, p.15 (Letter to the Editor)

K. SRINIVASA RAO

- "The contemporary computer scene"
  Math. Education 3 (1986) 5.
- "The fifth generation computer"
  The Vedic Path XLIX (1986) 44.
- "Micro computers"
  Malayala Manorama - 1987 Year Book, p.187.

BOOK

R. BELLMAN and R. VASUDEVAN
"Wave Propagation and Invariant Imbedding"
D. Reidel Pub. Co., the Netherlands, 1986 (362 pages)

(This book of twelve chapters treats comprehensively the philosophy and methodology of invariant imbeding methods and dynamic programming techniques applied to solve differential equations with different types of boundary conditions. It deals with different types of eikonal equations, Bremmer series type solutions, ideas of finite ordering scattering, reflection and transmission functions, successive diagonalisation methods, operator techniques, quasi-linearization practical problems, linear and nonlinear, solvable by dynamic programming approach, variational principles, spline methods, differential quadrature techniques etc. to arrive at approximations which yield best numerical solutions to numerical questions).

Papers in the course of publication and preprints

R. BASU (with S.N. BISWAS and S.K. SONI)
"Neutron quark phase transition in a chiral sigma model"
(submitted for publication)

R. CHAKRABARTI and R. VASUDEVAN
"Quantum Langevin equation for a harmonic oscillator with a memory dependent damping"
(Submitted for publication)

S. CHATURVEDI (with V. BALAKRISHNAN)
"On a persistent random walk"
(submitted for publication)

R. PARTHASARATHY
"On the Gribov ambiguity in Abelian field theory at finite temperature"
(submitted for publication)

R. PARTHASARATHY (with J. PASUPATHY)
"On the quenching of g_A in nuclear medium"
(submitted for publication)

R. PARTHASARATHY (with R. NAGARAJAN and S. LAKSHMIBALA)
"On the cosmological constant problem in Kaluza-Klein Theory"
(submitted for publication)

RADHA BALAKRISHNAN, R. SRIDHAR and R. VASUDEVAN
"Nonlinear dynamics in superfluid ^{4}He"
(submitted for publication)

RADHA BALAKRISHNAN (with A.R. BISHOP)
"Nonlinear dynamics of a quantum ferromagnetic chain: Spin coherent state approach"
(submitted for publication)

RADHA BALAKRISHNAN (with J. HOLYST and A.R. BISHOP)
"Dispersion relation of pulse solitons in an anisotropic quantum Heisenberg ferromagnetic chain"
(submitted for publication)

R. SIMON and E.C.G. SUDARSHAN (with N. MUKUNDA)
"On the orbits in the Lie algebras of some (pseudo) - orthogonal groups"
(submitted for publication)

R. SIMON and E.C.G. SUDARSHAN (with MUKUNDA)
"Gaussian Wigner distribution: A complete characterization"
(submitted for publication)

R. SIMON and M. VENKATA SATYANARAYANA
"Logarithmic states of the radiation field"
(submitted for publication)

R. SIMON and E.C.G. SUDARSHAN (with N. MUKUNDA)
"Gaussian pure states in quantum mechanics and the symplectic group"
(submitted for publication)

E.C.G. SUDARSHAN and R. SIMON (with N. MUKUNDA)
"Families of Bose rays in quantum optics"
(submitted for publication)

K. SRINIVASA RAO and V. RAJESWARI
"Solution of Diophantine equations and polynomial zeros of degree one of the Racah coefficient"
(submitted for publication)

E.C.G. SUDARSHAN and R. SIMON (with N. MUKUNDA)
"Wolf's new theory of partial coherence in the space-frequency domain: Application to beam propagation problems"
(submitted for publication)

E.C.G. SUDARSHAN (with TOM IMBO)
"Quantization and perfect spaces"
(submitted for publication)

E.C.G. SUDARSHAN (with G. MARMO, G. MORANDI and A. SIMONI)
"Quasi-invariance and central extensions"
(submitted for publication)

G. RAJASEKARAN
"Perspectives in High Energy Physics"
I.M.Sc. Preprint - TP/87/004.

G. RAJASEKARAN
"Building up the standard gauge model of High Energy Physics"
I.M.Sc. Preprint - TP/87/005.

S.D. RINDANI (with R.M. GODBOLE)
"The equivalent vector boson approximation for intermediate mass Higgs boson production"
University of Dortmund Preprint.

T.S. SANTHANAM and R. JAGANNATHAN
"Finite-dimensional matrix representation of the differential operator, determinental-form and zeros of special functions"
ICTP-Trieste Preprint-IC/86/379.

T.S. SANTHANAM
"The concept of maximal CP nonconservation for arbitrary number of generations"
University of Bonn Preprint.

H.S. SHARATCHANDRA (with M. CVETIC and J.C. PATI)
"Meeting certain constraints of preonic theories within local supersymmetry"
ICTP-Trieste Preprint-IC/86/179.

COURSES FOR Ph.D. STUDENTS

PHYSICS

The course-work for Ph.D. students in Physics in the first two years consists of three levels: Level A: Foundation Courses-I year 1st Semester. Level B: Advanced courses - I year, 2nd Semester. Level C: Specialised Topics - II year. During 1986-87 the programme of courses were as follows :

Level A Classical mechanics (Dr. R. Jagannathan and Prof. E.C.G. Sudarshan)
Classicial theory of fields (Dr. R. Anishetty and Dr. R. Simon)
Mathematical Physics (Dr. S.D. Rindani and Dr. H.S. Sharatchandra)

Level B Quantum field theory (Dr. R. Parthasarathy and Prof. G. Rajasekaran)
Nuclear and Particle Physics (Dr. A.S. Joshipura and Dr. M.V.N. Murthy)
Condensed Matter Physics (Dr. H.S. Sharatchandra and Dr. R. Sridhar)
Computer programming and numerical methods (Dr. K. Srinivasa Rao)

Level C Differential geometry (Prof. N.D. Hari Dass)
Deep inelastic scatting of leptons on hadrons:
(a) Phenomenology (Dr. M.V.N. Murthy)
(b) Application of renormalization methods (Dr. G. Date)

Ph.D. Theses submitted during 1986-87

A. Shanthi, "Study of two-particle excitations in Super-fluid Helium-4", submitted to the University of Madras under the guidance of Dr. R. Sridhar.

M. Venkata Satyanarayana, "Some studies in coherent states and squeezed coherent states", submitted to the University of Madras under the guidance of Prof. T.S. Santhanam.

MATHEMATICS

Extensive courses of lectures were given for the benefit of Ph.D. students in Mathematics both by the Academic Members of the Institute and the Visitors. The list of courses is as follows :

'Class Field Theory' - Dr. R. Balasubramanian
'Functional Analysis' - Dr. H. Bhate
'Measure Theory' - Dr. P. Muthuramalingam
'Algebraic Curves', 'Representation Theory' - Prof. C.S. Seshadri
'Number Theory and Cryptography' - Prof. N.I. Koeblitz (University of Washington, USA)
'Hodge Classes on Abelian Varieties' - Prof. Madhav Nori (T.I.F.R. Bombay)
'Introduction to Teichmüller Theory' - Dr. S.Nag (I.S.I., Calcutta)
'Tate's Thesis' - Dr. M. Ram Murthy (McGill University, Canada)
'Representation of Lie Algebras and Algebraic Groups' - Dr. V. Lakshmi Bai (Texas A and M University, USA)
'Large Deviations' - Prof. S.R.S. Varadan (Courant Institute, New York, USA)
'Algebraic K-Theory' - Prof. K. Varadarajan (University of Calgary, Canada)
'Finite Groups' - Prof. J.G. Thompson (Cambridge University, England)

LECTURES OUTSIDE THE INSTITUTE, PARTICIPATION IN CONFERENCES AND VISITS TO OTHER INSTITUTIONS BY THE ACADEMIC STAFF

Erratum

Level A: Classical mechanics (Dr.R.Jagannathan and Prof.E.C.G. Sudarshan)

Classical theory of fields (Dr.S.Chaturvedi and Dr.R.Sridhar)

Quantum mechanics (Dr.R.Anishetty and Dr.R.Simon)

Mathematical physics (Dr.S.D.Rindani and Dr.H.S.Sharatchandra)

Dr. R. BALASUBRAMANIAN

- gave lectures in Number Theory, in particular on Waring's problem, at Ramanujam Institute (4 lectures); Indian Institute of Technology, Madras (3 lectures); Madras Christian College, Tambaram; Voorhese College, Vellore; Indira Gandhi Centre for Atomic Research, Kalpakkam.
- gave a lecture at Ramanujan Institute on the eve of the Ramanujan Birth Centenary Celebrations.
- conducted a quiz programme in Mathematics in Madras Christian College, Tambaram.

Dr. RAHUL BASU

- Participated in the International Conference on "Changing Faces of the Physics Particles and Nuclei" held at Banaras Hindu University, Varanasi, in January 1987.

Dr. S. CHATURVEDI

- gave an invited talk on 'Quantum Hall Effect' at the Annual DAE Symbosium on Solid State Physics held at Pantnagar in December 1986.

Dr. G. DATE

- participated in the UGC Instructional Conference on "Gravitation, Quantum Fields and Superstrings" held at Indian Institute of Technology, Madras, in December 1986, as an instructor in the Tutorial sessions.
- attended the International Workshop on "Superstrings, Compositeness and Cosmology" conducted at the University of Maryland, College Park, Maryland, USA in March 1987.
- gave a Theoretical Physics Seminar at Tata Institute of Fundamental Research, Bombay, in April 1987 discussing a minimal string field theory action for the Ramond sector of the Spinning string.

Prof. N.D. HARI DASS

- gave a talk on the 'Interrelationship between concepts in elementary Particle Physics and Statistical Mechanics' at the National Symposium held at George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam, in September 1986.
- gave invted talk, on 'Lattice gauge theories' in the VIII High Energy Physics Symposium held at Saha Institute of Nuclear Physics, Calcutta in November 1986.
- participated in the Workshop on Superstrings held at Saha Institute of Nuclear Physics, Calcutta, in November 1986.
- gave a series of lectures on Cosmology in the UGC Instructional Conference on "Gravitation, Quantum Fields and Superstrings" held at Indian Institute of Technology, Madras, in December 1986.
- lectured in the South Zone Winter School on General Relativity and Cosmology conducted by the UGC at the Regional College of Education, Mysore, in December 1986.

Dr. R. JAGANNATHAN

- gave an invited talk entitled 'Nonnegative phase-space distribution functions in quantum mechanics' in the International Symposium on Theoretical Physics conducted by the Calcutta Mathematical Society dedicated to the memory of Professor P.A.M. Dirac in January 1987 at Calcutta.

Dr. A.S. JOSHIPURA

- participated in the VIII High Energy Physics Symposium held at Calcutta in November 1986.
- gave an invited talk on 'Alternative to Calabi-Yau compactification' in the Workshop on Superstrings held at Saha Institute of Nuclear Physics, Calcutta, in November, 1986.

Dr. K.H. MARIWALLA

- gave an invited talk entitled 'Epistemological basis of mechanics of particles and fields' in the International Symposium on Theoretical Physics Conducted by the Calcutta Mathematical Society dedicated to the memory of Professor P.A.M. Dirac in January 1987 at Calcutta.
- participated in the First National Seminar on History and Philosophy of Science held at Amritsar, Punjab, during 2-4, March 1987 and gave two talks entitled 'Trends of thought in modern physics since Newton: an epistemological Analysis' and 'Socio-cultural problems in the development of science in India'.

Dr. M.V.N. MURTHY

- gave an invited talk on 'EMC Effect' in the VIII High Energy Physics Symposium held at Saha Institute of Nuclear Physics, Calcutta, in November 1986.
- gave an invited talk on 'Quark degrees of freedom in Nuclei' in the International Conference on "Changing Faces of the Physics of Particles and Nuclei" held at Banaras Hindu University in January 1987.

- gave an invited talk on 'EMC Effect' in the International Symposium on "Perspectives in Nuclear Physics" held at the Department of Nuclear Physics, University of Madras, in January, 1987.
- gave a seminar on 'EMC Effect' in the Department of Theoretical Physics, University of Madras, in July 1986.

Dr. R. PARTHASARATHY

- gave an invited talk on 'QCD vacuum, nontriviality, bag model: field theory viewpoint' in the International Symposium on "perspectives in Nuclear Physics" held at the Department of Nuclear Physics, University of Madras, in January, 1987 and Chaired one session of the Symposium.

Dr. RADHA BALAKRISHNAN

- participated in the Spring College on "Order and Chaos in Condensed Matter Physics" held at the International Centre for Theoretical Physics, Trieste, Italy during April-June, 1986 and was the group-leader for research activity on 'Integrable Systems: Solitons'. Also gave a formal seminar entitled 'Nonlinear excitations in a quantum ferromagnetic chain'.
- gave an invited talk on 'Solitons: Some applications in condensed matter physics' in the Annual DAE Symposium on Solid State Physics held at Pant Nagar in December 1986.
- participated in the International conference on 'Valence Fluctuations' held at Indian Institute of Science, Bangalore, in January 1987.
- taught an M.Sc. Course on 'Electromagnetic theory' at the Department of Theoretical Physics, University of Madrs during Aug. '86 - March '87.

Prof. G. RAJASEKARAN

- was a Visiting Scientist at the Institute of Theoretical Sciences, University of Oregon, Eugene, USA for a month (April '86) and Department of Physics and Astronomy, Hawaii University, Honolulu, USA for a month (May '86) and did Collaborative research with the scientists at these two institutions.
- gave an invited talk on 'Perspectives in High Energy Physics' in the VIII High Energy Physics Symposium held at Saha Institute of Nuclear Physics, Calcutta, in November 1986.
- participated in the Workshop on Superstrings held at Saha Institute of Nuclear Physics, Calcutta, in November 1986.
- gave an invited talk on 'Superstrings' in the International Conference on "Changing Faces of the Physics of Particles and Nuclei" held at Banaras Hindu University, Varanasi, in December 1986.
- gave a series of lectures on 'Superstrings' in the UGC Instructional Conference on "Gravitation, Quantum Fields and Superstrings" held at Indian Institute of Technology, Madras, in December 1986.
- participated in the International Symposium on "Perspectives in Nuclear Physics" held at the Department of Nuclear Physics, University of Madras in January 1987.

- participated in the 52nd Anniversary General Meeting of the Indian National Science Academy at Bangalore in January 1987.

Dr. S.D. RINDANI

- participated in the International Conference on "Changing Faces of the Physics of Particles and Nuclei" held at Banaras Hindu University, Varanasi, in December 1986.

Dr. T.S. SANTHANAM

- was invited to visit Tata Institute of Fundamental Research, Bombay for a month (Aug. '86) and delivered two lectures there.
- visited Europe for three months (Dec. '86 - Feb. '87) as a Visiting Scientist at the International Centre for Theoretical Physics, Trieste, Italy and CERN, Geneva and as a Guest Professor at the Physikalisches Institute of Bonn University, West Germany and Arnold Sommerfeld Institute of Mathematical Physics, Clausthal - Zellerfeld, West Germany. Visited DESY in Hamburg, West Germany. Also gave lectures at Padua, Italy and Marburg, West Germany.

Dr. H.S. SHARATCHANDRA

- participated in the XXIII International Conference on High Energy Physics, held at Berkeley, California, USA in July 1986 as an Institute delegate.
- participated in the Summer Workshop on "High Energy Physics and Cosmology" at the International Centre for Theoretical Physics, Trieste, Italy during June-August 1986.

Dr. R. SIMON

- gave a talk 'Wigner distributions in quantum optics' in the National Symposium on "Recent Developments in Theoretical Physics" held at George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam, in September 1986.

Dr. R. SRIDHAR

- participated in the Annual DAE symposium on Solid State Physics held at Pant Nagar in December 1986 and read a paper on ^{3}He - ^{4}He mixtures and hybridization of single and two-phonon excitations in superfluid ^{4}He'.
- gave a talk on 'Spin-polarized Hydrogen' in the National Symposium on "Recent Developments in Theoretical Physics" held at George Sudarshan Centre for Physics and Computer Sciences, C.M.S. College, Kottayam, in September 1986.

Dr. K. SRINIVASA RAO

- participated in the workshop on "Mathematics of Computer Algorithms" held at the Institute in May 1986.
- participated in the National Symposium on "Recent Developments in Theoretical Physics" held at George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam, in September 1986.

- gave an invited talk and chaired a session in the International Symposium on "Perspectives in Nuclear Physics" held at the Department of Nuclear Physics, University of Madras in January, 1987.
- participated in the International Symposium on "Towards the Fifth Generation Computer Systems" held at Adayar Park Hotel, in February 1987.
- participated and gave some lectures in the "Meet the Scientist" programme of the Department of Science and Technology, in which Prof. E.C.G. Sudarshan was met by a select group of M.Sc. students, for one week in June 1986, at George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam.
- was a Visiting Scientist at the Centre for Theoretical Studies of the Indian Institute of Science, Bangalore, during August 1986 and gave a seminar on his recent research work on quantum theory of angular momentum.
- visited George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam and delivered courses of lectures on BASIC language and on operating systems for microcomputers.
- gave the 'Srinivase Ramanujan Memorial Lecture' at Sri Vidya Higher Secondary School, Hyderabad, in March 1987.
- delivered a course of ten lectures on low energy nucleon-nucleon interaction and related topics in March 1987 at the University of Science and Technology, Cochin, as a member of the Guest Faculty.
- gave two special lectures on 'Parallel processing and Fast Fourier transform 'at the Department of Mathematics, Madras Institute of Technology, Anna University, in October, 1986.
- also gave lectures at the Hindu Senior Secondary School, Madras (June, Dec. '86), Holy Gross College, Nagercoil (April '86) and Bharathiyar College for Women, Madras (Jan. '87).

Prof. E.C.G. SUDARSHAN

- gave the Inaugural Address in the conference on "Theoretical Quantum Chemistry" held at Chandigarh in November 1986.
- gave the Inaugural Address in the conference on "Nonlinear Dynamics" held at Tiruchirapalli in January 1987.
- gave invited talk in the 'National Symposium on Recent Developments in Theoretical Physics' held at the C.M.S. College, Kottayam, in September 1986.
- gave invited talk in the "Seminar on Quantum Electronics" held at Cochin University in December 1986.
- gave two colloquia at the International Centre for Theoretical Physics, Trieste, Italy and one at the Rice University, Houston, Texas, USA.

Dr. P.S. THIAGARAJAN

- visited Cambridge University in August, 1986 and gave a talk on 'Event Structures, Transition Systems and Trace Languages'.

- gave a course of lectures entitled 'Introduction to Elementary Net Systems' at the Advanced Course on Petri Nets, Bad Honnof, West Germany, in September 1986.
- visited I.I.T. Kanpur for two weeks in February 1987 and gave a series of six lectures under the title: Lectures on Net Theory.

Prof. R. VASUDEVAN

- visited the centre for Theoretical Studies of the Indian Institute of Science, Bangalore on invitation to discuss his research on neural network and memory organisation in March 1987.

Miss. V. RAJESWARI

- attended the International Conference on "Perspectives in Nuclear Physics" held at the Department of Nuclear Physics, University of Madras.

CONFERENCES CONDUCTED BY THE INSTITUTE

A workshop on "Mathematics of Computer Algorithms' was held at the Institute during May 7th to 15th, 1986 with Dr. K. Srinivasa Rao as the Convener. The workshop was attended by about thirty participants from Madras and an equal number rom Institutions outside Madras. The resource persons for the lectures were from the Institute, Indian Institute of Science (Bangalore), Indian Institute of Technology (Madras), Christian College (Madras), Anna University (Madras) and the Joint Cipher Bureau (New Delhi). The lectures at the Workshop covered the following topics: Algebraic and Analytic Number Theory, Algorithmic Combinatorics, Graph Theory and Algorithms, Analysis of Algorithms, Complexity Theory, Parallelism in Computer Science, Theory and Practice of Computer Science, Multiplex Algorithm, Distributed Algorithms for Graph Problems and Mathematical Reasoning vs. Computer Algorithms. The Proceedings of the workshop edited by Dr. Srinivasa Rao has been brought out as I.M.Sc. Report No. 111 (1986).

The National Symposium on "Recent Developments in Theoretical Physics" cosponsored by the Institute and George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam, was held at Kottayam during Sept. 15-19, 1986. This Symposium was funded mainly by the Department of Science and Technology and the Department of Atomic Energy. This symposium brought together about 40 participants including specialists from the Institute, Indian Institute of Science (Bangalore), Indian Institutes of Technology (Madras, Kanpur), Raman Research Centre (Bangalore), University of Cochin, University of Madras and some young scientists from various Universitites and Research Institutes. Dr. K. Srinivasa Rao and Dr. R. Sridhar of the Institute were the Secretaries for the conduct of this Symposium. Proceedings f the Symposium edited by Prof. E.C.G. Sudarshan, Dr. K. Srinivasa Rao and Dr. R. Sridhar is to be published by the World Scientific Pub. Co., Singapore.

The Institute organized the UGC Instructional Conference on 'Gravitation, Quantum Fields and Superstrings' during December 4-24, 1986 in collaboration with the University of Madras. The venue of the Conference was I.I.T. Madras. Prof. G. Rajasekaran of the Institute and Prof. P.M. Mathews of the Department of Theoretical Physics, University of Madras were the organisers of the conference. At the conference main courses of lectures were delivered by about twenty principal lecturers from various Research Institutions covering the following topics: Structure formation in the Universe, Black holes and singularities, Quantum field theory methods, Superstrings, Supersymmetry and Supergravity, Group theory. Besides these lecture courses there were also workshop sessions. About fifty participants from various Universities and Research Institutes of India attended the conference.

The Institute organised a Refresher School in Mathematics during 2nd to 13th January, 1987, in Madras, for the benefit of college teachers in the southern region handling post-graduate courses in Mathematics. This refresher School organised by Prof. K.R. Unni of the Institute aimed at encouraging Continuing Education and Research Program in Mathematics by the college teachers. Selected topics in Algebra and Analysis were covered by the principal lecturers: Prof. S.Janakiraman (Madurai Kamaraj University, Madurai). Prof. Iqbal Unnisa (Ramanujan Institute, Madras) Prof. V. Kannan (University of Hyderabad, Hyderabad) and Prof. K.R. Unni (I.M.Sc.). About sixty teachers from various colleges in the Southern region participated in this CERPIM Refresher School.

VISITORS

R. Rajaraman, C.T.S. Indian Institute of Science, Bangalore (18.4.86) 'Consistency of Gauge theories in the presence of Anomalies'*

A.G. Dani, School of Mathematics, Tata Institute of Fundamental Research, Bombay, (15th and 24th April 1986) 'Ergodic Theory on Homogeneous Spaces'

Adimurthy, Tata Institute of Fundamental Research, Bombay (14.4.86 to 19.4.86) 'Tate's Thesis', 'Riemannian Surfaces'

M. Ram Murthy, Mathematics Department. McGill University, Montreal, Canada (16.4.86 to 25.5.86) 'Modular forms and Artin L-Series'.

M.K. Vijayakumar, Research Scholar, Madurai Kamaraj University, Madurai (1.4.86 to 30.6.86) (Mathematics).

Subhashis Nag, Indian Statistical Institute, Calcutta (20.5.86 to 15.6.86) 'Introduction to Riemann Surfaces'.

A.F. Treves, Mathematics Department Rutgers University, N.J., USA (12-15, June 1986) 'Hypoanalyticity'.

P.K. Mitter, Universite Pierre et Marie, Paris, France (26.5.86 to 6.6.86) 'The Wilson Renormalization Group and Renormalization Theory'.

Remy Y. Dennis, Gorakhpur University, Gorakhpur (6-20, June 1986) 'Hypergeometric functions and their applications'.

P. Mitra, Saha Institute of Nuclear Physics, Calcutta 13.6.86 to 20.6.86) 1. 'Geometric Approach to Lattice Fermions. 2. Consistent Chiral Anomaly.

M.S. Raghunathan, School of Mathematics, Tata Institute of Fundamental Research, Bombay (9.7.86) 'Topology of Compact Lie groups'.

N.R. Nandakumar, University of Nebraska, Omaha (15.7.86) 'Polynomial Preconditioning of Symmetric Indefinite Systems.'

V.S. Krishnan, Mathematics Department, Temple University, USA (21.7.86) 'Category Theory'.

C. Musili, Mathematics Department, Hyderabad University, Hyderabad (23.7.86 to 25.7.86) 'on the Frobenius Splittings of 'G/Q'.

Shrawan Kumar, School of Mathematics, Tata Institute of Fundamental Research, Bombay (4-8), August 1986) 'Basic Representation theory of Kac-Moody Lie Algebras and Generalizations of the Weyl character formula'

J. Pasupathy, C.T.S. Indian Institute of Science, Bangalore (12th and 13th August 1986) 'QCD Sum Rules'.

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* Subject of seminar/colloquium/informal discussion

V. Lakshmi Bai, A and M. Texas University, Texas, USA (10th June to 20th August 1986) 'Flag varieties and the Borel-Weil Theorems'

A.P. Balachandran, Syracuse University, Syracuse, USA (I.16 Dec. to 2nd Jan. 1986, II. 30th June to 14th Aug. 1986) 'Strings'.

R. Srinivasa Raghavan, AT and T Bell Lab., USA (19.9.86) 'A new approach for observing Solar Neutrinos'.

S.R.S. Varadhan, Courant Institute of Mathematical Sciences, New York University, New York, USA (4th July to 31st Aug. 1986) 'Large Deviations theory'

K. Varadarajan (NBHM Visiting Professor) Mathematics Department, University of Calgary, Alberta, Canada (Sep-Oct. 1986) 'Algebraic K-Theory'.

Siddharta Sahi, Institute for Advanced Study, Princeton, USA, (7th July to 15th Aug. 1986) 1. 'Spherical Unitary Representation of General Linear Groups', 2. 'Adduced Representations of General Linear Groups'.

V. Srinivasan, School of Physics, University of Hyderabad (8.10.86 to 14.10.86) 'Quantum Hall effect'.

V. Gupta, Theoretical Physics Section, T.I.F.R., Bombay (3.10.86 to 30.10.86) 'A new perturbative approach to field theory and its application to QCD'.

Bhaskara Datta, Indian Institute of Astrophysics, Bangalore (20.10.86 to 22.10.86) 'Fast Pulsars, some new Theoretical Results'.

D. Sengupta, National Institute of Oceanography, Goa, (3.11.86) 'Oceanography on the Slow time scale'.

Sandip Pakvasa, University of Hawaii, Honolulu, Hawaii, USA (8.11.86) 'Standard Model and Beyond'

R. Niranjan, Bangalore (19.11.86) 'Language Translations using Computers'.

P.P. Divakaran, T.I.F.R., Bombay (18.11.86 to 30.11.86) 'The structure of State Space and Central Extensions of Symmetry Groups'.

V. Ptak, Chairman, Department of Functional Analysis, Academy of Sciences, Prague, Czechoslavakia (28.11.86) 'Hermitian Star Algebras'.

R. Sawyer, Department of Physics, University of California, USA (2.12.86 to 9.12.86).

M.D. Srinivas, Department of Theoretical Physics, University of Madras, Madras (3.12.86) 'An Introduction to Indian Logic'.

Arnab Rai Choudhury, National Centre for Atmosphereic Research, USA (5.12.86) 'The Origin of Astronomical Magnetic Fields'.

J.G. Thompson, Department of Mathematics, University of Florida, Gainsville, Florida USA (10.12.86 to 4.1.87) 'Theory of Finite Groups'.

R. Rajaraman, Indian Institute of Science, Bangalore (11.12.86) 'On Anomalous Abelian theories in 4 Dimensions'.

N.S. Narasimha Sastry, Indian Statistical Institute, Calcutta (11.12.86 to 23.12.86, 29.12.86 to 18.1.87) (Mathematics)

Max Albert Knus, Zurich, Switzerland (15.12.86) 'Composition of Quarternary forms'.

B. Dewitt, University of Texas, Austin, USA (19.12.86) 'Foundations of Quantum Mechanics'.

Mahesh Nerurkar, Department of Mathematics, Ohio State University, Ohio, USA (23.12.86 to 26.12.86) 'Ergodic Theory and Combinational Number Theory'.

Gadadhar Misra, Indian Statistical Institute, Calcutta (23.12.86 to 1.1.87) 'Hilbert Modules'.

M.L. Michelson, State University of New York, at Stony Brook, USA (30.12.86) 'On positive curvature for manifolds with Boundary'.

H.B. Lawson, State University of New York at Stony Brook, USA (30.12.86) 'The Topological Structure of the space of Algebraic varieties'.

V. Ravishankar, University of Mysore, Mysore (2.1.87 to 6.1.87) 'Multiaxial Spin Systems'.

Rohit Parikh, Brooklyn College, New York, USA (4.1.87 to 9.1.87) 'Modal Logics in Computer Science'.

M.V. Nori, T.I.F.R. Bombay (7.1.87 to 6.3.87) 'Hodge classes on abelian varieties'.

K.S. Narain, Appleton Laboratory, Rutherford, USA (9.1.87) 'Torus Compactification of strings'.

Alain Bruguieres, Universite Paris, France (1.1.87 to 14.1.87) 'The convexity properties of the moment map'.

A Kundu, Theoretical Nuclear Theory Division, Saha Institute of Nuclear Physics, Calcutta (16.1.87) 'Solitons'.

J. Dey, Education Service, Government of West Bengal (17.1.87) 'Low Mass Skirmions in Spontaneously Broken Non-abelian Gauge Models'.

N.I. Koblitz, Department of Mathematics, University of Washington, Seattle, W.A. USA (18.1.87 to 6.3.87) 'Number Theory and Cryptography' 'Mathematics in Vietnam'.

Bikash Sinha, Bhabha Atmoic Research Centre, Calcutta (19.1.87 to 22.1.87) 'A new state of matter - the quark-Gluon plasma'.

A.P. Balachandran, Syracuse University, USA (22.1.87) 'I-Balls'.

Jean-Mare Deshouillers, Mathematics Department, University of Bordeant 1, Talence, France (20.1.87 to 26.1.87) 'Waring's problem', 'Kloosterman sums'.

C.P. Singh, Banaras Hindu University, Varanasi (24.1.87) 'Signals for Quark-Gluon Plasma in Fragmentation Region.'

Miles Reid, Mathematics Department, University of Warwick Conventry CV 4, 7AL, England (21.1.87 to 28.1.87) 'Surfaces and 3-folds'.

Y. Frishman, Weizman Institute of Science, Rehovot, Isreal (22.1.87 to 25.1.87) 'Global Anomalies in Quantum Mechanics'.

Neelima Gupta, Poona University, Poona (31.3.87) 'Dimensional Characterization of Partially Scaling Sets'.

Madhavan Mukund, Tata Institute of Fundamental Research, Bombay (4.2.87 to 28.2.87) (Computer Science)

Donald Hubertknight, Middlessex Polytechnic, London (7.2.87) 'Engineering Design and Cad'.

D. Sahdev, Tata Institute of Fundamental Research, Bombay (9.2.87 to 16.2.87) 1. 'Kaluza-Klein Theories and Strings from the Viewpoint of Higher-Spin systems' 2. 'Correlation functions for the spin fields of superstring theories' 3. 'Galaxy formation in Higher Dimensional Cosmologies'.

S.D. Mathur, Tata Institute of Fundamental Research, Bombay (23.2.87 to 5.3.87) 'Covariant Quantization of strings and superstrings'.

Sunil Mukhi, Tata Institute of Fundamental Research, Bombay, (23.2.87 to 6.3.87) 'Covariant Quantization of strings and superstrings'.

Kamal Lodaya, Tata Institute of Fundamental Research, Bombay (1-29 March 1987) (Computer Science).

Do Long Van, University of Hanoi, Vietnam (6.3.87) 'Infinitary Codes'.

R. Ramanujam, Tata Institute of Fundamental Research, Bombay (9.3.87 to 28.3.87) (Computer Science)

George Joseph, University of Manchester, USA (11.3.87)
'History of Mathematics: A Non-Euro-Centric approach'.

S. Subramanyan, Tata Institute of Fundamental Research, Bombay (13.3.87 to 12.4.87) 'Differential Geometry and Holographic Vector Bundles'.

V. S. Vladimirov, Steklov Institute of Mathematics, Moscow, USSR (19.3.87)
(Discussion on Indo-Soviet Collaboration in Mathematical Sciences)

W. Brauer, Technical University of Munich, West Germany (22.3.87 to 24.3.87) 'Concurrent Programming with Petri nets.'

L.P. Grishchuk, Sternberg Astronomical Institute, Moscow, USSR (26.3.87 to 27.3.87) 1. 'Gravitational wave Astronomy! 2. 'Field Theoretic Approach to Gravitation'.

J. Pasupathy, Indian Institute of Science, Bangalore (26.3.87 to 27.3.87) 'Structure functions in deep Inelastic Scattering'.

LIBRARY

During April 1986 - March 1987, 1481 books and bound volumes of periodicals were added to the Library bringing the total number of volumes to 22339. The additions include many classic publications in Mathematics and Physics. Steps were taken to obtain preprints from more Institutions/Laboratories throughout the world and hence there is a manifold increase in the number of preprints received by the Library compared to previous years.

Subscription to many new Journals started, particularly in Theoretical Computer Science. As usual we are receiving many Journals and Lecture Notes on exchange basis from several Institutions. The number of users of the Library has increased substantially compared to previous years and to make the Library more convenient for use, the stack area, reading room and the current journals and preprints section have been rearranged completely.

We are thankful to the International Centre for Theoretical Physics (Trieste, Italy), Tata Institute of Fundamental Research (Bombay), Prof. E.C.G. Sudarshan, Prof. R. Hotta (Tohuku University, Japan). Prof. V.Kac (Massachussets Institute of Technology, Cambridge, USA), Dr. B.K. Shivamoggi (University of Central Florida, Orlando, USA) and Mr. M. Satyanarayana (I.M.Sc.) for donation of many useful books to our Library.

Mr. K.S. Santhanagopalan, Librarian and Mr. G. Venkatesan, Jr. Library Assistant, participated in the Seminar cum Workshop on 'Computerised Information Retrieval' organized by the Library and Computer Centre of Madras Institute of Technology at Madras on 18th and 19th March 1987.