RAMAN RESEARCH INSTITUTE

C. V. Raman Avenue
Sadashivanagar
Bangalore 560080
India

Annual Report
2000 – 2001

Correct citation:
Raman Research Institute, 2001. Annual Report: 2000-2001.
Bangalore, RRI, 67p.

For further information, please write to:

The Director
Raman Research Institute
C.V. Raman Avenue
Sadashivanagar
Bangalore 560 080, India

Phone	:	+91 (80) 334 0122 - 334 0129
Telefax	:	+91 (80) 334 0492
Telegram	:	RAMANINST, BANGALORE
e-mail	:	root@rri.res.in library@rri.res.in
URL	:	http://www.rri.res.in

ISSN : 0972-4117

September 2001

CONTENTS

PREAMBLE

As in the previous years, the Annual Report is a terse account of the main scientific activities of the Institute. Unlike in the previous years, however, it also gives, as part of the introduction, a general background to and the flavour of the research activities at the Institute, written in plain language for an uninformed but interested reader. The Annual Report gives the list of papers published in scientific journals, discussion meetings and seminars/colloquia held, and of the Ph.D. degrees awarded during the period 1 April 2000 to 31 March 2001. It also lists the visitors to the Institute – 35 of them from different parts of the world.

Other events that took place during the year were a "Summer School in Physics & Astrophysics", 15 May - 27 June 2000; a short course entitled "Survey of Astronomy", 7-19 August 2000, and a "Discussion Meeting on Isolated Horizons and Quantum Gravity", 2-9 January 2001. Details are given on page 20 of the Report.

The collaborative scientific work covered in the Report, the list of visitors, and the conferences attended and institutions visited by the members of the Institute indicate, as in the past, the extent of national and international interactions of the Institute. The list of colloquia given by the members of the Institute, those from the neighbouring institutions, and by the visitors clearly reflect the breadth of the areas covered.

Five Ph.D. degrees were awarded to the students of the Institute, and an equal number (five) have submitted their theses during the year. Research papers published in refereed journals and in conference proceedings for the same period counted 70 and 8 respectively.

Bangalore
20 August 2001

N. KUMAR
Director

RAMAN RESEARCH INSTITUTE
Bangalore

Annual Report 2000-2001

INTRODUCTION

The Raman Research Institute founded by Prof. C.V. Raman in the late forties was reorganised, after his death in 1970, as a national Institute for research in basic science, and it has been receiving grants from the Department of Science and Technology of the Government of India since 1972. The main fields of research have been, and continue to be, Theoretical Physics (gravitation and polarization optics), Liquid Crystals (thermotropic and polymeric), Astronomy & Astrophysics (radio-astronomy, interstellar medium, and pulsars). More recently, the Liquid Crystals research has been expanded so as to include soft-condensed matter and biological physics (membranes and single-DNA segments). Also, an Optics Lab has been set up for studying laser cooling and trapping of atoms, imaging through turbid media, and ultra-fast atomic processes using femtosecond (10^{-15} sec.) laser pulses.

1. Theoretical Physics

Here research is focussed on two main areas – gravitation and polarization optics. Gravitation is known to be the weakest of all known forces of nature, but it dominates all structure and motion on the astronomical scale because of its attractive universality (everything gravitates everything else), its long range, and the fact that matter on the large scale is essentially neutral. The correct theory of gravitation is now believed to be Einstein's General Theory of Relativity (GTR). One of the fundamental predictions of GTR is that of gravitational waves – waves of distortion of spacetime itself - propagating at a finite speed (of light). This replaces the Newtonian gravitational force which was instantaneous. Such waves are expected to be emitted when, e.g., two massive inspiralling stars tend to coalesce under their mutual gravitational attraction. Accurate calculation of this gravitational radiation – its waveform – has been one of the major research programmes in the Theoretical Physics Group at the Institute, and is expected to be a crucial input towards its eventual detection. It is hoped that these gravitational waves, though abysmally weak in strength, will be detected by the ultra-sensitive gravitational wave detectors expected to become operational in a few years in different parts of the world.

Einstein's General Theory of Relativity is central to the study of universe as a whole (cosmology) as also to the study of compact self-gravitating objects, such

as the black holes – yet another prediction of Einstein's General Relativity. While the theory has a beautiful geometrical structure, it is a challenge to analyse the behaviour of gravitational field and its coupling to matter and other fields as the equations involved are nonlinear — interactions too interact! Many conceptual questions and aspects of the formal structure continue to be fruitfully investigated more than seventy years after the theory came into being. Over the years, the work at the Institute has ranged over topics such as perturbations, the exploitation of symmetries, rotation and the analogy with magnetic fields, and a new Lagrangian formulation. One of the challenges in the field is to make contact with quantum theory, i.e., to combine consistently the two great framework theories of the twentieth century — the general theory of relativity and quantum mechanics. This is a long term programme. But some work on Quantum Gravity has already emerged.

Coming now to optics, two of the main interests have been in propagation of light waves in periodic media (like some liquid crystals) and the associated polarization phenomena, including the now well known geometric phase. There is a pleasing continuity with work in the fifties at the Institute on the optics of crystals and minerals. At the same time, introduction of a more modern viewpoint and techniques, brings about connections with other areas such as quantum theory, differential geometry, etc. In addition, astrophysics throws up a whole range of interesting optical problems in areas like that of gravitational lensing (i.e., bending and focussing of light rays by the strong gravitational fields of massive stars and galaxies which, therefore, act as lenses), scintillation and quantum effects in radiation and detection, making the study of optics in a broad sense particularly appropriate to this Institute. RRI is home to Optics!

2. Optics

In view of the rapid and important recent advances happening worldwide in modern optics, its clearly enormous potential, and taking full advantage of our proven traditional strength in this field, a modern optics laboratory has been set up at the Institute with facilities to address several interesting and basic questions involving, e.g., cooling and trapping neutral atoms using laser lights, studying fast atomic processes using ultra-short light pulses barely 10^{-15} second wide, polarization optics and geometrical phases, interferometry, and imaging through turbid media. This is expected to have substantial overlap with our research activities in the field of liquid crystals and astronomy.

3. Liquid Crystals

Liquid Crystals are states of condensed matter showing a variety of orderings of molecular positions and orientations intermediate between those of liquids and

crystalline solids. Thus, for example, we may have a crystalline periodicity along one direction and a liquid-like, albeit viscous, fluidity in the planes perpendicular to that direction – the so-called smectic (soap-like) liquid crystals. We can also have the nematic liquid crystals in which the rod-like molecules are orientated parallel to a certain direction on the average, but without any positional order. Yet another kind of liquid crystal is the discotic one in which the disc-like molecules form liquid-like parallel columns which are, however, arranged periodically in the plane perpendicular the columns. Many other complex forms of ordering are known. Many organic compounds whose molecules have pronounced shape anisotropy exhibit such phases. The unique combination of fluidity, softness and anisotropic properties of liquid crystals makes them readily respond to even a weak external stimulus, for example, an applied electric field. This has led to many technological applications of these materials, e.g., the very common liquid crystal displays. The Liquid Crystals Laboratory of the Raman Research Institute has contributed significantly to the development of this field over the past three decades.

The laboratory has been organised to undertake studies of most of the fundamental properties of liquid crystals. Theoretical and experimental work on liquid crystals covers areas like their unique mechanical and electrical properties, defects, X-ray and light scattering, and synthesis of new materials. Work on applications such as the liquid crystal displays is also being carried out. A new dimension has now been added to our LC research – the study of soft-condensed matter including membranes and the single-DNA molecules which are of great biological-physical significance.

4. Astronomy and Astrophysics

Astronomy, which is one of the oldest sciences, studies heavenly bodies, i.e., planets, stars, galaxies, clusters of galaxies, and the intervening matter such as gas and dust. This it does by investigating the radiation received on earth from or through them. Optical Astronomy deals with the *visible* part (wavelength 3000 Angstroms to 6500 Angstroms, 1 Angstrom $=10^{-10}$ metre) of the electromagnetic spectrum. Radio-astronomy, which had its beginnings in 1932 also deals with the study of these heavenly bodies, but the radiation received by the radio telescopes on earth is in the radio range of wavelengths (30 metres to 1 millimetre) of the same electromagnetic spectrum. The lower and upper limits in wavelength of the radio spectrum are set by the earth's atmosphere and ionosphere respectively. In spite of these limitations, the radio window is very wide (30,000 to 1 compared to the 2:1 wavelength ratio in the visible part), and studies within it over the years have yielded information leading to many exciting discoveries, such as the 3 degree kelvin cosmic background radiation (a relic from the hot big bang origin of the universe which is estimated to have taken place about 15 billion years ago, and

indeed, contributes some of the noise on our TV channels even today!); quasars (very bright but very distant quasi-stellar sources of radiation), pulsars (rotating neutron stars barely 10 kilometres in diameter, but still about as massive as the Sun); and now almost certainly the black holes (gravitationally collapsed objects from which even light cannot escape).

The Raman Research Institute has observational programmes in Radio Astronomy extending over most of the available radio spectrum. It has set-up a Decametrewave Radio Telescope at Gauribidanur about 80 km from Bangalore, jointly with the Indian Institute of Astrophysics. It is one of the few largest among the telescopes in the world operating at a wavelength of 10 metre and is being used to study radio emission from various types of celestial objects such as the Sun, Jupiter, and the radio sources of various kinds in our Galaxy and external Galaxies. Moving to somewhat shorter wavelengths, members of the Institute use the Ooty Radio Telescope operated by the Tata Institute of Fundamental Research (TIFR), Bombay. This instrument operates at a wavelength of approximately 1 metre and is used for carrying out observations of pulsars, and nebulae of various kinds in the Galaxy. There is an active programme under way to make observations using the Giant Metre wavelength Radio Telescope (GMRT), built by TIFR near Pune. In fact, RRI was and is deeply involved in the GMRT instrumentation. Another interactive project is the low-frequency (150 MHZ) Mauritius Radio Telescope (MRT) built at Mauritius by RRI in collaboration with the University of Mauritius and the Indian Institute of Astrophysics. A radio map of the southern sky at full resolution of 4 arcminute × 4 arcminute is getting ready.

During the past two decades, millimetrewave astronomy has assumed great importance because of the discovery of numerous molecules in the vastness of the interstellar space (combinations of Hydrogen, Carbon, Nitrogen, Oxygen, Silicon, etc.). These are identified by their emitted line radiation (spectra) in the shortest wavelength region of the radio spectrum. These molecules are generally found in dense molecular clouds in our own and other Galaxies, where star formation is thought to be taking place. The Raman Research Institute has set-up a millimetrewave telescope of diameter 10.4 metre on campus, which is being used for such studies.

In addition to the above observational programmes, the Institute has theoretical research programmes in many areas of Astrophysics, e.g., Pulsars, their evolution, structure and the emission mechanism; Supernova Remnants; the Inter-Stellar Medium; Galaxies and large-scale structure in the universe and cosmology.

A detailed, but admittedly technical account of the work carried in the past year at RRI is given in the pages that follow.

THEORETICAL PHYSICS (TP)

AREAS OF RESEARCH

Condensed Matter
Physics in Biology
Optics
Gravitation

CONDENSED MATTER

Driven Heisenberg Systems and spatio-temporal chaos. The dynamics of driven diffusive Heisenberg systems exhibits a rich complexion of nontrivial steady states as a result of the interplay between driving, dissipation and inertia. These models show a novel dynamical critical behaviour belonging to a distinct universality class and spatio-temporal chaos which may be controlled in a precise manner to give rise to helical configurations. [Madan Rao, Jayajit Das and Sriram Ramaswamy (IISc.)].

Ergodicity breaking in a Heisenberg chain. The microcanonical dynamics of a classical Heisenberg chain which dissipate into boundary heat baths (of temperature T) reveals that the system does not reach equilibrium when $T<J$, the exchange coupling. This ergodicity symmetry breaking at low enough temperatures is intriguing since the system is neither disordered nor integrable. [Madan Rao and Jayajit Das].

Dynamics of Solid-Solid Transformations: Ferrites and Martensites. The dynamics of solid state transformations in the context of martensites and bainites has been the focus of interest for a while. A molecular dynamics approach in 2-dimensions to study the square to triangular lattice transformation has lead to a new understanding of the nucleation phenomenon. Quenches across the structural phase boundary reveal two distinct nucleation mechanisms – a slow quench results in an equilibrium ferrite, while a fast quench obtains a martensite. Starting from the microscopic description (obtained from the MD simulation), it is possible to arrive at a coarse-grained elastic description in terms of the strain field and defects. A method for calculating elastic constants of a solid in the thermodynamic limit using fluctuations in particle positions has been worked out. Coarse-grained Langevin equations have been derived which describe the nucleation dynamics of solid state transformations. This description has been used to evaluate time-temperature- transformation curves for this structural change. [Madan Rao and Surajit Sengupta (S N Bose Inst.)].

Study of non-equilibrium steady states in energy-current-carrying systems. A detailed study of the non-equilibrium state of heat conduction in simple models such as the hard sphere system and disordered harmonic chains has been carried out in order to obtain some understanding of the non-equilibrium steady state. The choice of the models was motivated by the fact that in both cases one can proceed analytically to a large extent and many exact results can be obtained. Also numerical simulations can be performed very accurately. For the diatomic gas model in one dimensions it was found that a nontrivial steady state is obtained whenever the masses of the two atoms are different. The temperature profile seems to be in accordance to the predictions of kinetic theory, even though the heat conductivity itself diverges. For the case of the disordered harmonic chain the surprising result was found that the heat conductivity depends not just on the system properties but also on the properties of the heat reservoirs [Abhishek Dhar].

Some new properties of the zeros of generalized orthogonal polynomials. In an earlier work a detailed study of the low-energy spectrum of the Heisenberg ferromagnetic chain had been made by means of the Bethe ansatz formalism. As a spinoff from this study, some rather interesting properties of the zeros of general orthogonal polynomials were discovered. Using Green's functions and saddle-point techniques the distribution of the zeros was obtained analytically. [Abhishek Dhar and B. Sriram Shastry (IISc)].

PHYSICS IN BIOLOGY

Mechanisms and Dynamics of Trafficking within Cells. The study of the mechanisms of endocytosis in eukaryotic cells has been an intense field of research, in particular the physical and chemical mechanisms involved in the internalization of GPI-anchored proteins. Experiments using fluorescence energy transfer (FRET) and fluorescence correlation spectroscopy (FCS) reveal that GPI-anchored proteins are clustered in n-mers via cholesterol. These n-mers are further organised in a pool of sphingolipids. This organisation, identified with 'rafts', is shown to be directly involved in the endocytosis of GPI. [Madan Rao, Sarasij R.C., R. Varma, S. Chatterjee and S. Mayor (NCBS)].

Chirality induced budding. A physical model of rafts consisting of sphingolipids and cholesterol on the cell membrane within the framework of a Landau theory has been analysed, to obtain a shape-texture phase diagram of rafts of a prescribed area. These studies indicate how rafts might lead to membrane budding, a necessary precursor to endocytosis. [Madan Rao and Sarasij R.C.]

Active processes in membranes. The phenomena of fission and fusion of membranes in the internal membrane components of the cell are 'active processes' requiring the hydrolysis of ATP and a complex protein machinery. The dynamics, shape instabilities and steady states of a membrane subject to active fission and fusion events have been studied using a Langevin approach. [Madan Rao and Sarasij R.C.].

OPTICS

Quantum coherence and decoherence by interactions. The problem of Quantum coherence and decoherence by interactions was examined in relation to (a) Quantum classical cross-over for dynamics and statistical indistinguishability [N. Kumar (S. Dattagupta (SNBCBS) and A. M. Jayannavar (IOPB)] (b) Zeno effect and inter-layer pairing in HTSC, and (c) Bose-Einstein-Condensation. [N. Kumar and M.A.H. Ahsan (IISc)].

The sojourn time. The delay time for scattering is the most important quantity regarding the dynamical aspect of scattering in quantum mechanics, and one of the common measures for this quantity is the Wigner phase (ϕ) delay time ($\hbar d\phi/dE$). This quantity, however, has certain deficiencies and alternative clocks such as precession of a spin in a magnetic field have been proposed. A non-unitary clock, involving absorption/amplification by an added infinitesimal imaginary potential (iV_i) is discussed and found to not preserve the positivity of the conditional sojourn times, in general. The sojourn time is found to be affected by the scattering concomitant with the mismatch, however weak, due to the very clock potential (iV_i) introduced for this purpose. A formal procedure is proposed, separately for the cases of wave propagation and tunneling, by which the sojourn time can be clocked ideally using the non-unitary counter by correcting for these spurious scattering effects. The conditional sojourn time for reflection is positive definite only if one considers those partial waves that have traversed the region of interest. The resulting time is then positive definite for an arbitrary potential and has the proper high- and low-energy limits. [S. Anantha Ramakrishna and N. Kumar].

The distribution of delay and dwell times from reflection from a long disordered conductor. An earlier derivation of the distribution of the Wigner delay time for wave reflection from a long one-dimensional disordered conductor is corrected and numerically compared to the distributions of the Wigner delay time and the dwell time obtained by the use of an imaginary potential as a clock, to investigate the effects of strong disorder and a periodic background. The two distributions coincide even for strong disorder, but only for energies well away from the band-edges. The implications for the single parameter scaling ansatz for

Anderson localization are pointed out. For energies very close to the band-edge, however, the Wigner delay time distribution begins to differ and becomes non-zero for negative delay times indicating a strong deformation of the incident wave packet. The dwell time distribution obtained from the imaginary potential method in contrast displays no such behaviour. [S. Anantha Ramakrishna and N. Kumar].

The reflection delay time for tunneling in the WKB approximation. A simple approach to study the traversal time through a barrier using the WKB wave function has been generalized to the reflection time by considering the weighted sum of the times for the partial reflections from the barrier. For a symmetric barrier, such as a rectangular barrier or a parabolic barrier, the reflection time is equal to the traversal time within this WKB approximation. It is noted that equal reflection and traversal times for a symmetric scatterer are obtained for the Wigner delay time and the dwell time using an infinitesimal imaginary potential as a clock. [S. Anantha Ramakrishna and A.M. Jayannavar (IOP, Bhubaneshwar)].

GRAVITATION

Canonical gravity, diffeomorphisms and objective histories. The meaning of diffeomorphism invariance in a Hamiltonian formulation of gravity is clarified. Diffeomorphism invariance is a crucial property of General Relativity and it is very important to preserve this property in any reformulation of the theory. It is shown that diffeomorphism invariance of a constrained Hamiltonian formulation comprises two distinct requirements which are spelt out and illustrated in specific contexts. [Joseph Samuel].

Is Barbero's Hamiltonian formulation a Gauge theory of Lorentzian Gravity. It is shown that in Barbero's Hamiltonian formulation (which is the basis of Loop Quantum gravity), a gauge interpretation for the connection variable is inconsistent with the requirement of four dimensional diffeomorphism invariance. Thus Barbero's formulation marks a departure from one of the original motivations of the Ashtekar program: The gauge description of gravity [Joseph Samuel].

Observations on the Barbero formulation and the Immirzi parameter. This work concerns the Barbero formulation which is currently popular in the Loop Quantum Gravity program. One of the curious features of Barbero's Hamiltonian formulation is that there are many of them! The Immirzi parameter is a free parameter which appears in the physical predictions of Loop Quantum Gravity and is sometimes viewed as a quantisation ambiguity. It is shown that a previously discussed example containing a "finite dimensional analogue" of the "Immirzi ambiguity" is fallacious, in the sense that the ambiguity in this example is not

intrinsic to the system, but introduced artificially by compactifying the configuration space [Joseph Samuel].

Observations on Holst's Lagrangian formulation. It is observed that while the Lagrangian formulation due to Holst does yield Barbero's Hamiltonian formulation, the connection variable in the Hamiltonian formulation is not a pull back of a spacetime connection. These observations in no way affect the validity of Holst's result, but clarify that Barbero's connection is not a spacetime gauge field [Joseph Samuel].

Kruskal coordinates as canonical variables for Schwarzschild black holes. A transformation was derived from the usual ADM metric-extrinsic curvature variables on the phase space of Schwarzschild black holes, to new canonical variables which have the interpretation of Kruskal coordinates. It was explicitly shown that this transformation is non-singular, even at the horizon. The constraints of the theory simplify in terms of the new canonical variables and are equivalent to the vanishing of the canonical momenta [Madhavan Varadarajan].

Photons from quantized electric flux representations. The quantum theory of *U(1)* connections admits a diffeomorphism invariant representation in which the electric flux through any surface is quantized. This representation is the analog of the representation of quantum *SU(2)* theory used in loop quantum gravity. The relation between this representation, in which the basic excitations are 'polymer-like', and the Fock representation, in which the basic excitations are wave-like photons, was investigated. It was shown that normalizable states in the Fock space are associated with 'distributional' states in the quantized electric flux representation. This work was motivated by the question of how wave-like gravitons in linearised gravity arise from polymer-like states in non-perturbative loop quantum gravity [Madhavan Varadarajan].

Black hole fluctuations. A black hole interacting with a quantum field is viewed here as a dissipative open system. The quantum field acts as a bath whose degrees of freedom are integrated out to study the effective dynamics of the black hole. It is shown that the interaction with the quantum field induces fluctuations in the black hole mass and the spectrum of the fluctuations is computed under certain approximations. [Sukanya Sinha, B.L Hu (University of Maryland) and Alpan Raval (University of Wisconsin)].

Renormalization group equations for CTP coarse grained effective action. A self interacting ($\lambda\phi^4$) field in Minkowski spacetime is considered and a coarse grained closed-time-path (CTP) effective action is defined by integrating out

quantum fluctuations of wavelength shorter than a critical value. An exact renormalization group equation is derived for the dependence of the above coarse-grained effective action on the coarse graining scale. Unlike its Euclidean counterpart, this equation has the CTP boundary conditions incorporated in it, which makes it suitable to study non-equilibrium problems. This should serve as a useful tool to generate non-perturbative approximations to the effective action. Generalization to curved spacetime is under investigation [Sukanya Sinha].

A Comparison of search templates for gravitational waves from binary inspiral. The performances of the templates defined by three different types of approaches: Traditional post-Newtonian templates (Taylor-approximants), "resummed" post-Newtonian templates assuming the adiabatic approximation and stopping before the plunge (P-approximants), and further "resummed" post-Newtonian templates going beyond the adiabatic approximation and incorporating the plunge with its transition from the inspiral (Effective-one-body approximants) are compared. The signal to noise ratio is significantly enhanced (mainly because of the inclusion of the plunge signal) by using these new effective-one-body templates relative to the usual post-Newtonian ones for a total binary mass m approximately greater than 30 $M_{\odot}$ and reaches a maximum around $m \sim 80\ M_{\odot}$ Independently of the question of the plunge signal, the comparison of the various templates confirms the usefulness of using resummation methods. [Bala R. Iyer, T. Damour (Institut des Hautes Études Scientifique, Paris) and B.S. Sathyaprakash (Cardiff, U.K.)].

OPTICS

AREAS OF RESEARCH

Light in random media
Nonlinear Optics
Laser cooling and trapping of atoms
Development of experimental facilities

LIGHT IN RANDOM MEDIA

The study of the propagation of light in random media, with and without gain, has been continued further this year, both by means of experiments and numerical simulations. Several interesting results have been obtained.

The preservation of polarisation upon multiple scattering was investigated both by polarisation discrimination imaging experiments, and by Monte Carlo simulations, and it was found that there are two distinct regimes of decay of polarisation. This has been interpreted as a shift from predominantly ballistic to predominantly diffusive transport. [Sushil Mujumdar and Hema Ramachandran].

It was predicted and demonstrated that imaging capability by polarisation discrimination is enhanced upon the addition of isotropic scatterers into a turbid medium. Despite the medium becoming optically thicker, imaging is improved as the multiply scattered photons are depolarised in this case, and hence rejected by polarisation discrimination, yielding a ballistic signal that is much cleaner, albeit reduced in strength. [Hema Ramachandran and Sushil Mujumdar].

The technique of polarisation discrimination was applied to the study of coherent back-scattering from a colloidal suspension. A much improved signal-to-noise ratio was obtained. [Sushil Mujumdar, Hema Ramachandran and N. Kumar].

A device that acts as a diode for light - permitting light transport in one direction, and stopping it in the other has been designed, and experimentally realised. It consists of a capillary with a liquid dye of varying concentration, and its directional transmission property comes about due to the varying relative strengths of emission and absorption, along its length. [Sushil Mujumdar and Hema Ramachandran].

NONLINEAR OPTICS

Travelling wave lasing (amplified spontaneous emission), absorption characteristics, and emission lifetimes were studied in several tri-phenylamine

dimer based molecules. The results are being analysed. [Reji Philip and A. Penzkofer. The experiments were carried out at the latter's laboratory in Institut für Angewandte Physik, University of Regensburg, Germany].

A setup for conducting pulsed photo-acoustic experiments has been built and tested. [Reji Philip].

LASER COOLING AND TRAPPING OF ATOMS

The work on building a magneto-optic trap has progressed to the final stages. In addition, some theoretical investigations, with potential for applications, were taken up.

Saturation absorption spectra have been obtained in a mixture of ^{87}Rb and ^{85}Rb and the various hyperfine transitions have been identified. Using phase sensitive detection, the laser has been locked to the required wavelength for long durations (about 1 hour at a stretch). The linewidth of the external cavity laser is estimated to be less than 1 MHz. [Uday Kumar Khan, Meena M.S., Andal Narayanan, R. Srinivasan and Hema Ramachandran].

The time evolution equations for the average population and phase for a strongly coupled two-component Bose-Einstein condensate have been analytically derived, and expressions for the dynamical behaviour obtained; this hitherto, had only been studied numerically. Based on the analysis, a method for stabilising vortices in condensates has been suggested. [Andal Narayanan and Hema Ramachandran].

A method for the manipulation of quantum states of cold atoms by the Talbot effect, was proposed by us last year. Technical details have been worked out for several schemes that use this technique to bring about controlled interaction between neighbouring lattice sites in optical lattices. This has potential for application in quantum computing. [Hema Ramachandran and Andal Narayanan].

DEVELOPMENT OF EXPERIMENTAL FACILITIES

The femtosecond laser system, consisting of Spectra Physics lasers Millenia, Tsunami, Gaussian Coupled Resonator, and Titanium Sapphire Amplifier systems has been installed, optimised, and tested. Two of the scientists underwent on-site, and at-factory training on these systems. [Reji Philip and Hema Ramachandran].

LIQUID CRYSTALS (LC)

AREAS OF RESEARCH:

L.C. Synthesis
Phase Transitions
Studies on biological systems
Light scattering studies
Monolayers
Electrochemistry
L.C. Displays
Nonlinear Optics
Mean field and Landau theories
Studies on biological physics

EXPERIMENTAL STUDIES

Synthesis and physical studies of new compounds exhibiting liquid crystalline phases. Research and scientific investigations were pursued on the synthesis and characterisation of mesophases formed by compounds composed of banana-shaped molecules. The molecular structure of several compounds were examined and a few chosen for synthesis. A significant finding in this regard is the synthesis of new compounds which are the first examples to show a direct transition from the antiferroelectric B_2 phase to the uniaxial nematic phase.

The influence of lateral substituents on the mesophases formed by these banana-shaped or bent-core molecules have been examined by synthesising several series of compounds. Fluorine substitution in the middle ring of the arms of the bent-core molecules seems to favour the stabilisation of the banana phases. (B.K. Sadashiva, R. Amaranatha Reddy and H.N. Shreenivasa Murthy).

Discovery of the biaxial smectic A phase in pure compounds. A significant achievement has been the design and synthesis of compounds composed of unsymmetrical molecules containing a polar cyano group at one end of the molecule. This was planned to obtain a biaxial smectic A phase and indeed these compounds do show this phase and these represent the first examples of pure low molecular weight compounds exhibiting such a phase. [B.K. Sadashiva, R. Amaranatha Reddy, N.V. Madhusudana and R. Pratibha].

Phase transition studies on mixtures of compounds. The discovery of the biaxial smectic A (SmA_{2b}) phase in special mixtures of compounds composed of bent-core molecules and rod-like molecules was initially observed at about

100° C. Several mixtures have now been made which exhibit the SmA_{2b} phase close to room temperature facilitating many physical studies on them.

The SmA_{2b} phase has also been found in mixtures when the rod-like compound has only a smectic C phase which is associated with a tilt of the director. In addition to the SmA_{2b} phase, another phase was observed at a lower temperature which probably corresponds to a tilted phase. This is being analysed to determine the exact structure.

New type of phase transitions have been obtained when a chiral calamitic compound was mixed with an achiral bent-core compound exhibiting the B_6 phase. The complete characterisation of these chiral phases is in progress as they exhibit strange sequence of phase transitions. [R. Pratibha, N.V. Madhusudana and B.K. Sadashiva].

Electroclinic and dielectric dispersion studies. Electroclinic studies on mixtures of a chiral and a nonchiral compound which has an induced TGB_A phase have been carried out. The tilt susceptibility was found to decrease as the concentration of the non-chiral compound is increased, enhancing the twist penetration depth and hence the type II characteristics.

Dielectric dispersion studies on a nematic material in very thin (1 to 2 μm) cells have shown that ions make a significant contribution to the dielectric properties of the medium. A simple analysis was used to deduce the temperature dependences of the concentration and mobility of ions. [N.V. Madhusudana and Surajit Dhara].

An improved high pressure set up. An improved high pressure optical set up has been used to measure the effect of pressure on the nematic-nematic phase transition temperature in a highly polar compound. This experiment also demonstrates that the transition is a bulk property of the compound, even though earlier studies had shown that the transitions at atmospheric pressure could be detected only in thin cells in which the surface interaction played an important role. [N.V. Madhusudana and Manjula Devi].

Orientation and energetics of a smectic C* liquid crystal. The effect of different types of interfaces on the orientation and energies of a smectic C* liquid crystal has been studied by forming circular domains of the liquid crystal on an extremely thin free standing film of the same material. The dark brushes emanating from the point defect are curved and make an angle with the boundary of the domain, indicating that the C-vector makes an angle with the interface. In rare cases a reversing spiral was also observed if the C-vector starts of radially from the

defect center but at a critical radius rotates back to become tangential at the boundary. The radius of the domain, eccentricity of the defect and the orientation of the C-vector at the boundary were measured experimentally with the idea of relating these quantities to the associated elastic constants and energetics. [R. Pratibha and I. Krauss (Inst. de Physique et Chimie des Materiaux, Strasbourg, France)].

Studies on biological systems. DNA forms complexes with cationic lipid/ surfactants due to the increase in the translational entropy of the released counter ions. The complex of DNA with cationic surfactant CTAB (cetyltrimethyl-ammonium bromide) has been studied. Detailed X-ray diffraction experiments on these systems have been carried out as also the changes induced by adding the co-surfactant hexanol to determine the structure of the complex unambiguously. [V.A. Raghunathan, K. Rema and A.K. Sood (IISc.)].

Electroformation of giant unilamellar vesicles. With a view to understand the physical mechanisms involved in cellular processes like endocytosis and fusion, some experiments on lipid membranes reconstituted with biomolecules have been initiated. A giant unilamellar vesicles preparation chamber has been fabricated where the vesicles are formed in the presence of an electric field. Experiments on DNA in lamellar phases of lipids have indicated that the DNA strands can pack very closely on the bilayer surfaces. [V.A. Raghunathan and Sanat Karmakar].

Adsorption of DNA on lipid monolayers. Some experiments have been started on the adsorption of DNA on a lipid monolayer with a view to study the dependence of the structure of the adsorbed layer on the flexibility of the membrane. [V.A. Raghunathan and Mounir Maaloum (Institut Charles Sadron, Strasbourg, France)].

Light scattering studies and monolayers. Visco-elastic properties of liquid crystals are important in various applications. A dynamic light scattering method and an unused scattering geometry where the scattering wavevector 'q' is strictly parallel to the cholesteric axis has been used to study visco-elastic twist mode in cholesteric liquid crystals. By this approach, twist visco-elastic mode has been isolated and studied as a function of temperature.

The relaxation dynamics of DNA molecules in an anisotropic environment such as a nematic phase has been studied. The dynamic light scattering method was employed to probe the effect of DNA doping on the visco-elastic modes of a binary liquid crystal i.e., mixtures of caesium perfluoro octanoate and water.

The monolayer properties of biologically important cholesterol and cholesteryl esters at air-water interface have been studied. The different phases and their structures were probed by surface manometry, epifluorescence microscopy etc. The experimental results are being analysed. [K.A. Suresh, M.S. Giridhar and P.Viswanath].

Solvent effects on the adsorbed monolayer of alkanethiol. Cyclic voltammetric and electrochemical impedance spectroscopic studies have been carried out to compare the barrier properties of two alkanethiols of different chain lengths in four organic solvents, viz., acetonitrile, ethanol, formamide and propylene carbonate. It was found that the shorter chain alkanethiol coated monolayer shows no blocking properties to the ferrocene/ferricinium redox couple in acetonitrile and propylene carbonate whereas the same monolayer shows excellent barrier property in formamide medium. The formation of the monolayer by adsorption in neat thiols have excellent barrier properties compared to the monolayers formed in ethanol as a solvent medium. It was found that the electron transfer occurs by tunneling mechanism and the structural organisation of the molecules with the redox properties in these solvents is correlated.

Cyclic voltammetry and electrochemical impedance spectroscopic studies have shown that monolayers formed using neat thiols have much better barrier property than the one prepared in commonly used solvent such as ethanol. For example, evaporated gold adsorbed with neat hexadecanethiol has an impedance of about 400 $k\Omega cm^2$ at 1 Hz compared to the previously observed value of 100 $k\Omega cm^2$ reported in the literature. This measurement of electro-chemical capacitance has shown that the electrode acts as an ideally polarisable electrode, i.e., a low leakage capacitor. [V. Lakshminarayanan and Ujjal Kumar Sur].

Ultra microelectrode fabricated in the laboratory. The electrochemical impedance studies using the ultra microelectrodes fabricated in the laboratory have been carried out. An UME made of 10 μm gold wire was used for the studies. Such a measurement provided a simple means of characterising the electrode from the uncompensated resistance which can be correlated with the diameter of the wire by Newman's expression. Many experiments are planned for the future using such an electrode. [V. Lakshminarayanan, Ujjal Kumar Sur and A. Dhason].

Liquid crystal displays. Displaying gray shades in liquid crystal displays using successive approximation technique has been developed. In this technique amplitudes of both the row and column waveforms are modulated in different time intervals. The pixel information is represented as a digital number. This method

is useful to reduce the flicker in display which limits the number of gray shades in frame modulation.

A software has been developed to generate all the row waveforms and column waveforms necessary, given some basic parameters like the number of rows, number of rows in a subgroup, the addressing technique, etc. The software has been written for the windows platform using visual basic for the front end and C^{++} for the back end.

A machine has been designed and fabricated for aligning the liquid crystal molecules in a preferred direction at the inner surfaces of a cell used in making liquid crystal displays. Uniformity of alignment in the display cell has improved considerably using this machine. [T.N. Ruckmongathan, K.G. Panikumar and Pratiti Biswas].

THEORETICAL INVESTIGATIONS

New nonlinear optical process in liquid crystals. Some consequences of the optical nonlinearities due to laser induced changes in the order parameter of a liquid crystal has been worked out. The change in the order parameter can be affected by laser induced suppression of the director fluctuations in liquid crystals and or changes in the tilt angle of smectic liquid crystals. In addition to the well known nonlinear optical effects like self-focussing, self-divergence, self-phase modulation and wave mixing, new phenomena like self-iridescence and new types of optical spatial solitons have been predicted. In the case of chiral liquid crystals in the short wavelength limit, the laser beam induces a change in the twist and at the long wavelength edge of the Bragg band, it leads to temporal oscillations in the twist and transmitted intensity. In smectic liquid crystals interesting periodic structures in a standing laser wave have been observed. (G.S. Ranganath and S.K. Srivatsa)

Optical spatial solitons in liquid crystals. The structure of optical spatial solitons in liquid crystals has been worked out. By the combined effect of laser suppression of the director fluctuation and thermal indexing in addition to the usual soliton solutions, a kink soliton solution has been found. The critical laser power required for the formation of solitons in different cases has been worked out. In the case of nonlinear optical effects on light propagation in liquid crystals, interesting modulation of the beam width (beams with large width) in a nematic due to the second and fourth processes has been found. [G.S. Ranganath and S.K. Srivatsa].

Mean field theory. In order to account for the molecular origin of the tilt in smectic C liquid crystals, a mean field theory has been developed to account for the experimentally observed trends in phase transitions between smectic C, smectic A and nematic liquid crystals. It has been argued in this theory that the electrostatic interactions between off-axis dipoles with lateral components produce the tilt in smectic layers. [N.V. Madhusudana and A.S. Govind].

A Landau theory of the ripple phase. A Landau theory of the asymmetric ripple phase of phospholipids has been developed which takes into account the possible anisotropy in the bending modulus of a bilayer with tilt order. Experimentally observed structure can be obtained from this theory if the bending modulus of the bilayer is lower along the tilt direction. [Yashodhan Hatwalne, Kheya Sengupta and V.A. Raghunathan].

Structural parameters of the TGB_A phase. The structural parameters of the TGB_A phase have been evaluated by systematically taking into account the interaction between screw dislocations. The calculated values of the inter-grain boundary separation, the inter-dislocation distance within a grain boundary, as well as their temperature dependences reflect experimentally observed trends. [Yashodhan Hatwalne, Surajit Dhara and N.V. Madhusudana].

Chiral symmetry breaking in crystalline solids. Motivated by experiments on the crystallisation of polymers and some organic compounds, a mechanism for chiral symmetry breaking in crystalline ribbons made up of *achiral* molecules has been developed. It has been shown that the elastic free energy gain from negative Gaussian curvature of the twisted ribbons competes with the free energy loss due to the inhomogeneous strain induced in the ribbons to stabilize the observed chiral structure. [Yashodhan Hatwalne and M. Muthukumar (Univ of Massachusetts, U.S.A.)].

Electronic transport and self-assembly of individual DNA molecules.. A fully functional biological physics laboratory has been started. An optical tweezer has now been completed using a 200 mW ND-YAG laser and an inverted fluorescence microscope. Using a nanometer precision XYZ piezo stage fixed to the microscope, tethered particle position detection system for piconewton level force measurements has been developed. This has been combined with an atomic force probe required in these studies. The process for refining the biochemical methods for single DNA molecule trapping is in progress. [G.V. Shivashankar and T. Roopa].

ASTRONOMY AND ASTROPHYSICS (AA)

AREAS OF RESEARCH

Extragalactic Astronomy
The Galaxy and the Interstellar Medium
Neutron Stars and Pulsars
Instrumentation and Observational Techniques

EXTRAGALACTIC ASTRONOMY

Radio Observations (HI and OH, Recombination Lines). Centimeter and millimeter wavelength recombination lines and continuum were observed with high angular resolution from the starburst galaxy M 82. Line and continuum images at 8.5 GHz and 100 GHz were made with a resolution of 3 arc seconds. These images compared well with each other, as well as with the image obtained in the infrared spectral line of singly ionised Neon (NeII). These data were combined in order to understand the evolution of the starburst phenomena in M 82. Further high resolution (1 arc second) observations at 8.5 GHz are being undertaken in B-configuration of the VLA. [K.R. Anantharamaiah, A. Pedlar (NRAL, Jodrell Bank, UK), F. Viallefond (Observatorie de Paris, France), W.M. Goss (NRAO, VLA, Socorro, USA)].

Radio recombination lines were detected using the Very Large Array from a few nearby starburst galaxies and their origin was traced to the dense gas around Super Star Clusters in these galaxies (e.g., NGC 5253, NGC 253, He 2-10). These are parsec-sized compact ionised Hydrogen (HII) regions, very too obscured to be detected in the optical. This, along with the continuum emission detected by others, constitute the first detection of ionized gas around very young Super Star Clusters. [Niruj Mohan, K.R. Anantharamaiah and W.M. Goss (NRAO, USA)].

Properties of the population of Extremely Red Galaxies (ERGs) were derived from the multi-wavelength data (radio to optical) available on them, and it was concluded that very strong starbursting galaxies do not form a significant component of the ERG population. [Niruj Mohan, H.J.A. Rottgering (Leiden, The Netherlands), A. Cimatti (Arcetri, Florence, Italy), C.L. Carilli (NRAO, Socorro, USA)].

The 21-cm emission and absorption from neutral atomic Hydrogen (HI) and the 18-cm OH absorption from gas near the nucleus of a number of active galaxies were studied using the GMRT and the VLA respectively. These observations revealed the presence of a large amount of neutral atomic and molecular gas in the

nuclear regions of these galaxies. (Amitesh Omar and K.R. Anantharamaiah].

21-cm HI absorption was detected from the peculiar galaxy C153 in the cluster Abell 2125 using the GMRT. The absorption has a peak optical depth of 0.36 and is redshifted by ~ 400 km/s with respect to the [OIII] emission line (forbidden transition in doubly ionised Oxygen) seen in this system. This difference was interpreted in terms of a neutral infall and ionised outflow caused by tidal interactions of C153 with other cluster members. [K.S. Dwarakanath and F.N. Owen (NRAO, USA)].

Emission from neutral hydrogen was searched for from the galaxy cluster Abell 85 using the GMRT. No HI concentration with a mass in excess of 10^9 Solar Masses was detected. [K.S. Dwarakanath and J.H. van Gorkom, A. Fujita (Univ of Columbia, USA), A. Zabludoff (Univ of Arizona, USA)].

Based on the observations from the Australia Telescope Compact Array, evidence has been found for the giant radio source J0116-474 to be in its restarting phase with rejuvenated beams. [N. Udaya Shankar, R. Subrahmanyan (ATNF) and Lakshmi Saripalli (ATNF, Australia)].

Full resolution imaging with the Mauritius Radio Telescope (MRT) has been completed for the region between 18-19 hours in right ascension and between -70° and -10° in declination. [V.N. Pandey, N. Udaya Shankar and R. Somannah (Univ of Mauritius)].

Theoretical studies. Two possible models of mass distribution acting as the gravitational lens at redshift ~1, in the observed 6-image system CLASS 1359+154 were constructed. These models are stable against minor perturbations, and both models indicate the presence of dark matter with a distribution similar to that in nearby groups of galaxies. [Sunita Nair].

Estimates were made of the distortion of the microwave background by galactic winds from galaxies in the early universe. It was found that these distortions should be detectable in the experiments planned for near future, thus providing an observational signature of the process of enrichment of the intergalactic medium with heavy elements. [Biman Nath and S. Majumdar (IIA), M. Chiba (NAO, Japan)].

The heating rate of the intergalactic gas by shocks arising in the process of structure formation was estimated. The equation of state of this hot gas and the mass fraction of the intergalactic gas above a given temperature were well

modelled by this approach. The possible distortions of the microwave background radiation due to this gas were estimated. [Biman Nath and J. Silk (Univ of Oxford, UK)].

In the continued follow-up of Gamma Ray Burst afterglows, two more interesting afterglows (GRB 000926 and GRB 010222) were detected optically from Naini Tal observatory [D. Bhattacharya, R. Sagar, V. Mohan, C.S. Stalin, S.B. Pandey (UPSO)]. For the latter, upper limits to the radio emission were also obtained using the GMRT [D. Bhattacharya and A.P. Rao (NCRA)]. The multiwavelength temporal behaviour of both afterglows were successfully modelled in the picture of an expanding jet which loses collimation as the expansion slows down. In the case of GRB 010222 afterglow it was argued that the energy spectrum of shock-accelerated electrons is unusually hard. [D. Bhattacharya].

THE GALAXY AND THE INTERSTELLAR MEDIUM

Neutral Hydrogen (HI). The 21-cm Neutral Hydrogen (HI) absorption by the Warm Neutral Medium in the Perseus Arm of the Galaxy was detected towards the extragalactic source 3C147 using the Westerbork Synthesis Radio Telescope. 21-cm absorption was also detected from high velocity clouds in the Outer Arm towards the sources 3C147 and 3C380. These observations show that the spin temperature of the Warm Neutral Medium is 4500 ± 500 K, and that the neutral hydrogen in the outer arm have two distinct temperatures, ~1000 K and <200 K. [K.S. Dwarakanath, C.L. Carilli (NRAO) and W.M. Goss (NRAO, USA)].

HI 21-cm line absorption has been measured towards 125 extragalactic radio sources with the GMRT with a view to study the kinematics of interstellar clouds in our local neighbourhood. [Rekhesh Mohan, K.S. Dwarakanath and G. Srinivasan].

Interstellar clouds with high random velocity were imaged in HI 21-cm emission using the VLA. These observations are being analysed along with the 21-cm absorption studies made with the GMRT to determine the HI content and temperature of these clouds. [Rekhesh Mohan, K.S. Dwarakanath, G. Srinivasan and W.M. Goss (NRAO, USA)].

The study of 21-cm HI absorption towards the Galactic Centre with the Australia Telescope Compact Array has resulted in the detection of a wide absorption component, the likely origin of which is from a population of weakly absorbing interstellar clouds with large (~50 km/s) random motions. The study has been extended to the Galactic anticentre direction with the Westerbork Synthesis Radio

Telescope. [Rekhesh Mohan, K.S. Dwarakanath, G. Srinivasan and Ravi Subrahmanyan (ATNF, Australia)].

An unbiased survey of the galactic plane (longitude 320° to 80°, |latitude| < 0.5°) for methanol masers is being carried out with the 10.4 m telescope at 6.7 GHz. From about 480 two-hour sessions, 91 sources have been found, including many new detections. [N. Udaya Shankar and K. R. Vinod].

Interstellar Scattering. The Extreme Scattering Events in the interstellar medium, often thought to be due to isolated, overdense, high-pressure electron density structures, were explained in terms of a single power-law description of the electron density distribution without the need for such isolated, overdense regions. [A.A. Deshpande and V. Radhakrishnan].

NEUTRON STARS AND PULSARS

The Cartographic technique for pulsar polar emission mapping was applied to polarization data on the pulsar B0943+10, and the emission patterns in the two orthogonal (linear) polarization were found to be almost identical, but azimuthally shifted with respect to each other. [A.A. Deshpande and Joanna Rankin (Univ of Vermont, USA)].

A detailed polar emission map of B0943+10 at 35 MHz from data obtained with the Gauribidanur telescope was compared with similar results at higher frequencies. The results indicate that a system of emission "columns" in apparent rotation around the magnetic axis of the star are responsible for the observed modulations. The findings also point to an underlying common "seed" activity possibly close to the stellar surface. Using observations made at 35 MHz, the regular amplitude modulations of the pulsar B0834+06 were also traced to a system of discrete emission subbeams in steady rotation around the magnetic axis. [A.A. Deshpande and Ashish Asgekar].

Single-pulse observations on some 50 relatively bright southern pulsars were made using the Parkes telescope, with a view to conduct a preliminary search for periodic modulations in their sequences. [A.A. Deshpande, Dave McConnell (CSIRO) and Joanna Rankin (Univ of Vermont, USA)].

A wide-band pulsar back-end for the Australia Telescope Compact Array was commissioned successfully, and a user-friendly software package was developed for post-analysis. Using these, a closer look was taken at the recently reported giant pulses from the Vela pulsar. The new component emission was found to

occur about 100 times more frequently than reported earlier. [A.A. Deshpande, Martin Oestreich, Scott Cunningham and Dave McConnell (CSIRO, Australia)].

Constraints on the equation of state of pulsar matter using the observed widths of the core components of emission were refined, and the signature of lead/lag between the core and the conal components was searched for in the available pulsar data. [C.S. Shukre and R.C. Kapoor (IIA)].

A study of the space velocities of binary systems containing a neutron star and a massive star was completed, with the conclusion that the neutron stars in them must have received a kick of order 60-250 km/s at birth. [D. Bhattacharya, E.P.J. van den Heuvel, L. Kaper (Univ of Amsterdam, The Netherlands) and S.F. Portegies-Zwart (SUNY, UAA)].

A fully General Relativistic calculation of the observed spectrum of an accretion disk around a rapidly rotating neutron star was performed. The rotation of the neutron star was incorporated into these calculations in an exact manner, as opposed to approximate treatments done earlier. Important corrections to the results published earlier in this area were found. [D.Bhattacharya, S. Bhattacharyya (IIA) and A.V. Thampan (IUCAA)].

TOPOLOGICAL PHASES

A three-dimensional generalization of the sign-change (π phase shift) rule for adiabatic cycles of two-state wavefunctions encircling a degeneracy in the parameter space of the hamiltonian was proposed. Using the Berry's phase - monopole connection, implications for phase changes around a magnetic monopole pointed out.

A recent extension by Sjöqvist *et al.* of Pancharatnam's phase criterion for interference of pure quantum states to interference of mixed states of particles with N internal degrees of freedom was analyzed and the existence of phase singularities similar to those earlier predicted and observed with pure states at the Institute pointed out. Their relevance to the interpretation of neutron interference experiments with mixed states was demonstratd.

Topological phases are usually believed to be achromatic, i.e., independent of wavelength for small changes in wavelength. It was shown that under certain conditions topological phases can show the opposite behaviour, i.e., sharp changes originating in phase singularities and that this can happen for moderate changes in wavelength.

An error in the discussion of Berry's phase in a popular text book on Quantum Mechanics, significant in the light of the research done at the Institute, was discovered and pointed out to the editor

INSTRUMENTATION AND OBSERVATIONAL TECHNIQUES

The issue of antenna "shadowing" encountered in synthesis imaging instruments was studied in detail. A simple model was developed to explain the associated interferometric response observed for the antennas of the Australia Telescope Compact Array (ATCA). [A.A. Deshpande and Ravi Subrahmanyan (ATNF, Australia)].

The design of the coded mask for the Scanning Sky Monitor aboard the planned ASTROSAT mission has been completed and handed over to ISRO for fabrication. The basic image reconstruction software has been developed and refinements are being worked upon. (D. Bhattacharya, R. Mamatha and B.T. Ravishankar)

In order to streamline the analysis of observations from the Mauritius Radio Telescope (MRT) survey, software has been developed for automated data quality check including interference detection. The variation of the point spread function (PSF) with the declination arising from the non-coplanarity of the MRT was investigated. It was shown that it is possible to deconvolve a field of view of $10^\circ \times 10^\circ$ with a dynamic range of about 150 without changing the PSF. [V.N. Pandey, N. Udaya Shankar and Nadeem Oozeer (Mauritius)].

A 220 GHz radiometer installed at Hanle to monitor the atmospheric opacity was improved. The data obtained from the radiometer agree with the precipitable water vapour derived from surface relative humidity and temperature measurements. [P.G. Ananthasubramanian, T.P. Prabhu (IIA) and Satoshi Yamomoto (Univ of Tokyo, Japan)].

The second sideband of pulsar polarimeter and array combiner were tested at GMRT site along with the second sideband of the pulsar search preprocessor. Hard copy and web based documentation were completed for the pulsar backend developed at RRI for GMRT. The timing hardware for the pulsar search preprocessor for the Ooty radio telescope was improved by incorporating additional circuitry. A variable word size input interface (bit packing) for a generic

data acquisition has been developed and tested in the lab. [A.A. Deshpande, T. Prabu and D.K. Ravindra].

Work on the fabrication of a 12 m pre-stressed parabolic dish (PPD) antenna is in progress. Field trials have been carried out to validate the basic design of PPD. The 4 m. diameter hub on which the pre-stressed members will be anchored has been fabricated and a few test members are installed. Trial reflecting panels have been fabricated and mounted on test members. Design of the mount and control system for the dish have been initiated. Using object oriented programming techniques, an object model of the telescope has been analysed and designed for a likely application to the 12 m-telescope. [K.R. Anantharamaiah, C.M. Ateequlla, A. Krishnan, M. Modgekar, N.V.G. Sarma, M. Selvamani and N. Udaya Shankar].

Design work was initiated on the wideband orthomode transducer along with a corrugated horn in the frequency range of 4-8 GHz for the 12-m PPD antenna. A ridged prime focus horn has been designed to cover the lower frequency range of 0.5 to 1.2 GHz and fabrication work is in progress. A block level design of the complete receiver system and digital backend is in progress. A wideband spectrometer under construction is being adapted for the 12 m PPD antenna. Prototype boards have been built and tested for the various subsystems including the filter-bank, digitizer, local oscillator and correlator modules. System integration and software development are in progress. [P.G. Ananthasubramanian, R. Ganesan, B.S. Girish, T. Prabu, A. Raghunathan, D.K. Ravindra, N.V.G. Sarma and C.R. Subrahmanya].

In the ISRO-RRI collaborative program on satellite-based astrometry, a frequency transfer system was built to interface with standard up/down converters for broadcasting through any C band transponder of INSAT. As part of validation of the system, real-time determination of range rate of INSAT 2A was demonstrated to an accuracy of a few mm/s within a few seconds integration. A dedicated 3.8 m antenna is being commissioned by Insat Master Control Facility(MCF), Hassan, for use in the future ISRO-RRI collaborative experiments. A transponder on INSAT 2B has been identified for the uplinking requirements of the project. A pilot programme has been initiated to explore the techniques of radio interferometry for determining the location of INSAT to much higher accuracies than currently achieved. [C.R. Subrahmanya, R. Ganesan, N.V.G. Sarma, S. Rangarajan (ISRO), S. Sukumar (ISRO), M.Y.S. Prasad (MCF) and D. Ravindranath (MCF)].

COMPUTERS

The primary emphasis of the computer division during the year 2000-2001 was on the improvement of efficiency of campus network and a promotion of Linux Operating System and related applications from public domain. The network within the campus was isolated from the problems due to internet traffic by operating an independent local area network and providing the services of proxy and gateway for access to internet. In addition to the home page available for internet users, a separate home page was created exclusively for the local area network within the campus. The local webserver links to a variety of useful information related to the computers, availability of software, tips to users, internet status etc.

A CD-writer was commissioned and a PC dedicated for CD writing has been commissioned with Windows NT and Linux operating systems. The central computing facility was shifted to its new location in the main building. The commissioning of the new network for the campus was completed. With this, computers in various departments have been networked through a series of segment routers connected by a fibre optic backbone running through various buildings.

In order to meet the growing needs of internet requirements from the users at the Institute, it was decided to increase the bandwidth from the current 64 kbps to 512 kbps. The necessary formalities with DoT and VSNL have been initiated for this purpose.

A beginning was made in the area of cluster computing by procuring a set of cards capable of transmitting data at very high speeds of several gigabytes per sec between PCS using a technology called the Scalable Coherent Interconnect. A set of 4 cards constituting "Wulfkit" was procured for evaluation from Dolphin Interconnect along with the software "Scali" which provides a standard message passing library (called MPI) for application software development. It is planned to identify a set of four high performance Pentium PCS interconnected through this fast network to form an initial cluster. Depending on the usage, it is possible to enlarge the cluster and/or replace the nodes with more powerful PCS at a future date.

OTHER ACTIVITIES

Ph. D.

Awarded

Name	*Topic of Study*
Dipanjan Mitra	A study of the emission and propation of radio signals from pulsars *Jawaharlal Nehru University, New Delhi*
Kheya Sengupta	Investigations on the ripple phase of phospholipids *Jawaharlal Nehru University, New Delhi*
P.K.Thiruvikraman	Study of electric phase transitions at high pressures *Jawaharlal Nehru University, New Delhi*
M.S. Giridhar	Dynamic light scattering and optical diffraction in cholesteric liquid crystals *Jawaharlal Nehru University, New Delhi*
S. K. Srivatsa	Non-linear optical effects in liquid crystals *Jawaharlal Nehru University, New Delhi*

Submitted

Anantha Ramakrishna	Wave propagation and diffusion in active and passive random media *Jawaharlal Nehru University, New Delhi*
Ashish Asgekar	Single-pulse studies of pulsars at decameter wavelengths *Jawaharlal Nehru University, New Delhi*
Jayajit Das	Dynamics of driven dissipative Heisenberg spins with inertia *University of Madras, Madras*
S. Shubhashree	Synthesis and physical properties of compounds exhibiting ferro-, ferri-, anti-ferroelectric and twist grain boundary phases. *Bangalore University, Bangalore*
R. Subramanian	Studies on adsorption of azoles and alkanethiols onto some electrode surfaces *Jawaharlal Nehru University, New Delhi*

Publications

The research work done by the staff of the Institute has been published in a number of journals. A list of publications that have already appeared, as also those submitted and in press, is given at Annexure - I (Page 44).

Summer School in Physics & Astrophysics, 15 May - 27 June 2000

Twenty three students drawn from different parts of the country representing universities, IIT's and Colleges were selected from the eighty one who had applied. Finally fourteen M.Sc, two B. Tech. and five B. Sc students participated. In addition to fifteen lectures on core topics like Interaction of atoms with light, Noise, and Statistical Physics, there were thirty nine lectures on different research topics pursued at RRI. The students also worked on one of the ten projects offered by the faculty. A visit to Gauribidanur observatory, the Planetarium and screening of educational films was also part of the programme.

A short course entited "Survey of Astronomy" was held as a part of the Joint Astronomy Programme during 7-19 August 2000 at the Institute. There were 35 talks given by scientists from Indian Institute of Astrophysics, Bangalore; National Centre for Radio Astronomy, Pune; ISRO Satellite Centre, Bangalore; and Raman Research Institute. The topics covered were: *Interstellar medium; Birth of stars; Cosmology, High Energy Astrophysics; Mysteries of the Sun; Solar System; Stellar evolution; Optical and IR Telescopes; The Gamma ray Universe; X-ray Astronomy; HI, Active Galaxies, Galaxy Formation, Pulsars, ISS, GMRT, Structure and Stability of Stars, Cluster of Galaxies, Radio Galaxies & Quasars, Gravitational Radiation, Gravitational Lensing*, and *Radio Telescopes*.

A Discussion Meeting on Isolated Horizons and Quantum Gravity was held during 2-9 January 2001. Apart from the faculty of the Theoretical Physics Group of the Institute, Prof. Abhay Ashtekar (of The Pennsylvania State University, U S A), Dr. Sukratu Barve, Dr. G. Date, Dr. Parthasarathy Majumdar and Dr. Somen Basak (all from the Institute of Mathematical Sciences, Chennai), Dr. Paramapreet Singh (of IUCAA, Pune) and Dr. B.S. Ramachandra (of Indian Institute of Astrophysics, Bangalore) participated in the Meeting.

Conferences/Seminars and Meetings

The staff of the Institute visited various institutions in India and abroad and attended conferences and presented papers. In addition, 108 lectures were given by them at other places.

Colloquia

The scientists of the Institute and visiting scientists, both from within and outside the country, gave colloquia at the Institute on different topics during the year (Annexure II, page 54).

Journal Club Meetings

Nineteen meetings were held during the year. Preprints as well as recently published papers dealing with topics of great current interest were reviewed in the meetings (Annexure III, page 61).

And, as in the past, several informal Group meetings in Theoretical Physics, Optics, Liquid Crystals and Radio Astronomy were held throughout the year.

In-House Meeting

An In-House Meeting, which is an annual feature at the Institute, was held on 2 & 3 March 2001 where the staff and students presented their research work. In all 30 oral presentations spread over 7 sessions chaired by Faculty Members were made. There were also 6 poster presentations The presentations were followed by lively scientific discussions with critical comments and suggestions relevant to the reported research from the members.

Gandhi Memorial Lecture

The Gandhi Memorial Lecture for 2000 was given by Mrs. Mrinalini Sarabhai Darpana Academy of Performing Arts, Ahmedabad, entitled "The Performing Arts for Social Awareness" on 2 October 2000.

Visiting Scientists

A number of scientists from institutions within the country and from outside visited the Institute during the year. Their names are listed separately (page 38).

LIBRARY

The library procured 456 new books out of which 91 were received on gratis. The total book collection is 21378. It has subscribed to 139 scientific/technical journals and 11 magazines of which 14 were received by air-mail . Of these about 55 titles are available on-line and one of them is an electronic only journal and is received as a CD. The library has subscribed to some online archives to bring information to the user's desktop namely Physical Review Online Archives (PROLA) and also five more journals from AIP.

The library staff participated in seminars/attend lectures arranged by by the Karnataka State Library Association and the Institute for Information Studies and others in the city and elsewhere.

Modernisation. The Libsys software has been changed from Scounix to Linux platform on a trial basis. Additional terminals were installed for users' access. The reprographic facilities were streamlined and upgraded. The barcoding of all the books and journals was completed and the issue/receipt process was also computerized analogous to the bar-coding system.

Other Activities. The library continued to participate actively in inter-library sharing of resources. It also continued its involvement in the relevant Library Associations, and was instrumental in reviving Forum for Resource Sharing in Astronomy (FORSA).

General

Following grants were received from the Department of Science and Technology during the year:

PLAN (Recurring & Non-Recurring)	Rs. 600.00 lakh
NON PLAN (Recurring)	Rs. 307.00 lakh
Total	Rs. 907.00 lakh

COUNCIL

Dr. K. Kasturirangan *Chairman*	*Chairman, Space Commission* *Government of India, Bangalore 560 094*
Mr. Arun Sharma	*Joint Secretary & Financial Adviser* *Ministry of Science & Technology* *Government of India, New Delhi 110 016*
Professor S. Dhawan	*7/11, Palace Cross Road* *Bangalore 560 020*
Professor P. K. Kaw	*Director, Institute of Plasma Research* *Gandhinagar 382 248,*
Professor N. Kumar	*Director, Raman Research Institute* *Bangalore 560 080*
Professor G. Mehta	*Director, Indian Institute of Science* *Bangalore 560 080*
Professor V.S. Ramamurthy	*Secretary, Ministry of Science & Technology,* *Government of India, New Delhi 110 016*
Professor S. Ramaseshan	*Member-Secretary, Raman Research* *Institute Trust, Bangalore 560 080*

FINANCE COMMITTEE

Dr. K. Kasturirangan *Chairman*	*Chairman, Space Commission* *Government of India, Bangalore 560 094*
Mr. Arun Sharma	*Joint Secretary & Financial Adviser* *Ministry of Science & Technology* *Government of India, New Delhi 110 016*
Professor S. Ramaseshan	*Member-Secretary* *Raman Research Institute Trust* *Bangalore 560 080*
Professor N. Kumar	*Director, Raman Research Institute* *Bangalore 560 080*

STAFF

N. Kumar
Director

V. Radhakrishnan
Distinguished Professor Emeritus

S. Ramaseshan
Distinguished Professor Emeritus

G.S. Ranganath, *Dean of Research (up to 31.12.2000)*
N.V. Madhusudana, *Dean of Research (from 1.1.2001)*

THEORETICAL PHYSICS

Research

B.R. Iyer *(Chairman)*
N. Kumar
Joseph Samuel
Madan Rao
Madhavan Varadarajan
R. Nityananda *(on lien at NCRA)*
G.S. Ranganath
Abhishek Dhar (*from 2.3.01*)

Post-Doctoral Fellows

Abhijit Kar Gupta (*up to 30.4.00*)
Abishek Dhar *(up to 1.3.01)*
M.A.H. Ahsan (*up to 25.10.00*)
Anshu Gupta (*up to 30.11.00*)
Shrirang Deshingkar *(from* 6.10.00)
Sukanya Sinha (*CSIR Pool Officer up to 2.11.00 & Visiting Scientist from 3.11.00*)

Research Students

S. Anantha Ramakrishna (*up to 8.3.01)*
Jayajit Das (*up to 6.10.00*)
Sarasij Ray Chaudhari
Roopa T (*2.8.00)*

Visiting Professor

S. K. Rangarajan

Secretarial

G. Manjunatha

OPTICS

Research

Hema Ramachandran
Reji Philip
N. Kumar

Research Students

Sushil Majumdar
Udaya Kumar Khan

Post-Doctoral Fellows

Venkatesh Gopal *(up to 7.7.00)*
R. N. Andal (*from 2.8.00*)

Visiting Professors

A. K. Sood
R. Srinivasan

Technical Assistants

M.S. Meena
P.S. Sasi Kumar

LIQUID CRYSTALS LABORATORY

Research
U.D. Kini
V. Lakshminarayanan
N. V. Madhusudana (*Chairman up to 31.5.00*)
R. Pratibha
V.A. Raghunathan
G.S. Ranganath
T.N.Ruckmongathan
B.K. Sadashiva (*Chairman from 1.6.00*)
K.A. Suresh
Yashodhan Hatwalne

Scientific/Technical
A. Dhason
Mohammed Ishaq
B.P. Neena (*Trainee, from 21.3.01*)
P.N. Ramachandra
N. Ravi Sankar
S. Seshachala (*up to 10.11.00*)
M.R. Subrahmanyam
K. Subramanya (*up to 31.1.01*)
H. Subramonyam
D. Vijayaraghavan

Visiting Scientist
G.V. Shivashankar

Research Students
Amarnatha Reddy
Debashish Chaudhuri (*from 18.5.00*)
M. S. Giridhar
Kheya Sengupta (*up to 21.2.01*)
V. Manjula Devi
K.G. Pani Kumar
Pratiti Biswas
Raj Kumar Gupta
K. Rema
Samir Mandal (*from 7.8.00*)
Sanat Karmakar
H.N.Shreenivasa Murthy
S. Shubhashree
S.K. Srivatsa
R. Subramanian
Sudipto Muhuri (*from 3.8.00*)
Surajit Dhara
P.K.Thiruvikraman (*up to 28.6.00*)
Ujjal Kumar Sur
Utpal Chatterjee (*from 17.8.00*)
P. Viswanath

Secretarial
K. Radhakrishna

ASTRONOMY & ASTROPHYSICS

Research
K.R. Anantharamaiah (*Chairman*)
R.Bhandari
Biman Nath
A.A. Deshpande
Dipankar Bhattacharya
K.S. Dwarakanath
C. Indrani (*up to 2.11.00*)
V. Radhakrishnan
Rajaram Nityananda
B. Ramesh (*On leave with University of New South Wales, Australia)*
C.S. Shukre
G. Srinivasan
C.R. Subrahmanya
N. Udaya Shankar

Secretarial : V. Vidyamani

Research Students
Amitesh Omar
Ashish Asgekar *(JAP)**
Dipanjan Mitra (*up to 13.8.00*)
Kaustav Moni Basu (*from 9.9.00*)
Navinder Singh (*from 29.7.00*)
R. Niruj Mohan *(JAP)**
V.N. Pandey *(from 29.7.99)*
Rekesh Mohan
Suparna Roy Chowdhury (*from 5.9.00*)

**Joint Astronomy Programme*

Post-Doctoral Fellows
C.H. Ishwara Chandra *(up to 29.2.00)*
Sunita Nair

RADIO ASTRONOMY LAB

Technical

P. G. Ananthasubramanian
M.S. Ezhilarasi
B.S. Girish
M. R. Gopala Krishna
P.A. Kamini
S. Kasturi
S. Madhavi
T. Prabu
K.B. Raghavendra Rao
A. Raghunathan
D. K. Ravindra (*Head*)
P. Sandhya
G. Sarabagopalan
S. Siva (*Trainee, from 29.1.01*)
S. Sujatha (*Trainee*)
K.S. Srivani *(up to 21.1.01)*
B.K. Udaya Shankar (*up to 19.10.00*)

Visiting Scientist

A. Krishnan

Secretary

Mamatha Bai

TELESCOPE

R. Ganesan
K. Gurukiran (*up to 22.9.00*)
D. Madhusudhana Rao (*Trainee, from 29.1.01*)
Manohar O. Modgekar
K. Ramesh (up to 12.2.01)
P.V. Rishin (*Trainee, from 29.1.01*)
A. Satish Jadhav (*Trainee, from 2.2.01*)
Sunil Castroe (*Trainee, from 7.3.01*)
S. Swarna (*up to 3.2.01*)
K.R. Venkatesh (*Trainee, from 7.2.01*)
K.R. Vinod

ELECTRONICS & INSTRUMENTATION

Technical

K. Chandrashekara
S. Krishnamurthy
H. N. Nagaraja
Ranganatha *(up to 9.10.00)*
M. Selvamani (*Head*)
S. Shameem (*Trainee, from 29.1.01)*
G. Suresh
C.Vinutha

COMPUTERS

C.R. Subrahmanya (*Head*)
Jacob Rajan
R. Nanda Kumar
B. Sridhar
B.T. Ravishankar (*Trainee, from 2.2.01*)

LIBRARY

Geetha S.
Girija Srinivasan
Hanumappa
M. Manjunath
M. N. Nagaraj
Y.M. Patil (*Librarian, from 26.6.00*)
A. Ratnakar (*Librarian, up to 10.10.00*)
Vrinda J. Benegal

Support Staff

K. Chowdasetty
C. Elumalai
Hanumappa

MECHANICAL & ENGINEERING SERVICES

S. Abdul Rahim
M. Achankunju
I. Charles Paul
V. Dhamodaran
R. Elumalai
K.O. Francis
K. T. Gangadharan
(*In-Charge - General Workshop*)
V. Gokula Chandran
N. Gopal
G. Gopi
I. Henry
M. Mani
K.M. Mohandas
C. Mohammed Ateequlla
(*In-Charge, Basement Workshop*)
V. K. Muthu
V. Nagaraja
N. Narayanaswamy
T. Puttaswamy
M. Selvamani (*Head*)
D. Sunand
P. Srinivasa
S. Sunderaj
M. Suresh Kumar
V. Venu

GAURIBIDANUR TELESCOPE

Technical
H.A. Aswathappa

Support Staff
Bheema Naik
Gangaram
M. Muniyappa (*Nandi Hills*)
Papanna
Prahallada Rao
N. Raja Rao
R.P. Ramji Naik
Ranoji Rao
Shivarudraradhya
Thippanna
Venkataswamy

ADMINISTRATION

G. V. Srinivasa (*Administrative Officer*)
K. Krishnama Raju (*Dy. Admn. Officer*)
S. Raghavachar (*Asst. Admn. Officer*)
R. Ganesh
L.P. Kumar
Marisa D'Silva
K. Radha
S.R. Ramasubramaniyan
V. Raveendran

ACCOUNTS

R. Ramesh
K. R. Shankar (*Accounts Officer*)
S. Srinivasa Murthy
P.V. Subramanya

PURCHASE

Lakshmi Rajagopal (*Purchase Officer*)
Sowjanya Kumar
B. Srinivasa Murthy
Sujatha Anil Kumar

STORES

S. Rajasekharan Nair (*Stores Officer*)
C. N. Ramamurthy
M.V. Subramanya

GRAPHIC ARTS

Raju Verghese

ESTATE & BUILDINGS

S. Anantha Raman
R. Anantha Subba Rao (*Consultant*)
K. Bhoopalan
D. Gangappa
Gunashekar
C. Haridas
K. Palani

M. Rajagopal (*from 2.11.00*)
C. Sampath
R. Sasidharan (*Supervisor*)
S. Sridhar
K.N. Srinivas
T. Subramaniyam Naidu
G. B. Suresh (*Civil Engineer*)

Secretarial: V. Raghunath

CARPENTRY

M. Gopinath
K. M. Lakshmanan (*Supervisor*)
V. Muniraju (*up to 26.7.00*)

L. Muthu
V. Ramu
T. Subramani

MEDICAL

Dr. M.R. Baliga (*Consultant Paediatrician*)
Dr. A.R. Pai (*Consultant Physician*)

Lab. Technician
R. Shanthamma

TRANSPORT

Abdul Khader
M. Balarama
R. Jayaram
C. K. Mohanan
G. Raja

G. Prakash
Rahamath Pasha
Rahamathulla Khan
M. K. Raju Kutty

AMENITIES (Canteen, Guest House and Hostels)

C. V. Bharghavan
T. V. Janardhanan
Mangala Singh
Muniratna
T. Naganna
N. Narayanappa
P. C. Prabhakar
N. Puttaswamy

A. Raju
N. Seetharam
Sharadamma
Shivamallu
Uma
K. Velayudhan
V. Yeshodha

HORTICULTURE

Bylappa
Chikkamunivenkatappa
V. Krishnappa (*Consultant)*
Lakshmamma
Lingegowda
D. Mahalinga
Maiga
Mailarappa
Marappa
Munilakshmi
D. Muniraja
S. Muniraju
P. N. Sachidananda (*Adviser, up to 31.3.01*)
Thimmarayappa
Varalakshmi

UPKEEP

Hanumantha
Jayamma
K. N. Kawalappa
D. Krishna
C. Lakshamma
T. Murali
A. Ramanna
Rangalakshmi
Ranjithamma
Saroja
V. Venkatesh

SECURITY

V. Arputha Raj (*In-charge*)
B. M. Basavarajaiah
U. A. Earappa
H. Gangaiah
Govind K. Kundagol
K. Govindappa
Joseph Kunjachan
Keshavamurthy
K. Krishnappa
Munihobalaiah
K. Pushparaj
O. M. Ramachandra
G. Ramakrishna
M. Sannaiah
Suresha
H. Vaderappa

LIST OF VISITORS

Shrirang S. Deshingkar Sumati Surya G. Date Institute of Mathematical Sciences Chennai	2-4 April 2000 1-5 May 2000 8-12 May 2000
S. Jeyakumar National Centre for Radio Astrophysics Pune	14-21 May 2000
P B Sunil Kumar Indian Institute of Technology Chennai	18 May 2000
Gaurav Dar Indian Institute of Technology Chennai	23-24 May 2000
Willem Baan & Mark Bentum Netherlands Foundation for Radio Astronomy Dwingeloo The Netherlands	28-31 May 2000
Suketu P. Bhavsar University of Kentucky USA	15-26 June 2000
Aalok Pandya University of Rajasthan Jaipur	29 June - 4 July 2000
E.P.J. Van den Heuvel University of Amsterdam Amsterdam The Netherlands	15-19 July 2000
Krishnaswami Alladi University of Florida, Gainesville, USA	22-25 July 2000
Stephen R. Lau University of North Carolina, USA	31 July - 20 Aug 2000

N D Hari Dass Institute of Mathematical Sciences Chennai	7-23 August 2000
Denis Bartolo Institut Curie, Paris France	9 Aug - 2 Sept. 2000
Yeshwant Gupta National Centre for Radio Astrophysics Pune	17-20 August 2000
Roberto de Pietri Dipartimento di Fisica Universita di Parma, Italy	29 Aug - 1 Sept. 2000
G V Vijayagovindan Mahatma Gandhi University Kottayam, Kerala	9-23 September 2000
Nimisha G. Kantharia National Centre for Radio Astrophysics Pune	10-17 September 2000
Yannick Mellier Institut d'Astrophysique de Paris France	13-17 September 2000
Francis Bernardeau C. E. de Saclay France	13-17 September 2000
R V Krishnan Inter-University Consortium for DAE Facilities, Indore	15 September 2000
Govind Swarup National Centre for Radio Astrophysics Pune	20-22 September 2000
Sumithra Sankararaman Institute of Mathematical Sciences Chennai	14-16 October 2000

T. Padmanabhan Inter-University Centre for Astronomy & Astrophysics Pune	1-21 October 2000
Irving A. Lerch The American Physical Society, U S A	19 October 2000
James S. Langer University of California Santa Barbara, USA	20 October 2000
Prasad Subramanian National Centre for Radio Astrophysics Pune	20 October 2000
Phil Dooley National Radio Astronomy Observatory Socorro, New Mexico, USA	24-28 October 2000
Andrzej A. Zdziarski Copernicus Astronomical Centre Warszawa, Poland	30 Oct. - 2 Nov.2000
Robert Beswick University of Manchester Jodrell Bank Observatory Macclesfied, Cheshire, U.K	17-21 November 2000
Surajit Sengupta S.N. Bose National Centre for Basic Sciences Calcutta	2-30 November 2000
Suresh Chandra School of Physical Sciences Swami Ramanand Theerth Marathwada University Nanded	22-23 November 2000
Divya Oberoi National Centre for Radio Astrophysics Pune	22-25 November 2000
Ashok Singal Physical Research Laboratory Ahmedabad	24-25 November 2000

Nandor Eber Research Institute for Solid State Physics and Optics, Budapest, Hungary	27-30 November 2000
Roy Bhaskar Centre for Critical Realism, London Linacre College, Oxford City University London England	28-30 November 2000
Roland Winston The Enrico Fermi Institute University of Chicago U S A	28 Nov. - 8 Dec. 2000
Marc Verheijin National Radio Astronomy Observatory Socorro & University of Wisconsin USA	30 November 2000 - 28 February 2001
Ranjeev Misra Northwestern University U S A	11-12 December 2000
Pier A. Mello Institute of Physics UNAM, Mexico	13 December 2000 - 31 January 2001
J. Heinrichs Institute de Physique Universite de Liege Liege, Belgium	13-23 December 2000
Jean-Louis Pichard Service de Physique de l'Etat CEA-Saclay, Gif-sur-Yvette France	14-21 December 2000
V. Kravtsov International Centre for Theoretical Physics Trieste, Italy	14-21 December 2000

A.M. Jayannavar Institute of Physics Bhubaneshwar	16-24 December 2000
A.E. Piskunov Institute of Astronomy Russian Academy of Sciences Moscow, Russia	13-22 December 2000
Wolfgang Kundt Bonn University Germany	22 December 2000
Abhay Ashtekar Pennsylvania State University University Park, PA 16802-6300 U S A	26 Dec.2000 - 9 Jan. 2001
Sukratu Barve Institute of Mathematical Sciences Chennai	31 Dec. 2000 - 11 Jan.2001
Parampreet Singh Inter-University Centre for Astronomy & Astrophysics Pune	1-10 January 2001
B.S. Ramachandra Indian Institute of Astrophysics Bangalore	1-9 January 2001
Joanna M. Rankin University of Vermont U S A	1-31 January 2001
G. Date Parthasarathy Majumdar Somen Basak Institute of Mathematical Sciences Chennai	2-9 January 2001 2-8 January 2001 2-11 January 2001
V.V. Sreedhar School of Theoretical Physics Dublin Inst. for Advanced Studies Ireland	12 January 2001

M. P. Das Australian National University Canberra, Australia	15-21 January 2001
G. Ravindra Kumar Tata Institute of Fundamental Research Mumbai	22-27 January 2001
Vikram Soni National Physical Laboratory New Delhi	1-28 February 2/001
I. Procaccia Weizmann Institute of Science Rehovot, Israel	16 February 2001
Olivier Mondain-Monval Centre de Recherche Paul Pascal, Bordeaux France	9 February 2001
L. Woltjer Observatoire de Haute Provence St. Michel l'Observatoire France	9-14 February 2001
Sayan Kar Indian Institute of Technology Kharagpur	21-24 February 2001
Daniel Stinebring Oberlin College, Ohio USA	5-14 March 2001
Sanjay Bhatnagar National Centre for Radio Astrophysics Pune	15-17 March 2001
Mark Walker University of Sydney Australia	25 March - 7 June 2001
Avinash Khare Institute of Physics Bhubaneshwar	30 March 2001

Annexure I

PAPERS PUBLISHED

In Journals

1 "Reflection of light from a random amplifying medium with disorder in the complex refractive index: Statistics of fluctuations" (S Anantha Ramakrishna, E Krishna Das, G V Vijayagovindan and N. Kumar), *Phys. Rev.*, **B 62,** 256 (2000).

2 "Random amplifying medium: Statistics of super-reflectance and time-delay fluctuations" (N. Kumar), *Physica* **E, 9,** 356 (2001).

3 "Why are we not blinded by the star light?" (N. Kumar), *Resonance*, p.56 (July 2000).

4 "Blocking of inter-subspace tunneling by intra sub-space inelsatic scattering" (T.P. Pareek, A.M. Jayannavar and N. Kumar), *Indian J. Phys.* **74A,** 413 (2000).

5 "Nonlinear optical studies in tetraphenyl-porphyrin-doped boric acid glass using picosecond pulses" (K. Divakara Rao, S. Anantha Ramakrishna and P.K. Gupta), *Appl. Phys.* **B 72,** 215 (2001).

6 "Padé approximants for truncated post-Newtonian neutron star models (Anshu Gupta, A. Gopakumar, B.R. Iyer and Sai Iyer), *Phys. Rev.* **D, 62,** 044038 (2000).

7 "Frequency-domain P-approximant filters for time-truncated inspiral gravitational wave signals from compact binaries" (T. Damour, B.R. Iyer and B.S. Sathyaprakash), *Phys. Rev.* **D 62,** 084036 (2000).

8 "Comparison of search templates for gravitational waves from binary inspiral" (T. Damour, B.R. Iyer and B.S. Sathyaprakash), *Phys. Rev.* **D 63,** 044023 (2001).

9 "Kruskal coordinates as canonical variables for Schwarzschild black holes" (Madhavan Varadarajan), *Phys. Rev.* **D 63,** 084007 (2001).

10 "A proposal for anlysing the classical limit of kinematic loop gravity" (Madhavan Varadarajan and José A Zapata), *Class. Quantum Grav.* **17,** 4085 (2000).

11 "Fock representations from $U(1)$ holonomy algebras" (Madhavan Varadarajan), *Phys. Rev.*, **D 61**, 104001 (2000).

12 "Is Barbero's Hamiltonian formulation a gauge theory of Lorentzian gravity?" (Joseph Samuel), *Class. Quantum Grav.* **17**, L141 (2000).

13 "Canonical gravity, diffeomorphisms and objective histories" (Joseph Samuel), *Class. Quantum Grav.* **17**, 4645 (2000).

14 "Brownian motion on a sphere: distribution of solid angles" (M.M.G. Krishna, Joseph Samuel and Supurna Sinha), *J. Phys. A: Math. Gen.* **33**, 5965 (2000).

15 "Comment on Holst's Lagrangian formulation" (Joseph Samuel), *Phys. Rev.* **D 63**, 068501 (2001).

16 "Transport along null curves" (Joseph Samuel and Rajaram Nityananda), *J. Phys.* **33**, 2895 (2000).

17 "Translational diffusion of fluorescent probes on a sphere: Monte Carlo simulations, theory, and fluorescence anisotropy experiment" (M.M.G. Krishna, Ranjan Das, N. Periasamy and RajaramNityananda), *J. Chem. Phys.*, **112**, 8502 (2000).

18 "Ordering dynamics of Heisenberg spins with torque: Crossover, spin waves and defects" (J. Das and M. Rao), *Phys. Rev.* **E 62**, 1601 (2000).

19 "Elastic constants from microscopic strain fluctuations" (S. Sengupta, P. Nielaba, M. Rao), *Phys. Rev.* **E 61**, 1072 (2000).

20 "Structure of non space like geodesics in dust collapse" (S.S. Deshingkar and P.S. Joshi), *Phys. Rev.* **D 63**, 024007 (2001).

21 "A Tolman-Bondi-Lemaitre cell model for the universe and gravitational collapse" (A. Chamorro, S.S. Deshingkar, I.H. Dwivedi and P.S. Joshi), *Phys. Rev.* **D 63**, 084018 (2001).

22 "Heat conduction in a one-dimensional gas of elastically colliding particles of unequal masses" (A. Dhar), *Phys. Rev. Lett.* **86**, 3554 (2001).

23 "Heat conduction in the disordered harmonic chain revisited" (A. Dhar), *Phys. Rev. Lett.* **86**, 5882 (2001).

24 "Picosecond optical nonlinearity in monolayer protected gold, silver and gold-silver alloy nanoclusters" (Reji Philip, G. Ravindra Kumar, N. Sandhyarani and T. Pradeep), *Phys. Rev.* **B 62**, 13160 (2000).

25 "Sensitive measurement of absolute two-photon absorption cross sections" (P. Sengupta, J. Balaji, S. Banerjee, Reji Philip, G. Ravindra Kumar and S.Maiti), *J. Chem. Phys.* **112**, 9201 (2000).

26 "Nonlinear optical properties of mixed Mo/Fe, mixed chalcogen clusters $Cp_2Mo_2Fe_2STe(CO)_7$ and $Cp_2Mo_2Fe_2(\mu 3\text{-}S)(\mu 3\text{-}Te)(\mu 2\text{-}SPh)(\mu 3\text{-}H)(CO)_5$" (Reji Philip, G. Ravindra Kumar, P. Mathur and S. Ghose), *Opt.Comm.* **178**, 469 (2000).

27 "Synthesis, optical nonlinearity and crystal structure of a novel mixed-chalcogen, thiolato-bridged complex $[(\eta^5\text{-}C_5H_5)_2Mo_2(\mu\text{-}S)(\mu\text{-}Te)(\mu\text{-}SPh)_2]$" (Pradeep Mathur, Sanjukta Ghose, Rajiv Trivedi, Michael Gelinsky, Michael Rombach, Heinrich Vahrenkamp, Sudeep Banerjee, Reji Philip, G. Ravindra Kumar), *J. Organometallic Chem.*, **595**, 140 (2000).

28 "Density-matrix approach to a strongly coupled two-component Bose-Einstein condensate" (Andal Narayanan and Hema Ramachandran), *Phys. Rev.* **A 62**, 055602 (2000).

29 "Y2 stop cock double pipette for easy filling of liquids" (A. Dhason), *Quarterly Journal of the Indian Society of Scientific Glassblowers News*, **1**, 9 (2000)

30 "An orientational transition of bent-core molecules in an anisotropic matrix" (R. Pratibha, N.V. Madhusudana and B.K. Sadashiva), *Science*, **288**, 2184 (2000).

31 "Experimental studies on the undulated twist grain boundary-C* liquid crystal" (P.A. Pramod, R. Pratibha, Sobha R. Warrier and N.V. Madhusudana), *Ferroelectrics* **244**, 31 (2000).

32 "A molecular theory including hard rod interactions of liquid crystalline phases exhibited by highly polar compounds" (A.S. Govind and N.V. Madhusudana), *Liquid Cryst.* **27**, 1249 (2000).

33 "Synthesis and mesomorphic properties of banana-shaped compounds derived from 2,7-dihydroxynaphthalene" (R. Amaranatha Reddy and B.K. Sadashiva), *Liq. Cryst.* **27**, 1613 (2000).

34 "Crystal structure and EPR studies of bis[1,3-di(p-n-octylphenyl)propane-1,3-dionato]oxovanadium(IV)" (Sujatha Venkataraman, Babu Varghese, B.K. Sadashiva and S. Subramanian), *Molec. Cryst. Liq. Cryst.* **357B,** 199 (2001).

35 "An addressing technique for displaying restricted patterns in rms-responding LCDs by selecting a few rows at a time" (K.G. Pani Kumar and T.N. Ruckmongathan), *Journal of the SID*, **8**, 155 (2000).

36 "New nonlinear optical processes in liquid crystals" (S.K. Srivatsa and G.S. Ranganath), *Optics Comm.* **180**, 349 (2000).

37 "A study of kinetics of adsorption of alkanethiols on gold using electrochemical impedance spectroscopy" (R. Subramanian and V. Lakshminarayanan), *Electrochemica Acta* **45**, 4501 (2000).

38 "Comparative behaviour of aromatic disulfide and diselenide monolayers on polycrystalline gold films using cyclic voltammetry, STM and quartz crystal microbalance" (M. Aslam, K. Bandyopadhyay, K. Vijayamohanan and V. Lakshminarayanan), *J. Colloid. Inter. Sci.* **234**, 410 (2001).

39 "Chemical bond formation at atomic and molecular scale by STM" (Ujjal Kumar Sur), Research News, *Curr. Sci.* **79**, 15 (2000).

40 "Phase transitions in colloidal dispersions in a liquid crystalline medium" (V.A. Raghunathan, P. Richetti, D. Roux, F. Nallet and A.K. Sood), *Langmuir* **16**, 4720 (2000).

41 Evidence of Columnar structure in compounds composed of banana-shaped molecules" (B.K. Sadashiva, V.A. Raghunathan and R. Pratibha), *Ferroelectrics* **243**, 249 (2000).

42 "Twist grain boundary a phase in [R]-[-]-1-methyl-heptyl 4'-(3"-chloro-4"-*n*-alkoxybenzoyloxy) biphenyl-4-carboxylates" (N. Kasthuraiah, B.K. Sadashiva, H.T. Nguyen, J.C. Rouillon and N. Isaert), *Ferroelectrics,* **243**, 37 (2000).

43 "Effect of lateral substituents on the mesophases formed by some achiral banana-shaped molecules" (B.K. Sadashiva, H.N. Shreenivasa Murthy and Surajit Dhara), *Liq. Cryst.*, **28**, 483 (2001).

44 Starburst in the ultraluminous galaxy Arp 220: Constraints from observations of radio recombination lines and continuum" (K.R. Anantharamaiah, F. Viallefond, Niruj R. Mohan, W.M. Goss and J.H. Zhao), *Astrophys. J.* **537**, 613 (2000).

45 "Hydrogen recombination lines near 327 MHz - I: Distribution of low-density ionized gas in the galactic disk" (D. Anish Roshi and K.R. Anantharamaiah), *Astrophys. J.*, **535**, 231 (2000).

46 "Hydrogen recombination lines near 327 MHz - II: A galactic plane survey with a $2^{\circ}\times6'$ beam" (D. Anish Roshi and K.R. Anantharamaiah), *J. Astrophys. Astr.*, **22**, 81 (2001).

47 "The central velocity field in NGC 253: Possible indication of a bar" (Mousumi Das and K.R. Anantharamaiah), *Astrophys. J.*, **549**, 896 (2001).

48 "Carbon recombination lines from the galactic plane at 34.5 and 328 MHz" (N.G. Kantharia and K.R. Anantharamaiah), *J. Astrophys. Astr.*, **22**, 51 (2001).

49 "On the origin of the difference between the runaway velocities of the OB-supergiant X-ray binaries and the Be/X-ray binaries" (E.P.J. van den Heuvel, S.F. Portegies Zwart, D. Bhattacharya and L.Kaper), *Astron. Astrophys.* **364**, 563 (2000).

50 "GRB 000926 and its optical afterglow: Another possible evidence for non-isotropic emission" (R. Sagar, S.B. Pandey, V. Mohan, D. Bhattacharya and A.J. Castro-Tirado), *Bull. Astr. Soc. India*, **29**, 1 (2001).

51 "On cooling flows and the Sunyaev-Zeldovich effect" (Subhabrata Majumdar and Biman B. Nath), *Astrophys. J.*, **542**, 597 (2000).

52 "Using HI to probe large scale structures at z~3" (S. Bharadwaj, B.B. Nath and S.Sethi), *J. Astrophys. Astron.*, **22**, 21 (2001).

53 "Power spectrum of the density of cold atomic gas in the galaxy toward Cassiopeia A and Cygnus A (A.A. Deshpande, K.S. Dwarakanath and W.M. Goss), *Astrophys. J.* **543**, 227 (2000).

54 "The small-scale structure in interstellar HI: A resolvable puzzle" (A.A. Deshpande), *Mon. Not. R. Astr. Soc.*, **317**, 199 (2000).

55 "Search for discrete refractive scattering events" (R. Ramachandran, A.A. Deshpande and B.W. Stappers), *Astron. & Astrophys.* **364**, 71 (2000).

56 "Upper Limits on Periodic, Pulsed Radio Emission from the X-Ray Point Source in Cassiopeia A" (M.A. McLaughlin, J.M. Cordes, A.A. Deshpande, B.M. Gaensler, T.H. Hankins, VM. Kaspi and J.S. Kern), *Astrophys. J.* **547**, 41 (2001).

57 "The topology and polarization of sub-beams associated with the 'drifting' sub-pulse emission of pulsar B0943 + 10 - I. Analysis of Arecibo 430- and 111-MHz observations" (A.A. Deshpande and J.M. Rankin), *Mon. Not. R. astr. Soc.*, **322**, 438 (2001).

58 "GMRT detection of HI 21 cm-line absorption from the peculiar galaxy in Abell 2125" (K.S. Dwarakanath and F.N. Owen), *J. Astrophys. Astr.* **22**, 1 (2001).

59 "GMRT observations of interstellar clouds in the 21 cm-line of atomic hydrogen" (Rekesh Mohan, K.S. Dwarakanath, G. Srinivasan and J.N. Chengalur), *J. Astrophys. Astr.* **22**, 35 (2001).

60 "Fresh results from modelling the gravitationally lensed system PKS1830-211" (S. Nair and M.A. Garrett), *Bull. Astron. Soc. India*, **28**, 401 (2000).

61 "An Australia Telescope survey for CMB anisotropies" (Ravi Subrahmanyan, Michael J. Kesteven, Ronald D. Ekers, Malcolm Sinclair and Joseph Silk), *Mon. Not. R. Astron. Soc.*, **315**, 808 (2000).

62 "A measurement of the cosmic microwave background temperature at 1280 MHz" (A. Raghunathan and Ravi Subrahmanyan), *J. Astrophys. Astr.* **21**, 1 (2000).

63 "Vacuum gaps in pulsars and PSR J2144–3933" (Janusz Gil and Dipanjan Mitra), *Astr. J.*, **550**, 383 (2001).

64 "Scatter broadening of pulsars in the direction of the Gum nebula" (D. Mitra and R. Ramachandran), *Astron. Astr.*, **370**, 586 (2001).

65 "Kinematics of molecular gas in the nucleus of barried galaxies: NGC 253 and M82" (Mousumi Das), . *Astr. Soc. India,* **28**, 357 (2000)

66 "Modelling the bar in the centre of the starburst galaxy M82" (K.A. Wills, Mousumi Das, A. Pedlar, T.W.B. Muxlow and T.G. Robinson), *Mon. Not. R. Astron. Soc.*, **316**, 33 (2000).

67 "Tidally compressed molecular gas in ultraluminous and early type galaxies" (Mousumi Das), *Bull. Astr. Soc. India,* **28**, 389 (2000).

68 "Relativistic beaming effects in the spectra of cores and hotspots in radio galaxies and quasars" (C.H. Ishwara Chandra and D.J. Saikia), *Mon. Not. R. Astron. Soc.*, **317**, 658 (2000).

69 "Astronomy's Devices" (V. Radhakrishnan), *Jansky Lecture 2000.*

70 "Bose-Einstein condensation: Birds of a feather flock together" (R. Nityananda), *Resonance*, p. 46 (April 2000)

In Conference Proceedings

1 "Radiation reaction in electrodynamics and general relativity" (B.R. Iyer), **in** *The Universe, Visions and Perspectives*, Eds. N. Dadhich and A. Kembhavi (Kluwer, Dordrecht, 2000), p. 145.

2 "Second post-Newtonian gravitational wave polarisations for inspiralling compact binaries in elliptical orbits" (A. Gopakumar and B.R. Iyer), **in** *Gravitational waves and experimental gravity*, Eds. J. Trân Thanh Vân, J. Dumarchez, S. Reynaud, C. Salomon, S. Thorsett and J.Y. Vinet (World Publishers, Hanoi, 2000).

3 "On the classical limit of kinematical loop quantum gravity" (Madhavan Varadarajan and Z.A. Zapata), *Proceedings of the Fourth International Conference on Gravitation and Cosmology - Pramana, J. Phys.* **55**, 598 (2000).

4 "Optical diode using a graded-gain random amplifier" (Sushil Mujumdar and Hema Ramachandran), *Conference Digest, CLEO-Europe 2000, Nice, France.*

5 "Using Talbot lattices for quantum state manipulation" (Hema Ramachandran, Harald Ellmann, Johan Jersblad and Anders Kastberg), **in** *Proc. International Conf. On Quantum Electronics (IQEC-2000), Nice, France, 14-15 Sept. 2000.*

6 "New type of high field electrooptic responses in nematics" (Geetha Basappa and N.V. Madhusudana), **in** Liquid Crystals: Chemistry, Physics and Applications, eds. S.J. Klosowicz, J. Rutkowska, J. Zielinski, J. Smilja, Proc. SPIE, **4147**, 116 (2000).

7 "What would the sky look like at long radio wavelengths?" (K.S. Dwarakanath), **in** *Geophysical Monograph 119*, Eds. Robert Stone *et al.*(2000).

8 "On the limiting mass of neutron stars" (G. Srinivasan), **in** *Proc. ESO Workshop, Garching, Germany, 6-8 September 1999* (Springer, 2001).

Book Review

1 "Computational Physics: An Introduction" by R.C. Verma, P.K. Ahluwalia and K.C. Verma (B.R. Iyer and H.R. Madhusudana), *Curr. Sci.*, **79**, 1113 (2000).

PAPERS IN PRESS

In Journals

1 "Rotating Bose gas with hard-core repulsion in a quasi-2D harmonic trap: Vortices in BEC" (M.A.H. Ahsan and N. Kumar), *Phys. Rev. A*

2 "Photon transport in thin disordered slabs" (Venkatesh Gopal, S. Anantha Ramakrishna, A.K. Sood and N. Kumar), *Pramana J. Phys.*

3 "A note on the generalization of the Telegrapher process to describe photon migration in higher dimensions" (S Anantha Ramakrishna and N. Kumar), *Phys. Rev. E.*

4 "Landau diamagnetism revisited" (S Dattagupta, A M Jayannavar and N Kumar), *Curr. Sci.*

5 "Comment on The Immirzi parameter in quantum general relativity" (Joseph Samuel), *Phys. Rev.* **D.**

6 "Active fusion and fission processes on a fluid membrane" (M. Rao and Sarasij Ray), *Phys. Rev. Lett.*

7 "The physics of active membranes" (S. Ramaswamy and M. Rao), *C. R. Acad. Sci., Paris.*

8 "Comment on Can disorder induce a finite thermal conductivity in 1D lattices?" (A. Dhar), *Phys. Rev. Lett.*

9 "Gravitational collapse and the cosmological constant" (S.S. Deshingkar, S. Jhingan, A. Chamorro and P.S. Joshi), *Phys. Rev.* **D**

10 "Use of a graded-gain random amplifier as an optical diode" (Sushil Mujumdar and Hema Ramachandran), *Opt. Lett.*

11 "Comparative features of optical limiting in monolayer protected gold, silver and alloy nanoclusters under picosecond and nanosecond laser excitation" (Reji Philip, S. Mujumdar, Hema Ramachandran, G. Ravindra Kumar, N. Sandhyarani and T. Pradeep), *Nonlinear Optics.*

12 "Recent advances in thermotropic liquid crystals" (N.V. Madhusudana), *Curr. Sc.*

13 "A phenomenological model for the undulating twist grain boundary-C* phase" (P.A. Pramod, Yashodhan Hatwalne and N.V. Madhusudana), *Liquid Crystals*

14 "Induction of B_1, B_6 and biaxial smectic A phases in binary mixtures of compounds with rod-like and bent-core molecules" (R. Pratibha, N.V. Madhusudana and B.K. Sadashiva), *Molec. Cryst. Liq. Cryst.*

15 "Effect of adsorption of some azoles on copper passivation in alkaline medium" (R. Subramanian and V. Lakshminarayanan), *Corrosion Science*

16 "The role of tilt order in the asymmetric ripple phase of phospholipid bilayers" (K. Sengupta, V.A. Raghunathan and Y. Hatwalne), *Phys. Rev. Lett.*

17 "Optical diffraction in non-uniform cholesteric liquid crystals - phase grating mode" (M.S. Giridhar, K.A. Suresh and G.S. Ranganath), *J. Opt. Soc. Am.* **A**.

18 "Hydrogen recombination lines near 327 MHz - III: Physical properties and origin of the low-density ionised gas in the Inner Galaxy" (Anish D. Roshi and K.R. Anantharamaiah), *Astrophys. J.*

19 "General relativistic spectra of accretion discs around rapidly rotating neutron stars: Effect of light bending" (Sudip Bhattacharyya, Dipankar Bhattacharya and Arun V. Thampan), *Mon. Not. R. Astr. Soc.*

20 "Sunyaev-Zel'dovich distortions from early galactic winds" (S. Majumdar, B.B. Nath and M. Chiba), *Mon. Not. R. Astr. Soc.*

21 "VLA Observations of H92α line from NGC 5253 and Henize 2-10: Ionized gas around super star clusters" (Niruj R. Mohan, K.R. Anantharamaiah and W.M. Goss), *Astrophys. J.*

22 "Topology and polarization of subbeams associated with pulsar B0943+10's 'drifting' subpulse emission: II. Analysis of Gauribidanur 35-MHz observations" (Ashish Asgekar & A.A.Deshpande), *Mon. Not. R. Astr. Soc.*

In Conference Proceedings

1 "Detecting binary black holes with efficient and reliable templates" (T. Damour, B.R. Iyer and B.S. Sathyaprakash), **in** *Gravitational waves, A Challenge to Theoretical Physics (2001);* gr-qc/00121070.

2 "Padé approximants for gravitational waves from inspiralling compact binaries" (T. Damour, B.R. Iyer and B.S. Sathyaprakash), **in** *Proc. JGRG2000* (2001).

3 "Nematic liquid crystals: Coefficients of viscosity" (U.D. Kini), **in** *Encyclopaedia of Materials* (Science & Technology), Elsevier.

4 "Growth patterns of smectic C liquid crystals in some binary mixtures (R. Pratibha, Geetha Basappa, N.V. Madhusudana and B.K. Sadashiva), **in** *Proc. European Symposium on Molecular Orientations and Interfaces*, Ed. A. Strigazzi (World Scientific).

5 "Liquid crystals of compounds composed of banana-shaped molecules: Influence of a fluorine substituent" (R. Amaranatha Reddy and B.K. Sadashiva), (*invited*), **in** a special volume entitled '*Materials Research: Current Scenario and Future Projections*', edited by R. Chidambaram (MRSI).

6 "Optical spatial solitons in liquid crystals" (S.K. Srivatsa and G.S. Ranganath), **in** *Proc. Eighteenth International Liquid Crystal Conf., Kent, USA, 24-28 July 2000 - Molec. Cryst. Liq. Cryst.*

7 "Using HI to probe the large scale structures" (S. Bharadwaj, B.B. Nath, S. Sethi), **in** *Proc. IAU Symposium 199: "The Universe at low radio frequencies", Pune, India,* November 3, 2000 - December 4, 2000.

8 "220 GHz tipping radiometer for monitoring atmospheric opacity at Hanle" (P.G. Ananthasubramanian, Satoshi Yamamoto and Tushar P. Prabhu), **in** *Proc. IAU Workshop "Site-2000",* Marrakech, November 2000.

9 "Magnetic filaments at the galactic center: Clues to the field configuration in the Inner Galaxy" (C. Lang Cornelia and K.R. Anantharamaiah), **in** *Proc. Twenty Fourth General Assembly of IAU.*

10 "A sub-arcsecond study of ionized gas in NGC 253" (K.R. Anantharamaiah, Niruj R. Mohan and W.M. Goss), **in** *Proc. International Astronomical Union Symposium 205* (2000).

Annexure - II

COLLOQUIA

Name	Title	Date
Shrirang G. Deshingkar Tata Institute of Fundamental Research, Mumbai	The structure of singularity in Gravitational collapse	3.4.2000
G. Suryan Indian Institute of Science Bangalore	1 Some new mathematics 2 Some new physics	27.4.2000 28.4.2000
Sumati Surya Tata Institute of Fundamental Research, Mumbai	Topology change and causal continuity	1.5.2000
Joseph Samuel Raman Research Institute Bangalore	A critique of Barbero's Hamiltonian formulation	5.5.2000
G. Date Institute of Mathematical Sciences, Chennai	Isolated horizons: An overview	8.5.2000
S R Rajagopalan 11.5.2000 National Aerospace Lab Bangalore	In search of superhard materials	
S. Jeyakumar National Centre for Radio Astrophysics, Pune	The baby radio sources: Compact steep spectrum (CSS) and Gigahertz peaked spectrum (GPS) radio sources	16.5.2000
Gaurav Dar Indian Institute of Technology Kanpur	Energy spectra and transfers in magneto-hydrodynamic turbulence	23.5.2000
Willem Baan Netherlands Foundation for Radio Astronomy Dwingeloo The Netherlands	WSRT science results & Classification of megamaser ULIRGs	30.5.2000

Name		Title	Date
Mark Bentum Netherlands Foundation for Radio Astronomy Dwingeloo The Netherlands		Technical aspects of WSRT upgrade	30.5.2000
Suketu P. Bhavsar University of Kentucky U S A		The magnitude distributions of first-ranked cluster galaxies	16.6.2000
C. S. Shukre Raman Research Institute Bangalore		Pulsar core component widths and the mass-radius relationship of neutron and strange stars	30.6.2000
Holger Merlitz Indian Inst. of Astrophysics Bangalore		The message passing interface (MPI) and its application to parallel coupled cluster computations	3.7.2000
Sushanta Dattagupta S.N. Bose National Centre for Basic Sciences Calcutta		Activated escape over oscillating barriers	13.7.2000
C. Sivaram Indian Institute of Astrophysics, Bangalore		Black hole Hawking radiation may never be observed!	17.7.2000
Yuvaraj Sah Mahindra British Telecom Pune		Demonstration of computer based optical tools (employing graphical user interface, optical tools like filter, reflector, antenna, etc.)	21.7.2000
Krishnaswami Alladi University of Florida U S A		A new weighted Roger-Ramanujam partition theorem and its implications	24.7.2000
N D Hari Dass Institute of Mathematical Sciences Chennai	1 2	Some issues in quantum statistical mechanics Matrix models of strings: A popular account	7.8.2000 10.8.2000
Stephen R. Lau University of North Carolina USA	1 2	Light cone reference for gravitational energy Hyperbolic formulations of general relativity	7.8.2000 11.8.2000

Name	Title	Date
J.L. Osborne University of Durham U K	Very high energy gamma ray astronomy at Durham: Past and future	18.8.2000
Roberto De Pietri Universita di Parma Italy	Canonical 'Loop' quantum gravity and spin foam models	30.8.2000
C. R. Subrahmanya Raman Research Institute Bangalore	Computers and computing	7.9.2000
F. Bernardeau C. E. de Saclay France	Signatures of lensing effect on the cosmic microwave background anisotropies	14.9.2000
Y. Mellier Institut d'Astrophysique de Paris, France	First detection of cosmic shear	15.9.2000
R.V. Krishnan Inter-University Consortium for DAE Facilities, Indore	Magnetism and electron transport in *Al* doped lanthanum manganites	15.9.2000
Alan Gilchrist Editor, Journal of Information Sciences, U. K. AND Stevan Harnod University of Southampton U. K.	Open archives and search engines	20.9.2000
T. Padmanabhan Inter-University Centre for Astronomy & Astrophysics	A series of five lectures on Order of magnitude astrophysics & Intergalactic medium: The next frontier	4,5,9,10,12 Oct. 2000 Pune 19.10.2000
Irving A. Lerch The American Physical Society, U S A	Electronic publishing and tele-communications: Impacts on the global science enterprise	19.10.2000
James S. Langer University of California & The American Physical Society, U S A	1. The changing world of physics and physical societies 2. How solids bend and break	18.10.2000 20.10.2000

Name	Title	Date
Prasad Subramanian National Centre for Radio Astrophysics, Pune	Black hole accretion disks and relativistic jets	20.10.2000
Divya Oberoi National Centre for Radio Astrophysics, Pune	Tomography of the solar wind using interplanetary scintillation	27.10.2000
Andrzej A. Zdziarski Copernicus Astronomical Centre, Warszawa Poland	Radiative processes and geometry of black hole binaries	2.11.2000
V. K. Balasubramanyan Astrophysicist (NASA Retd.) Bangalore	Some recent studies in complex systems	6.11.2000
T.N. Ruckmongathan Raman Research Institute Bangalore	Emerging flat panel displays	9.11.2000
Sanjay Jain Indian Institute of Science Bangalore	Modelling the evolution of networks	14.11.2000
Surajit Sengupta S N Bose National Centre for Basic Sciences Calcutta	Elastic moduli, defect fugacity and disordering in two-dimensions	15.11.2000
Suresh Chandra Swami Ramanand Teerth Marathwada University Nanded	Theoretical study of molecules observed in cosmic objects	22.11.2000
Roy Bhaskar Centre for Critical Realism, London, & City University, London, and Linacre College Oxford, U. K.	Scientific realism and human emancipation	29.11.2000
Nandor Eber Research Institute for Solid State Physics and Optics, Budapest, Hungary	Electroconvection in homeotropic nematics	29.11.2000

Name	Title	Date
Roland Winston The Enrico Fermi Institute University of Chicago U S A	Advances in solar energy science	30.11.2000
Ranjeev Misra Northwestern University USA	Timing properties of X-ray binaries	11.12.2000
A.E. Piskunov Institute of Astronomy Russian Academy of Sciences Moscow, Russia	Young open clusters and star formation	20.12.2000
Andes Kastberg Stockholm University & Umea University Sweden	Optical lattices	21.12.2000
Wolfgang Kundt Bonn University Germany	The 1908 Tunguska catastrophe: A meteoritic impact?	22.12.2000
Dipanjan Mitra IUCAA Pune	Vacuum gaps and the 8.5 sec. pulsar	29.12.2000
Marc Verheijen University of Wisconsin USA	An HI study of the Ursa major cluster of galaxies	5.1.2001
V V Sreedhar Dublin Institute of Advanced Studies, Ireland	Explosion-implosion duality	12.1.2001
Shiv Sethi Harish Chandra Research Institute, Allahabad	Detecting HI at large redshifts	12.1.2001
Pier A. Mello Institute of Physics, UNAM, Mexico	Random matrices in physics: A historical account	18.1.2001

Name	Title	Date
Joanna M. Rankin University of Vermont Burlington, USA	Sub-beam systems and their circulation: Touching the physics of pulsar radio emission	19.1.2001
Mukunda P. Das Australian National University, Australia	Where are the fractional charges and how are they detected?	19.1.2001
G. Ravindra Kumar Tate Institute of Fundamental Research, Mumbai	Ultrashort laser pulses, ultrahigh intensities, superhot temperatures and supersolid densities	24.1.2001
Abhishek Dhar Raman Research Institute Bangalore	Understanding heat conduction in one dimensional systems	29.1.2001
Rajendra Bhandari Raman Research Institute Bangalore	Are $2n\pi$ phase shifts of wave functions physical?	1.2.2001
P. Sreekumar ISRO Satellite Centre Bangalore	On the origin of the extragalactic gamma-ray background	2.2.2001
K. Somashekar Manasa Clinic Bangalore	Heart attack – The Indian scenario – Causes and prevention	3.2.2001
Olivier Mondain-Monval Centre de Recherche Paul Pascal, Bordeaux, France	Force measurements and materials formulation using colloidal suspensions	9.2.2001
Rajaram Nityananda National Centre for Radio Astrophysics, Pune	Lies, damn lies, and statistics	12.2.2001
A. A. Deshpande Raman Research Institute Bangalore	Pulsar polar emission mapping: A status report	16.2.2001
L. Woltjer Observatoire de Haute Provence & Osservatorio Astrofisico di Arcetri Florence, France	Unification of active galactic nuclei	15.2.2001

Name	Title	Date
Itamar Procaccia The Weizmann Institute of Science, Israel	Fractal growth patterns and iterated conformal maps	16.2.2001
Sayan Kar Indian Institute of Technology, Kharagpur	Kinematics of flows in diverse contexts	22.2.2001
K.R. Anantharamaiah Raman Research Institute Bangalore	Radio spectroscopy of ionized gas in galaxies	1.3.2001
T. N. Misra Indian Association for the Cultivation of Science Calcutta	Surface enhanced Raman spectroscopy: Some applications in surface physics	7.3.2001
Dan Stinebring Oberlin College Oberlin, U S A	Faint scattering around pulsars: Probing the interstellar medium on solar system size scales	9.3.2001
Raghavendra Gadagkar Indian Institute of Science & Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore	The evolution of co-operation and altruism in animals	15.3.2001
Jayadev K. Rajagopal Space Telescope Science Institute, USA	Interferometry from space: SIM and beyond	16.3.2001
M. Vijayan Indian Institute of Science Bangalore	Structural diversity and functional similarity in proteins. A case study involving lectins	29.3.2001
Avinash Khare Institute of Physics Bhubaneshwar	Some unusual exactly solvable band theory problems in one-dimension	30.3.2001
Subhabrata Majumdar Indian Institute of Astrophysics, Bangalore	Using Sunyaev-Zel'dovich distortion from galaxy clusters as a cosmological probe	30.3.2001

Annexure III

JOURNAL CLUB

Discussed by	Paper discussed	Date
Niruj R. Mohan	A unified scaling law in spiral galaxies Jin Koda *et al.* *The Astrophysical Journal*, **531**, L17 (2000)	6.4.2000
Sukanya Sinha	Decoherence of quantum superpositions through coupling to engineered reservoirs C.J.Myatt *et al.* *Nature*, **403**, 269 (2000)	6.4.2000
Ahsan M. A. H.	Predicted signatures of rotating Bose-Einstein condensates D.A. Butts and D.S. Rokhsar *Nature*, **397**, 327 (1999)	20.4.2000
Ujjal Kumar Sur	Single-bond formation and characterization with a scanning tunneling microscope H.J. Lee and W. Ho *Science*, **286**, 1719 (1999)	20.4.2000
Bikram Phookun	Is dark matter white? Rodrigo Ibata *et al.* *Ap. J. Letters*, **532**, L41 (2000)	4.5.2000
Anshu Gupta	Symmetry without symmetry: Numerical simulations of axisymmetric systems using Cartesian grids Alcubierre *et al.* Ref: *gr-qc*/9908012	4.5.2000
Udaya Shankar N	Fundamentals of data fusion: Some terms of reference in data fusion Lucien Wald *IEEE Transactions on Geoscience & Remote Sensing* **37**, 1190 (May 1999)	6.7.2000
Kumar N	A photon-activated switch detects single Far-infrared photons Rep. Richard Fitzgerald *Physics Today* (March 2000), 20 Original: S. Komiyama *et al. Nature*, **403**, 405 (2000)	6.7.2000

Discussed by	Paper discussed	Date
Dwarakanath K S	Mapping the interstellar cloud we live in B. Schwarzschild *Physics Today*, January 2000, p.17	20.7.2000
Joseph Samuel	Quantum superposition of distinct macroscopic states Friedman *et al.* *Nature*, **406**, 43 (2000)	20.7.2000
Madan Rao	Actively contracting bundles of polar filaments K. Kruse and F. Jülicher Ref: arXiv:*cond-mat*/0007409, 26 July 2000	3.8.2000
Yashodhan Hatwalne	Particle diffusion in a quasi-two-dimensional bacterial bath Xiao-Lun Wu and Albert Libchaber *Phys. Rev. Lett.*, **84**, 3017 (2000)	3.8.2000
Lakshminarayanan V	Direct measurement of electrical transport through **DNA** molecules Danny Porath *et al.* *Nature*, **403**, 635 (2000)	17.8.2000
Ruckmongathan T N	Quantum mirages formed by coherent projection of electronic structure H. C. Manoharan *et al.* *Nature*, **403**, 512 (2000)	17.8.2000
Subramanian R	Enantioselective magnetochiral photochemistry G.L.J.A. Rikken and E. Raupach *Nature*, **405**, 932 (2000)	31.8.2000
Suresh K A	Smart polymer solutions Vance Bergeron *et al.* *Nature*, **405**, 745, 772 (2000)	31.8.2000
Pratibha R	Nanoscopic channel lattices with controlled anisotropic wetting M. Gleiche, L.F. Chi and H. Fuchs *Nature*, **403**, 173 (2000)	14.9.2000
Anantha Ramakrishna S	Gain-assisted superluminal light propagation L.J. Wang, A. Kuzmich and A. Dogariu *Nature*, **406**, 277 (2000)	14.9.2000

Discussed by	Paper discussed	Date
Rekesh Mohan	Resolving the extragalactic hard X-ray background R.F. Mushotzky *et al.* *Nature*, **404**, 459 (2000)	5.10.2000
Ranganath G S	Natural strength of the conch shell the giant pink queen S.Kamat *et al.* *Nature*, **405**, 1036 (2000)	5.10.2000
Vijayaraghavan D	Superconductivity in molecular crystals induced by charge injection J.H. Schön, Ch. Kloc and B. Batlogg *Nature*, **406**, 702 (2000)	12.10.2000
Abhishek Dhar	Simulating dynamical features of escape panic Dirk Helbing *et al.* *Nature*, **407**, 487 (2000)	12.10.2000
Andal Narayanan	Experimental verification of decoherence-free subspaces Paul G. Kwait *et al.* *Science*, **290**, 498 (2000)	2.11.2000
Shukre C S	PSR 0943+10: A bare strange star? R.X. Xu *et al.* *Astrophysical Journal*, **522**, L109 (1999)	2.11.2000
Giridhar M S	Colloidal ordering from phase separation in a liquid-crystalline continuous phase Jean-Christophe Loudet *et al.* *Nature*, **407**, 611 (2000)	16.11.2000
Sushil Mujumdar	Trapping and emission of photons by a single defect in a photonic band gap structure S. Noda *et al.* *Nature*, **407**, 608 (2000)	16.11.2000
Viswanath P	Dynamic self-assembly of magnetized, millimetre-sized objects rotating at a liquid-air interface Bartosz A. Grzybowski *et al.* *Nature*, **405**, 1033 (2000).	23.11.2000

Discussed by	Paper discussed	Date
Kheya Sengupta	Hydrodynamic coupling of two Brownian spheres to a planar surface Eric R. Dufresne *et al.* *Phys. Rev. Lett.*, **85**, 3317 (2000)	23.11.2000
Raghunathan V A	Defect-induced phase separation in dipolar fluids T. Tlusty and S.A. Safran *Science*, **290**, 1328 (2000)	11.1.2001
Anantharamaiah K R	Quasar Strömgren spheres before cosmological reionization Renyue Cen and Zoltan Haiman *The Astrophysical Journal*, **542**, L75 (2000)	11.1.2000
Abhishek Dhar	Flexible filaments in a flowing soap film as a model for one-dimensional flags in a two-dimensional wind Jun Zhang *et al.* Nature, **408**, 835 (14 Dec. 2000)	25.1.2001
Subramanian R	Macroscopic fibers and ribbons of oriented carbon nanotubes Brigitte Vigolo et al. *Science*, **290**, 1331 (17 Nov. 2000)	25.1.2001
Uday Kumar Khan	Optical gain in silicon nanocrystals L. Pavesi *et al.* *Nature*, **408**, 440 (23 Nov. 2000)	8.2.2001
Srivatsa S K	Stopping light via hot atoms Olga Kocharovskaya *et al.* *Phys. Rev. Lett.*, **86**, 628 (22 Jan. 2001)	8.2.2001
Dipankar Bhattacharya	Near-Maximal Kerr black holes in active galaxies? G. Branduardi-Raymont *et al.* *Astronomy & Astrophysics*, **365**, L140 (2001)	22.2.2001
Surajit Dhara	Transparent nematic phase in a liquid-crystal-based microemulsion Jun Yamamoto and Hajime Tanaka *Nature*, **409**, 321 (18 Jan. 2001).	22.2.2001

Discussed by	Paper discussed	Date
Dwarakanath K S	The cosmic microwave background radiation temperature at a redshift of 2.34 R. Srianand et al. *Nature*, **408**, 931 (Dec. 2000)	8.3.2001
Sukanya Sinha	Sonic analog of gravitational black holes in Bose-Einstein condensates L.J. Garay *et al.* *Phys. Rev. Lett.*, **85**, 4643 (2000)	8.3.2001
Sunita Nair	How well do we know the value of Newton's gravitational constant G? *Subtitle*: Measurement of Newton's constant using a torsion balance with angular acceleration feedback Jens H. Gundlach *et al.* *Phys. Rev. Lett.*, **85**, 2869 (Oct. 2000)	22.3.2001
Pani Kumar K G	Unconventional edge detector R. Chandrasekhar *et al.* *Electronics Letters*, **37**, 79 (Jan. 2000)	22.3.2001

ABBREVIATIONS USED

ADM	Arnowit-Deser-Misner
ASTROSAT	ISRO's Astronomical Satellite
ATCA	Australia Telescope Compact Array
ATNF	Australia Telescope National Facility
ATP	Adenosine Triphosphate
CD	Compact Disk
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
CTAB	Cetyltrimethylammoniumbromide
CTP	Closed Time Path
DNA	Deoxyribonucleic acid
DoT	Department of Telecommunication
ERGs	Extremely Red Galaxies
FCS	Fluorescence Correlation Spectroscopy
FRET	Fluorescence Energy Transfer
Ghz	Giga Hertz
GMRT	Giant Meterwave Radio Telescope
GPI	Glycosylphosphatidylinosital
HI	Neutral Atomic Hydrogen
HII	Ionized Hydrogen
HTSC	High Temperature Super Conductivity
IIA	Indian Institute of Astrophysics
INSAT	Indian National Satellite
ISRO	Indian Space Research Organisation
IUCAA	Inter University Centre for Astronomy & Astrophysics
L.C.	Liquid Crystal

MCF	INSAT Master Control Facility
MD	Microscopic Description
MHz	Mega Hertz
MPI	Message Passing Interface
MRT	Mauritius Radio Telescope
NAO	National Astronomical Observatory (Japan)
NCRA	National Centre for Radio Astrophysics
ND- YAG	Neodymium - Yttrium Aluminium Garnate
NeII	Singly Ionized Neon
NRAL	National Radio Astronomical Laboratory (UK)
NRAO	National Radio Astronomical Observatory (USA)
OH	Hydroxyl Radical
OIII	Doubly Ionized Oxygen
PC	Personal Computer
PPD	Pre-stressed Parabolic Dish
PSF	Point Spread Function
RAL	Radio Astronomy Laboratory
SUNY	State University of New York (USA)
TGBA	Twist Grain Boundary A Phase
UME	Ultra Micro Electrode
UoM	University of Mauritius
UPSO	Uttar Pradesh State Observatory
VLA	Very Large Array (USA)
VLBI	Very Long Baseline Interferometry
VSNL	Videsh Sanchar Nigam Ltd.
WKB	Wentzel-Kramers-Brillouin