Matscience

ANNUAL REPORT 1967

Institute of Mathematical Sciences,
Madras, India

THE INSTITUTE OF MATHEMATICAL SCIENCES,

MADRAS

"THE PURSUIT OF SCIENCE IS AT ITS BEST WHEN IT IS PART OF A WAY OF LIFE"

ANNUAL REPORT 1967

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Mr. C. Subramaniam.

CHAIRMAN OF THE BOARD OF GOVERNORS :

Mr. V. R. Nedunchezhian

Minister for Education, Government of Madras.

DIRECTOR :

Professor Alladi Ramakrishnan

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3.	Professor M. G. K. Menon, Director, Tata Institute of Fundamental Research, Bombay.	"
4.	Professor Alladi Ramakrishnan, Director, The Institute of Mathematical Sciences, Madras.	"
5.	Dr. R. Vasudevan, Permanent Member, The Institute of Mathematical Sciences, Madras.	"
6.	Professor P. M. Mathews, Department of Physics, University of Madras, Madras.	"

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3.	Professor Alladi Ramakrishnan, Director, The Institute of Mathematical Sciences, Madras.	"
4.	Dr. R. Vasudevan, Permanent Member, The Institute of Mathematical Sciences, Madras.	"

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1.	Professor Alladi Ramakrishnan, Director, The Institute of Mathematical Sciences, Madras.	Chairman
2.	Dr. R. Vasudevan, Permanent Member, The Institute of Mathematical Sciences, Madras.	Member
3.	Dr. K. R. Unni, Permanent Member, The Institute of Mathematical Sciences, Madras.	"
4.	Dr. N. R. Ranganathan, Associate Member, The Institute of Mathematical Sciences, Madras.	"

Matscience

General Information

The aims and objects of the Institute are :

Aims and Objects

1. To create and provide an atmosphere and environment suitable for creative work and the pursuit of knowledge and advanced learning in the Mathematical Sciences for their own sake.
2. To promote and conduct research and original investiga tion on fundamental sciences in general, with particular emphasis on Mathematics, Applied Mathematics, Theoretical Physics and Astrophysics.
3. To foster a rigorous mathematical discipline, to stimulate a zest for creative work and cultivate a spirit of intellectual collaboration among academic workers in pure and applied branches of science.
4. To arrange lectures, meetings, seminars and symposia in pursuance of its academic work and for the diffusion of scientific knowledge.
5. To invite scientists in India and abroad actively engaged in creative work to deliver lectures and participate in academic activity.

The primary activity of the Institute is creative research in the mathematical sciences. In pursuance of the objectives of the Institute, weekly seminars as well as series of lectures on various topics of interest, both by visiting scientists and the academic staff of the Institute and opportunities are provided for leisurely discussion and exchange of ideas.

Academic activities

The Institute organises a Summer or Winter School in Mathematical Sciences in which lectures range from introductory to advanced levels to commemorate the inauguration of the Institute an Anniversary Symposium is held in the first of week of January in which scientists from India and abroad are invited to deliver one hour addresses summarizing their original work or recent advances in various branches of mathematical sciences.

Academic Staff

The academic group consists of Professors, Permanent Members and Associate Members of the various faculties, visiting scientists, temporary members, research fellows and research trainees.

Ph.D. Programme

Facilities are available for post-graduate students to work for the Ph. D. degree under the guidance of the academic staff of the Institute in various faculties. Senior and junior research fellowships of value Rs. 500/- per mensem and Rs. 300/- per mensem respectively are awarded by the

Institute. Besides these, fellowships tenable at the Institute are awarded by the Department of Atomic Energy and Council of Scientific and Industrial Research.

Mode of admission

Memberships (temporary and permanent) of the Institute are made available on invitation or by application to the Director.

Students intending to become research trainees and research fellows of the Institute are expected to apply on prescribed forms which are supplied on request.

Visiting scientists programme

Facilities are offered to visiting scientists to spend a considerable time in the Institute and work in collaboration with the academic staff. of the Institute.

Distinguished scientists of established reputation are invited by the Director on behalf of the Board of Governors as Visiting Professors of the Institute. They are expected to stay for six weeks or more and the Institute will pay their travel expenses by air (round trip tourist) from the place of their residence to Madras. An allowance of Rs. 75/- per day will be made available to them during their stay at the Institute.

The Visiting membership programme of the Institute is designed to enable young, active and promising scientists to pursue research and take part in various academic activities of the Institute. Such memberships are available on invitation or by request for such periods as may be fixed in consultation with the visiting members. A living allowance of Rs. 50/- per day and travel expenses by air (round trip tourist) from the place of the residence to Madras are made available to residents outside India and salaries of Rs. 600/- to Rs. 1,500/- to research workers in India. Scientists intending to be admitted under this scheme can contact the Director of the Institute giving particulars of their academic career and indicating the probable period of their stay.

Besides the above, scientists from various institutions may be invited to deliver lectures and seminars for which suitable honorarium will be offered.

Publications

1. **Research papers** (Preprints and reprints are available by request).
2. **Seminar lecture notes** (available by request).
3. **Matscience reports** based on the lecture courses delivered at the Institute both by visiting scientists and academic staff. (Price Rs. 5/- or U. S. $ 1.00 outside India).
4. Proceedings of the Summer School and the Anniversary Symposium published as a series entitled **"Symposia on theoretical Physics and Mathematics"** by the **Plenum Press,** New York.

1967 - A year of fruitful activity.

A fruitful year

The past year has been the most fruitful period of scientific activity since the inception of the Institute in 1962.

Research contributions

In theoretical physics, we have had a rewarding experience for we were able to complete a programme of work, the origins of which can be traced to the informal discussions held in my family home almost twelve years ago by the 'Theoretical Physics Seminar,' a group of eager students who formed the nucleus of the present Institute. We were at that time considered as late entrants into the stream of high energy physics which had received its greatest impulse with the triumphs of electrodynamics in 1949 and the discovery of strange particles in the years that followed. Such a belated entry turned out to be a very fortuitous circumstance for we were able to view the developments following Feyman's significant contributions in leisured and critical detail rather than with the exuberant faith in their completeness which characterised the work that immediately followed their first formulation. The result was the unfolding of new features of the Feynman graphical formalism hitherto obscured by an undue insistence on the manifest covariance of the theory. Quite unexpectedly our efforts also led to some mathematical investigations in matrix analysis culminating in the construction of what we have begun to call the L-matrix structure, in which is imbedded the Dirac-Hamiltonian. The peculiarities of the algebra of gamma matrices and the symmetries of the Dirac equation emerge as natural consequences of quite general mathematical results.

Prime Minister's Visit

The annual symposium in 1967 was as successful as the preceding meetings due to the active participation of scientists from various countries. The period of the symposium coincided with one of the most exhilarating experiences we had in recent years—the visit of the Prime Minister of India along with Mr. C. Subramaniam, our Patron and Mr. M. Bhaktavatsalam, the then Chief Minister of Madras.

Mathematics Seminar

It was very gratifying that in pure mathematics our hopes as expressed in the introduction to the proceedings of the symposium in 1966 have been well fulfilled. In referring to the supplementary mathematics session of that symposium, I expressed the hope that it will soon grow into a full-fledged seminar on mathematics to be concurrently held with a symposium on theoretical physics. We have just completed a Seminar on Mathematical Analysis with Professors Fuchs, Rubel and Unni as the principal lecturers. The response from various universities and institutions has been so good that we are encouraged to conduct the seminar as an annual programme.

Our Permanent Staff

My colleagues Professors Vasudevan and Unni have worked with steadfast faith and ardent enthusiasm reminiscent of the idealism that characterised the early days of the 'Theoretical Physics Seminar.' Last summer Professor Unni had the privilege of participating in a seminar at the University of Montreal, Canada. Later he had the valuable opportunity of not only lecturing at Cambridge, England, but also in centres in Eastern

Europe. Dr. Vasudevan will be proceeding next week to Naples in response to the invitation from Professor Caianiello who is actively interested like us in some mathematical aspects of modern quantum mechanics.

International Support

On this occasion we wish to express our gratitude to the international scientific community which is offering its co-operation with solicitous interest and spontaneous enthusiasm. Such co-operation made it possible for me to lecture at twenty-one centres in Europe and America and discuss the work on L-matrices with leading scientists there.

A continuing Series

The academic activities of the Institute find outward expression not only through original contributions in research journals but through the Proceedings of the Symposia published as a continuing series by the Plenum Press in the United States. Their magnificent effort is in consonance with the spirit of collaborative effort of the international scientific community. The more extended series of lectures are as usual published as MATSCIENCE Reports; the demand for which is as keen as ever from centres like Berkeley in the United States to Dubna in Soviet Russia.

A Revival of Hope

At the time of the inauguration I spoke of a splendid sickness that had stricken the academic group — the desire for stimulating an atmosphere for creative work in our country by our own exertions. For sometime I felt a little worried that this splendid sickness was being dispelled by the great opportunities in the affluent countries which are attracting away our young scientists in increasing numbers. But our hopes have been revived when we realised that our distinguished Chairman of the Board of Governors Mr. V. R. Nedunchezhian seems to have yielded to the same splendid sickness. His enthusiasm for mathematics can be best expressed through his own words :

> "If one ponders over it, one would be struck by the strange phenomenon that while mathematicians withdraw more and more from the masses and develop apparently abstract theories, their application brings about changes and developments that affect every aspect of our living."

We need not look for a better source of hope than this enlightened attitude towards mathematics which would do credit even to professional mathematicians.

Our Sponsors

It is our earnest desire that we should get increased support through the Chief Minister of our State and the Prime Minister of India.

A Pleasant Prospect

Coming to more mundane and concrete matters, our building programme is now progressing well and we will be entering the new premises by the middle of this year. Such a prospect adds an additional zest to the festive atmosphere of the anniversary during the Pongal season.

ALLADI RAMAKRISHNAN.

News of the Institute

Prime Minister's visit

On 6th January 1967, Institute had the pleasure of welcoming Mrs. Indira Gandhi the Prime Minister of India who was accompanied by Mr. M. Baktavatsalam, the then Chief Minister of Madras and Mr. C. Subramaniam, Patron of the Institute. The Prime Minister spent an hour at the Institute, meeting the foreign visiting scientists and other participants of the fifth Anniversary Symposium.

Our new Chairman

The new chairman of the Board of Governors of the Institute, Mr. V. R. Nedunchezhian, Minister for Education, Government of Madras, visited the Institute on 22nd March 1967.

U.G.C. Chairman's visit

Prof. D. S. Kothari, Chairman, University Grants Commission, visited the Institute on 7th December 1967 and had discussions with the Director.

Anniversary Symposium

The Fifth Anniversary Symposium of the Institute which was inaugurated by Mr. R. Venkataraman, the then Minister for Industries on 2nd January was held for two weeks. Among the scientists who participated in the symposium were, Professors N. Dallaporta, Italy; M. Gourdin, France; G. Charpak, Switzerland; D. G. Ravenhall, U.S.A.; M. Moshinsky, Mexico; J. H. Williamson, U.K.; J. I. Horvath, Hungary; S. D. Nigam, S. K. Srinivasan, I.I.T., Madras; P. M. Mathews, University of Madras, Madras; N. V. Subramanyan, Waltair; Drs. V. K. Balasubramaniam, U.S.A.; S. G. Deo, Marathwada University, Aurangabad; S. P. Misra, R.E.C., Rourkela; K. S. Padmanabhan, Annamalai University, Annamalai Nagar; Nirmala Prakash, Delhi; G. Bhamathi, University of Madras, Madras; and P. Achuthan, I.I.T., Madras.

Winter Seminar in Mathematical Analysis

The First MATSCIENCE "SEMINAR IN MATHEMATICAL ANALYSIS" was inagurated by Mr. V. R. Nedunchezhian, Minister for Education, Government of Madras on 20th December, 1967. The main series of lectures at the seminar were given by Professors W. H. J. Fuchs, Cornell University, U.S.A.; L. A. Rubel, Institute for advanced study, Princeton, U.S.A. and K. R. Unni, MATSCIENCE.

Visiting Scientists

As in the previous years, under the visiting scientists programme supported by the Government of Madras and the department of Atomic Energy, Goverment of India, distinguished professors sf established reputation as well as younger scientists oi great promise have visited the Institute to deliver lectures, participate in seminars, symposium and also to collaborate actively with the members of the Institute in their research work.

Matscience—I. I. T. Seminar

The MATSCIENCE—I.I.T. Seminars under the auspices of MATSCIENCE and the department of Mathematics, Indian Institute of Technology, Madras, continued to be held during the year.

Matscience—A.C. College Seminar

A joint seminar between the Institute of Mathematical Sciences and the Physics Department of A.C. College of Technology was initiated this year. The inaugural lecture was given by Prof. Alladi Ramakrishnan and next talk was by Dr. V. Devanathan, Department of Physics, A. C. College of Technology.

Publications

The publications of the Institute include research papers based on work carried out by members of our Academic staff and the visiting scientists, MATSCIENCE Reports and seminar lectures. The monthly reports on recent experimental data are being published regularly.

The lectures in our Anniversary symposium and Winter seminar proceedings are published as a series "Symposia on Theoretical Physics and Mathematics" by the Plenum Press, New York. Volumes I and II have been published and Volumes III to IX are in print or under preparation.

A New Journal for Mathematical Sciences

The Institute welcomes and extends whole hearted support to the publication of the new journal entitled "Journal of Mathematical and Physical Sciences" by the Indian Institute of Technology, Guindy, Madras. This Journal is first of its kind in India and its main aim is to publish both original research work and critical reviews in various branches of theoretical physics and applied mathematics.

The journals represents a collaborative effort of three institutions :—

1. Indian Institute of Technology, Guindy, Madras.
2. Institute of Mathematical Sciences, Adyar, Madras.
3. Department of Theoretical Physics, University of Madras, Madras.

Seminar in Analysis

A special feature of the Institute during the year under review is a Seminar in Analysis conducted by the Faculty of Mathematics for a period of three weeks from 20th December to 6th January, supported by a special grant from the Department of Atomic Energy, Government of India. This seminar was intended for the mathematicians and students engaged in study and research at Pre-doctoral and Post-doctoral levels. There were three main lecturers, each giving a series of lectures on advanced topics, among whom Prof. W. H. Fuchs of Cornell University, and Prof. L. A. Rubel of the University of Illinois and the Institute for advanced study, Princeton were the visiting professors at Matscience.

The success of the seminar was indicated by the large number of participants from the different Universities in India from Jammu and Kashmir down to Trivandrum. Nearly fifty mathematicians took advantage of the seminar. This is the first seminar in mathematics of its type held in India.

Topics of the lectures:

Prof. W. H. J. Fuchs	...	"Meromorphic Functions of Lower Order less than one"
Prof. L. A. Rubel	...	"Vector Space of Analytic Functions"
Prof. K. R. Unni	...	"Bernstein Approximation Problem"

Delegations

In response to an invitation by Professor Abdus Salam, F.R.S., Director, International Centre for Theoretical Physics, Trieste, Italy, Professor Alladi Ramakrishnan spent six weeks commencing from 15th June 1967 as a visiting scientist at the Institute in Trieste. The Director was also invited by Professor R. E. Marshak to participate in the international Conference on High Energy Physics held at the University of Rochester from August 28th to September 1st, 1967. He returned to India on 28th September 1967. During this trip, the Director delivered seminars at the following centres of research in Europe and USA besides the above on his recent work on in response to invitations from various scientists listed below:

Universities / Institutions Visited	*At the invitation of*
University of Rome	Professor F. Calogero
International Centre of Theoretical Physics, Trieste, Italy (Supported by the International Atomic Agency, Vienna, Austria)	Professor Abdus Salam, Director.
Univesity of Geneva	Professor J. M. Jauch
Atomic Energy Commission, Saclay (Parish - France)	Professor C. Bloch

Universities / Institution Visited	*At the Invitaion of*
Operation Research Group, Air Canada, Montreal	
Bell Telephone Laboratory, Murray Hill, N.J., U.S.A.	Dr. J. McKenna
New York University	Professor K. Symanzik
U. S. Naval Research Establishment, Washington, D.C.	Dr. Maurice M. Shapiro
University of Colorado, Boulder, (Summer Institute of Theoretical Physics).	Professor W. E. Brittin
University of Wisconsin, Madison	Professor Keith R. Symon
Universities of Illinois, Urbana	Professor D. G. Ravenhall
Purdue University, Lafayette	Professor S. Abhyankar
International Conference on High Energy Physics, University of Rochester	Professor R. E. Marshak
University of Toronto, Canada	Professor Robert E. Pugh
University of Wisconsin at Milwaukee	Professor Umezawa
University of Stanford	Professor L. I. Schiff
University of California at Berkeley	Professor K. M. Watson
Douglas Corporate, Advanced Research Laboratories, California	Dr. Dave Pandres
Boeing Scientific Research, Laboratries, Seattle, Washington, U. S. A. (Plasma Physics Group)	Prof. James E. Drummond
Simon Fraser Uuniversity Bernaby, Canada	Prof. K. S. Viswanathan
University of Washington, Seattle	Professor R. Geballe

Professor K. R. Unni, Permanent Member was invited to participate in the sixth session of the Seminare de Mathematiques Superieures on "Complex Analysis" held at the Universite de Montreal, Canada, (June 26—July 29, 1967) by Professor Maurice L'Abbe. On his return journey to India he also gave lectures at the Universities of Cambridge (England), Lublin (Poland) and Wroclaw (Poland). He returned to Madras on September 13, 1967.

Faculty of Theoretical Physics

Academic Group

Permanent Staff:

1. Professor Alladi Ramakrishnan — Director
2. Dr. R. Vasudevan — Permanent Member

Associate Member:

1. Dr. N. R. Ranganathan

Temporary Members:

1. Professor V. V. L. Rao†
2. Dr. K. Venkatesan
3. Dr. K. H. Mariwalla*
4. Dr. I. V. V. Raghavacharyulu†
5. Dr. V. Radhakrishnan†
6. Mr. T. S. Santhanam

Senior Research Fellows:

1. Mr. T. S. Shankara
2. Mr. K. Srinivasa Rao
3. Mr. A. Prabhakar†
4. Dr. C. G. Shukla†

Junior Research Fellows:

1. Mr. A. Sundaram
2. Mr. R. Sridhar
3. Mr. S. N. Siva
4. Mr. Syed Siddique†
5. Mr. P. S. Chandrasekaran
6. Mr. J. V. Subramanyam†
7. Mr. D. Radhakrishnan†
8. Miss Nalini B. Menon

* *Pool Officer, C.S.I.R. (From August to October, 1967)*

† *Indicates persons who have completed their tenure at the Institute*

Visiting Scientists:

Prof. M. Gourdin (*France*)
Prof. D. G. Ravenhall (*U.S.A.*)
Prof. A. S. Galiullin (*U.S.S.R.*)
Prof. M. Moshinsky (*U.S.A.*)
Dr. D. M. Chibisov (*U.S.S.R.*)
Prof. R. J. Elliott (*U.K.*)
Prof. F. A. Hinchey (*U.S.A.*)
Dr. Daniel A. Dubin (*U.K.*)
Dr. G. Shaw (*U.S.A.*)
Prof. G. Charpak (*Switzerland*)
Prof. N. Dallaporta (*Italy*)
Prof. Y. V. Novozhilov (*U.S.S.R.*)
Prof. J. I. Horvath (*Hungary*)
Dr. V. V. Sazonov (*U.S.S.R.*)
Dr. A. V. M. Ferris-Prabhu (*U.S.A.*)
Dr. D. Atkinson (*U.S.A.*)
Prof. Roland H. Good (*U.S.A.*)
Prof. Khalatnikov (*U.S.S.R.*)

Lecture Courses:

Name	*Period*	*Title*
Professor D. G. Ravenhall, University of Illinois, U.S.A.	January February	1. 'The Bethe Salpeter Equation' 2. 'Form factors and strongly interacting particles.'
Professor S. K. Srinivasan, Indian Institute of Technology, Madras.	April–June	'C* Algebra' (Lecture series)

Invited Lectures:

Name	*Date*	*Title*
Dr. A. V. M. Ferris-Prabhu, George Washington University, Washington, U.S.A.	July	'Temperature dependence of the spontaneous magnetisation of a Heisenberg ferromagnet'
Prof. Fred A. Hinchey, Oberlin College, Oberlin, Ohio, U.S.A.	August	1. 'Singular intergal equations' (2 lectures) 2. 'Group theory and net work analysis'
Dr. D. Atkinson, University of California, Berkeley, U.S.A.	September	1. 'Is crossing symmetry compatible with unitarity ?' 2. 'Are superconvergence relations empty ?'

Invited Lectures—(Contd.)

Name	*Date*	*Title*
Dr. Krishna Athreya, Stanford University, California, U.S.A.	June	'Limit theorems for multitype continuous time Markov branching processes and some classical urn schemes'.
Prof. R. J. Elliott, University of Oxford, England U.K.	June	'Vibrations of defects in Crystal lattices'.
Dr. D. M. Chibisov, Steklov Mathematical Institute, Moscow, U.S.S.R.	June	'On asymptotic properties of empirical distribution function'
Dr. V. V. Sazonov, Steklov Mathematical Institute, Moscow, U.S.S.R.	June	'On multidimensional concentration function'
Prof. A. S. Galiullin, People's Friendship University, U.S.S.R.	January	'On analytical construction of the material systems of the programmed motion'
Prof. Y. V. Novozhilov, Leningrad University, U.S.S.R.	February	1. 'Unitary representations of the Generalized Poincare Groups' 2. 'Strong coupling and symmetries'
Dr. G. Venkataraman, Bhabha Atomic Research Centre, Bombay	March	'Neutron-scattering in solids and liquids'
Dr. S. C. K. Nair, Saha Institute of Nuclear Physics, Calcutta	March and July	1. 'Realistic nuclear interactions and nuclear structure' 2. 'Selected topics in nuclear physics'
Dr. R. Ramachandran, Tata Institute of Fundamental Research, Bombay	October	'N charge exchange polarization and indefinitely rising trajectories'

Invited Lecture—(contd.)

Name	*Date*	*Title*
Prof. M. Rho, Saclay, France	October	1. 'Migdal's theory of nuclear structure' 2. 'Muon capture'
Dr. K. V. Prasad, Microwave Associates Ltd., Cradock Road, Luton, Beds		'A class of devices based on Electrophysical phenomena'
Dr. D. A. Dubin, Imperial College of Science and and Technology, University of London, London, U.K.	December	'Model Field Theories in two discussions'
Prof. Khalatnikov, Institute of Theoretical Physics, Academy of Sciences, U.S.S.R.	December	'Hydrodynamics of mixtures of Fermi and Bose liquids.'

Lectures and Seminars by the Members of the Institute:

Name	*Title*
Professor Alladi Ramakrishnan	'L-matrix theory'[1]
Dr. R. Vasudevan	'Superconductivity formalisms'
Dr. N. R. Ranganathan	1. 'Spectral representations and current algebra' 2. 'Algebra of fields'
Dr. V. Radhakrishnan	1. 'Ginzburg-Landu theory of Super-conductivity' 2. 'Ginzburg-Landau equation for superconductor and Abrikosov's solution' 3. 'Ultrasonic attenuation in two-band superconductors'

Lecture Seminars by the Members of the Institute—(contd.)

Name	*Title*
Dr. K. H. Mariwalla	1. 'Admissibility conditions of wave functions in quantum mechanics'
	2. 'Covering algebra for the generators of the discrete symmetries'
	3. 'Relevance of certain concepts in relativity to elementary particle physics,
	4. 'Field of a charge in Uniform Acceleration'
Mr. T. S. Santhanam	1. 'Clebsch-Gordan programme for arbitrary semi-simple groups'
	2. 'Superconvergence and current algebra'
	3. 'Chiral symmetry-superconvergence and sum rules'
	4. 'Spectral functions, sum rules and super-convergence'

Research Papers — (Published and in the course of publication).

Author	*Title*
Alladi Ramakrishnan	1. 'Some new topological features of Feynman graphs (Journal of Mathematical Analysis and applications V. 17 pp. 68-91, 1967)'
	2. 'Graphical representation of CPT (Journal of Mathematical Analysis and applications V. 17 pp. 147-150, 1967)'
	3. 'A new form for the feynman propagator (Journal of Mathematics & Physical Sciences V. 1, No. 1 and 2 pp. 57-64, 1967)'
	4. 'The Dirac Hamiltonian as a member of a Hierarchy of matrices (to be published in Journal of Mathematics Analysis and applications)'
	5. 'Helicity and energy as members of a Hierarchy of eigenvalues' (to be published in Journal of Mathematics Analysis and applications).

Research Papers—(Contd.)

Author	*Title*
Alladi Ramakrishnan	6. 'Symmetry operations on a Hierarchy of matrices' (to be published in Journal of Mathematics Analysis and applications).
	7. 'On the relationship between the L-matrix Hierarchy and Cartan spinors (to be published in Journal of Mathematics Analysis and applications)'
Alladi Ramakrishnan, R. Vasudevan, N. R. Ranganathan and P. S. Chandrasekharan	8. 'A generalization of the L-matrix Hierarchy (to be published in Journal of Mathematics Analysis and applications)'
Alladi Ramakrishnan	9. 'L-matrices, Quaternions and propagators (to be published in Journal of Mathematics and Analysis and applications).
	10. 'L-matrix Hierarchy and the higher dimensional Dirace Hamiltonian (to be published in Journal of Mathematics and Physical Science)'
Alladi Ramakrishnan, R. Vasudevan and S. K. Srinivasan	'Angular correlation in Brightness of Milky way (Journal of Mathematics and Physical Sciences, V. 1, No. 1 and 2 pp. 75-84, 1967.)'
Alladi Ramakrishnan and I. V. V. Raghavacharyulu	1. 'A new combinatorial feature of Feynman graphs (Journal of Mathematics Analysis and Application V. 18, pp. 175-181, 1967).'
	2. 'A note on the representations of Dirac groups.' (Proceedings of Symposia in theoretical Physics and Mathematics. Vol. 8, Plenum Press)
S. K. Srinivasan and R. Vasudevan	1. 'Fluctuation of photoelectrons and intensity correction of light beams (IL Nuovo Ciment Seire V. Vol. 47 pp. 185-1967).'
	2. 'Fluctuation density fields.' (to be published)
T. S. Shankara	1. 'A Lie algebra of differential forms and quantum mechanics (IL Nuovo Cimento Serie X, V. 47, pp. 553–567, 1967).'
T. S. Shankara	2. 'A new phase space distribution function (Prog. Theor. Phys., V. 37, pp. 1335–1336, 1967).'

Research Papers—(Contd.)

Author	*Title*
R. Vasudevan, K. Venkatesan and N. R. Ranganathan	'A note on some solvable vector potentials for the Dirac equation' (to be published in Journal of Mathematics and Physical Sciences, Madras)
S. P. Misra and T. S. Shankara	'Semi-classical and quantum description.' (to be published in Journal of Mathematical Physics)
D. Radhakrishnan and T. S. Santhanam	'Internal multiplicity structure and Clebsch-Gordon series for the exceptional group G (2)—(to be published in Journal of Mathematical Physics.)'
A. Sundaram and R. Sridhar	Regge pole model for A2 – Meson production (Nuo. Cim. V. 50, p. 969–971, 1967)
V. Devanathan, K. Srinivasa Rao and R. Sridhar	Photoprodnction of charges pions from ^{11}B. (Phys. letters V. 25 B p. 456, 1967)
V. Devanathan, M. Rho, K. Srinivasa Rao and S. C. K. Nair	Photoproduction of charged pions from o^{16}. (Nuc. Phys. B. 2, p. 329, 1967)
R. Vasudevan, R. E. Bellman, H. Kagiwada and R. E. Kalaba	'Quasilinearization and the estimation of differential operators from eigenvalues' (To be published in communication of the ACM)
R. Vasudevan and S. K. Srinivasan	'Fluctuation of photo-electrons and intensity correlation of light beams' (Nuo. Cim. Vol. 47-B, p. 185, 1967).
R. Vasudevan and S. K. Srinivasan	'Fluctuating density fields and Brownian motion (To be pnblished in Annales, Institut Henri Poincare).
R. Vasudevan and A. K. Rajagopal	'De Haas—Van Alphen Oscillations in the critical temperature of Type II super conductors (Phy. Lett. Vol. 23, p. 539, 1966).
R. Vasudevan and S. K. Srinivasan	'Response from nonlinear switching elements (To be published in Kybernetic Journal).

R. Vasudevan and V. Radhakrishnan — 'Thermal conductivity in stutnikov phase.' (To be published).

R. Vasudevan and T. S. Shankara — 'Quantum mechanical operators and new phase space distributions. (To be published)

Under Preparation

Alladi Ramakrishnan, T. S. Santhanam and A. Sundaram — Representation mixing effects in SU_3 symmetry.

N. R. Ranganathan, T. S. Santhanam and K. Venkatesan — 1. 'A remark on Jacobi identity and C-number Schwinger terms.'

N. R. Ranganathan and K. Venkatesan — 2. 'Algebra of fields and Cancellalion of Schwinger terms.'

K. H. Mariwalla and N. R. Ranganathan — 'Some remarks on Carruther's theorem.'

R. Vasudevan and S. K. Srinivasan — 'Stochastic Kinetic equations and particle statistics.'

List of Matscience Reports (1967-1968)

Report No.	*Author*	*Title*
57	K. Srinivasa Rao & R. Sridhar	'Lectures on Nuclear models and Nuclear matter.'
58	V. V. L. Rao	'International System of Units.'
59	D. A. Dubin	'Lectures on Relativistic Physics in one space and one time dimension.'
		Under Preparation
60	R. Vasudevan	'Coherence Phenomena in Quantum Mechanical systems.'
61	T. S. Santhanam	'Group Theory and Unitary Symmetry.'

Graduate Lecture Courses

A Graduate lectures course was held at the Institute during the months of May and June 1967. The aim of this programme was to give a course of lectures in some topics of current interest in theoretical physics by all the members of the Institute. Some fresh graduates from the M.Sc. degree class intending to take up a research career and some lecturers from Madras Institute of Technology, Presidency College, Christian College and A. M. Jain College attended these lectures.

The lectures can be broadly divided into three sets:

(i) Elementary particle physics with emphasis on the roll of symmetry,

(ii) Many-body Problem, and

(iii) Nuclear Physics.

The lectures on nuclear matter by K. Srinivasa Rao and R. Sridhar have been brought out as Matscience Report No. 57 while the lectures by Dr. R. Vasudevan on Coherence Phenomena in quantum mechanical system is under preparation as a Matscience Report.

Faculty of Mathematics

Research Group:

Permanent Staff:

Dr. K. R. Unni — **Permanent Member**

Pre-doctoral Research Fellows:

Mr. N. R. Nandakumar
Miss P. K. Geetha
Mr. G. N. Keshava Murthy
Mr. M. R. Subrahmanya
Mrs. S. P. Vasanthal
Mr. G. H. Raghunath

Visiting Scientists:

Professor H. S. Shapiro (*U.S.A.*)
Professor D. Gaier (*Germany*)
Professor W. H. J. Fuchs (*U.S.A.*)
Professor J. H. Williamson (*U.K.*)
Professor S. P. Franklin (*U.S.A.*)
Professor L. A. Rubel (*U.S.A.*)

Lecture Courses by Visiting Scientists

Visiting Scientists:	*Period*	*Title*
Professor H. S. Shapiro, Department of Mathematics, University of Michigan, U.S.A.	Feb.–March	1. 'Approximation Theory.' 2. 'Some Modern investigation in classical function theory.'
Professor D. Gaier, Department of Mathematics, Mathematicsche Institut, Giessen, German.	Feb.–March	'Complex Variable proofs of Tauberian Theorems.'

Invited Lecturers

Name	*Date*	*Title*
Professor S. P. Franklin, Department of Mathematics, Carnegie Institute of Technology, U.S.A.	December	'Ordinal invariants in topological spaces.'

Lectures and Seminars by members of the Institute:

Dr. K. R. Unni continued his lecture series on 'Complex Variables.' (March to June 1967)

Research Papers:

Name	*Title*
H. S. Shapiro	1. 'Generalized analytic continuation.'
	2. 'Smoothness of the boundary function of a holomorphic function of bounded type.'
K. R. Unni and I. Q. Rahman	'Co-efficient problem for polynomials and trigonometric polynomials.'

Matscience Reports:

Report No.	*Author*	*Title*
55	H. S. Shapiro	'Smoothing and approximation of function.'
56	D. Gaier	'Complex variable proofs of Tauberian theorems.'

Collaboration with Universities

With its permanent staff, its steady influx of visiting scientists and a well-equipped library, the Institute is able to offer facilities for post-graduate students to work in pursuance of the Ph.D. degree of the various Universities in India.

It is gratifying to record here that MATSCIENCE, Institute of Mathematical Sciences has has now been recognized as a centre where students from any university can carryout research towards Ph.D. degree of his parent university.

The list of persons who have worked under Professor Alladi Ramakrishnan before and after the inception of the Institute and obtained their Ph.D. degrees are given below :—

Before the inception of the Institute :

Dr. P. M. Mathews	1956	Dr. R. Vasudevan	1960
Dr. S. K. Srinivasan	1957	Dr. N. R. Ranganathan	1961

After the inception of the Institute :

Dr. K. Venkatesan	1963	Dr. S. Indumathi	1963
Dr. V. Devanathan	1963	Dr. G. Ramachandran	1964
Dr. T. K. Radha	1963	Dr. K. Raman	1965
Dr. Thunga Satyapal	1963	Dr. R. K. Umerjee	1965
Dr. A. P. Balachandran	1963	Dr. K. Ananthanarayanan	1965
Dr. G. Bhamathi	1963		

Persons who are registered for Ph.D. of the Madras and Mysore Universities.

Mr. T. S. Shankara (Submitted thesis to Mysore)

Mr. T. S. Santhanam	Madras	Mr. A. Sundaram	Madras
Mr. K. Srinivasa Rao	,,	Mr. G. N. Keshavamurthy	,,
Mr. R. Sridhar	,,	Miss P. K. Geetha	,,

Matscience—I I. T. Seminar

Name	*Date*	*Title*
Professor D. Gaier	March	'Conformal mapping of multiply connected signs.'
Professor Alladi Ramakrishnan	April	'Helicity and energy as a member of a hierarchy of eigenvalues.'
Professor V. V. L. Rao	April	'Rationalization of units.'
Professor Alladi Ramakrishnan	October	'On the relationship between the L-matrix theory and Cartan's spinors.'
Professor S. K. Srinivasan	October	'Queing theory and imbedded Markov Process.'
Dr. R. Srinivasan	November	'Experimental methods for studying lattice vibrations in solids with special references to inelastic Neutron Scattering.'

Matscience—A. C. College Seminar

Name	*Date*	*Title*
Professor Alladi Ramakrishnan	October	'A new look at the Pauli Matrices.'
Dr. V. Devanathan	November	'Muon Capture.'

Library

Books:

During the period under report (January–December 1967) 374 new books (Pure Mathematics, Applied Mathematics, Theoretical Physics and Astrophysics) were added to the library. These include many of the recent publications in Mathematics and Physics.

We received some books from LIBRARY OF CONGRESS, U.S.A. in exchange to our MATSCIENCE REPORTS.

Periodicals:

Twenty new journals were added during this period, bringing the total number of periodicals on subscription to *one hundred and thirty seven.*

List of New Journals:

Annalen der Physik

Astrophysical Letters

Bulletin de la societe Mathematique de France

List of New Journals—(contd.)

Comentarii Mathematici Helvetici
Comments on Nuclear and Particle Physics
Fortschritte der physik
I. I. T. Journal of Mathematical and Physical Sciences
IEEE Journal of Quantum Electronics
International Journal of Quantum Chemistry
Journal of Computational Physics
Journal of Differential Equation
Journal of Differential Geometry
Journal of Functional Analysis
Journal of the Physical Society of Japan
Mathematical Biosciences
Mathematical System Theory
SIAM Journal of Control
SIAM Review
Soviet Physics - Semiconductors
Thin Film
Zeitschrift Fur Naturforchung Part A

Apart from this, nearly 30 journal are being received regularly from Institutions throughout the world in exchange to MATSCIENCE REPORTS. Also 15 journals are being received free from various institutions.

Catalogue of Periodicals is brought out once a year.

Preprints :

We receive approximately 70 preprints (papers to be published in Journals) fortnightly from institutions and scientists throughout the world and they are arranged in the filing cabinet serially. Fortnightly 'list of Preprints received' is issued regularly.

Lecture Notes :

Lecture notes of various institutions all over the world are regularly coming in exchange to our MATSCIENCE REPORTS.

Lists Published :

1. List of preprints received in the Library (issued fortnightly)
2. List of periodicals (issued yearly)
3. List of MATSCIENCE REPORTS (issued yearly)
4. List of reprints (issued yearly)

The Plenum Press Series

on

"Symposia on Theoretical Physics and Mathematics"

Edited by ALLADI RAMAKRISHNAN

The proceedings of the Summer Schools and Anniversary Symposia of the Institute are published in a series entitled 'Symposia on Theoretical Physics and Mathematics' by the Plenum Press, New York, a division of the Consultants Bureau Enterprises Inc., Volumes I to IV have been published and Volumes V to VIII are in the course of publication.