MATSCIENCE

INSTITUTE OF MATHEMATICAL SCIENCES
MADRAS, INDIA.

ELEVENTH ANNIVERSARY

ANNUAL REPORT 1972

The Institute of Mathematical Sciences

Madras

"The pursuit of science is at its best
when it is a part of a way of life"

Annual Report 1972

Patron:

Mr. C. Subramaniam

Union Minister for Industries, Science and Technology, Government of India

Chairman of the Board of Governors:

Mr. V. R. Nedunchezhiyan

Minister for Education, Government of Tamil Nadu

Director:

Professor Alladi Ramakrishnan

General Information

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 investigation 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 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.

Academic Activities

The primary activity of the Institute is creative research in Mathematical Sciences. In pursuit 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 are held.

To commemorate the inauguration of the Institute an Anniversary Symposium is held in January for which scientists from India and abroad are invited to deliver one hour addresses summarizing their original work on recent advances in various branches of Mathematical Sciences. The Institute also organises a seminar in Analysis in which lectures range from introductory to advanced levels.

Academic Staff

The Academic Staff 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 postgraduate students to work for Ph.D. degree under the guidance of the academic staff of the Institute in various faculties. Senior and Junior research fellowships are awarded by the Institute. Besides these, fellowships tenable at the Institute are awarded by the Department of Atomic Energy and the Council of Scientific and Industrial Research.

The Standing Committee of the Inter-University Board of India and Ceylon at its meeting held in February 28, 1967 adopted a resolution recognising the Institute as a suitable centre for research work. In view of the above resolution the Institute is now recognised by the various Indian Universities as a centre for research for the doctorate degree in Theoretical Physics and Mathematics.

Mode of Admission

Memberships (temporary and permanent) of the Institute are 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 academic staff of 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. Scientists intending to be invited 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 a suitable honorarium is offered.

Publications

1. RESEARCH PAPERS (Preprints and reprints are available on request)

2. MATSCIENCE REPORTS based on the lecture courses delivered at the Institute both by visiting scientists and academic staff (Price Rs. 5/- within India or U.S $ 1-00 outside India)

3. PROCEEDINGS OF THE SEMINAR IN ANALYSIS is based on lecture courses delivered at the Institute by visiting scientists or members of the Institute during the Annual Seminar in Analysis (Price Rs. 5/- within India or U.S. $ 1-00 outside India).

News of the Institute

President's visit

On 23rd December 1972, the Institute had the pleasure and privilage of welcoming His Excellency Shri V. V. Giri, the President of India, who inaugurated the Eleventh Anniversary Celebraions of the Institute. The President released the book "L-matrix theory or the Grammar of Dirac matrices" by Professor Alladi Ramakrishnan. His Excellency Shri K. K. Shah, Governor of Tamil Nadu presided over the function. On this occasion Hon'ble Thiru V. R. Nedunchezhiyan, Minister for Education, Government of Tamil Nadu and Chairman, Board of Governors of the Institute unveiled the portraits of DIRAC and PAULI and Professor J. H. Williamson of University of York, England, delivered a speech.

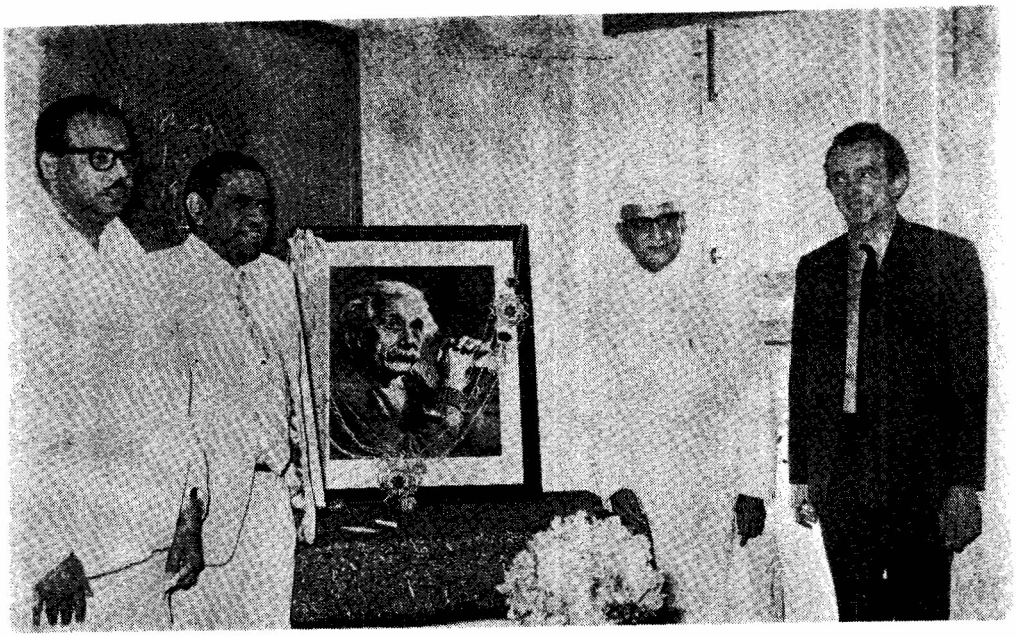
Tenth Anniversary Symposium

The TENTH Anniversary Symposium of the Institute was held for a week starting from 8th January 1972. The symposium entitled "Einstein - his contributions to physical, mathematical and philosophical thought" was inaugurated by His Excellency K. K. Shah, Governor of Tamil Nadu. On this occasion Hon'ble Mr. V. R. Nedunchezhiyan Minister for Education, Tamil Nadu and Chairman of the Board of Governors of the Institute unveiled the portrait of Einstein. Professor Gordon L. Shaw, University of California, Irvine U.S.A. delivered the inaugural address.

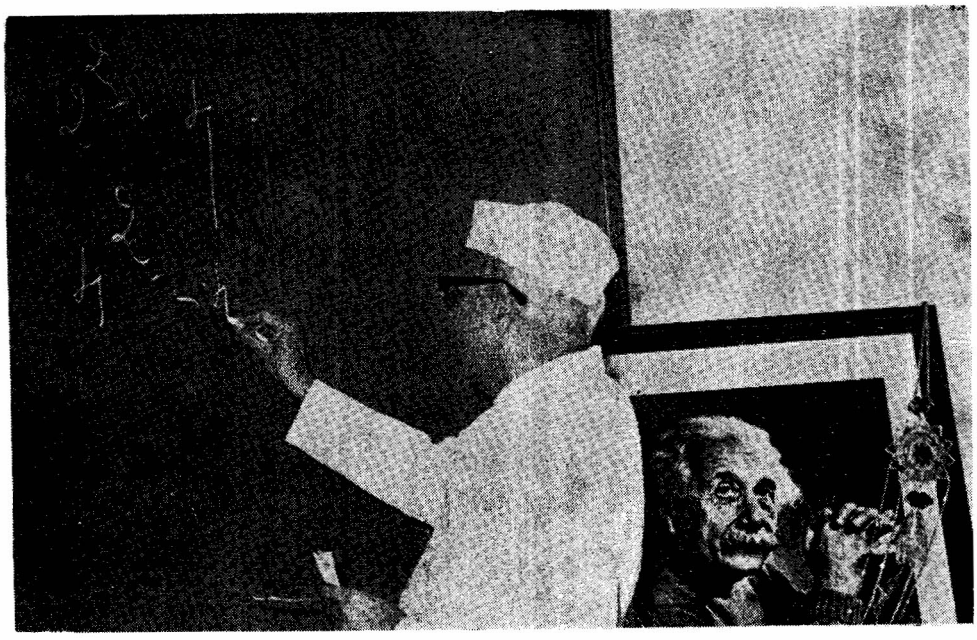
Among the scientists who delivered lectures in the symposium were Professor Alladi Ramakrishnan, Drs. Eric A. Lord, N. R. Ranganathan, V. Radhakrishnan, K. H. Mariwalla, K. Srinivasa Rao, A. R. Prasanna, R. Sridhar and T. S. Shankara.

Twin Matscience Conferences

A twin MATSCIENCE Conference entitled "Symposium on Matrix theory" and "Fifth seminar in analysis" was inaugurated by Professor Alladi Ramakrishnan at Bangalore on 11th March 1972. Dr. McCrea Hazlett, Counsellor for cultural affairs, American Embassy, New Delhi released the "Proceedings of the Conference on Clifford Algebra, its generalization and Applications". The conference on Matrix Theory was attended by lecturers and professors of the post-graduate departments of Mathematics and physics from various college in South India.



Hon'ble Thiru V. R. Nedunchezhiyan, Chairman, Board of Governors, MATSCIENCE, unveiling the portrait of Albert Einstein. (L to R) Hon'ble Thiru V. R. Nedunchezhiyan, Prof. Alladi Ramakrishnan, Director, MATSCIENCE, His Excellency K. K. Shah, Governor of Tamil Nadu and Prof. Gordon L. Shaw



His Excellency K. K. Shah, Governor of Tamil Nadu posing a mathematical problem at MATSCIENCE, on the occasion of the inauguration of the tenth anniversary symposium,

Academic Staff

Professor Alladi Ramakrishnan — *Director*

Permanent Members:

Dr. R. Vasudevan*
Dr. K. R. Unni

Associate Member:

Dr. N. R. Ranganathan

Temporary Members:

Dr. V. Radhakrishnan
Dr. T. S. Santhanam
Dr. K. H. Mariwalla
Dr. K. Srinivasa Rao
Dr. A. R. Prasanna§

Senior Research Fellows:

Dr. T. S. Shankara§
Dr. R. Sridhar
Miss P. K. Geetha
Mr. M. R. Subrahmanya
Mr. G. N. Keshavamurthy

Junior Research Fellows:

Miss Nalini B. Menon§
Miss Vimala Walter ‡
Miss G. Shanthi§
Mr. A. Tekumalla
Mr. R. Jagannathan
Miss Kasturi Nagarajan
Mr. D. Vijaya Kumar

Research Trainees:

Mr. Y. S. Prahalad
Mr. S. Mani
Mr. G. S. N. Murthy

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‡ Junior Research Fellow, CSIR Scheme

* On leave of absence at: University of Southern California, Los Angeles, California, U.S.A.

§ Persons who have completed their tenure at the Institute.

Invited Lectures

Professor Gordon L. Shaw, University of California, Irvine, USA.	"Duality in Poin-Nucleon scattering"
Professor P. R. Krishnaiah, Aerospace Research Laboratories, Wright Patterson Laboratories, U S. Air Force Base, Ohio, USA.	"Application of statistics to study the nuclear energy level distributions"
Dr. Tom R. Miller, Stanford University, Stanford, USA.	"New techniques for measurement of nuclear dipole moments"
Professor A. Ghosal, C.S.I.R., New Delhi.	"Some aspects of queuing and storage systems"
Dr. G. Rajasekaran, Tata Institute of Fundamental Research Colaba, Bombay.	"The theory of weak and electromagnetic interactions based on non-Abelian gauge symmetry"
Dr. Dennis Chakkalakal, Physics Department, Southern University, Louisiana, USA.	"The correlated basis functions method in Nuclear many-body theory"
Professor S. P. Pandya, Physical Research Laboratory, Ahmedabad, Gujarat.	"Self consistent fields"
Professor R. Isaacson, Illinois Institute of Technology, Chicago, Illinois, USA.	"Cosmic effect of gravitational waves"
Professor S. Dutta Majumdar, Indian Institute of Technology, Kharagpur.	"Finite transformations of SU (n)"

Professor Bodo Volkmann, Institute of Mathematics of the University of Stuttgart, West Germany.	1. "Recent developments in the theory of fractional dimensions" 2. "Introduction to the theory of Hansdorff measure"
Dr. A. Sundaram, S.P.K. College, Alwarkurichi.	"The puzzle of the Pomeron"
Professor G. Ripka, C.E.N. Saclay, France.	"An eikonal approach to electron scattering"
Professor R. M. Littauer, Cornell University, USA.	"The university and the high energy accelerator: Do they belong together?"
Mr. T. S. Radhakrishnan, Tata Institute of Fundamental Research, Colba, Bombay.	"Investigation of magnetic hyperfine fields using Mossbauer effect"
Professor R. Vijayaraghavan Tata Institute of Fundamenlal Research, Colaba, Bombay.	"Some recent NMR studies in magnetic and rare earth systems"
Dr. M. Rho, C.E.N. Saclay.	"Exotic currents in muon capture and lepton conservation"
Prof. P. Hariharan, Indian Institute of Science, Bangalore.	

Invitations and Delegations

In response to invitations from various research institutions, Prof. Alladi Ramakrishnan gave lectures at the following research centres abroad on his recent work during 1972:

U.S.A.: University of California at Riverside; U.S. Naval Research Laboratory Washington, D. C.; New York State University, Buffalo; Pennsylvania State University, Pennsylvania; University of R hode Island, Kingston; Rutgers University, New Jersey; University of Southern California, Los Angeles; Stanford, University, Stanford; Syracuse University, Syracuse; Utah State University Logan; University of Wyoming, Laramie; Yeshiva University, New York.

Canada: McGill University, Montreal; University of Montreal, Montreal.

In response to invitations he also gave lectures on his recent work at Calicut and Annamalai Universities.

Professor K. R. Unni, Permanent member, was invited to give a series of four lectures on "Multiplier Problem" at the Centre of Advanced Study in Applied Mathematics, University of Calcutta during April 1972.

Dr. N. R. Ranganathan delivered seminars on invitation at the Physics Departments of University of Dibrugarh; Indian Institute of Technology, Kharagpur; Saha Institure of Nuclear Physics, Calcutta. He was an invited speaker in the Workshop on Fourier optics, Holography and optical information processing organised by the Electrical Communication Engineering department of Indian Institute of Science, Bangalore. He was invited to inaugurate the Science Association of S.P.K College, Alwarkurichi; K.G. Arts College, Srivaikundam. He also delivered lectures on invitation at the Post graduate departments of physics at National College, Jamal Mohamed College, S. R. College, Trichinopoly. He was invited to deliver a series of four lectures on Generalized Clifford groups in the applied mathematics department of Madras Institute of Technology, Chrompet. He also delivered lectures at the departments of Mathematics, Indian Institute of Technology, Madras and Nuclear Physics, University of Madras. He presented a paper on magneticgroups at the Indo-Soviet Conference on Solid State Materials held at Indian Institute of Science, Bangalore during December 11-16,1972.

Dr. T. S. Santhanam on invitation gave lectures at City college of the City, university of New York on his way to the Centre for Particle Theory, Austin Texas, where he spent a month at the invitation of Prof. E. C. G. Sudarshan.

Prof. Alladi Ramakrishnan addressing the audience on the occasion of the inauguration of the twin conference on "Symposium on Matrix Theory" and "Fifth Seminar in Analysis" held by MATSCIENCE, at Woodlands Hotel, Bangalore. (L to R) Prof. Alladi Ramakrishnan, Director, MATSCIENCE, Prof. McCrea Hazlett, Counsellor for Cultural Affairs, American Embassy, New Delhi and Prof. K.R. Unni, MATSCIENCE.

On his way back he gave lectures at the Physics Department of the University of California at Los Angeles and Tokyo University of Education, Tokyo, Japan. He was invited to spend a fortnight at the Tata Institute of Fundamental Research, Bombay where he delivered two lectures.

Dr. K. H. Mariwalla was invited to give a one hour talk on problems of gravitational radiation and massless spin two field at the Seminar on Relativity and gravitation organised by the Indian Association of General Relativity and Gravitation and the Indian National Science Academy at New Delhi during November 1-3, 1972. Material on the same topic was presented under the title massless spin two fields and gravitation at the Tata Institute of Fundamental Research (10-11-1972) and the Indian Institute of Technology, Bombay (10-11-1972). He also gave talks on gravitational radiation at the Madras Institute of Technology, Madras (October 1972) and on the Teaching of Mechanics at the T.T.T.I. (September 1972). At the symposium on High energy physics (December 12-16, 1972) at Bombay he presented two papers on geometric approach to dynamical symmetries and non-linear realizations, and invariant characterization of radiation field of massless integer spin particles.

Dr. K. Srinivasa Rao participated as delegate of MATSCIENCE in the Nuclear Physics and Solid State Physics Symposium, organized by the Department of Atomic Energy at Bombay from Feb. 1-4, 1972. On his way back, he delivered a lecture on "Generalized Clifford Algebra", at the Telecommunication Department of Osmania University in response to an invitation from Professor Alladi Prabhakar. He was invited to spend two months as a visiting scientist at the Tata Institute of Fundamental Research, Bombay, during April-June 1972. During his stay he gave a special seminar on "Shell model calculations" in the Summer Institute in Advanced Quantum Mechanics conducted at Tata Institute of Fundamental Research. At the invitation of Professor G. Ripka, he participated in the First European Conference on Nuclear Physics held at Aix-en-Provence from June 26 - July 1, 1972, by presenting a paper on "Photoproduction of charged pions from ^{16}O in the Saxon-Woods basis". During his two month stay in Europe, he delivered lectures at C E.N., Saclay, France, Institute de Physique Nucleaire, Orsay, France and University of Freiburg, Germany and also had discussions with the physicists at Atomic Energy Research Establishment, Harwell, Berkshire; Universities of Sussex and Oxford; Rutherford Laboratories, Chilton, Berkshire; Imperial College, London; CERN, Geneva, Switzerland and ICTP, Trieste, Italy. As a delegate of MATSCIENCE, he presented a paper of Professor Alladi Ramakrishnan on "Some new topological and combinatorial features of Feynman graphs" at

the conference on "Combinatorial mathematics and its applications" held at Delhi from December 22 to 27, 1972. He has been invited by the Department of Atomic Energy to be the Chairman for a session on "Nuclear Reactions II" in the Nuclear Physics and Solid State Physics Symposium held at Chandigarh from December 28, 1972 to January 1, 1973.

Miss. P. K. Geetha gave a lecture at the department of Mathematics, University of Punjab, Chandigarh on "Multipliers and multiplier transformations", on 12th July. She was invited to inaugurate the activities of the Mathematics Association of the Vivekananda College, Madras on 12th September and a survey of the elements of approximation theory was presented on that occasion.

Dr. R. Sridhar gave a series of four lectures on "Theory of Quantum Fluids" at the Department of Mathematics, Indian Institute of Technology, Madras at the invitation of Professor S. D. Nigam. He also participated as a delegate at the Indo-Soviet Conference on Solid State Materials held at the Indian Institute of Science, Bangalore during December 11-16, 1972.

Mr. A. R Tekumalla participated, in the First Symposium on High Energy Physics organised at Bombay by the Tata Institute of Fundamental Research in December.

Mr. R. Jagannathan participated as a delegate of MATSCIENCE in the Annual Conference of the Indian Mathematical Society, held at Bhopal in December 1972.

Research Papers

Theoretical Physics

Alladi Ramakrishnan

The weak interaction Hamiltonian in L-matrix theory
(J. Math. Anal Appl., 37, 432-434, 1972)

On the shell structure of an L-matrix
(J. Math. Anal Appl., 38, 106-108, 1972)

A matrix decomposition theorem.
(J. Math. Anal. Appl, 40, 36-38, 1972)

A new approach to Quantum numbers in elementary particle physics.
(The structure of matter – Rutherford centennial symposium, New Zealand 1972, ed by B. G. Whybourne, pp. 150-156, 1972)

Stochastic theory of evolutionary processes (1937-71)
(Stochastic point processes, Lewis, Ed. pp. 533-548, John Wiley, 1972)

R. Vasudevan (with S. K. Srinivasan)

Photoelectron statistics due to mixing of different types of fields
(Nuovo Cim. (11) 8B, 278-282, 1972)

R. Vasudevan, R. Sridhar (with R. Pratap)

Collective effects in an electron gas-a study in de Haas-van Alphen oscillations
(Nuovo Cim, (11) 8B, 223-241, 1972)

N. R. Ranganathan

Hadamard matrices and optical information proceesing
(Proceedings of Workshop on Fourier Optics, Holography, Optical Information Processing, Indian Institute of Science, Bangalore, 1972)

N. R. Ranganathan and R. Jagannathan

On generalized Clifford groups I
(Reports on Mathematical Physics, in press)

Generalized Clifford groups and magnetic translation groups
(Proc. of Indo-Soviet Conf. on Solid State Materials,
Indian Institute of Science, Bangalore, 1972)

K. H. Mariwalla

Conformal invariance of zero mass Klein-Gordan type equation
(Lettere Nuo. Cim. (2), 4, 295, 1972)

Applications of the concept of strength of a system of partial differential equations.
(J. Math. phys., in press)

Geometrization of Geafton field and its physical interpretation.
(Proc. Conference on Cosmology, gravitation and application to Particle Theory, Bangalore, 1971)

Conservation of laws in classical and quantum mechanics and in general relativity
(Proc. Conference on Cosmology, gravitation and application to particle theory, Bangalore, 1971)

Mechanics of the growth of photolytic silver
(Proc. symposium on Photographic sinsitivity, Royal Photographic Soc., Sept., 1972)

History in the teaching of physics
(Proc. Inter. working seminar in the role of history of physics in Physics Education, S. G. Brinsh and A.L. King, Ed. Univ. Press of New England, Hanover (N.H), p. 108, 1972)

T. S. Santhanam

Configuration mixing and renormalization in Cabibbo theory
(Lettere Nuo. Cim. (2) 3, 454, 1972)

Remarkable connection between multi - Veneziano integrand and the character function of special unitary group
(J. Math. Phys., in press)

T. S. Santhanam and A. R. Tekumalla

Relativistic wave equations describing the neutrinos
(Lettere Nuo. Cim. (2) 3, 190-193, 1971)

A note on the matrix theory of symmetrical component networks for N - Phase systems
(Matrix and Tensor Quarterly, 21, 121, 1971)

Bhabha's equations for unique mass and spin
(Proc. of the First High Energy Physics Symp., Bombay, Dec. 1972)

T S. Santhanam (with Nalini B. Menon and P. S. Chandrasekaran)

A class of linear relativistic wave equations describing particles with spin $\frac{1}{2}$
(Prog. Theor. Phys., 47, 671-677, 1972)

A. R. Prasanna

A new invariant for electromagnetic fields in curved space-time.
(Phys. Lett., A37, 331-332, 1972)

K. Srinivasa Rao

Analogs of giant resonances and photoproduction of positive pions from ^{16}O.
(J. Phys., A, 4, 928-933, 1971)

Photoproduction of charged pions from 160 in the Saxon-Woods basis
(Proc. European Conf. on Nucl. Phys., Aix-en-Provence, France, V. 2, pp. 135. 1972 Proc. of Nucl. Phys. and Solid State Phys., Symp., Bombay, V. 14B, p. 143, 1972)

K. Srinivasa Rao (with R. Parthasarathy and V. Devanathan)

Influence of realistic deuteron wave functions on neutral pion photoproduction cross sections.
(Nuo. Cim, (11), in press)

R. Sridhar

Excited states generated by densities and currents for an interacting Bose gas
(Prog. Theor. Phys., 47, 1772-1773, 1972)

Collective effects in an electron gas - II
(Nuovo. Cim. (11) 10B, 36, 1972)

Magnetoplasma effects in semiconductors
(Proc. Indo-Soviet conference on Solid State Materials, Indian Institute of Science, Bangalore, 1972)

R. Sridhar (with R. Pratap)

Statistical mechanics of magnetoactive plasma.
(Nuovo. Cim. (11) 9B, 279, 1972)

A. R. Tekumalla (with I. V. V. Raghavacharyulu)

Solution of the difference equations of generalized Lucas polynomials.
(J. Math. Phys., 13, 321-324, 1972)

Pure Mathematics

G. N. Kesavamurthy and K. R. Unni

Multipliers on space of Wiener functions.
(Nanta Mathematica, in press)

A. L. Brown

On the space of subspaces of a Banach space.
(J. London Math. Soc., (2) 5, 67-73, 1972)

MATSCIENCE REPORTS

Report Number	*Author*	*Title*
73	R. Sridhar	Lectures on the Theory of Quantum Fluids.
74	Krishnaswami Alladi	Contributions to Number theory.

Library

Books:

During the year under report 850 new books, including bound periodicals and lecture notes were added to the library bringing the total number of volumes to 11,668. These include many of the recent publications in pure mathematics and theoretical physics.

Periodicals:

Exchange contacts were established with the following four institutions for MATSCIENCE REPORTS and SEMINAR IN ANALYSIS and we started receiving the following items from them:

Nanyang University, Singapore	"Nanta Mathematica"
Queen's University, Kingston, Canada	"Queen's papers on pure and applied mathematics"
Tokyo Institute of Technology, Tokyo, Japan	"Kodai Mathematical Seminar Reports"
Yokohama City University, Yokohama Japan	"Yokohama Mathematical Journal"

Apart from these we are regularly receiving periodicals and lecture notes from 39 institutions throughout the world in exchange.

Preprints:

The library maintains a preprint collection. On an average, approximately 150 preprints were received per month from institutions like CERN, NORDITA, Berkeley, Trieste, Princeton, etc.

Lecture Notes:

Lecture Notes of various institutions all over the world are regularly received in exchange to MATSCIENCE REPORTS and SEMINAR IN ANALYSIS

Lists Published:

1. List of Preprints received in the library (issued Fortnightly)
2. List of Periodicals (issued Yearly)
3. List of available MATSCIENCE REPORTS and SEMINAR IN ANALYSIS (issued Yearly)
4. List of Institute Reprints (issued Yearly)
5. List of Institute Preprints (issued Yearly)

25
Years of research

Alladi Diary

1947 – 1972

SILVER THOUGHTS

What a fortunate visitation of God's grace it is to greet the President of India at a time when our nation is celebrating the silver jubilee of its independence! What a happy thought it is for me that I am completing twentyfive years of research in mathematical sciences and receiving in person his blessings for the book which represents the essence of my efforts during this period.

I remember vividly the day when I met Professor Bhabha during my stay in Delhi in 1947 when I was acting as a personal assistant to my great father who was engaged in the high task of drafting the Indian Constitution. At that period the atmosphere in India was charged with triumph and hope. After years of unrelenting struggle against the proud British empire the prospect of a prosperous future seemed to unfold before a redeemed people. Fascinated by the reputation of Bhabha and enchanted by his personal charm I leapt into the scientific world leaving the ready and rightful inheritance of a legal career. My gracious mother endorsed my choice and my generous father blessed me in the new endeavour.

The great excitement in science is the pursuit of the first problem and this came as a gift from Bhabha of the famous unsolved fluctuation problem of cosmic radiation. Untrammelled by conventional training I plunged into speculation and surmise which resulted in my first work on product densities in stochastic processes. Since its scope stretched beyond the immediate interests of Professor Bhabha I had to seek the guidance of Professors Bartlett and Kendall, the leaders of stochastic theory in England. Returning to India in 1951 I was given the privilege of initiating the physics department of the Madras University in the modest position of a reader in theoretical physics. Till 1956 I worked on the theory of stochastic processes and indulged in an impertinent but enjoyable intrusion into the hallowed domain of astrophysics. Chance and circumstance then took me to the Yukawa Hall in Kyoto and to the famous Institute for Advanced Study at Princeton. Close contact with Professor Oppenheimer drew me into the domain of elementary particle physics and the four years after my return from Princeton were spent in groping and searching for new areas of research in high energy physics.

Meanwhile by a miraculous turn of fortune, through the grace of Professor Bohr, the support of our Prime Minister Nehru and the efforts of Mr. C. Subramaniam, I was invested with opportunities to serve an institute of advanced learning

which corresponded in every aspect to my own vision of a haven of creative science. My own prediliction towards mathematical methods asserted itself in preference to phenomenological physics and the main contributions we made were the uncovering of new topological and combinatorial features of Feynman graphs. This encouraged me to tackle an old, neglected but unsolved problem of the transition from Pauli to Dirac matrices. The answer came out as a simple revelation rather than as a profound deduction and once it was obtained it was possible to weave systematically the logical pattern into which the Pauli and Dirac matrices could be imbedded. It yielded a new approach to matrix theory which enabled me to understand in a deeper way the creators of matrix analysis like Sylvester, Clifford, Cayley and Hamilton on the one hand and the makers of modern physics like Pauli, Dirac, Feynman and Gell-Mann on the other.

The generous hospitality of the American institutions provided me opportunities to undertake several round the world missions accompanied by my wife and son to propagate the new methods of matrix theory in over a hundred international centres of higher learning and research. I was encouraged in my efforts by the thoughtful opinion of our sympathetic Chairman, Mr. Nedunchezhiyan that mathematics is a discipline which develops the ability of logical reasoning and rational approach. The experience of twentyfive years of research makes me yield to the exalted thought that :

'The physical universe is a revelation of mathematical logic'.

The astronauts may have brought home the same message after their lunar Odyssey.

ALLADI RAMAKRISHNAN.

December 1972

LIST OF PUBLICATIONS

of

Professor ALLADI RAMAKRISHNAN

DURING THE PERIOD

1947—1972

Astrophysics

1. On an integral equation of Chandrasekhar and Munch.
(Astrophysical Jour. **115**, 141, 1952)

2. A stochastic model of a fluctuating density field - I.
(Astrophysical Jour. **119**, 443, 1954)

3. A stochastic model of a fluctuating density field - II.
(Astrophysical Jour. **119**, 682, 1954)

4. ——— (with P. M. Mathews)
On the solution of an integral equation of Chandrasekhar and Munch.
(Astrophysical Jour. **119**, 81, 1954)

5. On stellar statistics.
(Astrophysical Jour. **122**, 24, 1955)

6. ——— (with S. K. Srinivasan)
Correlation problems in the study of the brightness of the milky way.
(Astrophysical Jour. **123**, 479, 1956)

7. ——— (with R. Vasudevan)
On the distribution of visible stars.
(Astrophysical Jour. **126**, 573, 1957)

8. ——— (with R. Vasudevan and S. K. Srinivasan)
Angular correlations in brightness of the milky way.
(Jour. Mathl. and Phyl. Sci., **1**, 75, 1967)

Monographs

1. Probability and stochastic processes.
(Handbuch der Physik, V. 3, Springer-Verlag, pp. 524-651, 1959)

2. Elementary Particles and Cosmic Rays.
(Pergamon Press, 580 p. 1962)

3. L–Matrix Theory or The Grammar of Dirac Matrices
(Tata McGraw-Hill, Delhi, 1972)

Cosmic Rays

1. A note on the size frequency distribution of penetrating showers.
(Proc. Phys. Soc., London, **A63**, 861, 1950)

2. ——— (with H. J. Bhabha)
The mean square deviation of the number of electrons and quanta in cascade theory.
(Proc. Ind. Acad. Sci., **32A**, 141, 1950)

3. A note on Janossy's mathematical model of a nucleon cascade.
(Proc. Camb. Phil., Soc., **48**, 451, 1952)

4. ——— (with P. M. Mathews)
Studies in the stochastic problem of Electron-Photon cascades.
(Prog. Theor. Phys.. **11**, 95, 1954)

5. ——— (with S. K. Srinivasan)
Two simple stochastic models of cascade multiplication.
(Prog. Theor. Phys., **11**, 595, 1954)

6. ——— (with S. K. Srinivasan)
Fluctuations in the number of photons in an electron-photon cascade.
(Prog. Theor. Phys., **13**, 93, 1955)

7. ——— (with S. K. Srinivasan)
A new approach to cascade theory.
(Proc. Ind. Acad. Sci., **44A**, 263, 1956)

8. ——— (with S. K. Srinivasan)
A note on the cascade theory with ionisation loss.
(Proc. Ind. Acad. Sci., **45A**, 133, 1957)

9. ——— (with S. K. Srinivasan, N. R. Ranganathan and R. Vasudevan)
Multiple processes in electron-photon cascades.
(Proc. Ind. Acad. Sci., **45A**, 311, 1957)

10. ——— (with S. K. Srinivasan)
A note on electron-photon showers.
(Nulc. Phys., **25**, 152, 1961)

11. ——— (with P. M. Mathews)
Numerical work on the fluctuation problem of electron cascades.
(Prog. Theor. Phys., **9**, 679, 1953)

12. ——— (with R. Vasudevan and S. K. Srinivasan)
Some new mathematical features of cascade theory.
(Inter. Conf. on Cosmic Rays, V. 5, p. 498–501, TIFR, Bombay, 1964)
(Jour. Math. Anal. Appl., **11**, 278, 1965)

Stochastic Processes and Methods

1. Stochastic processes relating to particles distributed in a continuous infinity of states.
(Proc. Camb. Phil. Soc., **46**, 595, 1950)

2. Some simple stochastic processes.
(Jour. Roy. Stat. Soc., **B13**, 131, 1951)

3. ——— (with P. M. Mathews)
On a class of stochastic integro-differential equations.
(Proc. Ind. Acad. Sci., **38A**, 450, 1953)

4. ——— (with P. M. Mathews)
A stochastic problem relating to counters.
(Phil. Mag., (7), **44**, 1122, 1953)

5. Stochastic processes associated with random division of a line.
(Proc. Camb. Phil. Soc., **49**, 473, 1953)

6. On counters with random dead time.
(Phil. Mag., (7), **45**, 1050, 1954)

7. On the molecular distribution functions of a one-dimensional fluid - I.
(Phil. Mag. (7), **45**, 401, 1954)

8. ——— (with P. M. Mathews)
On the molecular distribution functions of a one-dimensional fluid - II.
(Phil. Mag. (7), **45**, 1053, 1954)

9. Phenomenological interpretation of the integrals of a class of random functions I & II.
(Nederl-Akad. Wetensch. Proc. Ser. A, **58**, and Indag. Math. **17**, 470, 634, 1955)

10. ——— (with P. M. Mathews)
Straggling of the range of fast particles as a stochastic process.
(Proc. Indian Acad. Sci., **41A**, 202, 1955)

11. Inverse probability and evolutionary Markoff stochastic processes.
(Proc. Ind. Acad. Sci., **41A**, 145, 1955)

12. ——— (with P. M. Mathews)
Stochastic processes associated with a symmetric oscillatory Poisson processes.
(Proc. Ind. Acad. Sci., **43A**, 84, 1956)

13. Processes represented as integrals of a class of random functions.
(Nederl-Akad. Wetensch. Proc. Ser. A, **59**, and Idag. Math. **18**, 120, 1956)

14. A physical approach to stochastic processes.
(Proc. Ind. Acad. Sci., **44A**, 428, 1956)

15. ——— (with S. K. Srinivasan)
Stochastic integrals associated with point processes (in French).
(Publ. Inst. Statist. Univ., Paris, **5**, 95, 1956)

16. Ergodic properties of some simple stochastic processes.
(Z. Angeno Math. Mech., **37**, 336, 1957)

17. Ambigenous stochastic processes.
(Z. Angeno Math. Mech., **39**, 389, 1959)

18. ——— (with S. K. Srinivasan)
On age distribution in population growth.
(Bull. Math. Bio-Physics, **20**, 289, 1958)

19. Applications of the theory of stochastic processes to physical problems.
(Studies in Theor. Phys., Proc. Summer School, Mussoorie, 1959, pt. 2, pp. 239–253, 1960)

20. ——— (with R. Vasudevan and P. Rajagopal)
Ambigenous stochastic processes.
(Jour. Math. Anal. Appl. **1**, 145, 1960)

21. ——— (with R. Vasudevan)
A physical approach to limiting stochastic operations.
(Jour. Ind. Math. Soc., (N. S.) Golden Jubilee, Vol. **24**, 457, 1961)

22. ——— (with T. K. Radha)
Correlation problem in evolutionary stochastic processes.
(Proc. Camb. Phil. Soc., **57**, 843, 1961)

23. ——— (with K. Venkatesan)
Some new stochastic aspects in cascade theory.
(Proc. 7th Annual Cosmic Ray Symposium, Chandigarh, pp. 59–61, 1961)

24. ——— (with N. R. Ranganathan)
Stochastic methods in quantum mechanics.
(Jour. Math. Anal. Appl., 3, 261, 1962)

25. ——— (with R. Vasudevan and S. K. Srinivasan)
Scattering phase shifts in stochastic fields.
(Zeit. fur Physik, **196**, 112, I966)

26. ——— (with R. Vasudevan S. K. Srinivasan)
Some new mathematical features of cascade theory.
(Jour. Math. Anal. Appl., **11**, 278, 1965)

27. ——— (with S. K. Srinivasan and R. Vasudevan)
Multiple product densities.
(Jour. Mathl. and Phyl. Sci., **1**, 275, 1969)

Elementary Particle Physics

1. Theoretical Physics in the U.S.A.
   (Current Science, **27**, 469, 1958)

2. ——— (with N. R. Ranganathan and S. K. Srinivasan)
   Meson production in nucleon-nucleon collisions.
   (Nucl. Phys., **10**, 160, 1959)

3. ——— (with N. R. Ranganathan, S. K. Srinivasan and K. Venkatesan)
   Photo-mesons from polarized nucleons.
   (Proc. Ind. Acad. Sci., **49A**, 302, 1959)

4. ——— (with N. R. Ranganathan and S. K. Srinivasan)
   A note on the interaction between nucleon and antinucleon.
   (Proc. Ind. Acad. Sci., **50A**, 91, 1959)

5. Perturbation expansions and Kernel functions associated with single particle wave functions.
   (Proc. of the Summer School, Mussoorie, Pt. 1, pp. 1–14, 1959)

6. ——— (with N. R. Ranganathan, R. Vasudevan and S. K. Srinivasan)
   A note on dispersion relations.
   (Nucl. Phys., **15**, 516, 1960)

7. ——— (with A. P. Balachandran and N. R. Ranganathan)
   Some remarks on the structure of elementary particle interactions.
   (Proc. Ind. Acad. Sci., **53A**, 1, 1961)

8. ——— (with G. Bhamathi and S. Indumathi)
   A limiting process in quantum electrodynamics.
   (Proc. Ind. Acad. Sci., **53A**, 206, 1961)

9. ——— (with V. Devanathan and G. Ramachandran)
   Elastic photo-production of neutral pions from deuterium.
   (Nucl. Phys., **24**, 163, 1961)

10. ——— (with A. P. Balachandran, N. R. Ranganathan and N. G. Deshpande)
    On isobaric spin scheme for leptons and the leptonic decays of strange particles.
    (Nucl. Phys., **26**, 52, 1961)

11. ——— (with G. Ramachandran and V. Devanathan)
A time dependent approach to rearrangement collisions.
(Nuovo Cim., **21**, 145, 1961)

12. ——— (with R. Thunga and T. K. Radha)
Physical basis of quantum field theory.
(Jour. Math. Anal. Appl., **4**, 494, 1962)

13. ——— (with R. Thunga, T. K. Radha, S. Indumathi and G. Bhamathi)
Some consequences of spin 3/2 for Ξ.
(Nuovo Cim., (10), **22**, 604, 1961)

14. ——— (with R. Thunga and T. K. Radha)
Possible resonances in Ξ - p reactions.
(Nucl. Phys., **32**, 517, 1962)

15. ——— (with V. Devanathan and K. Venkatesan)
On the scattering of pions by deuterons.
(Nucl. Phys., **29**, 680, 1962)

16. ——— (with A. P. Balachandran)
Partial wave dispersion relation for Lambda-Nucleon scattering.
(Nuovo Cim., (10), **24**, 980, 1962)

17. ——— (with A. P. Balachandran, T. K. Radha and R. Thunga)
Photoproduction of pions from Λ - hyperons.
(Nuovo Cim., (10), **25**, 939, 1962)

18. ——— (with A. P. Balachandran, T. K. Radha and R. Thunga)
On the spin and parity of the Y* - resonances.
(Nuovo Cim., (10), **25**, 723, 1962)

19. ——— (with G. Bhamathi, R. Thunga, T. K. Radha and S. Indumathi)
Dispersion analysis of Ξ production in $\bar{K}$ - N collisions.
(Nucl. Phys., **37**, 585, 1962)

20. ——— (with T. K. Radha, R. Thunga, and A. P. Balachandran)
On the Y* - resonances.
(Nuovo Cim., (10) **24**, 1006, 1962)

21. ——— (with A. P. Balachandran and K. Raman)
Low energy K^+ - nucleon scattering.
(Nuovo Cim., (10) **24**, 369, 1962)

22. ——— (with T. K. Radha, R. Thunga and K. Raman)
Quantum numbers and decay models of the resonances.
(Rand Corporation preprint, 1962)

23. Quantum mechanics of the photon.
(Proc. of Summer School, Mussoorie, p. 15–18, 1959)

24. ——— (with G. Ramachandran)
Magnetic bremsstrahlung in neutron-electron collisions.
(Rand Corporation preprint, 1962)

25. ——— (with T. K. Radha)
Essay on "symmetries".
(Lect. series at the Kodaikanal Summer School, Kodaikanal pt. II, p. 1–77, 1961)

26. ——— (with K. Raman and R. K. Umerjee)
Isobar production in nucleon-nucleon collisions—I.
(Nucl. Phys., **60**, 401, 1964)

27. ——— (with K. Raman and R. K. Umerjee)
Isobar production in nucleon-nucleon collisions—II.
(Nucl. Phys., **66**, 609, 1965)

28. Fundamental multiplets.
(ICTP, Trieste preprint IC/65/49, 6 p. 1965)
(Symp. in Theor. Phys. and Maths., ed. by Alladi Ramakrishnan, V. 5, pp. 85–92, Plenum Press, N.Y., 1967)

29. New perspectives on the Dirac Hamiltonian and Feynman.
(Proceedings of the 1967 Colorado Summer School, Gordon & Breach)

30. An unconventional views of perturbation expansions
(Proc. Inter. Seminar on Unified Field Theory, Uni. of Rochester, p. 411–421, 1963)

31. ——— (with K. Venkatesan and T. S. Shankara)
Sensitivity of the vector coupling constant to μ—Neutrino mass and T—invariance.
(Nuovo Cim., (10) **37**, 1046, 1965)

Field Theory and Feynman Graphs

1. ——— (with T. K. Radha and R. Thunga)
   On the decomposition of the Feynman propagator.
   (Proc. Ind. Acad. Sci., **52A**, 228, 1960)

2. ——— (with T. K. Radha and R. Thunga)
   On the concept of virtual states.
   (Jour. Math. Anal. Appl., **5**, 225, 1962)

3. ——— (with K. Venkatesan and V. Devanathan)
   A note on the use of Wick's theorem.
   (Jour. Math. Anal. Appl., **8**, 345, 1964)

4. CPT in Feynman formalism.
   (Jour. Math. Anal. Appl., **17**, 147, 1967)

5. ——— (with I. V. V. Raghavacharyulu)
   New combinatorial features of Feynman graphs.
   (Jour. Math. Anal. Appl. **18**, 175, 1967)

6. Some new topological features of Feynman graphs.
   (Jour. Math. Anal. Appl., **17**, 68, 1967)

7. New perspectives on the Dirac Hamiltonian and the Feynman propagator.
   (High Energy Physics and Fundamental Particles, pp. 665–672,
   Gordon & Breach, N.Y., 1965)

8. A new form of Feynman propagator.
   (Jour. Mathl. and Phyl. Sci., **1**, 57, 1967)

Theory of L - Matrices

1. The Dirac Hamiltonian as a member of a Hierarchy of matrices.
   (Jour. Math. Anal. Appl., **20**, 9, 1967)

2. Helicity and energy as members of a Hierarchy of Eigenvalues.
   (Jour. Math. Anal. Appl., **23**, 397, 1967)

3. Symmetry operations on a Hierarchy of matrices.
   (Jour. Math. Anal. Appl., **22**, 39, 1967)

4. ——— (with I. V. V. Raghavacharyulu)
   A note on the representations of Dirac groups.
   (Symp. in Theor. Phys. and Maths., ed by Alladi Ramakrishnan, V. 8, 25–32, Plenum Press, N. Y.,)

5. On the relationship between the L-matrix Hierarchy and Cartan spinors.
   (Jour. Math. Anal. Appl., **22**, 570, 1968)

6. ——— (with R. Vasudevan, N. R. Ranganathan and P. S. Chandrasekaran)
   A generalization of the L-matrix hierarchy.
   (Jour. Math. Anal. Appl., **23**, 10, 1968)

7. L-matrices, quaternions and propagators.
   (Jour. Math. Anal. Appl., **23**, 250, 1968)

8. On the algebra of L-matrices.
   (Symp. in Theo. Phys. and Maths., ed by Alladi Ramakrishnan, V. 9, pp. 73–78, 1969, Plenum Press, N. Y.,)

9. ——— (with R. Vasudevan)
   A Hierarchy of idempotent matrices.
   (Symp. in Theor. Phys. and Maths., ed by Alladi Ramakrishnan, V. 9, pp. 85–88, 1969, Plenum Press. N. Y.,)

10. L-matrix hierarchy and higher dimensional Dirac Hamiltonian.
    (Jour. Mathl. and Phyl. Sci., **1**, 190, 1967)

11. L-matrices, propagators with imaginary parameters.
    (Symp. in Theor. Phys. and Maths., ed by Alladi Ramakrishnan, V. 9, pp. 79–84, Plenum Press, 1969)

12. Generalized helicity matrices.
(Jour. Math. Anal. Appl., **26**, 88, 1969)

13. ——— (with P. S. Chandrasekaran, T. S. Santhanam and A. Sundaram)
Helicity matrices in the generalized Clifford algebra.
(Jour. Math. Anal. Appl., **26**, 275, 1969)

14. ——— (with P. S. Chandrasekaran and T. S. Santhanam)
L-matrices and the fundamental theorem of spinor theory.
(Symp. in Theor. Phys. and Maths., ed. by Alladi Ramakrishnan, V. 10, pp. 63–68, Plenum Press, 1970)

15. ——— (with T. S. Santhanam and P. S. Chandrasekaran)
On the representations of generalized Clifford algebra.
(Jour. Mathl. and Phyl. Sciences, **3**, 307, 1969)

16. ——— (with P. S. Chandrasekaran, N. R. Ranganathan, T. S. Santhanam and R. Vasudevan)
The generalised Clifford algebra and the unitary group.
(Jour. Math. Anal. Appl., **27**, 164, 1969)

17. ——— (with R. Vasudevan, P. S. Chandrasekaran and N. R. Ranganathan)
Kemmer algebras from generalized Clifford elements.
(Jour. Math. Anal. Appl., **28**, 108, 1969)

18. Pageant of modern physics - Planck to Gell-mann.
(C. P. Ramaswamy Iyer Memorial Volume, Madras)

19. Unitary generalization of Pauli matrices.
(Symp. in Theor. Phys. and Maths. ed. by Alladi Ramakrishnan, V. 10, pp. 51–57, Plenum Press, 1970)

20. ——— (with P. S. Chandrasekaran, N. R. Ranganathan, T. S. Santhanam and R. Vasudevan)
Idempotent matrices from a generalized Clifford algebra.
(Jour. Math. Anal. Appl., **27**, 563, 1969)

21. ——— (with I. V. V. Raghavacharyulu)
Generalized Clifford basis and infinitesimal generators of unitary groups.
(Symp. in Theor. Phys. and Maths., ed by Alladi Ramakrishnan, V. 10, pp. 59-62, Plenum Press, 1970)

22. ——— (with R. Vasudevan and P. S. Chandrasekaran)
Representation of Para-Fermi rings and generalized Clifford algebra.
(Jour. Math. Anal. Appl., **31**, 1, 1970)

23. ——— (with R. Vasudevan and P. S. Chandrasekaran)
Algebras derived from polynomial conditions.
(Jour. Math. Anal. Appl., **35**, 131, 1971)

24. On the composition of generalized helicity matrices.
(Jour. Math. Anal. Appl., **31**, 254, 1970)

25. Should we revise our notions about spin and parity in relativistic quantum theory?
(Jour. Mathl. and Phyl. Sci., **3**, 213, 1969)

26. Symmetries associated with the roots of the unit matrix.
(Jour. Mathl. and Phyl. Sci., **3**, 317, 1969)

27. ——— (with R. Vasudevan and P. S. Chandrasekaran
Para-Fermi operators and special unitary algebras.
(Jour. Math. Anal. Appl., **35**, 249, 1971)

28. ——— (with R. Vasudevan)
On generalized Idempotent matrices.
(Jour. Math. Anal. Appl., **32**, 414, 1970)

29. Mathematical logic as a guide to physical thought.
(Science Reporter, **7**, 24, 1970)

30. New generalizations of Pauli matrices.
(Proc. inter. conf. on symmetries and quark models ed. by Ramesh Chand, Wayne State Univ., (1969), pp. 133–138, Gordon & Breach, 1970)

31. The weak interaction Hamiltonian in L-matrix theory.
(Jour. Math. Anal. Appl., **37**, 432, 1972)

32. On the shell-structure of an L-matrix.
(Jour. Math. Anal. Appl., **38**, 106, 1972)

33. A matrix decomposition theorem.
(Jour. math. Anal. Appl., 40, 36, 1972)

LIST OF JOURNALS IN WHICH PROFESSOR ALLADI RAMAKRISHNAN'S RESEARCH PAPERS WERE PUBLISHED:

1. Astrophysical Journal (Chicago, USA)
2. Bulletin of the Mathematical Bio-Physics (Michigan, USA)
3. Current Science (Bangalore, India)
4. Indagationes Mathematicae (Proc. Netherlands Academy of Sciences, Sec. A) (Amsterdam, Netherlands)
5. Journal of the Indian Mathematical Society (Delhi, India)
6. Journal of Mathematical Analysis and Applications (New York, USA)
7. Journal of Mathematical and Physical Sciences (Madras, India)
8. Journal of the Royal Statistical Society, Sec. B (London, England)
9. Nuclear Physics (Amsterdam, Netherlands)
10. IL Nuovo Cimento (Bologna, Italy)
11. Philosophical Magazine (London, England)
12. Proceedings of the Cambridge Philosophical Society (London, England)
13. Proceedings of the Indian Academy of Sciences (Bangalore, India)
14. Proceedings of the Physical Society, London, Sec. A (London, England)
15. Progress of Theoretical Physics (Kyoto, Japan)
16. Publications of Institute of Statistics, Univ. Paris, (Paris, France)
17. Science Reporter (Delhi, India)
18. Zeitschrift fur Angewandte Mathematik und Mechanik (Berlin, West Germany)
19. Zeitschrift fur Physik (Berlin, Germany)

LIST OF INSTITUTIONS
AT WHICH PROFESSOR ALLADI RAMAKRISHNAN, DIRECTOR, MATSCIENCE GAVE LECTURES ON HIS RESEARCH WORK

UNITED STATES OF AMERICA

University of Arizona at Tempe (1970)
Bell Telephone Laboratories, New Jersey (1963)
Boeing Research Laboratories, Seattle, Washington (1968–69)
Boston University, Boston (1967)
University of California, Berkeley (1962, 65, 71)
University of California, Irvine (1966–71)
University of California, Los Angeles (1962, 69)
University of California at Riverside (1971, 72)
Case Institute of Technology, Cleveland (1958)
University of Chicago, Chicago (1956)
University of Colorado, Boulder (1962)
Cornell University, Ithaca (1967)
Courant Institute of Mathematical Sciences, New York (1967)
University of Dayton, Dayton, Ohio (1968–70)
Douglas Aircraft Corporation, New York (1966–69)
General Motors Research Laboratories, Detroit, Michigan (1969)
University of Hawaii, Honolulu (1966–69)
Hughes Research Laboratories, Malibu, California (1962)
Howard University, Washington, D. C. (1971)
Illinois Institute of Technology, Chicago (1958)
University of Illinois, Urbana (1970)
Institute of Advanced Study, Princeton (1957–58)
Institute of Theoretical Physics, M.I.T., Cambridge (1968)
Iowa State University, Iowa (1971)
Lockheed Aircraft Corporation, New York (1969)
St. Louis University, St. Louis (1966–71)
University of Maryland, Maryland (1958)

Massachusetts Institute of Technology, Massachusetts (1956)
U. S. Naval Research Laboratory, Washington, D. C. (1958–1972)
New York State University, Buffalo (1967–70, 72)
University of North Carolina, Chapel Hill (1971)
North Texas University, Denton (1969–70)
Oak Ridge National Laboratory, Tennessee (1970)
Pennsylvania State University, Pennsylvania (1972)
Purdue University, Lafayette (1968–70)
Rand Corporation, California (1962–71)
University of Rhode Island, Kingston (1972)
Rutgers University, New Jersey (1971–72)
University of Rochester, Rochester (1963)
University of Southern California, Los Angeles (1967–72)
Stanford University, Stanford (1962–72)
State College, Long Beach, California (1966-70)
Syracuse University, Syracuse (1966, 69, 72)
University of Texas at Austin (1970)
University of Texas at Dallas (1970–71)
Thomas J. Watson Research Center, IBM, New York (1971)
Utah State University, Logan, Utah (1971–72)
University of Washington, Seattle (1967–69)
University of Wisconsin at Madison (1966–70)
University of Wisconsin at Milwaukee (1966, 67, 71)
Wright–Patterson Air Force, Dayton, Ohio (1968–70)
University of Wyoming, Laramie (1972)
Yeshiva University, New York (1967–72)

ENGLAND

University of Edinburgh, Edinburgh (1949)
Imperial College of Science and Technology, London (1960, 63, 67, 69)
University of Manchester, Manchester (1949, 56)
Oxford University, Oxford (1960)
Physical Society of Great Britain, Birmingham (1949)

AUSTRALIA

Australian National University, Canberra (1954, 71)
Latrob University, Melbourne (1954, 71)
University of Melbourne, Melbourne (1954, 71)
University of Sydney, Sydney (1954, 71)

CANADA

University of Alberta, Edmonton (1969)
Carleton University, Ottawa (1969)
Sir George Williams University, Montreal (1971)
McGill University, Montreal (1971–72)
University of Montreal, Montreal (1968, 71, 72)
National Research Council, Ottawa (1958)
Simon Fraser University, Vancouver (1968)
University of Toronto, Toronto (1968)

WEST GERMANY

University of Bonn, Bonn (1971)
University of Gottingen, Gottingen (1956)
University of Heidelberg, Heidelberg (1956)
University of Marburg, Marburg (1956, 60)
University of Stuttgart, Stuttgart (1956)

U. S. S. R.

Academy of Sciences, Moscow (1968)
Physical–Technical Institute, Academy of Sciences, Leningrad (1968)

JAPAN

University of Kyoto, Kyoto (1956)
Osaka University, Osaka (1956)
Tokyo University of Education, Tokyo (1966, 70)
Yukawa Hall, Kyoto (1956)

BELGIUM

Department of Mathematics, University of Liege, Liege (1971)
Department of Physics, University of Liege, Liege (1971)

IRELAND

University of Dublin, Dublin (1949)
Dublin Institute for Advanced Studies, Dublin (1950)

SWEDEN

Cramer's Institute, Stockholm (1950)
University of Uppsala, Uppsala (1950)

NORWAY

University of Oslo, Oslo (1950)

SWITZERLAND

University of Berne, Berne (1960, 69)
CERN, Geneva (1960, 62, 66)
E.T.H. Zurich (Federal Institute of Technology), Zurich (1950)
University of Geneva, Geneva (1967)
Swiss Physical Society, Winterthur (1960)
University of Zurich, Zurich (1950, 56)

NEW ZEALAND

University of Canterbury, Christchurch (1971)

FRANCE

Institute of Henri Poincare, Paris (1960, 66)
C. E. N., Saclay (1964, 1965, 1967, 1968, 1969)

ITALY

International Centre for Theoretical Physics, Trieste (1963, 1965, 67, 68, 70)
University of Naples, Naples (1967)
University of Padua, Padua (1966–69)
University of Rome, Rome (1966, 69)

SINGAPORE

University of Singapore, Singapore

IRAN

Aria-Mehr University, Teheran

DENMARK

Bohr Institute, Copenhagen (1950, 1960)

LIST OF INTERNATIONAL CONFERENCES AND SYMPOSIA IN WHICH PROFESSOR ALLADI RAMAKRISHNAN PARTICIPATED

International Conference on Theoretical Physics, Edinburgh, Scotland	1949
Annual Meeting of the Physical Society of Great Britain, Birmingham	1950
Seminars at Cramer's Institute, Stockholm	1950
Symposia and Colloquia, E.T.H. and University of Zurich	1951
Sixth International Conference on High Energy Physics, University of Rochester, Rochester	1956
Conference on Applied Mathematics and Mechanics, GAMM, Stuttgart, West Germany	1956
International Conference on Elementary Particles, Venice, Italy	1957
Annual Meeting of the Swiss Physical Society, Winterthur, Switzerland	1960
Symposium on Low Energy Nuclear Physics, Copenhagen, Denmark	1960
Symposium on Elementary Particles, Trieste, Italy	1960
International Seminar on Unifield Field Theories, University of Rochester, Rochester	1963
International Conference on Cosmic Rays, Jaipur	1963
Tenth International Conference on High Energy Physics, Dubna, USSR	1964
Eleventh International Conference on High Energy Physics, University of California, Berkeley	1966
Seminar on Relativistic Cosmology and Gravitation, CSIR, New Delhi	1966
International Conference on High Energy Physics, Rochester	1967
Summer Institute for Theoretical Physics, Boulder, Colorado	1967
Twelfth International conference on High-Energy Physics, Vienna, Austria	1968
International Conference on High-Energy Physics, Detroit	1969
Rutherford Centennial Symposium on the Structure of Matter, University of Canterbury, Christchurch, New Zealand	1971
International Conference on Stochastic Point Processes, IBM, Yorktown Heights, New York	1971

LIST OF CONFERENCES AND SEMINARS ORGANISED BY PROFESSOR ALLADI RAMAKRISHNAN

1. First Anniversary Symposium on "Resonant States in Elementary Particles", Madras — *Sponsor*: MATSCIENCE (January, 1963)

2. Summer School on High Energy Physics, Kodaikanal — *Sponsor*: Ministry of Scientific Research and Cultural Affairs, Government of India (June, 1963)

3. Second Anniversary Symposium on "Recent Trends in Theoretical Physics", Madras — *Sponsor*: MATSCIENCE (January, 1964)

4. First MATSCIENCE Summer School on Theoretical Physics, Bangalore — *Sponsor*: Council of Scientific and Industrial Research, New Delhi (September, 1964)

5. Third Anniversary Sympoisum on "The present state of elementary particle physics", Madras — *Sponsor*: MATSCIENCE (January, 1965)

6. Second MATSCIENCE Summer School on Theoretical Physics, Bangalore — *Sponsor*: Council of Scientific and Industrial Research, New Delhi (August—September, 1965)

7. Fourth Anniversary Symposium, Madras—*Sponsor*: MATSCIENCE (January, 1966)

8. Third MATSCIENCE Summer School on Theoretical Physics and Mathematics. Bangalore—*Sponsor*: Department of Atomic Energy, Government of India and MATSCIENCE (September, 1966)

9. Fifth Anniversary Symposium, Madras—*Sponsor*: MATSCIENCE (January, 1967)

10. Sixth Anniversary Symposium, Madras—*Sponsor*: MATSCIENBE (January, 1968)

11. Seventh Anniversary Symposium on Mathematical Analysis and its Applications, Madras—*Sponsor*: MATSCIENCE (January, 1969)

12. Symposium on "Computors in Science and Technology", Madras—*Sponsor*: MATSCIENCE (March, 1969)

13. Eight Anniversary Symposium on "Land marks in modern physics 1900–1970", Madras—*Sponsor*: MATSCIENCE (January, 1970)

14. MATSCIENCE Seminar on Elementary Particles and Nuclear Theory, NAL, Bangalore—*Sponsors*: Department of Atomic Energy, Government of India and MATSCIENCE (January, 1970)

15. Seminar on "Frontiers of Physics", Ooty—*Sponsor*: Department of Atomic Energy, Government of India (September, 1970)

16. One day Symposium on "Caylay, Hamilton and Clifford in the light of Modern Physics", Madras—*Sponsor*: MATSCIENCE (April, 1970)

17. First IMPACT Conference on "Co-ordinal transformations and their applications", Madras—*Sponsors*: MATSCIENCE Fundamental Engineering Research Establishment, and Directorate of Collegiate Education, Madras (March, 1970)

18. Second IMPACT Conference on "Developments in Aviation and their Economic Impact in India", Madras—*Sponsors*: MATSCIENCE, Fundamental Engineering Research Establishment and Directorate of Collegiate Education, Madras (September, 1970)

19. First MASTECH Conference on "Matrix Analysis and its Applications to Science and Technology", NAL, Bangalore—*Sponsor*: Council of Scientific and Industrial Research, New Delhi (September, 1969)

20. Second MASTECH Conference on "Probability and Statistics and their Applications to Science and Technology", Madras—*Sponsor*: Council of Scientific and Industrial Research, New Delhi (January, 1970)

21. Ninth Anniversary Symposium on "Bhabha's contribution to Modern Physics", Madras—*Sponsor*: MATSCIENCE (January, 1971)

22. Symposium on "Clifford Algebra, its Generalization and Applications", Ooty—*Sponsor*: MATSCIENCE (January, 1971)

23. Symposium on "Cosmology, Gravitation and Applications to Particle Theory", Bangalore—*Sponsor*: MATSCIENCE (November, 1971)

24. Symposium on " Fourier Optics, Lasers and Holography ", Mysore—*Sponsor*: MATSCIENCE (November, 1971)

25. Symposium on " Fifty years of Mathematical Education in India ", Madras—*Sponsor*: MATSCIENCE (December, 1971)

26. Third MASTECH Conference on " Statistical Mechanics and its Applications to Science and Technology. NAL, Bangalore—*Sponsor*: Council of Scientific and Industrial Research, New Delhi (January, 1971)

27. Fourth MASTECH Conference on " Functional Analysis and its Applications to Science and Technology ", NAL, Bangalore—*Sponsor*: Council of Scientific and Industrial Research, New Delhi (September, 1971)

28. Tenth Anniversary Symposium on " Einstein, his contributions to Physical, Mathematical and Philosophical thought ", Madras—*Sponsor*: MATSCIENCE (January, 1972)

29. Symposium on Matrix Theory, Bangalore—*Sponsor*: MATSCIENCE (March, 1972)

LIST OF STUDENTS OF PROFESSOR ALLADI RAMAKRISHNAN FOR THE Ph. D. DEGREE

Dr. P. M. Mathews	1956
Dr. S. K. Srinivasan	1957
Dr. R. Vasudevan	1960
Dr. N. R. Ranganathan	1961
Dr. K. Venkatesan	1963
Dr. V. Devanathan	1963
Dr. T. K. Radha	1963
Dr. Thunga Satyapal	1963
Dr. A. P. Balachandran	1963
Dr. G. Bhamathi	1963
Dr. S. Indumathi	1963
Dr. G. Ramachandran	1964
Dr. K. Raman	1965
Dr. R. K. Umerjee	1965
Dr. K. Ananthanarayanan	1965
Dr. T. S. Shankara	1970
Dr. T. S. Santhanam	1970
Dr. K. Srinivasa Rao	1972
Dr. A. Sundaram	1972
Mr. P. S. Chandrasekaran	Submitted
Miss Nalini B. Menon	Submitted