INSTITUTE OF MATHEMATICAL SCIENCES

Annual Report

1985-86

MADRAS-600 113

INDIA

THE INSTITUTE OF MATHEMATICAL SCIENCES

Annual Report

1985-1986

MADRAS 600 113, India

Contents

Introduction

This annual report of the academic activities of the Institute of Mathematical Sciences covers roughly the period April 1985 - March 1986. During this period the Institute underwent a major growth. The staff strength as well as the number of pre-doctoral and post-doctoral fellows registered a substantial increase. Consequently the tempo of activity rose to a new height, as is evidenced by the increase in the number of publications for instance.

Among the highlights of achievement during this period, mention must be made of the complete solution of Waring's problem which is a 200-year old problem in Number Theory. This breakthrough was achieved by Dr.R.Balasubramaniam of the Institute of Mathematical Sciences in association with two French mathematicians, Dr.Jean - Marc Deshouillers and Dr.Francois Dress.

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Junior Research Fellows (contd...)

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Rajeswari. V.	(Physics)
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Sandhya. K.	(Mathematics)
Shaji. N.	(Physics)
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Vanchinathan. P.	(Mathematics)
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AWARDS AND HONOURS

Professor E.C.G. Sudarshan was awarded the First Physics Prize by the Third World Academy of Sciences, Trieste for his fundamental contributions to the understanding of the weak nuclear force, in particular for his part on the formulation of the universal V-A Theory of Sudarshan and Marshak.

Professor C.S. Seshadri was awarded the Srinivasa Ramanujan Medal for the year 1985 by the Indian National Science Academy, New Delhi.

Professor G. Rajasekaran was elected Fellow of Indian National Science Academy, New Delhi with effect from January 1986.

RESEARCH IN MATHEMATICS

The standard monomial theory gives not only a canonical
basis of the irreducible representations of the classical
groups and some qualitative properties of the Schubert
varieties (e.g. these varieties are arithmetically
Cohen-Macaulay), but also gives that certain canonical
degenerations of these varieties are Cohen-Macaulay. This
theory also exhibits explicitly a set of generators for the
defining ideals of the Schubert varieties.

A Theorem of Bertson was proved and strictly convex s.i.p.
spaces was investigated. For single elements $a \in A$, $b \in B$ of
unital Branch algebra, m the convex hull of $V(a, b)$ is known
to be the convex hull of $V(a) \cup V(b)$. This was generalised to
n-tuple of elements. It is known for a single element $a \in A$ in
a C^* algebra, a is normaloid iff $\|a^k\| = \|a\|^{\pm k}$.
It is proved that this does not hold for n-tuples

The Waring's conjecture was completely settled. A short proof
and improvements of a few results of Erdös et.al was given on
additive number theory. The study of the lower bound for the mean
square of Dirichlet series and its applications to the Ω result
in the Zeta function theory was continued; certain arithmetic
functions (like the number of integers n with $nd(n) \leq N$, the
complement of a set of squares the gap between square full
integers and the question whether two sets of consecutive integers
can have the same prime factors) were investigated.

An Erdos - Kac theorem for integers without large prime factors
was investigated : General questions about "Multiple functions

and Brun's sieve" was discussed. Moments of additive functions
was explored in its full generality; Some applications of
Sieve methods to probabilistic number theory was discussed.

A simple proof of the existence of the wave operators in
the Longrange scattering for all the operators was given.

RESEARCH IN PHYSICS

HIGH-ENERGY PHYSICS

String theories, which are potentially the much sought-after unified theories of all interactions, have been the focus of attention of physicists everywhere in recent times. They have also been an important field of activity in the Institute. The string theory obtained as a natural generalization of the relativistic spinning top to $1+1$ dimensions has been constructed and quantized. Symmetry properties of the quantum levels of the string, especially the massive sector are being studied, with emphasis on improper transformations, parity, charge conjugation and time reversal for uncompactified and compactified string theories. In order to make contact with the real world the compactification of high dimensional string theories to four dimensions and the consequent states and interactions have to be examined. The possibility of compactification of strings on six dimensional coset spaces preserving supersymmetry in the presence of gaugino condensation has been pointed out. The role of discrete symmetries in obtaining a low-energy theory from strings consistent with proton stability and the existence of a light neutrino has been studied.

The question of the masses and interactions of neutrinos is of importance even apart from string theories. A theoretical understanding of the existence of light Dirac neutrinos has been sought in unified models, with certain global leptonic symmetries, consistent with phenomenology in the quark as well as the lepton sector. The mechanisms by which supersymmetric theories

could incorporate Dirac neutrinos have also been suggested.

Higher dimensional theories à la Kaluza and Klein incorporate in them gravitational as well as gauge interactions. A detailed study of such theories has been made in various contexts. Quantum interference effects for a charged particle in an electromagnetic and gravitational field have been worked out. The possibility of using general conformal factors in the metric of the higher-dimensional space to obtain vanishing cosmological constant has been studied. An S^2 non-linear sigma model is shown to induce compactification of a six-dimensional theory to $M^4 \times S^2$ without making the gauge fields massive. That the Kaluza-Klein procedure may be used to obtain massive theories with π gauge invariance, was illustrated in the case of the spin 3/2 field, where the resultant interacting gauge-invariant theory was shown to avoid the Velo-Zwanziger problem of non-causal propagation modes.

A non-perturbative approach to the study of non-Abelian gauge theories has been through lattice gauge theories. Evidence has been found from existing Monte-Carlo data that monopole condensation is responsible for confinement in non-Abelian gauge theories and the interpretation and implications are being studied.

Again in the context of fundamental interactions of quarks, a relativistic model of permanently bound mesons and baryons has been set up and its implications for the spectrum and interactions are being studied.

The question of the charge of the quarks, which has not been settled, has been addressed in the context of a gauge theory. An empirical test of the quark charges in the process $\bar{p}p \to W\gamma X$ has been proposed, which can distinguish between fractional and integer-charge quark models.

The problem of chiral symmetry is important in sub-component models for quarks and leptons. It has been argued that supergravity theories coupled to vector-like supersymmetric gauge theories with massless matter fields have supersymmetry and chiral symmetry breaking patterns that are useful for construction of realistic preon models.

NUCLEAR PHYSICS

The work in the field of quantum theory of angular momentum was continued and the following results were obtained: The sets of $_4F_3(1)s$ obtained for the Racah coefficient, were shown to be related to one another through the reversal of series. The polynomial or non-trivial zeros of the 3-j and the 6-j coefficients were classified according to their degree and for the majority of these - polynomial zeros of degree one - a single closed form expression: $(1 - \delta_{x,y} \quad \delta_{n,1})$ was obtained. An algorithm to generate the polynomial zeros of degree one of the Racah coefficient based on the solution provided by Brahmagupta in the 6th Century A.D. for the Diophantine equation $\alpha xy = \beta x + \gamma y + \xi$, was proposed. A three-term recurrence relation has been derived for the Racah coefficients based on a set of orthogonal polynomials, called Racah polynomials, that generalize these coefficients. This three-term recurrence relation has been shown to be also derivable from the Biedenharn - Elliott identity.

Neutrino induced neutral-current interactions on certain isoscalar nuclear states has been studied. Predictions have been made for the cross sections and a clean way of studying isospin mixing has been pointed out.

STOCHASTIC QUANTIZATION

The main thrust of the work on Stochastic Quantization had been to prove renormalizability of stochastically quantized field theories. This programme has been completed for scalar φ^4 theory and scalar electrodynamics. Ward-Takahashi identities for non-abelian gauge fields have also been derived which would be useful in proving the renormalizability for this theory.

CONDENSED MATTER PHYSICS

A non-linear evolution equation for the order parameter in superfield ^{4}He is derived using a pseudospin model for a system of hard-core bosons with nearest neighbour attraction. The spin coherent states are used to take care of the condensation. When we go to the continuum limit the results lead to a non-trivial spatial dependence of the vorticity. We can also find a periodic travelling wave solution with velocity-dependent amplitude for the condensate density. For certain values of the parameters domain-wall structure for this quantity can also be found. Some features of the ^{4}He film can also be arrived at.

QUANTUM OPTICS

Polarization properties of laser beams with Gaussian profile have been studied and it has been shown that the beam necessarily has a cross-polarization component and a component along the beam axis in addition to the principal polarization component. Propagation of partially coherent beams through optical systems has been studied using the coherent-mode decomposition technique. Orbits in the Lie algebras of (pseudo) orthogonal groups of the form $SO(p,q)$, $p+q \leqslant 5$ have been completely classified. The problem of smoothed (non-negative) Wigner distributions has been studied within the framework of dynamical maps, and it has been shown that not every Wigner distribution can be used as a smoothing kernel. Gaussian Wigner distributions in finite dimensional phase-space have been completely characterised. The advantage of using Wigner distribution technique in problems involving the squeezed states has been demonstrated and the squeezing and antibunching properties of logarithmic states of the radiation field analysed.

The O(4) algebra of the hydrogen atom has been made use of to define the squeezed coherent states of the hydrogen atom. The hydrogen atom in such a squeezed state has more energy than given by the usual Bohr formula. The bunching and anti-bunching properties of various coherent states (including the generalized coherent states) have been analysed. It has been found that the counting distribution of the squeezed coherent states could be made use of to describe the hadronic multiplicity distributions.

STATISTICAL MECHANICS AND STOCHASTIC PROCESSES

The study of first passage times of a stochastic model of a finite dam with random inputs and outputs while the release is deterministic is carried in detail. Closed solutions for the Laplace transform of the first passage are obtained using suitably defined product density functions leading to third order differential equations. These are important to get insights into the threshold studies in storage, biological and other environmental problems. In insurance and actuarial problems first passage to ruin without touching the upper limit is studied when there are deterministic additions of premiums and interests while random claims occur. The upper barrier is a waiting barrier. The solutions of this interesting boundary-value problem for the first passage times are obtained in a closed form.

The following relates to the work done in the distribution of photons in a cavity and the number of counts in the detector where non-Markovian features are introduced. The cavity photons are assumed to interact with the atoms of the detector via a two-stage process. The cavity photons are modelled as usual as a population process. The memory effects due to the two-stage model results in the depletion of the bunching. The evolution of the cavity radiation is examined by visualising the production process by photons which will contribute to the population growth in an age dependent manner. The Bellman-Harris process is an appropriate description and the spontaneous emission is taken as an immigration

process. The results due to this non-Markov model of evolution is compared with the usual Shepherd model both at finite times and at equilibrium. The usual procedure is to study the statistics of the detection process in a cavity when the cavity field and the detection process are in equilibrium from the distant past. However when the detector is introduced at the time origin the probability of the monitored photons at finite time t is naturally different from the equilibrium model. The effect of introducing the detector is studied after infinite time and the approach to equilibrium is analysed.

Higher -order spin -- spin correlations have been studied in the two - dimensional Ising model.

The approach to equilibrium of a quantum system in a heat bath with a memory - dependent dissipative force has been studied.

MATHEMATICS

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MATHEMATICS

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Alladi Krishnaswami - Multiplicative functions and Brun's sieve
(preprint)

Balasubramanian, R. - A note on a theorem of Erdos, Sarkozy and Sos·
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Balasubramanian, R. - On the additive completion of squares
(to appear in Jour. Number Theory)

Balasubramanian, R. - (with K. Ramachandra) : On the frequency of
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Balasubramanian, R. - (with K. Ramachandra) : On the number of
integers   n   such that $nd(n) \leqslant N$ (preprint)

Balasubramanian, R. - (with K. Ramachandra) : On square full integers
(Preprint)
Balasubramanian, R. - (with K. Ramachandra and M.V. Subbarao) :
On the error function in the asymptotic formula for the counting
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On the maximal length of two sequences of consecutive integers
with the same prime divisors (preprint)

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N.Mukunda, R.Simon and E.C.G.Sudarshan, 'Cross-polarization in laser beams'.

N.Mukunda, R.Simon and E.C.G.Sudarshan, 'On the orbits in the Lie algebra of some (Pseudo) orthogonal groups'.

N.Mukunda, R.Simon and E.C.G.Sudarshan, Anisotropic Gaussian Schell-Model beams: Passage through optical systems and associated invariants.

T.S.Santhanam and K.Srinivasa Rao, 'A new recurrence formula for the Racah Coefficient!

A.Shanthi and R.Sridhar, 'Temperature dependence of the structure factor of Liquid He^4', (to appear in Physica).

H.S.Sharatchandra, 'Quark confining mechanism in QCD', I.M.Sc., preprint.

R.Sridhar, 'Anomalous phonon Dispersion in liquid HeII' Phys. Reports - (to appear).

R.Simon, 'Mueller matrices and depolarization criteria', to appear in Optica Acta.

K.Srinivasa Rao, 'Parallelism in Computer Science' in Workshop on 'Mathematics of Computer Algorithms' IMSc Report **111**(1986).

E.C.G.Sudarshan, 'Unfolding, Fibre Bundles, Colour breaking and Gauge invariance'.

E.C.G.Sudarshan, 'Mid-Century Adventures in Particle Physics', to be published in the proceedings of the conference at Fermi lab. May 1-4, 1985.

E.C.G.Sudarshan, 'Quantum Measurements and dynamical maps' contribution to Y.Neemans 60th birthday.

R.Vasudevan and P.R.Vittal, 'Some first passage time problems with restricted reserve and two components of income'.

M.Cvetic, J.C.Pati and H.S.Sharatchandra, 'Towards a resolution of certain dilemmas in preon dynamics through local supersymmetry'.

X.-G.He, S.Pakvasa, G.Rajasekaran, S.D.Rindani, '$e^+e^- \rightarrow \gamma$ +2 jets as a test of quark charges'.

A.S.Joshipura, A.Mukherjee and S.K.Soni, 'Tree level breaking of $SU(2) \times U(1)$ in general SUGRA theories'.

R.Parthasarathy, R.Nagarajan and G.Rajasekaran, 'Quantum interference effects in a generalized Kaluza-Klein theory'.

WORKSHOPS

CONDUCTED IN THE INSTITUTE

A workshop on "Recent developments in Theoretical Nuclear Physics" was conducted in the Institute from 1st May 1985 to 9th May 1985, in which many members of the Institute and many from outside participated.

grants were received for the conduct of the Workshop and for publishing the proceedings from Department of Atomic Energy, Bombay, Department of Science and Technology, Delhi and Indian National Science Academy, Delhi.

Workshop on superstrings was conducted in the Institute of Mathematical Sciences from 14th November 1985 to 20th November 1985. Many members of the Institute and a few physicists from other institutions participated in the Workshop.

DOCTORALS

Prem Kumar Yesudian got Ph.D. under the guidance of Dr.R. Parthasarathy for his thesis "Neutrino Neutral current reactions in light nuclei".

LECTURES OUTSIDE THE INSTITUTE
(including visits and conferences)

Dr.Krishnaswami Alladi returned from the University of Hawaii in Honolulu in June 1985. He gave lectures on Moebius function in the University of Madras in August 1985.

Dr. Hemant Bhate gave a colloquium talk in Tata Institute of Fundamental Research, Bombay in February 1986.

Dr.S. Chaturvedi delivered a talk in the Workshop on Random walks held at T.I.F.R. Bombay.

Dr.G.D. Date participated in the T.I.F.R. Winter School
(25th January to 5th February 1986) in theoretical
physics held at Panchagani and gave a talk on "Bosonization
in two dimensions and applications"

Dr.K.H. Mariwalla gave a course of lectures on "Groups and
relativity" and "simplectic geometry with applications to
mechanics and quantisations problem" in Aligarh Muslim University.

Dr.G. Rajasekaran : Gave a series of lectures on "Composite Models"
in the Summer School on Theoretical High Energy Physics organized
by Department of Science and Technology and held at I.I.Sc.
Bangalore in April 1985
— Gave a series of lectures on "Building up the Standard Model
of High Energy Physics" in the UGC Instructional Conference on
Gravitation, Gauge Theory and Early Universe held at I.I.Sc.,
Bangalore in June 1985.
—Participated and gave a series of lectures on "Superstring
Field Theory" in the informal Workshop on Superstrings, at the
Centre for Theoretical Studies, I.I.Sc., Bangalore in Sept. 1985.
— Participated in the 51st Annual Meeting of the Indian Academy
of Science at Madurai-Kamraj University in November 1985.
— Participated in the National Seminar on Sixty Years of
Quantum Mechanics held at Santiniketan in Nov. 1985 and gave
an invited talk on "Recent Developments in High Energy Physics
and their repercussions on the future of Quantum Mechanics".

— Participated in the Symposium on "Current Trends in Physics"
held at Institute of Physics, Bhubaneswar in Feb. 1986 and gave
an invited talk entitled "Why Superstrings?"

—Participated in the UGC Workshop on Gravitation, Particle
Physics and Cosmology held at University of Madras in Feb. 1986.

Dr.S.D. Rindani visited the International Centre for Theoretical
Physics, Trieste, Italy from 4th June to 7th August 1986 and
attended a Workshop on High Energy Physics and Cosmology
during this period.

Dr.T.S. Santhanam gave lectures in Presidency College as well as in Annamalai University. He also visited Tata Institute of Fundamental Research, Bombay for a month and gave two lectures there. He also gave lectures on 14th International Conference on Group theoretical methods in Physics. He delivered talks in the National Conference "Special functions " at Gorakhpur and in "Recent trends in theoretical physics" held at the Institute.

Dr.H.S. Sharatchandra visited Saha Institute, Calcutta from 4th December to 12th December 1985 where he gave three seminars and one colloquium. He also participated in the Workshop in Scattering theories held at Centre for Theoretical Studies, Bangalore, in September 1985. He gave a talk at "Tropical meeting on Quark gluon Plasma" held at V.E.C. Centre, Calcutta.

Ms. A. Shanti participated in the National Symposium on Solid state physics conducted by Department of Atomic Energy held at Nagpur from 27th December to 30th December 1985 and gave two lectures.

Dr.R. Simon delivered lectures in the National Seminar on "Applications of group theory to Physical problems", held in Waltair in January 1986, the symposium on "Symmetries in Science II", held in Carbondale, Illinois in March 1986 as well as in the "Recent developments in Theoretical Physics" held at the George Sudarshan Centre for Physics and Computer Science, C.M.S. College, Kottayam in September 1985. He also lectured at the following institutes.
a) Southern Illinois University, Carbondale, USA
b) University of Arkansas, Feyetteville
c) University of Maryland, College Park, USA
d) Polytechnic Institute of New York, Brooklyn, USA
e) I.I.T. Madras.

Dr.K. Srinivasa Rao gave a talk and chaired a session at the
National Symposium on special functions and their applications
held at Gorakhpur in March,1986.

He also lectured at the following institutes :

a) Gorakhpur University, Gorakhpur
b) University of Delhi, Delhi
c) Meenakshi College for Women, Madras
d) Holy Cross College, Nagercoil
e) Presidency College, Madras
f) Indian Pharmaceuticals Limited, Rishikesh
g) George Sudarshan Centre for Physics and Computer Sciences,
C.M.S. College, Kottayam, Kerala

He also participated and lectured in the "One week with a
Scientist programme" (Professor E.C.G. Sudarshan being the
Scientist) held at the George Sudarshan Centre for Physics
and Computer Science, C.M.S. College, Kottayam.

Dr.K.R. Unni gave a series of lectures on Harmonic analysis at
Vikram University, Ujjain in January. He participated in the
symposium in Mathematics in connection with the Silver Jubilee
of I.I.T. Kanpur. He also participated in the symposium on
Functional Analysis, Mysore University in June 1985 and in the
symposium by Calcutta Mathematical Society in September 1985
in honour of M.Dutta.

Dr.R. Vasudevan gave the lectures at the Summer School organised
by Theoretical Physics department of University of Madras.
He also gave lectures on Stochastic theory for the Summer School
organised by the Statistics Department of the University of Madras.

Dr.E.C.G.Sudarshan visited a large number of institutions in the
country as well as abroad and gave lectures on various
topics.

Pre-Ph.D. LEVEL COURSES (Physics)

The Institute has started conducting pre-Ph.D. level courses in Theoretical Physics and Mathematics.

The Physics courses have been divided into three levels:

Level A : Foundation courses : 1st year, 1st Semester

Level B : Advanced Courses : 1st year, 2nd Semester

Level C : Specialised Topics : 2nd year

The following subjects were taught in the courses:

Level A
1) Classical Mechanics

2) Classical Electrodynamics

3) Statistical Mechanics

4) Quantum Mechanics

5) Mathematical Physics (including Numerical methods and computation)

Level B
1) Condensed Matter Physics

2) Nuclear Physics

3) High Energy Physics

4) Quantum Field Theory

5) Gravitation and Cosmology

Level A courses were started during the third week of August 1985 and at the ratio of two lectures (each of 90 minutes duration) per week about 30 lectures were given in each subject. Level B courses commenced during January 1986.

A special feature of this program was that the lecturers included besides the staff of the Institute, the faculty members from the Department of Theoretical Physics, Madras University (Prof.P.M.Mathews and Dr.Radha Balakrishnan) and the Physics and Mathematics Departments of I.I.T. Madras (Prof.V. Balakrishnan and Dr.S.G. Kamath.) The courses were attended by the Junior Research Fellows of the Institute as well as Ph.D. students from Madras University and I.I.T. Madras.

Pre-Ph.D. LEVEL COURSES (Mathematics)

An extensive course of lectures were given both by Academic Members of the Institute and Visitors (Prof. Kalyan Mukherjee, Prof. S.R.S.Varadan, Prof.R.Hotta and Prof. Ravi Kulkarni) on the following topics:

1. Algebraic curves and Jacobians

2. Differential Manifolds

3. Analytic Number Theory (Turan-Kubilius inequality)

4. Algebraic Number Theory (Class - field theory)

5. Lie algebras and Lie groups

6. D-modules

7. Geometry of curves

8. Algebraic Topology

9. Spectral Theory

10. Classical Harmonic Analysis

LIBRARY

During the reporting period (1985-86) 1133 books and bound volumes of periodicals were added to the Library.

One notable feature during the period was that the National Board for Higher Mathematics has recognised the Library of the Institute of Mathematical Sciences, as a Regional Library with financial support. This will cater to the needs of the Mathematicians in the Southern Region. Many back volumes of Mathematics Journals were added under this scheme and we hope to acquire more in the near future.

COMPUTER

An IBM - PC/AT Computer (512 KB Memory; 20 MB Winchester drive; 1.2 MB floppy drive and 360 KB floppy drive) was gifted to the Institute in January 1986 by Alexander Von Humboldt foundation.

VISITORS

April 1985

Dr. H.S. Sharatchandra, Univ. of Maryland, USA

Dr.T.S. Balasubramanian, Banaras Hindu University, Varanasi

Dr.Rohini Godbole, University of Bombay, Bombay

Dr.Alladi Sitaram, Stat-Math. Indian Statistical Institute, Calcutta

Dr.S. Lokanathan, University of Rajasthan, Jaipur

Dr.T.W.B. Kibble, Imperial College, London, U.K.

May 1985

Dr.R. Simon, American College, Madurai

Dr.S.R.S. Varadhan, Courant Institute, New York University, USA

Dr.K.S. Narain, Rutherford Appleton Laboratory, U.K.

Dr.R. Ramachandran, Indian Institute of Technology, Kanpur

Dr.Sumit Ranjan Das, Fermilab, USA

June 1985

Dr.Haridas Banerjee, Saha Institute, Calcutta

July 1985

Dr.A.P. Balachandran, Syracuse University, USA

Dr.Vinaya Joshi, University of Jammu,

Dr.T. Padmanabhan, Tata Institute of Fundamental Research, Bombay

Dr.Mendes, France

Mr.K.R. Narayanan, Minister of State (Planning) , New Delhi

August 1985

Dr.J. Chakrabarti, I.S.I. Calcutta

Mr.S.P. Inamdhar, Research Scholar, TIFR, Bombay

Mr.A.J. Parameswaran, Research Scholar, TIFR, Bombay

Dr.V.J. Menon, Bhuaras Hindu University, Varanasi

Dr.R.A. Gustafson, Texas A and M University, USA

Dr.N. Mohanakumar, Tata Institute of Fundamental Research, Bombay

Dr.Ravi Kulkarni, Indiana University, Bloomington, USA

Dr.Michael Wäldschmidt, Institut Henri Poincare, Paris

Dr.V.S. Varadarajan, UCLA, U.S.A.

Dr.V. Lakshmibai, Texas A and M University, USA

Dr.K. Varadarajan, University of Calgary, Canada

Dr.R.S. Chakravarti, Cochin University, Cochin.

September 1985

Dr.K.B. Sinha, I.S.I. Delhi

Dr.A. Mukherjee, I.I.T. Kanpur

Dr.T.R. Ramadas, Tata Institute of Fundamental Research, Bombay

Dr.Sibaji Raha, Saha Institute of Nuclear Physics, Calcutta

Dr.Bindu Bambah, University of Madras, Madras.

Dr.N. Shankar, University of Texas at Austin

October 1985

Dr. Bhaskar Datta, Indian Institute of Astrophysics, Bangalore

Dr. Rohini M. Godbole, University of Bombay, Bombay.

Dr. Rahul Basu, University of Delhi, Delhi.

Dr. R. Ramanathan, University of Delhi, Delhi.

November 1985

Dr. Jagjit Singh,   Delhi

Dr. M. Jutila, University of Turku, Finland

Dr. P.K. Mitter, Universite Pierre of Marie Curie, Paris, France

Dr. S.M. Mahajan, Physical Research Laboratory, Ahmedabad

Dr.S. Ramanathan, Tata Institute of Fundamental Research, Bombay

Dr. B. Sriram Shastry, Tata Institute of Fundamental Research, Bombay

Dr.M.S. Raghunathan, Tata Institute of Fundamental Research, Bombay

Dr.M.D. Scadron, CTS, Indian Institute of Science, Bangalore

Dr. Gordon Shaw, UCLA, California, U.S.A.

Ms. Neelima Gupta, University of Pune, Pune

Dr. Utpal Sarkar, University of Texas at Austin, USA

December 1985

Dr. P.S. Thiagarajan,   Aarhus University, Denmark

Dr. K.K. Mukherjee, Indian Statistical Institute, New Delhi

Dr. P.K. Malhotra,   Tata Institute of Fundamental Research, Bombay

Dr. Sagun Chanillo, Ohio State University , USA

Dr.J.M. Field, DESY, Hamburg, Germany

Dr.T.S. Radhakrishnan, Indira Gandhi Centre for Atomic Research,
                    Kalpakkam

Dr. Hermann Bondi,   King's College, University of London/
                    Master of Churchill College, Cambridge

Dr. Bhama Srinivasan, University of Illinois, Chicago, USA

Dr. S. Kumaresan, Tata Institute of Fundamental Research, Bombay

Dr. Ryoshi Hotta, Mathematical Institute, Tohoku University, Sendai,
                    JAPAN

Mr. Kamal Lodaya, Tata Institute of Fundamental Research, Bombay

January 1986

Dr. Pierre Jean Laurant, IMAA, France

Dr. A.P. Balachandran, Syracuse University, USA

Dr. R. Kannan, Carnegie Mellon University, USA

Dr. M.J. Beckman, Technical University, Munich, West Germany

Dr. C.A. Hurst, University of Adelaide, South Australia

Dr. J.G. Pati, University of Maryland, USA

Dr. Tong Cheon, Yonsei University, Seoul, Korea

Dr. A. Martin, CERN, Geneva, Switzerland

Dr. Vladimirov, Academician, USSR

Dr. Victor Kac, Massachusetts Institute of Technology, Cambridge, USA

February 1986

Dr. R. Weissauer, Mathematik, Universitat Heidelberg, W.Germany

Dr. Claudio Procesi, Mathematik, University of Rome, Italy.

Dr. Ramesh Kaul, CTS, Indian Institute of Science, Bangalore

Dr. A.K. Kapoor, University of Hyderabad

Ms. V. Saraswathi, University of Alberta, Edmonton, Canada

Dr. J.S. Fedorchenko, Kiev University, USSR

Dr. John Hagalin, Maharishi International University, Fairfield,
                  IOWA, U.S.A.

Dr. B.M. Udgaonkar, Tata Institute of Fundamental Research, Bombay

Dr.Y.I. Zaparovanny, Patrice Lumumba Peoples Friendship University,
                     Moscow.

Dr. S. Kichennasamy, Institut Henri Poincare, Universite De Paris VI,
                     Paris, France.

Dr. Satyanand Kichenassamy, Ecole Normale Superieure, Paris, France

Dr. Marchuk, Steklov Institute, U.S.S.R.

March 1986

Dr. Prabir Roy, Tata Institute of Fundamental Research, Bombay

Dr. Taqder Hussain, McMaster University, Canada

Dr. Afras Abbas, Institute for Kern Physik, Technische Hochschuli,
                 W. Germany.