RAMAN RESEARCH INSTITUTE

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Annual Report

2004 - 2005

CONTENTS

PREAMBLE

The Annual Report of the Raman Research Institute for the year 2004-2005 is a synopsis of the research and academic activities of the Institute during the year. The Annual Report lists research publications made in scientific journals, seminars/colloquia and joint scientific discussions held at the Institute, and of the Ph.D. degrees awarded during the period 1 April 2004 to 31 March 2005. Eight students of the Institute received Ph.D. degrees during the year. It also lists the scientists who have visited the Institute from India and overseas during this period.

A Summer Programme in Physics was held during May-July 2004, as was done in previous years.

The lists of colloquia and journal club discussions display the remarkable breadth of research at the Institute and the extent of collaborative work with scientists across the world. The linkages are strengthened by the visitors to the Institute, by the visits made by the Institute scientists to other research organizations, and the scientific discussions and collaborations that such interactions spawn. All these are a tribute not only to the scientists of the Institute but also the untiring efforts of the administration that has admirably supported the endeavors.

The quality of research outlined in this report is an obvious statement of the healthy state of the Institute at a time when Prof. N. Kumar nears the end of his time as Director. As I take up the office of my predecessor, I would like to take this opportunity to congratulate Prof. Kumar for preserving the high academic traditions of the Institute and, more importantly, for his vision and courage in steering the Institute along several fresh paths. I look forward to interesting times ahead in my new position, to continue the evolution in the Institute's activities towards inter-disciplinary and holistic approaches to basic science research, and to actively promote interactions with the global scientific community at a time when the world is looking at India with high expectations and keen interest in partnerships.

Bangalore
14 October 2005

RAVI SUBRAHMANYAN
Director

RAMAN RESEARCH INSTITUTE
Bangalore

Annual Report 2004 - 2005

INTRODUCTION

The Raman Research Institute was founded by Prof. C.V. Raman in the late forties. After his death in 1970, it was reorganised as a national institute for research in basic science. The institute 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, Liquid Crystals, and Astronomy & Astrophysics. More recently, high-energy astrophysics research has been initiated and the Raman Institute participates in the Indian ASTROSAT mission. The Liquid Crystals research theme has been expanded to include inter-disciplinary soft-condensed matter and biological physics (studies on membranes and single-DNA segments). In addition, an Optics Lab is making experimental studies in the emerging fields of laser cooling and trapping of atoms, imaging through turbid media, and ultra-fast atomic processes using femtosecond (10^{-15} s) laser pulses.

1. Theoretical Physics

Theoretical physics research in the Raman Institute is primarily in the areas of condensed matter physics, statistical physics and gravitation: quantum gravity and gravitational radiation. The activity in the theoretical physics group has today diversified into physics in biology, in an active effort to research in inter-disciplinary areas and to build bridges with the newly founded National Centre for Biological Sciences (NCBS) at Bangalore.

In non-equilibrium statistical mechanics, there is research interest in heat and charge conduction in simple systems with disorder. Questions of

interest are the validity of Fourier's law and the role of boundary conditions. There is also some interest in the non-equilibrium statistical mechanics of spin systems, where the dynamics and late time steady state behaviour arises out of a complex interplay between driving, dissipation and inertia. Issues related to non-equilibrium statistical mechanics of liquid matter and polymers, which have some applications in biological physics, are also of interest.

In general relativity, research has been on precise calculations of the gravitational wave-forms expected from in-spiralling binaries. This problem is of contemporary significance because of the ongoing construction of gravitational wave detectors which need an accurate 'template' with which the data can be cross correlated to detect the signal from an in-spiralling binary. Classical gravity research includes aspects of Lorentzian geometry and casual structure.

Work in quantum gravity includes the approach initiated by Ashtekar which is based on the prejudices common among general relativists that the failure of perturbative approaches means that theory must be background independent and defined non-perturbatively. Any such definition must confront the conceptual and technical problems of defining quantum field theory in the absence of fixed space time geometry. Investigations into these problems have been carried out either in the extremely promising `head on' approach of Loop Quantum Gravity (LQG) or in the context of simpler yet highly instructive model systems. Apart from the canonical approach to quantum gravity, there is an interest in the covariant path integral approach within which the question of dynamical topology can be addressed. Work has also been carried out on Black Holes and their entropy.

Biological physics research is attracting increasing interest among theoretical physicists as well as scientists from soft condensed matter areas of the Institute. Here again is an example of the value of having a relatively small institute with a wide range of professional research interests and

scientists who are open minded and willing to move into new areas and apply their experience to related fields. The development of the physics behind the folding and subsequent rotation of red blood cells in an optical trap is a step towards its application in medical diagnosis and treatments. Another area of activity is in the mechanism of endocytosis in eukaryotic cells; Landau theory has been used to understand the shape-texture phase diagram and the process of budding. Interest also centres on protein-DNA interactions, biological membranes, rafts and DNA elasticity. There is also related experimental activity both on campus and in the neighbouring NCBS.

2. Optics

Quantum optics, requiring advanced technologies related to the laser cooling and trapping of atoms in magneto-optic traps, is a very fast advancing field of research and development in the world today, particularly because of its potential applications in industry. The Optics Lab at the Raman Institute is well on the road to setting up a double-Magneto-optic trap and producing Bose-Einstein condensates (BEC) for researches into this novel state of matter. A multitude of enabling techniques has been developed as a spin-off from this quest; including a deeper understanding of associated phenomena as a result of experimental developments and theoretical studies. The Optics group has adopted a basic science research approach, as opposed to a competitive technology development approach, in keeping with the overall aims of the Institute. In parallel with the development of the BEC capability, the optics group has pursued experimental research into selected problems related to electro-magnetically induced transparency, fluorescent emission from cold atoms and the phenomenon of double resonance.

Experimental studies of the interaction of ultra-short light pulses, barely 10^{-15} second wide; with nano-particles is another activity of the optics group. The non-linearity exhibited by doped heavy metal borate glasses in

the transparency region, and the non-linear optics characterization of alloy core-shell particles, are also investigations carried out during the year.

Optics activity at the Raman Institute is diverse: an example is the study of the propagation of light in a new kind of random medium consisting of active amplifying fibre segments embedded in a passive scattering medium. Research in quantum communication, specifically protocols for quantum cryptography, is another significant outcome of the interdisciplinary approach to research at the Institute.

3. Liquid Crystals

The Raman Institute has made outstanding contributions to the development of the field of liquid crystals for over three decades. Liquid crystals are a thermodynamic stable phase of matter that has anisotropy of properties without the 3-dimensional order of crystal lattices. Nematic liquid crystal molecules are rod-like and tend to point in the same direction but without positional order; smectic liquid crystal molecules align themselves in layers that can flow past each other; in discotic liquid crystals disc-like molecules are stacked in parallel columns. There are many more complex forms of molecular ordering known with interesting and subtle properties; research in this field at the Raman Institute is unique in that it enjoys the interactions between chemists, electrochemists, condensed matter physicists, theoretical physicists and research staff with statistical physics expertise.

Liquid crystalline substances have interesting optical properties, and external perturbations can cause significant changes in their macroscopic properties; the theoretical and experimental research at the Raman Institute is towards understanding these unique effects and synthesising new liquid crystalline materials. Work on algorithms in liquid crystal displays is also being carried out. Current research in the group includes synthesis and studies of new series of compounds that have banana-shaped or bent-core molecules, novel aspects in discotic liquid crystals, monolayers and of defects in liquid crystals.

4. Astronomy and Astrophysics

Astronomy measures phenomena in outer space, i.e., planets, stars, galaxies, clusters of galaxies and the intervening gas and dust in interstellar and intergalactic space; astrophysics develops physical models that deepen our understanding of the universe. An important aspect of modern astronomy and astrophysics is the study of the evolution of the universe and its constituents: the formation of stars and galaxies out of the primordial gas. These studies are accomplished by examining the radiation received on Earth from or through them, developing theoretical models for the observed phenomena, and simulating the physical processes in powerful computers.

The diversity of objects in the Universe emits radiation across the electromagnetic spectrum: from low frequency radio waves to extremely energetic gamma ray photons. Studies of phenomena in space, or objects in the Universe, require a holistic approach if a deep understanding is to be attained: astronomers cannot look at the skies with coloured glasses. Telescopes have been built to cover all bands of the electromagnetic spectrum and in those wavelength bands in which our atmosphere is opaque, telescopes have been launched into space in our quest for a deeper understanding of our universe and its origins.

The Raman Institute has participated in several telescope projects. It has set-up a Decametre wave Radio Telescope at Gauribidanur - about 80 km from Bangalore - jointly with the Indian Institute of Astrophysics. Members of the Institute use the Ooty Radio Telescope (ORT), which is operated by the Tata Institute of Fundamental Research (TIFR), Mumbai, and have recently developed and built state-of-the-art digital receivers that enhance its capabilities. The Radio Astronomy Lab of the Institute has built receivers in the 20-cm wavelength band for the Giant Metre wave Radio Telescope (GMRT), which is also operated by TIFR, and also built specialized pulsar receivers for GMRT. Another project is the low-frequency (150 MHz) Mauritius Radio Telescope (MRT) built at Mauritius in collaboration with

the University of Mauritius and the Indian Institute of Astrophysics. The Raman Institute has set-up a millimetre wave telescope of diameter 10.4 metre on campus. More recently, the institute is involved in the development of low-cost 12 metre class parabolic dish antennas, based on the pre-formed parabolic dish concept, for potential use as the element for the Square Kilometre Array (SKA), which is an international collaboration to build the next generation radio telescope. An innovative design for large-aperture millimetre wavelength telescopes has also been proposed and manufacturing methods developed. Additionally, the Raman Institute contributes to the Indian ASTROSAT mission, which is a high-energy astrophysics space observatory due to be launched by ISRO in 2007.

Members of the Astronomy & Astrophysics group are currently engaged in research into a variety of phenomena: Pulsars: their evolution, structure and the emission mechanisms; star forming regions and the interstellar medium; observations and modelling of gamma-ray bursts; the influence of black holes on the evolution in galaxies and intra-cluster gas; beams and jets from active galaxies; gas and galaxy evolution in groups of galaxies and cosmology. The preparation of a 150-MHz survey of the southern sky, based on radio observations with the Mauritius radio telescope, is in progress. The telescopes and receivers developed and built in the Radio Astronomy Laboratory provide vital observational clues for this research; however, it may be noted that the windows covered by the Institute's facilities cover only a part of the electromagnetic spectrum. Additionally, a holistic investigation of space phenomena often require observing capabilities not available in India; therefore, the astronomers of the Institute propose and successfully win the use of valuable observing time on facilities throughout the world.

Technical summaries of the work carried in the past year at the Raman Institute are given in the pages that follow.

THEORETICAL PHYSICS (TP)

AREAS OF RESEARCH: Condensed Matter & Statistical Physics
Gravitation
Optics, Quantum Mechanics &
General Physics
Physics in Biology

CONDENSED MATTER AND STATISTICAL PHYSICS

Work distribution functions in polymer stretching experiments. The distribution of work done in stretching a Gaussian polymer at a finite rate is computed. For a one-dimensional polymer undergoing Rouse dynamics, the work distribution is a Gaussian and its mean and width are explicitly computed. The two cases where the polymer is stretched, either by constraining its end or by constraining the force on it, are examined. Connections to Jarzynski's equality and the fluctuation theorems are discussed. [A. Dhar].

Work fluctuations in hysteresis loops for a single spin. For a small magnetic system driven by a time-dependent magnetic field the area under the hysteresis curve gives the work done on the system. A simple model system of a single Ising spin in a time-dependent field and driven by a Markovian dynamics (Glauber dynamics) is considered. The fluctuations of the work done are computed by Monte-Carlo simulations. For the special cases of slow and fast driving rates some exact results are obtained. [A. Dhar and R. Marathe].

Heat transport in disordered harmonic systems. The problem of a disordered harmonic system in two dimensions is studied. Extensive molecular dynamics simulations have been done, with two different types of reservoirs, to find the system-size-dependence of the current. A special case of a system with correlated disorder is treated analytically. We again find that Fourier's law is not valid. These studies are expected to be relevant for experimental studies on heat transport in nanotubes and molecular wires. [A. Dhar + L.W. Lee (University of California, Santa Cruz, USA)].

An alternative derivation of non-equilibrium Green function formalism for quantum transport. The non-equilibrium Green function formalism (NEGF) is commonly used to study electron transport in mesoscopic systems. An alternative derivation of the results of NEGF had earlier been obtained by A. Dhar and S. Shastry. This involved a direct solution of the equations of motion

for the system and reservoirs both of which are taken to be non-interacting. This equation-of-motion derivation of NEGF has now been simplified further and also generalized to the case of phonons. This derivation, which is exact, seems to be much more straightforward than the conventional derivations. Some subtle points such as the possibility of non-unique steady states are now being investigated for a simple model system, namely that of single Anderson impurity coupled to reservoirs. For an interacting system a mean field approach to NEGF is also being investigated. [A. Dhar + D. Sen (IISc., Bangalore)].

Viscosity of suspensions and the glass: Turning power-law divergence into essential singularity. Starting with an expression, due originally to Einstein, for the shear viscosity $\eta(\delta\varphi)$ of a liquid having a small fraction $\delta\varphi$ by volume of solid particulate matter suspended in it at random, an effective-medium viscosity $\eta(\varphi)$ for arbitrary φ is derived which is precisely of the Vogel-Fulcher form. An essential point of the derivation is the incorporation of the excluded-volume effect at each turn of the iteration $\varphi_{n+1} = \varphi_n + \delta\varphi$. The model is frankly mechanical, but applicable directly to soft matter like a dense suspension of microspheres in a liquid as function of the number density. Extension to a glass forming supercooled liquid is plausible inasmuch as the latter may be modelled statistically as a mixture of rigid, solid-like regions φ and floppy, liquid-like regions $(1 - \varphi)$, for φ increasing monotonically with supercooling. [N. Kumar].

Inequivalence of ensembles in single molecule measurements. The role of fluctuations in single molecule experimental measurements of force-extension curves was studied. The worm like chain (WLC) model was used to bring out the connection between the Helmholtz ensemble characterized by the free energy and the Gibbs ensemble characterized by the free energy. The rigid rod limit of the WLC model was considered as an instructive special case to bring out the issue of ensemble inequivalence. The need for taking into account the free energy of transition when one goes from one ensemble to another was pointed out. The "phase transition" noticed in an isometric setup for semiflexible polymers was commented on and a realization of its thermodynamic limit proposed. General arguments which rule out non-monotonic force-extension curves in some ensembles were presented and it was noted that these do not apply to the isometric ensemble.
[J. Samuel and S. Sinha].

GRAVITATION

Ricci Flows. Work was begun on the use of the Ricci flow to address problems in general relativity like the Penrose inequality. Some preliminary findings,

which recover the positive energy theorem using a new method have been obtained. [J. Ahmed, S. Roychowdhury and J. Samuel].

A new class of post-Newtonian waveform templates for inspiralling test-mass in Schwarzschild spacetime. A new and simple complete adiabatic approximant is proposed using the energy and flux functions. At the leading order, it uses the 2PN energy function rather than the 0PN one in the standard approximation so that in spirit it corresponds to the complete 2PN dynamics. The complete adiabatic approximants lead to a remarkable improvement in the effectualness at lower PN (< 3PN) orders. Standard adiabatic approximants of order $\leq$3PN are nearly as good as the complete adiabatic approximants for the construction of effectual templates. Faithfulness of complete approximants is also better than that of standard approximants. [P. Ajith, B.R. Iyer + C.A.K. Robinson and B.S. Sathyaprakash (Cardiff University, U.K)].

Parameter estimation of inspiralling compact binaries using 3.5PN gravitational wave phasing. The problem of parameter estimation of gravitational-wave chirp signals from inspiralling non-spinning compact binaries is reexamined using the 3.5PN gravitational wave phasing. In both initial and advanced detectors the estimation of the chirp mass ($\mathcal{M}$) and symmetric mass ratio (η) improve at higher PN orders but oscillate with every half-a-PN order. Errors in parameter estimation at a fixed SNR are smaller for VIRGO than for both initial and advanced LIGO because of the larger bandwidth over which it observes the signals. For sources at a fixed distance it is advanced LIGO that achieves the lowest errors owing to its greater sensitivity. [K.G. Arun, B.R. Iyer + B.S. Sathyaprakash (Cardiff University, U.K.) and P. Sundararajan (BITS, Pilani)].

Inspiralling compact binaries in eccentric orbits: Instantaneous terms in energy, angular momentum and linear momentum fluxes. The instantaneous term in energy and angular momentum fluxes at 2.5PN and 3PN orders and of linear momentum flux at 1.5PN and 2PN orders have been obtained in the case of inspiralling compact binaries moving on general non-circular orbits. These results are needed to construct search templates for binaries moving in elliptical orbits to be used for matched filtering of gravitational wave signals. [K.G. Arun, B.R. Iyer, M.S.S. Qusailah + L. Blanchet (IAP, France)].

The Hereditary terms in the energy flux up to 3PN. The hereditary contributions to the GW energy flux at 2.5PN and 3PN orders are calculated. This, together with the instantaneous part up to 3PN and the hereditary contribution at 1.5PN, computed earlier, give the complete 3PN accurate expression

for the GW luminosity up to 3PN order. At 2.5PN order the hereditary contribution is only due to the 'tails'. At 3PN order there are 'tails of tails' and 'tail square' contributions as well. They are worked out using the 3PN generalized quasi-Keplerian model for the binary orbit. [K.G. Arun, B.R. Iyer, M.S.S. Qusailah + L. Blanchet (IAP, France)].

Hadamard regularization of the third post-Newtonian gravitational wave generation of two point masses. The 3PN mass quadrupole and dipole moments are obtained in harmonic coordinates for binaries moving in non-circular general orbits using Hadamard regularization. The final expressions are given in terms of their core parts, resulting from the application of the pure Hadamard-Schwartz self-field regularization scheme, augmented by an ambiguous part. For the 3PN mass quadrupole, three ambiguity parameters exist. These results form the basis of the complete calculation of the 3PN radiation field of compact binaries by means of dimensional regularization. [B.R. Iyer + L. Blanchet (IAP, France)].

Surface-integral expressions for the multipole moments of an extended post-Newtonian source and the boosted Schwarzschild solution. New expressions are derived for the multipole moments of an isolated post-Newtonian source in the form of surface integrals in the outer near-zone. The third post-Newtonian source quadrupole moment of a Schwarzschild solution boosted to uniform velocity is computed as an application. A comparison with the 3PN computation of the gravitational wave generation by compact binaries uniquely determines one of the 3PN ambiguity parameters. A far-zone expansion of the boosted Schwarzschild metric, and a calculation of non-linear multipole interactions in the external metric at 3PN order reconfirms this value. [B.R. Iyer + L. Blanchet (IAP, France) and T. Damour (IHES, France)].

Dimensional regularization of the third post-Newtonian gravitational wave generation from two point masses. The general relativistic prediction for compact binary inspiral is completed up to 3.5PN order using dimensional regularization in the computation of the gravitational wave field at 3PN. The quadrupole moment of point-particle binaries in harmonic coordinates contains a pole at the 3PN order that can be renormalized away by means of the same shifts of the particle world-lines as in the 3PN equations of motion. The renormalized quadrupole moment leads to unique values for all the three ambiguity parameters coming from the Hadamard self-field regularization at 3PN. These results should be of use for searching and deciphering the signals in the current network of gravitational wave detectors. [B.R. Iyer + L. Blanchet, G. Esposito-Farèse (IAP, France) and T. Damour (IHES, France)].

Functional evolution of cylindrical gravitational waves. Einstein-Rosen wave is perhaps the best known symmetry-reduced gravitational system with infinite degrees of freedom and is canonically equivalent to a cylindrically symmetric scalar field in 4-dimensional Minkowski space with arbitrarily parametrized time and space. Evolution of quantum states on two arbitrary spatial slices may be implemented by proving the existence of unitary operators that map the states on one slice to the other. A precise criterion is given by the well-known Hilbert-Schmidt condition on the Bogolubov coefficients. It is proved that the Bogolubov coefficients are not of Hilbert-Schmidt type for pure spatial diffeomorphism and therefore unitary maps between two quantum states on two arbitrary spatial slices do not exist. [D. Cho and M. Varadarajan].

Observables in classical stochastic models of causal set theory. A classical stochastic dynamics was formulated for causal set theory by Rideout and Sorkin in 2001, that adapts most easily to a path integral quantisation of causal sets. The set of covariant observables for a class of these theories has been completely characterised in terms of *past-sets* by Brightwell *et al.* These correspond to the past light cones of observers in continuum classical general relativity and hence have a very simple and physically accessible interpretation. This work was extended to include generalisations of the dynamics and hence the robustness of this characterisation of observables was demonstrated. [S. Surya + F. Dowker (Imperial College, London)].

Observability of spatial hypersurfaces and transitions between them. The continuum approximation arises from causal sets that *faithfully* embed *via* a random sprinkling of the elements of the causal set into a continuum spacetime geometry. In such an approximation, a proposal for a discrete analogue of a spatial hypersurfaces in a causal set is made. Using the classical stochastic models for causets, it is demonstrated that such hypersurfaces which represent a covariant *moment-of-time* can be assigned a covariant meaning, as can transitions between them. Within this class of models, the sets of histories containing these hypersurfaces are *observable* in striking contrast to the canonical framework. Moreover, because of the use of *completed histories*, the construction provides a new (non-local) way to sum perform the sum-over-histories in quantum gravity. [S. Surya + S. Major and D. Rideout (Hamilton College, USA)].

Recovering continuum topology from causal sets. Using the discrete analogues of spatial hypersurfaces, homological information was constructed from the causal set which recovers the homology of a globally hyperbolic continuum spacetime with high probability, up to the cut-off scale. Along the

way, this work used some lesser known results of algebraic topology and provided a new way of constructing a discretisation of a continuum spacetime, which derives from its causal structure. Numerical work was also carried out. This result could contribute significantly to the larger goal of obtaining the continuum approximation of a causal set. [S. Surya + S. Major and D. Rideout (Hamilton College, USA)].

The graviton vacuum as a distributional state in kinematic loop quantum gravity. The graviton vacuum state was identified with kinematically non-normalizable, distributional states in LQG by demanding that relations between linearised operator actions on the former were mirrored by those of their non-linear counterparts on the latter. A norm on the space of kinematical distributions was defined and it was shown that the identification was approximate up to distributions which were small in this norm. It was argued that the candidate states were annihilated by the linearised constraints (expressed as operators in the full theory) to leading order in the parameter characterising the approximation. This suggested the possibility, in a scheme such as this, of solving the full constraints order by order in this parameter. [M. Varadarajan].

A general solution for classical sequential growth dynamics of causal sets. A classical precursor to a full quantum dynamics for causal sets was formulated by Rideout and Sorkin in terms of a stochastic sequential growth process in which the elements of the causal set arise in a sort of accretion process. The transition probabilities of the Markov growth process satisfy certain physical requirements of causality and general covariance, and the generic solution with all transition probabilities non-zero was found by them. In this work the assumption of non-zero probabilities was removed, a reasonable extension of the physical requirements to cover the case of vanishing probabilities, was defined and the completely general solution to these physical conditions was found. The resulting family of growth processes has an interesting structure reminiscent of an *infinite tower of turtles* cosmology. [M. Varadarajan + D. Rideout (Hamilton College, USA)].

Quantum resolution of the black hole information loss problem in 1+1 black holes. Recently, Abhay Ashtekar and Martin Bojowlad have proposed a paradigm to discuss Hawking evaporation of a black hole in the context of a non-perturbative quantization of the gravitational field. To convert the paradigm into a concrete resolution of the black hole evaporation paradox, extremely technically involved calculations need to be made. Hence an appropriate toy model in which to test the paradigm before embarking on these

calculations is of immense use. In this context, a non-perturbative quantization of the CGHS model of 1+1 black holes was constructed several years ago by Kuchař, Romano and Madhavan Varadarajan. Hence the CGHS model offers a good testing ground for the paradigm where all technical steps may be completed. The relevant work is in progress. [M. Varadarajan + A. Ashtekar (Penn State, USA)].

OPTICS, QUANTUM MECHANICS & GENERAL PHYSICS

Quantum measure and CP maps. It was shown that a Markovian evolution for a wavefunction on a discrete spacetime lattice can be non-trivial if unitarity is replaced with CP evolution. However, the Markovian character of the decoherence functional remains incompatible with CP evolution, hence establishing that a fully path-integral formulation of Markovian quantum theory on a discrete spacetime lattice has no immediate correspondence to a unitary process. This has potential relevance to models of causal set quantum gravity which employ CP evolution, but are intrinsically tied to moments of time descriptions. This work is in progress. [S. Surya].

PHYSICS IN BIOLOGY

Euler buckling in red blood cells: An optically driven biological micromotor. The physics of an optically-driven micromotor of biological origin was investigated. A single red blood cell, when placed in an optical trap using circularly polarized light, first folds into a rod-like shape and then rotates. A model based on the concept of buckling instabilities captures the folding phenomenon; the rotation of the cell was modeled using the Poincare sphere. Predictions made by this model were successfully tested. [A. Ghosh, J. Samuel, S. Sinha + A.K. Dharmadhikari, J.A. Dharmadhikari, D. Mathur, S. Roy and S. Sharma (TIFR, Mumbai)].

DNA elasticity: Topology of self avoidance. This work in progress since last year studies the topological effects of self avoidance in DNA elasticity. It is shown that the topological effects of self avoidance can be captured by replacing it with the much simpler notion of south avoidance. [A. Ghosh, J. Samuel and S. Sinha].

Active trafficking dynamics of closed membranes: Non-equilibrium steady states. It is shown that active vesicular transport drives a closed membrane to non-equilibrium steady states with distinct morphologies maintained at a non-

uniform pressure and tension which have no analogue in equilibrium physics. Even under conditions of spatially isotropic activity, the closed membrane may spontaneously acquire a non-zero drift, a graphic demonstration of the Curie principle. For anisotropic activity, the generic steady state shapes are flattened sacs. There exist regimes of parameter space where quasi-spherical membrane shapes are unstable to tubular extensions with a radius inversely proportional to $\sqrt{\sigma_{eff}}$, the activity renormalised tension, leading one to believe that such active dynamical processes play an important role in determining subcellular shapes of membrane bound internal organelles. [G. Kripa and M. Rao].

OPTICS

AREAS OF RESEARCH: Laser Cooling and Trapping of Atoms,
Quantum Optics
Ultra-fast Processes, Non-linear Optics
Light in Random Media
Quantum Communication

LASER COOLING AND TRAPPING OF ATOMS, QUANTUM OPTICS

Electromagnetically-induced Transparency (EIT) was observed by studying the fluorescence from doubly-driven room temperature rubidium atoms in a vapour cell. In this effect, the destructive quantum interference of transition probabilities of two transitions with a common level renders a medium transparent to light, which it normally would have absorbed. This is a very delicate effect requiring lasers of very narrow linewidths and high frequency stability, and is usually observed in absorption. The transition from the incoherent Autler-Townes splitting to the coherent transparency effect was demonstrated for the first time in fluorescence. [Andal Narayanan].

The phenomenon of double-resonance that was observed and explained by us last year has now been used to frequency lock lasers. Most experiments in quantum optics require lasers with high frequency stability that are actively locked, usually to a hyperfine transition in the saturation absorption spectrum. By using the spectral feature of double resonance, one may lock the laser at any frequency, up to 1GHz away from a hyperfine transition. As a spinoff, this provides a way of detuning a laser from a hyperfine transition, without the use of acousto-optic modulators that are usually used. [Hema Ramachandran].

The measurement of fluorescent emission from cold atoms in a magneto-optic trap (MOT) as a function of detuning of the cooling laser showed a significant difference in intensity depending on whether the frequency was being ramped up or ramped down. The asymmetry was shown to arise from the different dependencies of the loading rate and the decay rates on detuning. Based on this, an asymmetry parameter was defined that was shown to be insensitive to the various parameters of the MOT and dependent only on the loading and decay rates, and thus on the lifetime of the trap, thereby providing a very simple means of estimating the lifetime of the trap based on measurements of fluorescent emission intensities as functions of frequency sweeps of the cooling laser. [Uday Kumar Khan, R. Srinivasan and Hema Ramachandran].

The various components of the Bose-Einstein condensation experiment that had been built last year, have now been assembled into a double-Magneto-Optic-Trap (MOT). The system is now maintained under differential pressure, with the upper MOT at $3x10^{-9}$ Torr, and the lower at 10^{-10} Torr. A cloud of cold atoms has been formed in the upper MOT. [Ashok Vudayagiri, Andal Narayanan, Hema Ramachandran, R. Srinivasan and Project Assistants].

A theoretical treatment of elementary excitations of a BEC near parallel plates was undertaken. Instability in surface modes are known to create vortices; the threshold velocities for vortex-formation, with and without the presence of parallel plates, were investigated. It is shown that measurable differences exist between the two geometries that may be used to experimentally verify the Casimir-Polder effect. [Andal Narayanan].

ULTRAFAST PROCESSES, NON-LINEAR OPTICS

Very small nano-particles, exhibiting quantum-size effects were investigated. Experimental studies on Au_{29} nanoparticles showed pico-second excited dynamics and relatively larger lifetimes. [Reji Philip + Pradeep (IIT-M)].

The experimental setup for studying the interaction of intense laser fields with liquid droplets is being built. [Reji Philip, Anija Matthew].

Neodymium-doped heavy-metal-borate glasses, which have potential for application in photonics devices were studied. Infra-red and optical absorption, photo-luminescence and open-aperture Z-scan measurements were performed. It was found that in the transparency region, the non-linearity exhibited is of fifth order. [Karthikeyan, Reji Philip + S. Mohan (Asian University, Malaysia)].

The non-linear characterization of Au-Ag alloy core-shell nano-particles were undertaken, based on which a qualitative model for the alloy-core nano-particle has been proposed. [Pradeep (IIT-M), Jinto Thomas, Anija Matthew, Reji Philip + S. Nair (IIT-M), V. Suryanarayanan (IIT-M)].

Silver-polyvinyl alcohol (Ag-PVA) films have been prepared and the influence of annealing time upon the variation in cluster-size has been investigated, using optical absorption, emission and Fourier-Transform Infra-Red (FTIR) spectroscopy. [B. Karthikeyan].

Quantum diffusion on a dynamically disordered and driven lattice with static bias: Decoherence. The problem of quantum diffusion of a particle

moving on a 1-D lattice with dynamical disorder is considered. Decoherence, essential for the diffusive motion, is introduced *via* a set of Lindblad operators, known to guarantee *per se* the positivity, Hermiticity and the trace-class nature of the reduced density matrix, derived and solved analytically for several transport quantities of interest. For the special Hermitian choice of the Lindblad operators projecting on to the lattice sites, we recover several known results, obtained by others, *e.g.,* through the stochastic Liouville equation using phenomenological damping terms for the off-diagonal density-matrix elements. An interesting new result obtained by us is the non-linear enhancement of the diffusion coefficient with increasing drive amplitude and its oscillatory behaviour as function of the drive frequency – clearly, a Wannier-Stark ladder signature. [Navinder Singh and N. Kumar].

Dissipative electron-phonon system photoexcited far from equilibrium. Generalizing the stochastic model known for a driven dissipative granular gas, we have derived the steady-state non-degenerate electron distribution for a semiconductor driven far from equilibrium by the interband photo-excitation assumed uniform over the nanoscale sample. Partitioning of the total inelastic electron scattering into dissipative electron-electron and electron-phonon components is included. The model is applicable to a photo-excited semiconducting sample with fast removal of the electrons by electron-hole recombination from the bottom of the conduction band. [Navinder Singh and N. Kumar].

LIGHT IN RANDOM MEDIA

A new kind of random, amplifying medium, the F-RAM (Fiber Random Amplifying Medium) has been devised, and its emission characteristics under nanosecond excitation experimentally studied. The F-RAM consists of segments of amplifying fibers, randomly embedded in a passive scattering medium. The propagation of light in such a medium consists of diffusion through the scattering medium, and guided propagation with amplification within the active fiber segments. In analogy with the well-known Arrhenius Cascade model, an F-RAM with fiber segments with an exponentially falling distribution of lengths was created. In this system, long fibers, rare though they are, dominate the emission due to the exponentially large gain associated with them. The statistics of sample-to-sample fluctuation in emission intensity was shown to exhibit a Levy distribution, hitherto unknown in optics of random amplifying media. [Divya Sharma, N. Kumar, and Hema Ramachandran].

QUANTUM COMMUNICATION

Secret-sharing is a cryptographic protocol, where a secret is mathematically broken into pieces (shares) such that only specified collection of shares, and not others, may reconstruct the secret. Using inflation, compression and twin-thresholding, the role of classical shares in quantum key sharing were investigated. [R. Srikanth + Sudhir Singh (IIT-Kgp)].

A quantum-seal is a way of encoding a message into quantum states, so that anybody may read the message with little error, while authorized verifiers can detect that the seal has been broken. A simple extension of the Bechmann-Pasquinicci majority-voting scheme was devised that allows the sealed states to be non-orthogonal, and further, encompasses sealing of quantum messages by means of quantum encryption. The scheme is relatively easy to implement, requiring neither entanglement, nor controlled operations during state preparation, reading or verification stages. [R. Srikanth + Sudhir Singh (IIT-Kgp)].

Quantum cryptography essentially consists of a transmission of a key over a quantum channel, and it requires that the error rate (which results either from a noisy channel or from eavesdropping, which alters the transmitted bit) be smaller than a particular value in order that the transmitted key to be secure. Various protocols are proposed in literature that attempt to increase the permissible error rate. We have proposed a protocol that uses the Bennett-Brassard (BB84) scheme, and in addition, a twin-coding of bases sets, with some pre-shared information. This scheme results in a larger cryptokey generation rate for a given quantum bit error rate, and it is found that asymptotically, no error rate is too high to tolerate. [R. Srikanth, Ashok Vudayagiri, Andal Narayanan and Hema Ramachandran].

LIQUID CRYSTALS (LC)

AREAS OF RESEARCH:

L.C. Synthesis
Phase Transitions
Monolayers
Soft Matter Physics
Electrochemistry
Liquid Crystal Displays
Theoretical Investigations

EXPERIMENTAL INVESTIGATIONS

LIQUID CRYSTAL SYNTHESIS

Synthesis and characterization of new compounds exhibiting liquid crystalline phases: Research and scientific investigations were continued on the design, synthesis and characterization of new compounds composed of banana-shaped as well as disc-like molecules.

New phase sequences in banana-shaped mesogens: Many new homologous series of bent-core compounds derived from 2,7-dihydroxynaphthalene were synthesized and the mesomorphic properties investigated using classical techniques. The position of fluorine substitution has an influence on the nature of mesophase formed. The compounds containing fluorine on the middle phenyl ring *ortho* to the carboxylate group exhibit new phase sequences such as N to X_1 to X_2 to B_6; N to B_6 to B_1; N to B_1 and a chiral SmC_AP_A mesophase on ascending the homologous series. The corresponding isomeric compounds (fluorine at *meta* position) show N to X_1 to X_2 to B_1; N to B_1; and a racemic $SmCP_A$ phase. However, some of the unsubstituted parent compounds show a chiral SmC_AP_A phase. The fluorine substitution in the middle phenyl ring induces a new phase sequence and also changes the chiral nature of the mesophases. Fluorine substitution at the *ortho* position w.r.t. the n-alkoxy chain on the central phenyl unit completely changes the mesophase behaviour when compared with the parent compounds. [R. Amaranatha Reddy and B.K. Sadashiva].

Unusual mesomorphic behaviour in bent-core compounds derived from 5 – cyanoresorcinol: Two new homologous series of compounds containing a highly polar cyano group along the arrow axis of bent-core molecules were synthesized and their mesomorphic behaviour investigated. The mesophase obtained for higher homologues of both series show a mixture of four different

possible structures. Among these, two are chiral conglomerates with opposite tilt and polarity. The remaining two have racemic structures which arise from a synclinic tilt of bent-core molecules in adjacent layers in one case, and in the other a synclinic tilt of molecules in adjacent layers forming two different domains which alternate. The observation of tristable switching, as well as two half period polarization current peaks, confirms the ground state antiferroelectric structure for the mesophase. The spontaneously formed helical filaments and chiral circular domains with helical periodicity suggest a structure for this mesophase that is different from B_2 phase [R. Amaranatha Reddy and B.K. Sadashiva].

Novel columnar mesophases obtained from banana-shaped mesogens: A few novel series of bent-core compounds containing cinnamoyloxy or ∝-methylcinnamoyloxy groups in the sidearms were synthesized and the mesophases exhibited by them compared. The influence of the central angular unit on the occurrence of mesophases was investigated. The higher homologues of compounds containing a cinnamoyloxy group in the sidearms and derived from 2,7-dihydroxynaphthalene show a direct transition from nematic phase to a columnar phase with an oblique lattice. The corresponding analogues derived from 1,3-dihydroxybenzene show a columnar phase with a rectangular lattice, which interestingly shows an antiferroelectric switching behaviour. Compounds derived from a naphthylene central unit containing α-methylcinnamoyloxy group in the sidearms show a direct transition from a nematic phase to an antiferroelectric B_2 phase. In contrast, the corresponding analogues derived from 1,3-dihydroxybenzene do not show any mesophase. A fluorine lateral substituent induces an interesting phase sequence, such as direct transition from a nematic phase to an antiferroelectric B_2 phase and to a columnar B_1 phase as well. An orthogonal arrangement of molecules in the B_1 phase was found in two homologous series of compounds containing 2,7-naphthylene central unit. [R. Amaranatha Reddy, B.K. Sadashiva and V.A. Raghunathan].

Fluorine-substituted unsymmetrical bent-core mesogens derived from resorcinol: The mesomorphic properties of forty unsymmetrical achiral bent-core compounds belonging to four different homologous series were investigated. A majority of the compounds exhibited an antiferroelectric B_2 phase. X-ray diffraction studies of the mesophases of compounds with fluorine substitution at the *ortho* position w.r.t. the terminal n-alkoxy chain show a B_2 phase with larger *d*-spacings than those of compounds with fluorine at the *meta* position. This indicates that the conformation of the n-alkoxy chain is affected by the presence of the highly electronegative fluorine substituent in the *ortho* position. It was also found that the position and number of fluorine substituents

play a significant role in inducing the ferro-/antiferro-electric mesophase in these five-ring achiral bent-core compounds [H.N. Shreenivasa Murthy and B.K. Sadashiva].

Novel ferroelectric and antiferroelectric smectic and columnar mesophases in fluorinated symmetrical bent-core compounds: The synthesis and mesomorphic properties of a new homologous series of compounds derived from 2,7-dihydroxynaphthalene with a fluorine substituent on the outer phenyl rings *ortho* to the n-alkoxy chain were investigated using classical techniques. A wide variety of electrooptically switchable mesophases have been obtained by varying the terminal n-alkoxy chain length. This is the first example of a series of compounds in which ferroelectric, antiferroelectric switching smectic and columnar phases are obtained with increasing chain length, which gives a new phase sequence in banana liquid crystals. It is apparent that fluorine substitution only at this position induces the switchable columnar phases and not at any other position in these compounds with isomeric structures, which also suggests the importance of the position of the electronegative fluorine substituent. [R. Amaranatha Reddy, V.A. Raghunathan and B.K. Sadashiva].

Mesomorphic properties of seven-ring banana-shaped mesogens derived from 5-choloresorcinol: The synthesis and characterization of two new homologous series of seven-ring symmetrical bent-core esters derived from 5-chlororesorcinol were carried out. These represent the first example of BC compounds containing a chloro substituent at position 5 of the central phenyl unit. The lower homologues of both series of compounds exhibit the rectangular columnar B_1 phase. Interestingly, the higher homologues show a mixture of three different possible structures, two chiral and one racemic. Although the ground state structure of the mesophase is antiferroelectric, it is different from the usual B_2 phase and hence has been termed as B_{2X}. Since the B_{2X} mesophase shows a helical pattern, it is possible that this mesophase is among the B_7 class of materials. [S. Umadevi and B.K. Sadashiva].

Recent developments in the chemistry of triphenylene–based discotic liquid crystals: Triphenylene based discotic liquid crystals, which have already been used commercially in phase compensation films to improve the viewing angle of liquid crystal display devices, also have application potential as one-dimensional charge carrier systems useful in electrical conduction, photoconduction, electroluminescence, photovoltaic solar cells, gas sensing, optical data storage and other devices. A summary of the advances in the chemistry of triphenylene based discotic liquid crystals since 1995 has been written as a review article. [Sandeep Kumar].

Inclusion of gold nanoparticles into a discotic liquid crystalline matrix: The thermophysical properties of mixtures of hexanethiolate capped gold nanoparticles and three types of discotic liquid crystals, investigated using polarizing optical microscopy, differential scanning calorimetry and DC conductivity measurements, indicate inclusion of gold nanoparticles into a matrix of triphenylene-based discotic liquid crystals [Sandeep Kumar and V. Lakshminarayanan].

Synthesis and characterization of novel imidazolium-based ionic discotic liquid crystals with a triphenylene moiety: Two novel triphenylene tethered imidazolium salts were synthesized either by the quaternization of 1-methylimidazole with a ω-bromo substituted triphenylene or the quaternization of a triphenylene-substituted imidazole with methyl iodide. These triphenylene based imidazolium salts with bromide or iodide as counterion show columnar mesophase properties over a wide temperature range. [Sandeep Kumar and Santanu Kumar Pal].

A convenient and economic method for the synthesis of monohydroxy-pentaalkoxy- and hexaalkoxytriphenylene discotics: A one step process for the preparation of mono-functionalized triphenylene discotics was developed. Oxidative trimerization of *ortho*-alkoxybenzenes using $FeCl_3$ in nitromethane and a catalytic amount of various acids, furnished monohydroxy pentaalkoxytriphenylene in addition to hexaalkoxytriphenylene which were separated by chromatography. [Sandeep Kumar and B. Lakshmi].

PHASE TRANSITIONS

Selective imaging of 3D director fields and study of defects in biaxial smectic A liquid crystals: The selective imaging of different director fields in a biaxial smectic A (SmA_b) liquid crystal using Fluorescence Confocal Polarizing Microscopy (FCPM) and Polarizing Microscopy (PM) was carried out. It has been shown that the two main director fields in biaxial smectic A phase, *viz.*, those corresponding to the rods and the bow axes of the banana-shaped molecules can be independently mapped using two different types of fluorescent dyes in fluorescence confocal polarized microscopy. The technique has led to direct proof of the correctness of the proposed structure of the biaxial smectic A phase. The defect patterns in the banana director field, the layer bending which leads to focal-conic domains, and the mutual influence of the two types of defects have also been studied. [R. Pratibha and N.V.

Madhusudana + I.I. Smalyukh and O.D. Lavrentovich, Liquid Crystal Institute, Kent, U.S.A].

Stripe phase in binary mixtures of rod-like and banana-shaped mesogens: It was discovered in the laboratory some years ago that binary mixtures of compounds composed of rod-like and banana-shaped molecules can exhibit the biaxial smectic A phase. In some specially prepared cells, it was found that the medium spontaneously breaks up into a stripe phase in which alternate stripes have biaxial and uniaxial character. Stripe phases are known in a number of other condensed matter systems, but the present one appears to be quite different as the ground state of the mixture is one with a uniform composition. Effort is being made to understand the origin of the stripes by conducting further experiments. A simplified model for the stripe phase is also being developed. [N.V. Madhusudana and R. Pratibha].

Dynamic light scattering studies on a disc-like nematic lyotropic liquid crystal: Lyotropic liquid crystals possess structures that are very different from thermotropic liquid crystals and have attracted considerable interest. Cesium perfluorooctanoate (CsPFO) dissolved in water form disc-like micelles. In a certain range of concentrations, the CsPFO in water system exhibits an isotropic phase, a nematic phase and a lamellar phase on cooling. The twist viscoelastic coefficient in this nematic phase has been measured employing dynamic light scattering technique and it was found that the viscoelastic coefficient increases with increase in temperature. The viscoelastic response of the medium as a function of concentration of CsPFO in water has also been studied. Twist viscoelastic coefficient rapidly increases with the concentration of CsPFO in water at a given reduced temperature. The activation energy corresponding to the viscosity has been estimated and is shown to be nearly independent of the concentration of CsPFO in water. The effects of doping polyethylene glycol polymer on the viscoelasticity of CsPFO in water system has also been studied [Amit K. Agarwal and K.A. Suresh].

MONOLAYERS

Studies on the Langmuir monolayer of cholesteric acid: Cholesteric acid (CA) molecule is an optically active molecule possessing a size anisotropy in the head and tail groups. This results in some interesting monolayer phases at the air-water interface. At low surface density, the monolayer exhibits a phase with a gradual tilt azimuth variation of the molecules. This is revealed by the stripe patterns seen in a Brewster angle microscope. Linear and concentric stripes and spirals are also observed. In addition to this loosely packed phase,

CA monolayer exhibits two more phases – a uniformly tilted condensed phase and an untilted condensed phase. [Rajkumar Gupta and K.A. Suresh].

SOFT MATTER PHYSICS

Spontaneously formed monodisperse biomimetic unilamellar vesicles: Using small-angle neutron scattering and dynamic light scattering techniques, partial structural phase diagrams of lipid mixtures composed of the phosphatidylcholines dimyristoyl and dihexanoyl doped with calcium ions (Ca^{2+}) and/or the negatively charged lipid, dimyristoyl phosphatidyl glycerol (DMPG) have been constructed. For dilute solutions (lipid concentration $\leq$ 1 Wt %), spontaneously forming unilamellar vesicles (ULVs) were found, and their polydispersity was determined to be $\sim$ 20%. The stability of Ca^{2+} – or DMPG doped ULVs was monitored over a period of 4 days and their structural parameters (*e.g.*, average outer radius, $< R_o >$) were found to be insensitive to the lipid concentration (C_{lp}). However, doping the dimyristoyl/dihexanoyl system with both Ca^{2+} and DMPG resulted in ULVs whose $< R_o >$ was found to be C_{lp} dependent. The $<R_o>$ of DMPG – doped ULVs remained unchanged over an extended period of time (at least 4 days), a good indication of their stability [V.A. Raghunathan + scientists at the Steacie Institute for Molecular Sciences, Ontario Canada, and the Center for Neutron Research, Gaithersburg, Maryland, USA].

Finite-size effects do not reduce the repeat spacing of phospholipid multibilayer stacks on a rigid substrate: Finite-size effects in stacks of phospholipid bilayers, in the fluid L_α phase, have been investigated using samples oriented on silicon substrates. Recently, such effects have been suggested, as the probable cause of reduced lamellar repeat spacings in very thin samples made up of a few (<10) bilayers. The systematic studies carried out on samples of different thicknesses do not support this conclusion. At full hydration all samples are found to have the same repeat spacing, irrespective of their thickness. At lower hydrations, on the other hand, very thin samples, consisting of only a few bilayers, have a slightly larger spacing. [V.A. Raghunathan + scientists at the Steacie Institute for Molecular Sciences, Ontario, Canada].

Magnetically alignable phase of phospholipid "Bicelle" mixtures is a chiral nematic made up of wormlike micelles: The phase behaviour of binary mixtures of long- and short-chain lipids, namely, dimyristoyl phosphatidylcholine (DMPC) and dihexanoyl phosphatidyl choline (DHPC), using optical microscopy and small-angle neutron scattering has been studied.

Samples with a total lipid content of 25 wt %, corresponding to ratios Q ([DMPC] / [DHPC]) of 5, 3.2 and 2, are found to exhibit an isotropic (I) → chiral nematic (N*) → lamellar phase sequence on increasing temperature. The I → N* transition coincides with the chain melting transition of DMPC at Q =5 and 3.2, but the N* phase forms at a higher temperature for Q = 2. All three samples form multilamellar vesicles in the lamellar phase. These results show that disc-like "bicellar" aggregates occur only in the lower temperature isotropic phase and not in the higher temperature magnetically alignable N* phase, where they were previously believed to exist. The N* phase is found to consist of long, flexible wormlike micelles, their entanglement resulting in a very high viscosity of this phase. [V.A. Raghunathan + scientists at the Steacie Institute for Molecular Sciences, Ontario, Canada, the National Institute of Standards and Technology, Gaithersburg, Maryland, USA, and the Institute of Biophysics and X-ray Structure Research, Schmiedlstrasse, Austria].

Phase behaviour of dipalmitoyl phosphatidylcholine (DPPC) - cholesterol membranes: The phase behaviour of dipalmitoyl phosphatidylcholine (DPPC) – cholesterol mixtures from small angle X-ray diffraction studies of oriented multilayers has been determined. A cholesterol induced modulated phase, denoted as P_{β} is obtained at intermediate cholesterol concentrations, which is distinct from the ripple ($P_{\beta'}$) phase found in earlier studies on similar systems. Some confocal fluorescence microscopy investigations on Giant Unilamellar Vesicles (GUVs) made from these mixtures have been carried out. [Sanat Karmkar and V.A. Raghunathan + Satyajit Mayor, National Centre for Biological Sciences, Bangalore].

ELECTROCHEMISTRY

Design of a compact scanning tunneling microscope: The design of a simple and compact scanning tunneling microscope based on the principle of an inertial slider mechanism has been described. The Z feedback which adjusts the tip-sample gap separation is applied to the coarse movement piezo, unlike the conventional method of applying it to the four quadrants of the tip scanning piezo. This method produces better stability in addition to eliminating the requirement of four high voltage amplifiers. Several simple features incorporated in the sample stage improve the stability and reliability considerably. [M. Jayadevaiah and V. Lakshminarayanan].

Fine grain growth of nickel electrodeposit effect of applied magnetic field during deposition: The electrodeposition of nickel from a nickel sulphamate bath in the presence of a magnetic field applied at an angle of 45° to the cathode

surface produces a nickel deposit with a fine grain structure. Scanning electron microscopy (SEM), scanning tunneling microscopy (STM) and X-ray diffraction (XRD) have been used to characterize the surface morphology of the deposit. From these studies, it is believed that magnetic field induced convection increases the mass transfer rate, reduces the concentration polarization and leads to the growth of fine grain deposit. Cyclic voltammetry (CV) has been used to determine the roughness factor and steady state current potential plots to study the hydrogen evolution reaction on the nickel electrodeposited surface. [V. Ganesh, D. Vijayaraghavan and V. Lakshminarayanan].

Assessment of liquid crystal template deposited porous nickel as a supercapacitor electrode material: The high surface area porous nickel, obtained by template electrodeposition using a hexagonal liquid crystalline phase medium as a template was evaluated as a potential material for electrochemical capacitors using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) studies in 6M KOH. A single electrode double layer capacitance of 1.4 F/cm^2 (at $2mV/s$ scan rate) was obtained using CV, which corresponds to a specific capacitance of 473 F/g. EIS studies show the typical behaviour of a porous electrode and the data were analyzed in terms of complex capacitance and complex power from which the relaxation time constant (τ_o) has been determined. Nickel oxide electrode, obtained by the electrochemical oxidation of porous Ni, shows a double layer capacitance value of 171 mF/cm^2, which corresponds to a specific capacitance of 57 F/g. The values of double layer capacitance and specific capacitance of the porous nickel with fast response time are the highest values reported for nickel in the literature so far. [V. Ganesh, V. Lakshminarayanan + S. Pitchumani, Central Electrochemical Research Institute, Karaikudi, India].

LIQUID CRYSTAL DISPLAYS

Main objective of the research and developmental work in the area of applications was to reduce the hardware complexity of the drivers and the controller in passive matrix liquid crystal displays (LCDs).

Displaying gray shades: The concept of using wavelets to display gray shades in LCDs has been extended to non-integer wavelets. We have shown that up to sixty four gray shades can be displayed by using four voltages in the row drivers and eight voltage levels in the column drivers [T.N. Ruckmongathan].

Application of sparse orthogonal matrices: A prototype based on 32 x 32 matrix LCD and driven by selecting the subgroup (each consisting of eight rows) with sparse orthogonal matrix was fabricated to demonstrate the reduction in the hardware complexity of the controller and effective use of all the eight voltages in the column driver [T.N. Ruckmongathan and A. R. Shashidhara].

Binary addressing technique with duty cycle control for LCDs: Introduction of duty cycle in the binary addressing technique is proposed to enable integration of liquid crystal display drivers with a digital system in a single chip. An analysis of this technique with duty-cycle control has been carried out. Effects of duty-cycle control on brightness uniformity of pixels in the liquid crystal display are discussed. A system on chip implementation of the technique is also demonstrated. [T.N. Ruckmongathan, M. Govind, S.V. Ashoka and G. Deepak].

THEORETICAL INVESTIGATIONS

Thermal indexing in cholesteric liquid crystals: The effects of thermal indexing in cholesteric liquid crystals has been theoretically worked out. It is observed that for light propagation parallel to the twist axis in a right (left) handed cholesteric, the right (left) circularly polarized state exhibits a large nonlinear optical (NLO) coefficient of the order of 10^{-4} cm^2/W. On the other hand, the NLO coefficient for left (right) circularly polarized state is of the order of $10^{-6}cm^2/W$. It has been observed that in both the cases, the NLO coefficient is positive or negative depending upon whether the pitch of cholesteric increases or decreases with laser intensity. Further, due to variation in the average refractive index, the NLO coefficient for the right (left) circularly polarized state changes sign as the Bragg band is approached. In the case of laser beams with a Gaussian intensity profile, self-focussing, self-divergence and self-phase modulation are obtained. In the Mauguin limit, a defect structure with a periodic array of disclination loops within the Gaussian beam is found. [Amit K. Agarwal and G.S. Ranganath].

The effects of a laser field on the nematic-isotropic phase transition: The nematic-isotropic phase transition in liquid crystals in the presence of a laser field has been considered. In some situations in non-absorbing nematics a laser induced one way transition from a paranematic to a nematic phase is obtained. In absorbing nematics, in addition to this transition, a one way transition from a nematic to a paranematic phase is obtained. Interestingly, in some range of temperatures a reentrant nematic or a reentrant paranematic *via* paranematic or

nematic phase respectively, is also found [Amit K. Agarwal and G.S. Ranganath].

Spontaneous breaking of symmetry in nematic liquid crystal drops with a bipolar structure due to dissolved polymers: Nematic droplets which are suspended in anisotropic medium exhibit a variety of structures, depending on the orientation of the director at the interface. If the director is parallel to the interface, two surface point defects of strength + 1 are seen on the drops. The interaction between them is repulsive, and they lie opposite to each other, giving rise to bipolar drops. In an experimental study carried out in our laboratory some years ago it was found that when some polymeric substances are dissolved in the sample, there is a spontaneous breaking of the symmetry of the drop and the point defects are no longer in diametrically opposite positions on the drops. A detailed theoretical model has been developed now, in which the effect of the dissolved polymer on the elastic anisotropy of the nematic is explicitly taken into account. The numerical calculations on the structure of the drop clearly demonstrate the breaking of the symmetry as seen in experiments. [N.V. Madhusudana and Yashodhan Hatwalne + Anand Kumar, Centre for Mathematical Modeling and Computer Simulation, Bangalore].

Escape configuration lattice near the nematic-isotropic transition tilt analogue of blue phases: The possible existence of a new phase of liquid crystals near the nematic-isotropic transition has been predicted. This phase is an achiral, tilt-analogue of the blue phase and is composed of a lattice of *double-tilt*, escape-configuration cylinders. The stability of this phase has been discussed and an estimate of the lattice parameter provided. [Yashodhan Hatwalne, N.V. Madhusudana + B. Chakrabarti, Department of Physics, University of Massachusetts, Amherst, U.S.A].

ASTRONOMY AND ASTROPHYSICS (A&A)

AREAS OF RESEARCH:
Extragalactic Astronomy
The Galaxy and the Interstellar Medium
Neutron Stars and Pulsars
Instrumentation and Signal Processing
Others

EXTRAGALACTIC ASTRONOMY

A new mechanism was suggested for generating magnetic fields in the pre-recombination era, in which it was shown that radiation pressure that preferentially accelerates electrons as compared to protons generates a current, which could generate magnetic fields if the current is vortical. This can be achieved in the second order of perturbation theory, with adiabatic, no-vorticity initial conditions. [S. K. Sethi and Rajesh Gopal].

Investigation was carried out on detectability of the neutral hydrogen (HI) signal from pre-reionization and reionization epochs. HI can be seen in both absorption and emission in the frequency range 20 to 150 MHz with a typical average signal around 0.1 Kelvin. Detection of this signal holds the promise of determining uniquely the thermal history of the universe and the epoch of reionization. By statistical analysis it was shown how the various parameters of the underlying model, *e.g.*, cosmological parameters, ionization fraction of the universe during reionization, etc., can be determined by the detection of this signal. [S. K. Sethi].

In continuation of an earlier suggestion that heating of the intracluster medium by active galactic nuclei is important, the implication of this heating process was calculated for the distortion of the cosmic microwave background radiation, *via* the Sunyaev-Zeldovich effect. Effect of thermal conduction was also considered in the calculation. It was shown that the heating decreases the anisotropy signal expected from the Sunyaev-Zeldovich effect and that the decrement is more severe than previously thought. [Biman Nath and S. Roychowdhury + M. Ruszkowski (University of Colorado, Boulder, USA)].

A model of accretion and growth of the central black holes in galaxies was worked out, where feedback from black holes regulated the accretion flow. From this it is seen that the observed correlation between the black hole mass and the halo velocity dispersion can be explained without invoking any large

scale wind from the galaxy. [Biman Nath + M.C. Begelman (JILA, Colorado, USA)].

A calculation of the effect of radiative pressure on dust grains produced in the first generation supernovae to explain some anomalous abundance patterns of metal poor stars in our galaxy was carried out. [Biman Nath + A. Venkatesan and J. M. Shull (University of Colorado, Boulder)].

Gamma Ray Bursts: The Afterglow of GRB030329 continues to be visible at GMRT radio bands. The radio follow-up has been extended to longer than two years. The late time radio evolution as observed at 1280 and 610 MHz using the GMRT has clearly shown the transition of the fireball from relativistic to non-relativistic expansion, flattening the radio light curve as a result. [D. Bhattacharya, L. Resmi and Atish P. Kamble + C. H. Ishwara Chandra (NCRA, Pune)].

X and Z shaped Galaxies: An investigation of the origin of X and Z shaped radio galaxies was carried out by assuming that they result from a major merger of two galaxies. The relativistic jet propagates along the spin axis of the central black hole of one of the galaxies. After the merger of the galaxies, the spin of the merged black hole probably points along the orbital angular momentum of the binary black hole and the jet flips into a new direction at a large angle. Thus the old and new pair of jets appear as an 'X' in the plane of sky. On the other hand, where the secondary passes through the polar regions of the primary, the primary's jet is bent into a Z-shaped symmetry. The distance where the bending of the jet happens will be dependent on the relative strength of the pressure of the jet and the ram pressure of the rotational gas motion in the wake of the secondary galaxy. By limiting this distance to a certain range, it was shown that the bent jets are of a power close to that corresponding to the transition between Fanaroff-Riley class I and II radio galaxies. [C. Zier].

Eridanus group of galaxies: Based on about 200 hours of observations carried out using the Giant Meterwave Radio Telescope, the Tully-Fisher (TF) or the luminosity - line width relations of the galaxies in the Eridanus group were constructed. The mean baryonic TF slope is 4.1 ± 0.7 and is consistent with the predictions of dark matter models. Most ($\sim$ 70 %) of the Eridanus galaxies follow the well-known radio-FIR correlation with their star formation rates below that of the Milky Way. Those galaxies having a significant excess of radio emission are identified as low luminosity AGNs based on their radio morphologies obtained from the GMRT observations. The Eridanus group also has two far-infrared luminous but radio-deficient galaxies. It is believed that

these galaxies are observed within a few Myr of the onset of an intense star formation episode after being quiescent for at least a 100 Myr. [K.S. Dwarakanath + A. Omar (ARIES, Nainital)].

Molecular and Neutral Hydrogen Observations of nearby galaxies: It is well known that some of the active galactic nuclei (Seyfert 2) harbour thick molecular disks around the nucleus which sometimes also have associated water megamasers. Based on the observations with the Nobeyama and Mopra telescopes, a water megamaser was discovered in NGC 6926 and the variability of the one in NGC 6240 was measured. [Balasubramanyam, R + N. Sato, A. Yamaguchi, N. Kuno (NRO, Japan), Y. Ishihara (Koriyama City Fureai Science Center, Japan), K. Sorai (Hokkaido University, Japan), N. Nakai (University of Tsukuba, Japan), P. Hall (ATNF, Australia)].

From a statistical study of HI content of loose groups with and without diffuse X-ray emission based on HIPASS data it is shown that galaxies in loose groups with hot intra-group medium have lost more HI gas compared to those in loose groups without diffuse hot gas. Either tidal assisted ram-pressure stripping or thermal evaporation could cause this excess gas loss. Twelve galaxies from various groups have been imaged with the GMRT looking for evidence for the cause of the excess loss. [C. Sengupta and B. Ramesh].

Survey of the Radio Sky with the Mauritius Radio Telescope (MRT): A cross comparison of the 450 MHz MRT Catalogue ($\approx$ 3,000 sources) with the 408 MHz Molonglo Reference Catalog (MRC) has been carried out. Almost all the MRC sources which lie in the overlapping regions are visible with the MRT. About 1000 sources which are not listed in the MRC are seen in MRT images. The images are being examined to identify interesting sources such as steep spectrum sources, relic sources, fossil galaxies, new Supernova Remnant (SNR) candidates, etc., by comparing them with other catalogues and images available in the literature.

The images of the extended sources in the survey clearly reveal that the sensitivity for extended sources is good (Brightness sensitivity $\approx 3 \times 10^{-21}$ watts/m^2/Hz). Most of the SNRs in our Galaxy have surface brightness higher than this limit. About 0.5 Sr of the sky containing the Galactic plane has been imaged and most of the SNRs expected to have been identified in the image. Detailed analysis of their properties is in progress. [V.N. Pandey and N. Udaya Shankar].

Helical jet in the gravitationally lensed system PKS1830-211: The interpretation of high resolution 43 GHz VLBA observations of the gravitationally lensed system PKS1830-211 in the context of a precessing (helical) jet with ballistically emitted plasma features or 'plasmons', hosted by a blazar-type active galactic nucleus, has had some degree of success, with the evaluation of a jet precession period. It has proven possible to determine an image-to-image transformation matrix from moving features in the data, in a way that is independent of any lens model. Combining information on the scales of milliarcseconds and tens of microarcseconds, the precession period for the jet in the underlying source is determined to be 1.08 years as observed, translating to a period of 30.8 years in the frame of the source. It has also proven possible to relate the temporal behaviour of the image-to-image flux density ratio to the evolution of synchrotron self-absorbed plasmons in the jet, yielding independent and close support for the picture of ballistically emitted features being lensed.

The rapidity of the precession period is consistent with the picture of a jet emitted from the vicinity of a black hole in a binary black hole system, with the orbital motion of the jet-emitting black hole producing an apparent helical motion for features emitted along the jet. From the jet precession period, one can infer that for typical masses of the black holes of order 10^8 solar masses, the system will have a gravitational lifetime until it collapses of about a few times 10^8 years. With a binary elemental separation of the order of less than 10^{17} cm, it may pose some questions for the evolution of binary black hole systems within the lifetime of the Universe. [(S. Nair + C. Jin (Beijing Astronomical Observatory, China), M. A. Garret, (JIVE, The Netherlands)].

THE GALAXY AND THE INTERSTELLAR MEDIUM

Studies on sites of Massive Star Formation: The progressively increasing density in a collapsing molecular core leads to adsorption of molecules onto the dust grains and hydrogenation and nitrogenation reactions on their surfaces. Subsequent formation of a massive star, with its copious heating and ionising radiation output, is expected to drive interesting time dependent chemistry, especially of endothermic nature. The study of W3(OH) and W3(IRS 5) shows clear evidence for time dependent chemistry but intrinsic molecular differences, and differences in the drivers of chemistry also play a significant role. Chemical modeling yields a fairly accurate age estimate of 10^4 yr for the molecular core W3(IRS5) supporting the idea of 'chemical chronometry' based on line surveys and chemical modeling. [B. Ramesh + S-J. Kim, D-W. Lee (Kyunghee University, Korea), H-D. Kim (University of Wollongong,

Australia), Y.C. Minh (Taeduk Radio Astronomy Observatory, Korea), M.G. Burton (University of New South Wales, Australia), T.J. Millar (UMIST, UK)].

Formyl ion is a good tracer of dynamics in the dense molecular cores. From a survey of southern massive star forming sites associated with methanol masers in methyl cyanide (CH_3CN) and formyl ion (HCO^+) using the Mopra 22m millimeterwave telescope, it has been found that both methanol and methyl cyanide are excited at very early phases and that methyl cyanide is commonly detected towards methanol maser sites; methyl cyanide emission is found to be brighter towards isolated masers associated with MSX dark clouds, indicating that these sources are internally heated. (B. Ramesh + C. R. Purcell, M. G. Burton (University of New South Wales, Australia)].

An 8.5 GHz Arecibo survey of Carbon Recombination Lines toward Ultra-compact HII regions: Physical properties of dense molecular material: From the survey carried out in August 2002 for carbon recombination lines (RLs) near 8.5 GHz toward 17 ultra-compact HII regions (UCHIIs), carbon RLs were detected in 11 out of the 17 observed directions (65 % detection), indicating the presence of dense photodissociation regions (PDRs) associated with the UCHIIs. It has been shown that the carbon RLs provide important, complementary information on the kinematics and physical properties of the ambient medium near UCHIIs. Non-LTE models for the carbon line forming region have been developed, assuming that the PDRs surround the UCHIIs, and the model parameters have been constrained using multi-frequency RL data. Modeling shows that carbon RL emission near 8.5 GHz is dominated by stimulated emission and hence we preferentially observe the PDR material that is in front of the UCHII continuum. The relative motion between ionized gas and the associated PDR is found to be about half that estimated earlier with an RMS velocity difference of 3.3 kms^{-1}. The density and pressure of the PDR derived from this model are consistent with a pressure confined HII region model where the stars are moving relative to the cloud core. The PDR pressure is estimated to be an order of magnitude larger than the pressure of the ionized gas. Further investigation is needed to understand this large pressure difference. [D. Anish Roshi + D. S. Balser, W. M. Goss (NRAO, USA) T. M. Bania (Boston University, USA), C. G. De Pree (Agnes Scott College, USA)].

Radio Recombination Lines: Spectroscopy at extremely low frequencies with radio recombination lines (RRLs) provides an effective way to study the cold interstellar medium. A series of RRLs using the UTR2 radio telescope in Ukraine, arising from bound carbon atoms undergoing δ transitions (among them from n=1005 to 1009) in the cool tenuous medium located in the Perseus

arm has been detected against the background continuum emission from the supernova remnant Cassiopeia A. They are by far the largest bound atoms (classical diameter ~ 0.1mm) occurring in ionised plasma detected in space. Further, α (around n=631), β (around n=795), and γ (around n=910) transitions arising in the same clouds have also been detected. The dependence of RRL broadening on quantum number as predicted by pressure driven and radiative mechanisms is in good correspondence with the observations, when proper account is taken of the behaviour of the galactic background and Cassiopeia A radio emission at frequencies less than 30 MHz. The data imply an upper limit to quantum levels with principal quantum number in the range 1,100 - 1,200. [N. Udaya Shankar + S. Stepkin, A. A. Konovalenko (Institute of Radio Astronomy, Ukraine), N. G. Kantharia (NCRA, Pune)].

Hα observations of NGC2024: NGC2024 is an HII region located at one of the closest sites of recent massive star formation. The nebula, considered to be a blister HII region, is bright in radio continuum as well as in optical line emission. An attempt was made to make Hα image of NGC2024 using the 1-m telescope at ARIES, Nainital, with a view to constrain the temperature of the ionized gas by combining Hα observations with existing radio recombination line data. It was, however, not possible to obtain an Hα image of required quality. [D. Anish Roshi + A. Omar (ARIES, Nainital)].

NEUTRON STARS AND PULSARS

Low frequency studies of Pulsars & Radio Recombination Lines: As a part of the Indo-Ukraine collaboration for pulsar and recombination line studies at low radio frequencies, extensive coordinated observations were conducted using the Gauribidanur & UTR-2 (Ukrainian Telescope) telescopes. Data analysis procedures were developed for high spectral and time resolution spectrometer modes as well as for pulsar-specific processing. The first-level reduction of all of the data collected at Gauribidanur was completed recently. Further analysis of the data is in progress. [A. A. Deshpande, N. Udaya Shankar, H. Aswathappa, + O.Ulyanov, S. Stepkin, V. Zakharenko (IRA, Ukraine), N. Kantharia (NCRA, Pune)].

More recently a set of coordinated observations on a few nearby pulsars were conducted using the Gauribidanur, Ooty, UTR-2 and Pushchino telescopes, spanning a frequency range from 25 to 327 MHz. The data analysis is in progress. [A. A. Deshpande, H. Aswathappa + P.K. Manoharan (RAC, Ooty) A. Asgekar (BITS, Goa), O. Ulyanov, V. Zakharenko, V. Malofeev (IRA, Ukraine)].

Altitudes of emission regions in radio pulsars: Earlier work that provided a new method for systematic understanding of radio pulsar emission altitudes, attributing the observed longitude offsets between core and conal components to the effects of differential aberration and magnetic field line sweepback, was further extended by including the effect of light travel time (retardation). [C. S. Shukre + R. C. Kapoor (Indian Institute of Astrophysics, Bangalore)].

Equation of state of matter at high density: From a study of ground states of quark matter with chiral symmetry breaking it was found that a three-flavour state with u and d forming a spin-polarized pion condensate is a possible state at high density. This state is spontaneously magnetized and can potentially form a magnetic core of a neutron star. From a detailed computation of stellar structure with such a core, it is found that at stellar masses above a certain limit a magnetized core may appear and may explain the observed characteristics of a special category of strongly magnetized neutron stars called Magnetars. [D. Bhattacharya + V. Soni (NPL, New Delhi)].

INSTRUMENTATION

A new analysis of optics has been carried out for high frequency telescopes that lends economy and overcomes the problem of gravitational flexure. The design and analysis of the mechanical structure of a telescope based on this optics is being carried out and preliminary panel design has been completed. (Ramesh B.).

Coded Mask Imaging: Refinement of the imaging algorithm for the SSM and CZT imagers aboard ASTROSAT has been taken up and development is continuing. Several new elements including iterative windowing for source recognition and least squares solution for source flux distribution have been now incorporated in the imaging process. A maximum likelihood method is under development. Recent design changes in the camera hardware have been taken into account in the revised imaging process. [D. Bhattacharya, B.T. Ravishankar, Sushila Mishra + G. Arun (TIFR, Mumbai)].

12m PPD: The fabrication of the 12m dish was completed and static tests have been carried out for estimating surface accuracy. A contract for the fabrication of its mount has been awarded to a fabricator in Pune. The receiver system for the telescope is ready for use -- a 4 to 8 GHz front-end receiver and a back-end spectrometer have been completed. The design and preliminary testing of a control system and development of a user-friendly control panel with a number

of safety interlocks have been completed. The control system consists of two control paths - one using a commercially available DSP based programmable multi-axes controller and the other using a PC under Linux based software. The site preparation at Gauribidanur has also been completed. The construction of an RCC tower for installing the mount and buildings required for installing the receiver have been completed. Due to unforeseen/unavoidable circumstances, the fabrication of the mount is behind schedule and the commissioning of the telescope at Gauribidanur is expected to be completed by September 2005.

As part of our effort in designing broadband feeds, studies related to frequency independent antennas have been taken up. In this connection, a planar trapezoidal structure with a decade structural bandwidth (0.5 to 5 GHz) has been designed and characterized. Satisfactory VSWR and field patterns have been obtained over the bandwidth range 0.7 to 2.2 GHz. Efforts are on to improve these characteristics and also to study its cross polarization performance. [N. Udaya Shankar, C.M. Ateequlla, Durai Chelvan, B.S. Girish, A. Krishnan, Manohar Modgekar, A. Raghunathan, P.V. Rishin, K.S. Srivani].

Satellite Astrometry: The high stability frequency transfer via INSAT 3A and a system for continuous ranging of the satellite have been completed. The passive system for precise orbit estimation based on a network of 4 VSATs in the GMRT campus is undergoing final integration and tests. The originally proposed scheme for burst mode data recording at the four modes has been modified to a new system which brings the RF from all the remote modes to the central station on optical fibres. The central receiver system provides for coherent down conversion to a convenient frequency band and centralized recording/data processing. [C. R. Subrahmanya, Peeyush Prasad, G. C. Rashmi, R. Somasekhar].

OTHERS

The concept of the nonmodular topological phase was clarified and elucidated. Its significance in a range of diverse physical situations was elaborated. [R. Bhandari].

COMPUTERS

To help improving internet connectivity, services like telnet, ssh, cvs, imap and ipop to remote machines was enabled from user's desktops in the RRI local network.

An antivirus software 'ClamAV' software was installed in the mail server for scanning mails on receipt for virus infections. Steps to handle and manage SPAM in a more effective manner were explored and incorporated.

An open source digital repository system 'Dspace' was deployed for archiving and delivery of documents, in digital form for the RRI library.

Routine maintenance and improvement of computer systems and local area network was undertaken. Up-gradation of the campus network was initiated.

LIBRARY

The Library continued its basic activities and maintaining liaison with other related institutes libraries for resource sharing and for information exchange; providing need based information services and access to a wide range of information resources both in print and electronic versions.

LIBRARY RESOURCES DEVELOPMENT

During the period, the following were added to the existing collection of the library:

Books	:	682 (including 90 on gratis, and 4 e-books)
Bound volumes of journals	:	566
Scientific and technical journals	:	162
Print and online Journals	:	66
Online through consortia and Non-Cancellation Option	:	36
Online only	:	5

Procured Physics Reports Vols.1–68; 1971–1980 on gratis from University of Rochester, New York, which were gaps in our holdings.

The collection at the end of period: books – 23,419; bound volumes of journals – 32,614 and the total collection of the library stood at: 56,033.

MODERNISATION

- LIBSYS library software was up graded to ver.4 (Rel.5) on latest version of LINUX;
- Liquid Crystals database version 4.5 was procured and installed.

STRENGTHENING LIBRARY FACILITIES

- Procured one digital photocopier and installed.
- Compact Storage Racks were installed in the basement floor.

CONSORTIA ACTIVITIES

- Under Open FORSA Consortium, the Library has entered into an online subscription to Lecture Notes in Physics (Springer) for the year 2005 with option to access back volumes (1996+);

- Subscribed to "Online Nature" for the year 2004-2005 under FORSA Consortium. The other participants are: IIA, PRL, IUCAA, ARIES, SNBNCBS, TIFR and JNCASR;

- After merger of Kluwer with Springer, FORSA Consortium re-entered subscription to Kluwer/Springer Physics and Astronomy Journals, wherein RRI could access to 12 additional titles and cancelled subscription to three journals which are subscribed by other participants in the consortium, thereby RRI could save Euro 5000.00. The other participants are: IIA, PRL, ARIES and SNBNCBS.

- The IoP's "Non-Cancellation Option" for 2005 was taken up and renewed subscription where the Library can access to 19 online physics journals.

DIGITAL LIBRARY INITIATIVES

Work on digitization of audio/video cassettes is continued; scanning work of Raman Archival material is completed.

OTHER ACTIVITIES

Ph. D.

Awarded

Amitesh Omar	A GMRT synthesis survey of radio continuum and atomic hydrogen in the Eridanus group of galaxies *Jawaharlal Nehru University, New Delhi*
Surajit Dhara	Physical studies on some liquid crystals *Jawaharlal Nehru University, New Delhi*
K. Rema	Structure of surfactant-polyelectrolyte complexes *Jawaharlal Nehru University, New Delhi.*
P. Viswanath	Studies on monolayers and multilayers of mesogenic amphiphilic molecules *Jawaharlal Nehru University, New Delhi*
Rekesh Mohan	Kinematics of diffuse interstellar clouds in the galaxy *Jawaharlal Nehru University, New Delhi*
H.N. Shreenivasa Murthy	Synthesis of compounds composed of bent-core molecules: Characterization of mesophases and some physical properties *Jawaharlal Nehru University, New Delhi*
V. Manjuladevi	Experimental studies on phase diagrams of liquid crystals *Jawaharlal Nehru University, New Delhi*
Sarasij Ray Chaudhuri	The organization of rafts and its relation to the endocytosis of the cell membrane *Jawaharlal Nehru University, New Delhi*

Joint Entrance Screening Test (JEST)

Several research institutions in India jointly conduct a screening test for candidates desiring to join the Ph.D. programmes in physics. This Joint Entrance Screening Test (JEST) for Ph.D. programmes was conducted by RRI during 2005. There were 12 participating institutions. The test was conducted nationwide at 28 centres. About 5700 candidates had applied and about 4700 took the test. [C.S. Shukre].

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 48).

Summer Programme in Physics, May - July 2004

The Summer Programme has been an important annual event in the Institute over the last few years. This year seventeen students drawn from different parts of the country representing universities, IITs and Colleges were selected. Of the seventeen students, nine were selected through JNCASR, four through the Indian Academy of Sciences, one through the KVPY program and three through direct contact with the Institute. These seventeen students were at different levels in their educational background: M.Sc. - 10, B.Tech. - 2, and B.Sc. - 5.

Contrary to the previous years, there was no lecture series arranged this year. However, three special lectures were arranged, apart from visits to the Institute museum and the laboratories. The summer students worked with the respective supervisors for periods ranging from 6 to 8 weeks.

Conferences/Seminars and Meetings

The staff of the Institute visited various institutions in India and abroad and attended conferences and presented papers. In all 153 lectures were given by them at other places (Annexure II, Page 61).

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 III, page 79).

Journal Club Meetings

Forty 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 IV, page 88).

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

In-House Meeting

An In-House Meeting, which is an annual feature at the Institute, was held on 19-20 March 2004 where the staff and students presented their research work. In all, 47 oral presentations spread over 8 sessions chaired by Faculty Members were made. There were also 26 poster presentations. The presentations were followed by lively scientific discussions with critical comments and suggestions relevant to the reported research from the members. This year a CD and a video tape of the poster presentations were also made and are kept in the Library, in addition to including the abstracts of the presentations at the meeting on the RRI Web Page.

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 43).

General

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

PLAN (Recurring & Non-Recurring)	Rs.1,650.00 lakh
NON-PLAN (Recurring)	Rs. 270.00 lakh
Total	Rs.1,920.00 lakh

COUNCIL (2004 – 2005)

Dr. K. Kasturirangan *Chairman*	*Member of Parliament, Rajya Sabha, & Director,* *National Institute of Advanced Studies, Bangalore*
Mr. K.P. Pandian	*Joint Secretary & Financial Adviser* *Ministry of Science & Technology* *Government of India, New Delhi 110 016*
Prof. P. K. Kaw	*Director, Institute of Plasma Research* *Gandhinagar 382 248*
Prof. N. Kumar	*Director, Raman Research Institute* *Bangalore 560 080*
Prof. G. Mehta	*Director, Indian Institute of Science* *Bangalore 560 080*
Prof. V.S. Ramamurthy	*Secretary, Ministry of Science & Technology* *Government of India* *New Delhi 110 016*
Prof. V. Radhakrishnan	*Member-Secretary* *Raman Research Institute Trust* *Bangalore 560 080*
Prof. O. Siddiqi	*TIFR National Centre for Biological Sciences* *GKVK Campus, Bangalore 560 065*

FINANCE COMMITTEE (2004 – 2005)

Dr. K. Kasturirangan *Chairman*	*Member of Parliament, Rajya Sabha, & Director* *National Institute of Advanced Studies, Bangalore*
Mr. K.P Pandian	*Joint Secretary & Financial Adviser* *Ministry of Science & Technology* *Government of India, New Delhi 110 016*
Prof. N. Kumar	*Director, Raman Research Institute* *Bangalore 560 080*
Prof. V. Radhakrishnan	*Member-Secretary* *Raman Research Institute Trust* *Bangalore 560 080*

STAFF

N. KUMAR
Director

V. Radhakrishnan
Distinguished Professor Emeritus

N.V. Madhusudana, *Dean of Research*

THEORETICAL PHYSICS

Research
B.R. Iyer, *Chairman*
Abhishek Dhar
Joseph Samuel
Madan Rao
Madhavan Varadarajan
G.S. Ranganath
Sumati Surya

Research Associate
Supurna Sinha

Visiting Professor
S.K. Rangarajan

Post-Doctoral Fellow
Demian Cho (*from 30.8.04*)

Research Students
Abhijit Ghosh
K.G. Arun
Javed Ahmad
G. Kripa
Mohd. Arif Kamal (*from 14.7.2004*)
Mohd. S.S. Qusailah
Rahul Marathe
Sarasij Rai Chaudhari
Siddhartha Sinha (*JAP*) (*from 2.8.04*)
Sudipto Muhuri
Suthirtha Roy Chowdhury

Secretary: G. Manjunatha

OPTICS

Research
Hema Ramachandran, *In-Charge*
N. Andal
A.A. Deshpande
N. Kumar
Reji Philip
Sadiqali Rangwala (*from 16.8.04*)
C S Shukre

Visiting Professors
A. K. Sood (*up to 31.12.04*)
R. Srinivasan

Technical Assistant: M.S. Meena

Research Students
M.Anija
Archana Sharma
Divya Sharma
Navinder Singh
Suchand Sandeep
Uday Kumar Khan (*up to 2.11.04*)

Post-Doctoral Fellows
Ashok Vudayagiri
B. Kartikeyan
R. Srikanth

LIQUID CRYSTAL LABORATORY

Research
B.K. Sadashiva, *Chairman*
Arun Roy
V. Lakshminarayanan
N.V. Madhusudana
R. Pratibha
V.A. Raghunathan
G.S. Ranganath
T.N. Ruckmongathan
Sandeep Kumar
K.A. Suresh
Yashodhan Hatwalne

Scientific/Technical
A. Dhason
Mohammed Ishaq
N. Ravi Sankar
A.R. Shashidhara
H.T. Srinivasa
H. Subramonyam
K.N. Vasudha
D. Vijayaraghavan

Visiting Scientists
Anand Kumar (*up to 28.2.05*)
G.V. Shivashankar

Post-Doctoral Fellows
Anita Semwal (*from 3.1.05*)
Jaishri Naidu (*up to 4.2.05*)

Research Students
Alpana Nayak
Amit Kumar Agarwal
Antara Pal (*from 14.7.04*)
Bharat Kumar (*from 19.7.04*)
Biburanjan Sarangi (*from 14.7.04*)
Brindaban Kundu
Dibyendu Roy (*from 26.7.04*)
Dipanjan Bhattacharya
V. Ganesh
M. Govind
Harikrishna Bisoyi (*from 19.7.04*)
V. Manjuladevi
S. Mohanapriya
A.V. Radhakrishnan (*from 14.7.04*)
Raj Kumar Gupta
K. Rema (*up to 24.9.04*)
T. Roopa
Sajal Kumar Ghosh
Sanat Karmakar
Santanu Kumar Pal
H.N. Shreenivasa Murthy
P. Suresh Kumar (*up to 29.7.04*)
Tripta Bhatia (*from 14.7.04*)
S. Umadevi
Vani Kulkarni (*up to 28.4.04*)
P. Viswanath (*up to 23.7.04*)

Secretarial: K. Radhakrishna

ASTRONOMY & ASTROPHSICS

Research
C.R. Subrahmanya, *Chairman*
Anish Roshi
R. Bhandari
Biman B. Nath
A.A. Deshpande*
Dipankar Bhattacharya
K.S. Dwarakanath
B. Ramesh
Shiv Kumar Sethi
C.S. Shukre
S. Sridhar
N. Udaya Shankar

Research Students
Amitesh Omar (*up to 23.8.04*)
Atish Kamble
Chandrayee Sengupta
V. N. Pandey
Rajesh Gopal
Raju Ramakrishna Baddi
L. Resmi (*JAP*)**
Shahram Amiri (*from 13.8.04*)
Supurna Roychowdhury

**On leave, visiting the Radio Astronomy Department, Arecibo Observatory, USA*
***Joint Astronomy Programme*

ASTRONOMY & ASTROPHYSICS

(*contd....*)

Honorary Visiting Professor
P. Sreekumar

Post-Doctoral Fellow
Christian Zier
Jeya Kumar (*up to 3.11.04)*
Nirvikar Prasad (*from 21.9.04*)

Research Associates
Sunita Nair
Sanjay Kumar Sahay (*up to 28.2.05*)

Technical
B.T. Ravishankar

Secretarial: V. Vidyamani

RADIO ASTRONOMY LAB

Scientific/Technical
N. Udaya Shankar, *In-Charge*
P. G. Ananthasubramanian
K. Chandrashekara
M.S. Ezhilarasi
B.S. Girish
M. R. Gopala Krishna
P.A. Kamini
S. Kasturi
S. Krishnamurthy
S. Madhavi
T.S. Mamatha
H.N. Nagaraja
T. Prabu
K.B. Raghavendra Rao
A. Raghunathan
P.V. Rishin
P. Sandhya
G. Sarabagopalan
P.S. Sasi Kumar
R.Somashekar
S. Sujatha
C. Vinutha

Visiting Scientist
A. Krishnan

Secretarial
R. Mamatha Bai

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

LIBRARY

Geetha S.
Girija Srinivasan
Hanumappa
Kiran P. Savanur
M. Manjunath
M. N. Nagaraj
Y.M. Patil, *Librarian*
Vrinda J. Benegal

Support Staff
K. Chowdasetty
C. Elumalai

ADMINISTRATION

K. Krishnama Raju, *Admin. Officer*
K. Raghunatha, *Dy. Admin. Officer*
S. Raghavachar, *Asst. Admn. Officer*
L.P. Kumar
Marisa D'Silva
K. Radha
S.R. Ramasubramaniyan
V. Raveendran
M. Prema
R. Ganesh

Accounts

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

Purchase

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

Stores

S. Rajasekharan Nair, *Stores Officer*
C. N. Ramamurthy
M.V. Subramanyam

Medical

Dr. M.R. Baliga,
Consultant Paediatrician
Dr. A.R. Pai, *Consultant Physician*
Dr. B.V. Sanjay Rao, *Consultant Physician*

Technician:
R. Shanthamma

Estate & Buildings

G. B. Suresh, *Civil Engineer*
R. Sasidharan, *Supervisor*
R. Anantha Subba Rao, *Consultant*
S. Anantha Raman
K. Bhoopalan
D. Gangappa
Gunashekar
C. Haridas
K. Palani
M. Rajagopal
C. Sampath
S. Sreedhar
K.N. Srinivas
T. Subramaniyam Naidu

Secretarial: V. Raghunath

Carpentry

K. M. Lakshmanan, *Supervisor*
M. Gopinath
L. Muthu

Transport

V. Jayaraman, *In-Charge*
Abdul Khader
M. Balarama
R. Jayaram
C. K. Mohanan
G. Prakash
Rahamath Pasha
G. Raja
M. K. Raju Kutty

Graphic arts

Raju Varghese

Amenities (Guest Houses and Hostels)

C.V. Bharghavan
T.V. Janardhanan
Mangala Singh
Muniratna
T. Naganna
N. Narayanappa
D.B. Padmavathy
P. C. Prabhakar
N. Puttaswamy
A. Raju
N. Seetharam
Sharadamma
Shivamallu
Uma
K. Velayudhan
V. Yeshodha

Horticulture

V. Krishnappa,
Consultant
Bylappa
Lakshmamma
Lingegowda
D. Mahalinga
Maiga
Mailarappa
Marappa
D. Muniraja
S. Muniraju
Rahamathulla Khan
Rangalakshmi
Varalakshmi

Upkeep

Hanumantha
Jayamma
K. N. Kawalappa
D. Krishna
C. Lakshamma
T. Mahadeva
T. Murali
Narayana
A. Ramanna
Ranjithamma
A. Sarojamma
Sidde Gowda
V. Venkatesh

Security

V.Jayaraman,*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

VISITORS

Ofer Biham The Hebrew University Jerusalem, Israel	6 April 2004
Badri Krishnan Albert-Einstein-Institut, Potsdam, Germany	20-24 April 2004
Tarun Deep Saini Institute of Astronomy Cambridge, England	9-25 April 2004
Mukunda P. Das The Australian National University, Canberra, Australia	11-18 April 2004
A. Pramesh Rao National Centre for Radio Astrophysics, Pune	26-27 April 2004
A M Jayannavar Institute of Physics, Bhubaneswar	24 April – 3 May 2004 10-21 September 2004
S. Anantha Ramakrishna Indian Institute of Technology, Kanpur	10 April – 12 May 2004
T.P. Singh Tata Institute of Fundamental Research Mumbai	6-23 May 2004
Dr. Reuben Rabi Massachusetts Inst. of Technology Cambridge, USA	6 May – 1 July 2004
A R Prasanna Physical Research Laboratory, Ahmedabad	7-15 May 2004 20 Nov – 20 Dec 2004
Vikram Soni National Physical Laboratory, New Delhi	7-21 May 2004, 18-26 July 2004 18 Oct. – 30 Nov. 2004 & 1-31 March 2005
Sushan Konar Indian Institute of Technology, Kharagpur	17-28 May 2004
Bikram Phookun St. Stephen's College, Delhi	18-23 May 2004

M.R. Sankararaman National Centre for Radio Astrophysics, Pune	7-8 June 2004
Pawan Kumar University of Texas, USA	19-25 June 2004
Y.C. Minh Korea Astronomy Observatory, Daejeon, Korea	21 June – 9 July 2004
Srikumar M. Menon Manipal Institute of Technology, Manipal	21 June – 5 July 2004 15-19 July 2004
Francois Brouers University of Liege Belgium	23 June to 3 July 2004.
Likwee Lee University of California, USA	25 June – 25 August 2004
R. Stinchcombe University of Oxford U K	3-10 July 2004
Subodh Shenoy The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy	3-16 July 2004
Indarnil Chattopadhyay University of Leuven, Belgium	4-6 July 2004
David Lacoste Paris, France	11-17 July 2004
Jayaram N. Chengalur National Centre for Radio Astrophysics, Pune	8-10 July 2004
Yashwant Gupta National Centre for Radio Astrophysics, Pune	13-20 July 2004 6-11 December 2004
Manojendu Choudhury Tata Institute of Fundamental Research, Mumbai	21-22 July 2004
B.S. Sathyaprakash Cardiff University, U K	26 July – 6 August 2004
Ujjwal Sen Institut für Theoretische Physik University of Hannover, Germany	1-8 August 2004

Aditi Sen Institut für Theoretische Physik University of Hannover, Germany	1-8 August 2004
Arundati Dasgupta University of New Brunswick, Canada	9-12 August 2004
Nick Seymour I A P, Paris, France	17-19 August 2004
A.R.P. Rau Louisiana State University, USA	17 - 19 August 2004
Sarmistha Banik Saha Institute of Nuclear Physics, Kolkata	29 August – 4 Sept. 2004
Biswajit Paul Tata Institute of Fundamental Research, Mumbai	14-17 September 2004 31 March – 1 April 2005
Hasi Ray Indian Institute of TechnologyRoorkee	20-30 September 2004
P. Hariharan CSIRO, Australia	24 September 2004
M. Gourie-Devi Institute of Human Behaviour and Allied Sciences, New Delhi,	24 September 2004
Govind Swarup National Centre for Radio Astrophysics, Pune	26 September – 2 October 2004
Anita Richards University of Manchester, UK	2-6 October 2004
Nimisha G. Kantharia National Centre for Radio Astrophysics, Pune	3-8 October 2004
Anirban Roy Institute of Mathematical Sciences, Chennai	8 October 2004
G. Tomilin Maxim Vavilov State Institute St. Petersburg, Russia	16-19 November 2004
Ravi Subrahmanyan Australia Telescope National Facility Australia	21-27 November 2004 15-29 January 2005

Michael Kosteven Australia Telescope National Facility Australia	21-27 November 2004
Ken Skinner Australia Telescope National Facility Australia	24-27 November 2004
Y. Shtanov Bogoliubov Institute for Theoretical Physics Kiev, Ukraine	27 November – 06 December 2004
Amit Ghosh Saha Institute of Nuclear Physics Kolkata	13-24 December 2004
Abhay Ashtekar Pennsylvania State University U S A	7-23 December 2004 & 8-12 January 2005
V.K. Kulkarni National Centre for Radio Astrophysics, Pune	16-22 December 2004
Kavita Jain University of Koeln, Germany	5 January 2005
Chinmay Das University of Leeds U K	7-14 January 2005
Ajith Parameswaran Max-Planck-Institut für Gravitationsphysik Albert-Einstein-Institut Hannover, Germany	18-20 January 2005
Tomaso Belloni Observatory of Merate, Milan, Italy	22-31 January 2005
L. Sriramkumar Harish-Chandra Research Institute, Allahabad	25 January 2005
Manoj Gopalakrishnan Max-Planck-Institute for the Complex Systems Dresden, Germany	25 January 2005
Tom Grydeland University of Troms, Norway	27-30 January 2005

Miller Goss National Radio Astronomical Observatory Socorro, USA	29 January – 12 February 2005
P.B. Sunil Kumar Indian Institute of Technology Chennai	5-8 February 2005
Debashish Chaudhuri S N Bose National Centre for Basic Sciences Kolkata	16 February – 15 April 2005
L. Woltjer Grand-Saconnex Switzerland	3-15 March 2005
Marsha Weaver University of Canberra Australia	10-20 March 2005
Ranjeev Misra Inter-University Centre for Astronomy & Astrophysics Pune	27-30 March 2005

Annexure I

PAPERS PUBLISHED

In Journals

1. "Dynamics of membrane nanotubulation and DNA self-assembly" (**T. Roopa**, **N. Kumar**, S. Bhattacharya and **G. V. Shivashankar**), *Biophys. J.*, **87**, 974 (2004).

2. "Flow-induced voltage and current generation in carbon nanotubes" (S. Ghosh, A.K. Sood, S. Ramaswamy and **N. Kumar**), *Phys. Rev.* B., **70**, 205423 (2004).

3. "Viscosity of suspensions and the glass: Turning power-law divergence into essential singularity" (**N. Kumar**), *Curr. Sci.* **88**, 143 (2005).

4. "A new class of post-Newtonian approximation to the dynamics of inspiralling compact binaries: Test-mass in the Schwarzchild spacetime" (**P. Ajith**, **B.R. Iyer**, C.A.K. Robinson and B.S. Sathyaprakash), *Phys. Rev. D*, **71**, 044029 (2005).

5. "Surface-integral expressions for the multipole moments of post-Newtonian sources and the boosted Schwarschild solution" (L. Blanchet, T. Damour and **B.R. Iyer**), *Class. Quant. Grav.*, **22**, 155 (2005).

6. "Hadamard regularization of the third post-Newtonian gravitational wave generation of two point masses" (L. Blanchet and **B.R. Iyer**), *Phys. Rev. D*, **71**, 024004 (2005).

7. "Gravitational radiation from inspiralling compact binaries completed at the third post-Newtonian order" (L. Blanchet, T. Damour, G. Esposito-Farese and **B.R. Iyer**), *Phys. Rev. Lett.*, **93**, 091101 (2004).

8. "Phasing gravitational waves from inspiralling eccentric binaries" (T. Damour, A. Gopakumar and **B.R. Iyer**), *Phys. Rev. D*, **70**, 064028 (2004).

9. "The 2.5PN gravitational wave polarizations from inspiralling compact binaries in circular orbits" (**K.G. Arun**, Luc Blanchet, **B.R. Iyer** and **M.S.S. Qusailah**), *Class. Quant. Grav.*, **21**, 3771 (2004).

10. "Measuring the general relativistic curvature of wavefronts" (**Joseph Samuel**), *Class. Quantum Grav.*, **21**, L83 (2004).

11. "Inequivalence of statistical ensembles in single molecule measurements" (**Supurna Sinha** and **Joseph Samuel**), *Phys. Rev. E*, **71**, 021104 (2005).

12. "Rafts: Scale-dependent, active lipid organization at the cell surface" (Satyajit Mayor and **Madan Rao**), *Traffic*, **5**, 231 (2004).

13. "A mesoscopic model of a two-dimensional solid state structural transformation: Statics and dynamics" (**Madan Rao** and Surajit Sengupta), *J. Phys.: Condens. Matter*, **16**, 7733 (2004).

14. "Path integral quantization of parametrized field theory" (**Madhavan Varadarajan**), *Phys. Rev. D*, **70**, 084013 (2004).

15. "The graviton vacuum as a distributional state in kinematic loop quantum gravity" (**Madhavan Varadarajan**), *Class. Quant. Grav.*, **22**, 1207 (2005).

16. "Cyclic statistics in three dimensions" (**Sumati Surya**), J. Math. Phys., **45**, 2515 (2004).

17. "Nonreciprocity and the second law of thermodynamics: An exact relation for non-linear media" (O. Narayan and **A. Dhar**), *Europhys. Lett.*, **67**, 559 (2004).

18. "Return to return point memory" (J.M. Deutsch, **A. Dhar** and O. Narayan), *Phys. Rev. Lett.*, **92**, 227203 (2004).

19. "Work distribution functions in polymer stretching experiments" (**A. Dhar**), *Phys. Rev. E*, **71**, 036126 (2005).

20. "Spin glasses in the limit of an infinite number of spin components" (L. W. Lee, **A. Dhar** and A.P. Young), *Phys. Rev. E*, **71**, 036146 (2005).

21. "Lanczos' generalized derivative for higher orders" (S.K. Rangarajan and S.P. Purushothaman), *J.Comput. & Appl. Math.*, **177**, 461 (2005).

22. "Writhe distribution of stretched polymers" (**Supurna Sinha**), *Phys. Rev. E*, **70**, 011801 (2004).

23. "Quantum diffusion on a dynamically disordered and harmonically driven lattice with static bias: Decoherence" (**Navinder Singh** and **N. Kumar**), *Modern Phys. Lett. B*, **19**, 379 (2005).

24. "Imaging through turbid media using polarization modulation: Dependence on scattering anisotropy" (Sushil Mujumdar and **Hema Ramachandran**), *Opt. Comm.*, **241**, 9 (2004).

25. "Observation of a fifth order optical nonlinearity in 29 kDa Au@alkanethiol clusters excited in the visible" (**Jinto Thomas**, **M. Anija**, Jobin Cyriac, T. Pradeep, and **Reji Philip**), *Chem. Phys. Lett.*, **403**, 308 (2005).

26. "Au_xAg_y@ZrO_2 core-shell nanoparticles: Synthesis, characterization, reactivity and optical limiting" (A. Sreekumaran Nair, V. Suryanarayanan, T. Pradeep, **Jinto Thomas**, **M. Anija** and **Reji Philip**), *Materials Sc. and Engg. B*, **117**, 173 (2005).

27. Optical and nonlinear optical properties of ND^{3+} doped heavy metal borate glasses" (**B. Karthikeyan**, **Reji Philip** and S. Mohan), Optics Comm., **246**, 153 (2005).

28. "Multiparameter segmented scan multichannel scaling system" (S.V.K. Kumar, T.S. Ananthakrishnan, E. Krishnakumar, **V.S. Ashoka** and S.K. Kataria), *Rev. Sci. Instruments*, **75**, 2711 (2004).

29. "Dissociative attachment of electrons to vibronically excited SO_2" (S.V.K. Kumar, **V.S. Ashoka** and E. Krishnakumar), *Phys. Rev. A*, **70**, 052715 (2004).

30. "Fluorescence from doubly driven four-level atoms: A density matrix approach" (**A. Narayanan, R. Srinivasan, U.K. Khan, A. Vudayagiri** and **H. Ramachandran**), *European Phys. J. D*, **31**, 107 (2004).

31. "Observation of narrow fluorescence from doubly driven four-level atoms at room temperature" (**U.K. Khan**, J. Sebastian, **N. Kamaraju, A. Narayanan, R. Srinivasan** and **H. Ramachandran**), *Europhys. Lett.*, **67**, 35 (2004).

32. "Condensation of bound pairs of fermionic atoms" (**R. Srinivasan** and **Andal Narayanan**), *Curr. Sci*, **86**, 1356 (2004).

33. "Slow ammonia molecules in an electrostatic quadrupole guide" (T. Junglen, T. Rieger, **S.A. Rangwala**, P.W.H. Pinkse and G. Rempe), *Eur. Phys. D*, **31**, 365 (2004).

34. "Two-dimensional trapping of dipolar molecules in time-varying electric fields" (T. Junglen, T. Rieger, **S.A. Rangwala**, W.H. Pinkse and G. Rempe), *Phys. Rev. Lett.*, **92**, 223001 (2004).

35. "Generalized quantum secret sharing" (Sudhir Kumar Singh and **R. Srikanth**), *Phys. Rev. A*, **71**, 012328 (2005).

36. "Quantum seals" (Sudhir Kumar Singh and **R. Srikanth**), *Physica Scripta,* **71,** 433 (2005).

37. "Quantum bit commitment with a composite evidence" (**R. Srikanth**), *Physica Scripta*, **70**, 343 (2004).

38. "Relaxation of femtosecond photoexcited electrons in a metallic sample" (**Navinder Singh**), *Modern Phys. Lett. B*, **18**, 979 (2004).

39. "Hot electron relaxation in a metal nanoparticle: Electron surface-phonon interaction" (**Navinder Singh**), *Modern Phys. Lett. B*, **18**, 1261 (2004).

40. "Relaxation between electrons and surface phonons of a homogeneously photoexcited metal film" (**Navinder Singh**), *Pramana*, **63**, 1083 (2004).

41. "Enhancement of orientational order parameter of nematic liquid crystals in thin cells" (**Surajit Dhara** and **N.V. Madhusudana**), *Euro. Phys. J. E.*, **13**, 401 (2004).

42. "Two-dimensionally periodic phases in mixtures of compounds made of rod-like and bent-core molecules" (**R. Pratibha**, **N.V. Madhusudana** and **B.K. Sadashiva**), *Phys. Rev. E*, **71**, 11701 (2005).

43. "Selective imaging of 3D director fields and study of defects in biaxial smectic A liquid crystals" (I.I. Smalyukh, **R. Pratibha**, **N.V. Madhusudana** and O.D. Lavrentovich), *Eur. Phys. J. E*, **16**, 179 (2005)

44. "Influence of director fluctuations on the electric field phase diagrams of nematic liquid crystals" (**Surajit Dhara** and **N.V. Madhusudana**), *Europhys. Lett.*, **67**, 411 (2004).

45. "A polar biaxial smectic A phase in new unsymmetrical compounds composed of bent-core molecules" (**H.N. Shreenivasa Murthy** and **B.K. Sadashiva**), *Liq. Cryst.*, **31**, 567 (2004).

46. "Synthesis and mesomorphic properties of unsymmetrical bent-core compounds containing 1,3-phenylene or 2,7-naphthylene as the central unit" (**H.N. Shreenivasa Murthy** and **B.K Sadashiva**), *Liq. Cryst.*, **31**, 1347 (2004).

47. "Influence of a fluorine substituent on the mesomorphic properties of unsymmetrical five-ring bent-core compounds" (**H.N. Shreenivasa Murthy** and **B.K Sadashiva**), *J. Mater. Chem.*, **14**, 2813 (2004).

48. "New phase sequences in banana-shaped mesogens: Influence of fluorine substituent in compounds derived from 2,7-dihydroxynaphthalene" (**R. Amaranatha Reddy** and **B.K. Sadashiva**), *J. Mat. Chem.*, **14**, 1936 (2004).

49. "Unusual mesomorphic behaviour in bent-core compounds derived from 5-cyanoresorcinol" (**R. Amaranatha Reddy** and **B.K. Sadashiva**), *Liq. Cryst.*, **31**, 1069 (2004).

50. "Fluorine substituted unsymmetrical bent-core mesogens derived from resorcinol" (**H.N. Shreenivasa Murthy** and **B.K Sadashiva**), *Liq. Cryst.*, **31**, 1337 (2004).

51. "Banana-shaped mesogens derived from 2,7-dihydroxynaphthalene and 1,3-dihydroxybenzene: Novel columnar mesophases" (**R. Amaranatha Reddy**, **B.K. Sadashiva** and **V.A. Raghunathan**), *Chemistry of Materials*, **16**, 4050 (2004).

52. "Optical investigations on the biaxial smectic-A phase of a bent-core compound" (S.T. Wang, X.F. Han, A. Cady, Z. Q. Liu, A. Kamenev, L. Glazman, **B.K. Sadashiva**, **R. Amaranatha Reddy** and C.C. Huang), *Phys. Rev. E*, **70**, 061705 (2004).

53. "Novel ferroelectric and antiferroelectric smectic and columnar mesophases in fluorinated symmetrical bent-core compounds" (**R. Amaranatha Reddy**, **V.A. Raghunathan** and **B.K. Sadashiva**), *Chemistry of Materials*, **17**, 274 (2005).

54. "Banana-shaped mesogens: Mesomorphic properties of seven-ring esters derived from 5-chlororesorcinol" (**S. Umadevi** and **B.K. Sadashiva**), *Liq. Cryst.*, **32**, 287 (2005).

55. "AFM studies on Langmuir-Blodgett films of cholesterol" (**Raj Kumar Gupta** and **K.A. Suresh**), *Eur. Phys. J. E*, **14**, 35 (2004).

56. "Phase behaviour of dipalmitoyl phosphatidylcholine (DPPC)–cholesterol membranes" (**Sanat Karmakar**, **V.A. Raghunathan** and Satyajit Mayor), *J. Phys. Cond. Matter*, **17**, S117 (2005).

57. "Binary addressing technique with duty cycle control for LCDs" (**T.N. Ruckmongathan**, **M. Govind**, **S.V. Ashoka** and **G. Deepak**), *IEEE Transactions on Electron Devices*, **52**, 345 (2005).

58. "Design of a compact scanning tunneling microscope with a feedback to coarse approach controller for low scan ranges" (**M. Jayadeviah** and **V. Lakshminarayanan**), *Measurement Science and Technology*, **15**, N35 (2004).

59. "Fine grain growth of nickel electrodeposit: Effect of applied magnetic field during deposition" (**V. Ganesh**, **D. Vijayaraghavan** and **V. Lakshminarayanan**), *Applied Surface Science*, **240**, 286 (2005).

60. "Preparation of high surface area nickel electrodeposit using a liquid crystal template technique" (**V. Ganesh** and **V. Lakshminarayanan**), *Electrochim. Acta*, **49**, 3561 (2004).

61. "Influence of secondary ion bombardment on the composition, structure and surface properties of platinum thin films" (S. Balaji, P.V. Satyam, **V. Lakshminarayanan**, and S. Mohan), *Nuclear Inst. & Methods in Phys. Res.* B, **217**, 423 (2004).

62. "Recent developments in the chemistry of triphenylene-based discotic liquid crystals" (**Sandeep Kumar**), Invited Article, *Liq. Cryst.*, **31**, 1037 (2004).

63. "Inclusion of gold nanoparticles into a discotic liquid crystalline matrix" (**Sandeep Kumar** and **V. Lakshminarayanan**), *Chem. Commun.*, 1600 (2004).

64. "A convenient and economic method for the synthesis of monohydroxypentaalkoxy- and hexaalkoxytriphenylene discotics" (**Sandeep Kumar** and **B. Lakshmi**), *Tetrahedron Lett.*, **46**, 2603 (2005).

65. "Synthesis and characterization of novel imidazolium-based ionic discotic liquid crystals with a triphenylene moiety" (**Sandeep Kumar** and **Santanu Kumar Pal**), *Tetrahedron Lett.*, **46**, 2607 (2005).

66. "Monolayers and 3D films of cholesteryl derivatives at the air-water interface" (**P. Viswanath** and **K.A. Suresh**), *J. Phys. Chem. B*, **108**, 9198 (2004).

67. "Photoinduced phase separation and miscibility in the condensed phase of a mixed Langmuir monolayer" (**P. Viswanath** and **K.A. Suresh**), *Langmuir*, **20**, 8149 (2004).

68. "Spontaneously formed monodisperse biomimetic unilamellar vesicles: The effect of charge, dilution and time" (M.-P. Nieh, T.A. Harroun, **V.A. Raghunathan**, C.J. Glinka and J. Katsaras), *Biophys. J.*, **86**, 2615 (2004).

69. "Finite-size effects do not reduce the repeat spacing of phospholipid multibilayer stacks on a rigid substrate" (T.A. Harroun, M. Koslowsky, M.-P. Nieh, **V.A. Raghunathan** and J. Katsaras), *Eur. Phys. J.*, E **13**, 359 (2004).

70. Magnetically alignable phase of phospholipid "bicell" mixtures is a chiral nematic made up of worm-like micelles" (M.-P. Nieh, **V.A. Raghunathan**, C.J. Glinka, T.A. Harroun, G. Pabst and J. Katsaras), *Langmuir*, **20**, 7893 (2004).

71. "Finite-size effects in biomimetic smectic films" (T.A. Harroun, **V.A. Raghunathan**, J. Pencer, M.-P. Nieh, , and J. Katsaras), *Phys. Rev.*, E., **70**, 062902 (2004).

72. "Development of single-molecule tracking confocal microscope combined with force spectroscopy for gene expression analysis" (Deepak Kumar Sinha, **Dipanjan Bhattacharya**, Bidisha Banerjee, Feroz Meeran Hameed and **G.V. Shivashankar**), *Curr. Sci.*, **87**, 239 (2004).

73. "Probing collective dynamics of active particles using modulation force spectroscopy" (G.V. Soni, G. Ananthakrishna and **G.V. Shivashankar**), *App. Phys. Lett.*, **85**, 2414 (2004).

74. "Stochastic simulations of the origins and implications of long-tailed distributions in gene expression" (Sandeep Krishna, Bidisha Banerjee, T.V. Ramakrishnan and **G.V. Shivashankar**), *PNAS*, **102**, 4771 (2005).

75. "Tracking operator state fluctuations in gene expression in single cells" (B. Banerjee, S. Balasubramanian, G. Ananthakrishna, T.V. Ramakrishnan and **G.V. Shivashankar**), *Biophys. J.*, **86**, 3052 (2004).

76. "Kinetic measurement of ribosome motor stalling force" (D.K. Sinha, U.S. Bhalla and **G.V. Shivashankar**), *App. Phys. Lett.*, **85**, 4789 (2004)..

77. "A new window on Strange Quark Matter as the ground state of strongly interacting matter" (V. Soni and **D. Bhattacharya**), *Phys. Rev.*, D, **69**, 074001 (2004).

78. "Contaminants in ATCA baselines with shadowing: A case study of cross-talk in short-spacing interferometers" (Ravi Subrahmanyan and **Avinash A. Deshpande**), *Mon. Not. R. Astron. Soc.*, **349**, 1365 (2004).

79. "Fluctuation properties and polar emission mapping of pulsar B0834+06 at decameter wavelengths" (Ashish Asgekar and **Avinash A. Deshpande**), *Mon. Not. R. Astron. Soc.*, (2005).

80. "On the origin of the wide HI absorption line toward SGR A*" (**K.S. Dwarakanath**, W.M. Goss, J.H. Zhao and C.C. Lang), *J. Astrophys. Astr.*, **25**, 129 (2004).

81. "Kinematics of diffuse interstellar clouds: Recent GMRT results" (**K.S. Dwarakanath**), *Bull. Astr. Soc. India*, **32**, 215 (2004).

82. "A high galactic latitude HI 21 cm-line absorption survey using the GMRT: I. Observations and spectra" (**Rekesh Mohan**, **K.S. Dwarakanath** and **G. Srinivasan**), *J. Astrophys. Astr.*, **25**, 143 (2004).

83. "A high galactic latitude HI 21 cm-line absorption survey using the GMRT: II. Results and interpretation" (**Rekesh Mohan**, **K.S. Dwarakanath** and **G. Srinivasan**), *J. Astrophys. Astr.*, **25**, 185 (2004).

84. "GMRT HI observations of the Eridanus group of galaxies" (**A. Omar** and **K.S. Dwarakanath**), *J. Astrophys. Astr.*, **26**, 1 (2005).

85. "The HI content of the Eridanus group of galaxies" (**A. Omar** and **K.S. Dwarakanath**), *J. Astrophys. Astr.*, **26**, 71 (2005).

86. "HI deficiency in groups: What can we learn from Eridanus?" (A. Omar), *Bull. Astr. Soc. India*, **32**, 239 (2004).

87. "Radio continuum and far-infrared emission from the galaxies in the Eridanus group" (**A. Omar** and **K.S. Dwarakanath**), *J. Astrophys. Astr.*, **26**, 89 (2005).

88. "An estimation of the plasma parameters in the solar corona using quasi-periodic metric type III radio burst emission" (R. Ramesh, A. Satya Narayanan, C. Kathiravan, Ch. V. Sastry and **N. Udaya Shankar**), *Astron. Astrophys.*, **431**, 353 (2005).

89. "Entropy of the intracluster medium at high redshift" (**B.B. Nath**), *Mon. not. Royal Astron. Soc.*, **353**, 941 (2004).

90. "Entropy 'Floor' and effervescent heating of intracluster gas" (**S. Roychowdhury**, M. Ruszkowski, **B.B. Nath** and M.C. Begelman), *Astrophys. J.*, **615**, 681 (2004).

91. "A telescope made with cylinders I. Some analytical results" (**R. Balasubramanyam**), *Mon. not. R. Astron. Soc.*, **354**, 1189 (2004).

92. "A search for 53 MHz OH line near G48.4-1.4 using the National MST Radar Facility" (S.M. Menon, **D.A. Roshi** and T.R. Prasad), *Mon. not. R. Astron. Soc.*, **356**, 958 (2005).

93. "Primordial magnetic fields in the post-recombination era and early reionization" (**Shiv K. Sethi** and K. Subramanian), *Mon. not. Royal Astron. Soc.*, **356**, 778 (2005).

94. "High redshift intergalactic medium: Probes and physical models" (**Shiv K. Sethi**), *Invited Review in the Special Section of Cosmology — Curr. Sci.*, **88**, 1117 (2005).

95. "Very large array H92α and H53α radio recombination line observations of M82" (C.A. Rodrigues-Rico, F. Viallefond, J.-H. Zhao, W.M. Goss and **K.R. Anantharamaiah**), *Astrophys. J.*, **616**, 783 (2004).

96. "Multi-density model of the ionized gas in NGC 253 using radio recombination lines" (Niruj R. Mohan, W.M. Goss and **K.R. Anantharamaiah**), *Astron. Astrophys.*, **432**, 1 (2005).

97. "Jet propagation and the asymmetries of CSS radio sources" (**S. Jeyakumar**, P.J. Wiita, D.J. Saikia and J.S. Hooda), *Astron. Astrophys.*, **432**, 823 (2005).

98. "Measurements of 220 GHz atmospheric transparency at IAO, Hanle, during 2000-2003" (**P.G. Ananthasubramanian**, S. Yamamoto, T.P. Prabu and D. Angchuk), *Bull. Astr. Soc. India*, **32**, 99 (2004).

In Conference Proceedings

1. "Normal-state c-axis resistivity of layered cuprates: Quantum Zeno effect" (**N. Kumar**), Proceedings of the XXVI Workshop on Condensed Matter Theories, Luso, Portugal, September 2002, Condensed Matter Theories, vol. 18, M. de Llano, C. Fiolhais and J. da Providencia, (editors), Nova Science Publishers, Inc., N.Y., 2004).

2. "Estimation-theoretic framework for comparing polarization-based continuous-wave direct imaging scheme" (R.S. Umesh, A.G. Ramakrishnan, **R. Srikanth** and Hema Ramachandran), *Proceedings of IEEE Conference on signal processing and Communications*, 2004.

3. "Relaxation between hot electrons and surface phonons in small metal particles" (**Navinder Singh**), *STATPHYS 22*, Topic 3: *Nonequilibrium Processess*, 2004.

4. "Observation of a fifth order optical nonlinearity in 29 kDa Au@alkanethiol clusters" (**Jinto Thomas**, **M. Anija**, Jobin Cyriac, T. Pradeep and **Reji Philip**), Photonics 2004, Cochin, December 2004.

5. "Optical nonlinearity in silver-sodium ion-exchanged planar waveguides" (P. Nandi, J. Thomas, **R. Philip**, G.D. Valle, S. Taccheo, G. Sorbello, P. Laporta and G. Jose), Photonics 2004, Cochin, December 2004.

6. "Random amplifying medium, Levy laser" (Divya Sharma, Hema Ramachandran and N. Kumar), Photonics 2004, Cochin, December 2004.

7. "Picosecond Z-scan investigations of optical nonlinearity in CdS nanostructure films" (Pushpa Ann Kurian, C. Vijayan, **C.S. Suchand Sandeep** and **Reji Philip**), *Proceedings of the Conference on Optoelectronics, Fiber Optics and Photonics*, Cochin, December 2004.

8. "Optical properties of stable, strongly confined CdS nanostructures prepared by microwave assisted synthesis" (P.A. Kurian, B.K. Money, M. Krishnamurthy, C. Vijayan, **C.S. Suchand Sandeep** and **Reji Philip**), *International Conf. On Nano-Materials: Synthesis, Characterization and Application, Kolkata, November 2004.*

9. "Quantum diffusion on a dynamically disordered and driven lattice with static bias" (**Navinder Singh** and **N. Kumar**), Proceedings of the Solid State Physics Symposium, Guru Nanak Dev University, Amritsar, 2004.

10. "Random amplifying medium: Levy laser" (**Divya Sharma, Hema Ramachandran** and **N. Kumar**) *Proceedings of the Conference on Optoelectronics, Fiber Optics and Photonics*, Cochin, December 2004.

11. "Broad-band microwave filters" (**Riya George**, D. Sriram and **B. Ramesh**), *Proceedings of the International Symposium on Microwaves*, Bangalore, September 2004 (No. ISMP 16, on CD).

12. "Laser cooling of atoms" (**R. Srinivasan**), in *Precision spectroscopy of atoms, molecules and Bose condensates*, Proc. SERC School, Indian Institute of Science, Bangalore, eds. B.P. Das and V. Natarajan (Allied Publishers, 2005), p.1.

13. "Liquid crystals under compression and tension" (**V. Manjuladevi** and **N.V. Madhusudana**), *SPIE*, **5565**, 141 (2004).

14. "Role of molecular dipoles in liquid crystals (**N.V. Madhusudana**), *Proceedings of the Nineteenth International Liquid Crystal Conf. (ILCC 2002), Edinburgh, UK - Molec. Cryst. Liq. Cryst.*, **409**, 371 (2004).

15. "Structural phase behaviour of high-concentration, alignable biomimetic bicelle mixtures" (Mu-Ping Nieh, **V.A. Raghunathan**, Charles J.Glinka, Thad Harroun and John Katsaras), in Macromolecular Symposia, Vol. 219 (Wiley-VCH Verlag GmbH, 2005) p. 135

16. "Unusual features in the surface pressure-area isotherms in the Langmuir monolayer of a siloxane polymer" (**A. Bhattacharyya** and **K.A. Suresh**), *Proceedings of the Nineteenth International Liquid Crystal Conf. (ILCC 2002), Edinburgh, UK — Molec. Cryst. Liq. Cryst*, **412**, 171 (2004).

17. "Combination of electron-deficient and electron-rich discotic liquid crystals in novel unsymmetrical columnar twins" (**Sandeep Kumar**, **Jaishri J. Naidu** and S.K. Varshney), *Proceedings of the Nineteenth International Liquid Crystal Conf. (ILCC 2002), Edinburg, UK — Molec. Cryst. Liq. Cryst*, **411**, 355 (2004).

18. "Cyclic voltammetry studies of discotic liquid crystals" (R.J. Bushby, L. Mason, N. Taylor, and **Sandeep Kumar**), *Proceedings of the Nineteenth International Liquid Crystal Conf. (ILCC 2002), Edinburg, UK — Molec. Cryst. Liq. Cryst*, **410**, 171 (2004).

19. "Liquid crystals made of banana-shaped molecules" (**N.V. Madhusudana**), in *Proceedings of the DAE Solid State Physics Symposium, 2003*, **46**, 977 (2005).

20. "Gray shades in LCDs using amplitude modulation" (**M. Govind** and **T.N. Ruckmongathan**), Proceedings of the Conference Photonics-2004, Cochin, 9-11 December 2004.

21. "Liquid crystal display for an automobile dashboard" (**A.R. Shashidhara, G. Deepak**, B.S. Manjunath, Arjun Murthy, and **T.N. Ruckmongathan**), Proceedings of the Conference Photonics-2004, Cochin, 9-11 December 2004.

22. "The application of cyclic voltammetry to the investigation of redox properties of discotic liquid crystals" (L. Mason, R.J. Bushby, N. Taylor and **Sandeep Kumar**), *Molec. Cryst. Liq. Cryst.*, **410**, 171 (2004).

23. "Design of a FPGA based data acquisition system for radio astronomy applications" (Yogindra Abhyankar, C. Sajish, Pallavi Kulkarni and **C.R. Subrahmanya**), *Proc. International Conf. on Microelectronics, ICM 2004, Tunisia, December 2004.*

24. "Space science & technology in Mauritius: Current status and future opportunities" (S.D.D.V. Rughooputh, G.K. Beeharry, K. Golap, N.H. Issure, R. Simanah, H.C.S. Rughooputh and **N. Udaya Shankar**), in *Developing Basic Space Science World-Wide*, eds. W. Wamsteker *et al.* (Kluwer Academic, Netherlands, 2004), p. 219.

25. "The Vela pulsar, the key?" (R. Dodson, D. Lewis, D. Legge, P. McCulloch, J. Reynolds, D. McConnell and **A. Deshpande**), in IAU Symposium No. 218: Young Neutron Stars and Their Environments, Sydney, July 2003, eds. Fernando Camilo and Bryan M. Gaensler (San Francisco, CA: Astronomical Society of the Pacific, 2004), p.193.

26. "MRT observations of the MSP J0437-4715 at 150 MHz" (N.H. Issur and **A.A. Deshpande**), in IAU Symposium No. 218: Young Neutron Stars and Their Environments, Sydney, July 2003, eds. Fernando Camilo and Bryan M. Gaensler (San Francisco, CA: Astronomical Society of the Pacific, 2004), p.345.

27. "Resource sharing through Consortia: An experience with FORSA libraries" (**Y.M. Patil**), in DRTC-INDEST (IIT, Delhi) – USEFI Joint Symposium on Consortia, DRTC, Bangalore 2004, Paper N:p.1-14.

28. "Managing change: Consortia efforts in IT environment" (**Y.M. Patil**), in *Library and Information Profession in India: Reflections and Redemptions, , Vol. 1, Part II Technical Papers*, ed. C.P. Vashishth and M.P. Satija (B.R. Publications, New Delhi, 2004), pp. 463-486.

Monograph

1. "The dawn of the universe" (**B.B. Nath**), Educational Monograph in association with JNCASR (Universities Press, Hyderabad, 2005).

Books Edited

1. "ICGC-2004: Proceedings of the fifth International Conference on Gravitation and Cosmology held at Cochin, January 2004, eds. B.R. Iyer, V.C. Kuriakose, C.V. Vishveshwara (Indian Academy of Sciences, 2004).

Popular Articles

1. "Paul Langevin" (Abhishek Dhar), *Resonance*, March 2005, p. 3.

2. "The mutable galaxies: How galaxies enrich with heavy elements" (Biman Nath), *Resonance*, May 2004, p. 10.

3. "Polarography" (V. Lakshminarayanan), *Resonance*, Sept. 2004, p. 51.

4. "Taylor the sailor" (V. Radhakrishnan), *Resonance*, Oct. 2004, p. 10.

5. "Burping black holes" (Biman Nath), *The Hindu*, May 20, 2004.

Others

1 "Sivaramakrishna Chandrasekhar" (**N.V. Madhusudana**), *Current* Science, **86**, 1031 (2004), reprinted in *Vignana Bharati*, Science Journal, Bangalore University, **17**, 103 (2005).

2 "Obituary: Prof. Sivaramakrishna Chandrasekhar" (**K.A. Suresh**), *National Academy Science Letters*, **28**, 57 (2005).

IN PRESS

In Journals

1. "Analytic approximation and perturbation methods" (**B.R. Iyer**), *Proceedings of GR17*, World Scientific.

2. Phasing of gravitational waves from inspiralling eccentric binaries" (T. Damour, A. Gopakumar and **B.R. Iyer**), *Class. Quant. Grav.*

3. "Parameter estimation of inspiralling compact binaries using 3.5 post-Newtonian gravitational wave phasing: The non-spinning case" (K. Arun, **B.R. Iyer**, B.S. Sathyaprakash and P.A. Sundararajan), *Phys. Rev. D.*

4. "Dimensional regularization of the third post-Newtonian gravitational wave generation from two point masses" (L. Blanchet, T. Damour, G. Esposito-Farese and **B.R. Iyer**), *Phys. Rev. D.*

5. "Flow driven electronic transport in carbon nanotube" (A.K. Sood, S. Ghosh and **N. Kumar**), *International Journal of Nanoscience*

6. "Dissipative electron-phonon photoexcited far from equilibrium" (**Navinder Singh** and **N. Kumar**), J. Stat. Phys. (2005)

7. "Relaxation of femtosecond photoexcited electrons in a polar indirect band-gap semiconductor nanoparticle" (**Navinder Singh**).

8. "On the fractal structure of solar supergranulation" (U. Paniveni, V. Krishnan, J. Singh and **R. Srikanth**), *Solar Physics.*

9. "Spectroscopic studies on Ag-polyvinyl alcohol nanocomposite films" (**B. Karthikeyan**), *Physica B.*

10. "Sivaramakrishna Chandrasekhar" (**N.V. Madhusudana**), in *Biographical Memoirs of Fellows of the Indian National Science Academy.*

11. "Thermal indexing in cholesteric liquid crystals" (**Amit K. Agarwal** and **G.S. Ranganath**), *Molec. Cryst. Liq. Cryst.*

12. "Structure of phospholipid-cholesterol membranes: An X-ray diffraction study" (**Sanat Karmakar** and **V.A. Raghunathan**), *Phys. Rev. E*

13. "Triphenylene-based discotic dimers, oligomers and polymers" (**Sandeep Kumar**), *Liquid Crystals.*

14. "Discotic-decorated gold nanoparticles" (**Sandeep Kumar**, **Santanu Kumar Pal** and **V. Lakshminarayanan**), *Molec. Cryst. Liq. Cryst.*

15. "The first examples of terminally thiol-functionalized alkoxycyanobiphenyls" (**Sandeep Kumar** and **Santanu Kumar Pal**), *Liq. Cryst.*

16. "Ionic discotic liquid crystals: Synthesis and characterization of pyridinium bromides containing a triphenylene core" (**Sandeep Kumar** and **Santanu Kumar Pal**), *Tetrahedron Lett.*

17. "Magnetic susceptibility studies on a lyotropic nematic system" (**D. Vijayaraghavan** and **K.A. Suresh**), *Molec. Cryst. Liq. Cryst.*

18. "Multiband optical photometry and bolometric light curve of the Type Ia supernova 2004S" (Kuntal Misra, **Atish P. Kamble**, **D. Bhattacharya** and Ram Sagar), *Mon. Not. R. Astron. Soc.*

19. "Radio, millimeter and optical monitoring of the GRB030329 afterglow: Constraining the double jet model" (**L. Resmi**, C.H. Ishwara Chandra, A.J. Castro-Tirado, **D. Bhattacharya**, A.P. Rao *et al.*), *Astron. Astro.*

20. "Water-vapor maser survey for active galactic nuclei: A megamaser in NGC 6926" (N. Sato, A. Yamaguchi, Y. Ishihara, K. Sorai, N. Kuno, N. Nakai, and **R. Balasubramanyam**), *Pub. Astron. Soc. Japan.*

21. "A molecular line survey of W3(OH) and W3(IRS5) from 84.7 to 115.6 GHz: Observational data and analyses" (S-J Kim, H-D Kim, Y. Lee, Y-C Minh, **R. Balasubramanyam**, M.G. Burton, T.J. Millar, D-W Lee), *Astrophys. J.*

22. "Multi-wavelength carbon recombination line observations with the VLA toward an UCHII region in W48: Physical properties and kinematics of neutral material" (**D.A. Roshi**, W.M. Goss, **K.R. Anantharamaiah** and **S. Jeyakumar**), *Astrophys. J.*

23. "An 8.5 GHz Arecibo survey of carbon recombination lines toward ultra-compact HII regions: Physical properties of dense molecular material" (**D.A. Roshi**, D.S. Balser, T.M. Bania, W.M.Goss and C.G. De Pree), *Astrophys. J.*

In Conference Proceedings

1 "A telescope made with cylinders: Constructing a 3m submillimeterwave prototype" (**B. Ramesh**, B. Gurumoorthy, S. Raghu Menon, N. Ramakrishna Reddy, **P.G. Ananthasubramanian**, A. Ghosal, **C.M. Ateequlla** and **V. Dhamodaran**), *Proceedings of the Int. Conf. on Submillimeterwave Science and Technology*, Ahmedabad, October 2004.

Annexure II

CONFERENCES ATTENDED

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Abhishek Dhar	Indian Institute of Technology, & The Institute of Mathematical Sciences, Chennai 29-30 April 2004	A discussion on some fluctuation theorems in nonequilibrium processes
	S.N. Bose National Centre for Basic Sciences, Kolkata, 5 May 2004	1. A discussion on some new fluctuation theorems in nonequilibrium processes 2. Science with soap films
	Institute of Physics, Bhubaneshwar, 28 October 2004	TPSC: Fourier's law, a theorist's challenge
	Indian Institute of Technology, Kanpur, 4-5 November 2004	1. TPSC: Fourier's law, a theorist's challenge 2. TPSC: Understanding the fluctuation theorems
	Harish-Chandra Research Institute, Allahabad, 9 November 2004.	TPSC: Fourier's law, a theorist's challenge
	Conference on Unifying Concepts in Glass Physics III, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, 28 June – 1 July 2004	
	International Conference on Statistical Physics, Indian Institute of Science, Bangalore, 4-9 July 2004	Exact result for non-reciprocity in one-dimensional wave transmission
	Workshop on Hydrodynamics, Indian Institute of Science, Bangalore, 5-9 December 2004	Nonequilibrium steady states of heat conduction in one-dimensional systems *(Invited)*

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Amit Kumar Agarwal	Disorder, Complexity and Biology, Banaras Hindu University, Varanasi, 12-15 July 2004	Liquid crystals phase transitions in the presence of a laser field.
Anija M	Seventh International Conference on Optoelectronics, Cochin University of Science & Technology, Kochi, 9-11 December 2004	Fiber optics and photonics
	Sathya Sai Institute of Higher Learning, Puttaparthi, 11-18 March 2005	
Anish Roshi D	National Center for Radio Astrophysics, Pune, India, June 2004	
	Aryabhata Research Institute of Observational Sciences, Nainital, February 2005.	
	Seventh User Scientists' Workshop, NMRF, Gadanki, July 2004	
	Astronomical Society of India Meeting, Nainital, February 2005	High-frequency carbon recombination line as a probe to study the environment of ultra-compact HII regions
Arun K G	Twenty third Conference of the IAGRG and Symposium on Recent Trends in General Relativity, Cosmology and Astrophysics, Jaipur, 7-10 December 2004	Implications of the 3.5PN phasing formula in parameter estimation of inspiralling non-spinning compact binaries
Arun Roy	Twenty-Second International Conference on Statphys, Indian Institute of Science, Bangalore, 4-9 July 2004	A frustrated packing model for the B_6-B_1-SmA P_A sequence of phases exhibited by banana-shaped molecules

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Ashok Vudayagiri	National Atomic & Molecular Conference, Ahmedabad, 20-23 December 2004	Competition and control between multiple CPT states
	Quantum Optics meeting, University of Innsbruck, Austria, 27 February – 5 March 2005	Qubits using CPT states of neutral atoms
Atish P. Kamble	Aryabhata Research Institute of Observational Sciences, Nainital, 20 January – 13 April 2005	
	Twenty third Meeting of the Astronomical Society of India, Nainital, 21-24 February 2005	Multiband optical photometry and bolometric light curve of the type 1a supernova SN2004S
Bhattacharya, Dipanjan	Twenty-Second International Conference on Statphys, Indian Institute of Science, Bangalore 4-9 July 2004	Mapping nucleosomal fluidity within single live cells
	Conference on Disorder, Complexity and Biology, Banaras Hindu University, Varanasi, 12-15 July 2005	Mapping nucleosomal fluidity within single live cells
	49th Annual Meeting of the Biophysical Society, Long Beach, USA, 16 February 2005	Probing the dynamics of nucleosomes
	Stanford University, California, USA, 16-25 February 2005	Probing the dynamics nucleosomes within single live cells
Bhattacharya, Dipankar	NATO Advanced Study Institute on the electromagnetic spectrum of neutron stars, Marmaris, Turkey, 7-18 June 2005	The evolution of neutron stars (*Invited*)

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Bhattacharya Dipankar (*contd.*)	Aryabhata Research Institute of Observational Sciences, Naini Tal, 22-31 December 2004	Radiation in astrophysics
	COSPAR Colloquium on Spectra and Timing of Compact X-ray Binaries, Tata Institute of Fundamental Research, Mumbai 17-21 January 2005	Imaging with the ASTROSAT SSM
	Astronomical Society of India Meeting, Nainital 21-24 February 2005	Multiband optical photometry and bolometric light curve of the type 1a supernova SN2004S
Christian Zier	Astronomical Society of India Meeting, Naini Tal 21-24 February 2005	Size and orientation of The 'Z' on XRGs
Demian H.J. Cho	Institute of Mathematical Sciences, Chennai 18 November 2004	Stationary Kaluza-Kelin states
Divya Sharma	Photonics-2004: Seventh International Conference on Opto-Electroncis, Fibre Optics & Photonics, Cochin, 9-11 December 2004	Random amplifying medium: Levy laser (*Invited*)
Dwarakanath K S	Bangalore University, Bangalore, 7 December 2004	Rotation of galaxies
	National Centre for Radio Astrophysics, Pune, 27 December 2004 – 6 January 2005	HI deficiency from HIPASS data + steep spectrum sources from low frequency surveys
	Astronomical Society of India Meeting, Nani Tal 21-24 February 2005	Galactic halo HI clouds (*Invited*)

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Ganesh V	International Conference on Electrochemical Power Systems, Hyderabad 20-21 December 2004	Nickel nanoparticles as electrochemical super-capacitors and hydrogen evolution catalyst
	National Conference on Thin Film Preparation and Characterisation Techniques for Energy Conservation, Karaikudi 22-26 November 2004	Self-assembly monolayer (SAM): Preparation and characterization using electrochemical techniques, FTIR and STM
	The American College, Madurai, 28 February 2005	Template electrodeposition: High surface area nickel as a super cap and as hydrogen evolution catalyst
	Central Electrochemical Research Institute, Karaikudi 1 August 2004 – 25 January 2005	
Girija S	Brain Storming Session on Open Access Services, Sources and Standards, National Centre for Science Information, Bangalore, 20 July 2004	
	National Workshop on Building Digital Libraries using Dspace, Indian Institute of Technology, Chennai, 16-17 December 2004	
Govind M	Photonics 2004: Seventh International Conference on Opto-Electronics, Fibre Optics & Photonics, Cochin, 9-11 Deceber 2004	Gray shades in LCDs using amplitude modulation
Hatwalne Y	Tata Institute of Fundamental Research, Mumbai, 9-30 August 2004	The elasticity of liquid crystals *(two talks)*
	STATPHYS 22, Bangalore, 21 March 2005	The Cohe phase and the escape phase of liquid crystals

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Hema Ramachandran	Photonics-2004: Seventh International Conference on Optoelectronics, Fibre Optics & Photonics, Cochin 9-11 December 2004	Levy lasing in a random amplifying medium (*Invited*)
	Photoncis: Process, Materials and Devices, Centre for Advanced Technology, Indore, 2 Nov. 2004.	Levy lasers (*Invited*)
Iyer B R	Physics Department, Delhi University, 19 May 2004	Gravitational Waves: A new window to the Universe
	Summer School Harish-Chandra Research Institute, Allahabad, 20-21 May 2004	Gravitational radiation (*2 lectures*)
	Bangalore Association for Science Education, Jawaharlal Nehru Planetarium, Bangalore, 28 May 2004	What is Special Relativity? (*2 lectures*)
	GR XVII Dublin, Ireland, 18-23 July 2004 – Workshop Chair on Analytical Approximation and perturbation methods (*Invited*)	The 2.5PN gravitational wave polarizations from inspiralling compact binaries in circular orbits
	AIDSO and Srujana, Bangalore, 26 August 2004	The relativity of Albert Einstein
	Cardiff University, Cardiff, U.K., 27 September – 3 October 2004	The 3.5PN generation of gravitational waves from inspiralling compact binaries
	Institut d'Astrophysique de Paris, France, 3 Oct – 3 Nov 2004	
	Albert-Einstein-Institut, Golm, Germany 3-6 November 2004	

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Iyer B R (*contd.*)	XXIII IAGRG – Recent trends In General Relativity, Cosmology and Astrophysics, Jaipur, 7-10 December 2004	1. Gravitational radiation of compact binaries at the third post-Newtonian order 2. Implications of 3.5PN phasing formula in parameter estimation of inspiralling non-spinning compact binaries
	Department of Physics, Jaipur University, Jaipur, 10 December 2004	Introduction to general relativity and gravitational waves
	Einstein's Theories Centenary Conference, Mumbai, 7-9 January 2005	Picking up strains of the gravitational wave symphony (*Invited*)
	Breakthrough Science Society, Second Science Festival, Bangalore, 30 January 2005	Albert Einstein's insight: Special relativity
	Gyan Vani, Radio Talk, Bangalore, 1 March 2005	Albert Einstein's insight: Special relativity
Javed Ahmed	Harish-Chandra Research Institute, Allahabad, 19 July – 16 April 2005	
	SERC School (Pre), Institute of Mathematical Sciences, Chennai, 27 September 2004 – 16 October 2004	
	SERC School (Main), Indian Institute of Technology, Kanpur, 4-24 December 2004	
Joseph Samuel	Harish-Chandra Research Institute, Allahabad, June 2004 – April 2005	1. Of connections and cats 2. Black hole mechanics for general Lagrangians 3. Black hole entropy as Noether charge (*2 talks*)

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Kumar N	Conference and School on Unifying Concepts in Glass Physics III , JNCASR, Bangalore, 4-9 July 2004	Vogel-Fulcher viscosity law for glass-forming liquids: An effective medium theory
	M.E.S. College, Bangalore, 25 August 2004	Physics of every other day life
	Lecture and Panel Discussion on Nanoscience & Technology, Indian Institute of Science, Bangalore, 26 August 2004	
	Course on Indian Space Enterprise: Technology for National Development, Bangalore, 6 September 2004	
	The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy, 3 October – 25 November 2004 & 2 February – 14 March 2005	
	Two-Day Conference to celebrate The Fortieth Anniversary of the International Centre for Theoretical Physics, Trieste, Italy, 4-5 October 2004	
	Fifteenth General Meeting of the Third World Academy of Sciences, Trieste, Italy, 22-24 November 2004	
	Indian Institute Technology, Kharagpur,11 January 2005	*Fourth S. Majumdar Memorial Lecture:* Righting of a cat in free fall: Zero angular momentum turns

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Lakshminarayanan V	Central Electrochemical Research Institute, Karaikudi, October 2004	Scanned probe microscopy
	BVB Engineering College Hubli, November 2004	Scanned probe microscopy in biological studies
	Alagappa College of Engineering, Karaikudi, November 2004	Scanning probe microscopy for thin film studies
	Madurai Kamaraj University, Madurai, February 2005	Molecular self-assembly on surfaces and interfaces
	Thyagaraja Engineering College, Madurai, February 2005	Scanned probe microscopy-Instrumentation
Madhusudana N V	Twentieth International Liquid Crystal Conference, Ljubljana, Slovania, 4-9 July 2004	i) Obituary talk on Prof. S. Chandrasekhar (*Invited*) ii) Influence of director fluctuations on the electric field phase diagrams of nematic liquid crystals
	International College on Optics of Liquid Crystals and Polymers, Tabriz, Iran, 4-10 September 2004	Liquid Crystals – Fundamental aspects. (*4 lectures*) (*Invited*)
	Indo-US Workshop on Collaborations and Networking, National chemical Laboratory, Pune, 19-21 December 2004	Liquid crystals made of highly polar molecules (*Invited*)
Manjunath M	Symposium on Consortia Approach to resource sharing: Issues and policies, Indian Statistical Institute, Bangalore, 6-8 October 2004	
Mohammed S.S. Qusailah	XXIII IAGRG – Recent trends In General Relativity, Cosmology and Astrophysics, Jaipur, 7-10 December 2004	

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Nirvikar Prasad	School on Cosmology and Strings, IUCA, Pune, November 2004	
	COSPAR Colloquium on Spectra and Timing of Compact X-ray Binaries, TIFR, Mumbai, January 2005	The occurrence of Type I X-ray bursts on strange stars
	International Conference on the Physics and Astrophysics of QGP, Kolkata, February 2005	Neutron stars and new phases in microscopic matter
	Astronomical Society of India Meeting, Nainital, February 2005	
	National Center for Radio Astrophysics, Pune, February 2005	
Pandey V N	Exploring Mathematics & Science with Mathematica, Indian Institute of Science, Bangalore, 5 February 2005	
	Astronomical Society of India, ARIES, Nainital, 5 January 2005	Southern sky at 151.5 MHz from the Mauritius Radio Telescopes
Patil Y M	AICTE-ISTE Short Term Training Programme on Library Networking and Consortia Development, Tumkur, 23-29 August 2004	Consortia efforts in Indian STM Libraries: Experiences and expectations
	Symposium on Consortia Approach to Resource Sharing: Issues and Policies, ISI-DRTC, Bangalore, 6-8 October 2004	Resource sharing through Consortia: An experience with FORSA libraries

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Radhakrishnan V	Peter Gruber Foundation, Washington D.C.; Space Telescope Institute, Baltimore; Arecibo Observatory, Arecibo, USA, 2-12 June 2004	
	National Institute of Advanced Studies, Bangalore, 10 Sept. 2004	Nautics & Aernautics
	International Conference on Submillimeter Science and Technology, Physical Research Laboratory, Ahmedabad, 12-15 October 2004	Inaugural address
Raghunathan A	International Symposium on Microwaves (ISM-04), IEEE Section, Bangalore, 1-3 September 2004	
	Astronomical Society Meeting, Nainital, 21-24 February 2005	A non planar trapezoidal structure for broad band applications in radio astronomy
Raghunathan V A	APS March Meeting, Montreal, Canada, April 2004	Influence of chain tilt on the phase behaviour of lipid-cholesterol membranes
	Canadian Association of Physicists Congress, Winnipeg, Canada, June 2004	Phase behaviour of mixtures of long- and short-chain lipids
	Steacie Institute of Molecular Sciences, Ottawa, Canada, August 2004	Phase behaviour of aqueous solutions of long- and short-chain lipids
	Chalk River Labs, Chalk River, August 2004	Finite-size effect in a membrane stack

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Rahul Marathe	STATPHYS-2004, Indian Institute of Science, Bangalore, 4-9 July 2004	
	Workshop on Hydrodynamics, Indian Institute of Science, Bangalore, 6-9 December 2004	
Ramesh B	International Symposium on Microwaves '04, Bangalore, 2-3 September 2004	Broad-band microwave filters
	International Conference on Submillimeterwave Science & Technology '04, Ahmedabad, 13-15 October 2004	A telescope made with cylinders: Constructing a 3m submillimeterwave prototype
Ranganath G S	Department of Physics, University of Mysore, Mysore, 9-10 September 2004	Quantum Physics (*4 lectures*) (*Invited*)
	Department of Physics Bangalore University, 3 & 21 November 2004	1. Special aspects of classical mechanics 2. Lagrangian formulating mechanics (*Invited*)
	Bangalore Science Forum National College, Bangalore 5 January 2005	World Year of Physics (*Invited*)
	NMKRV College, Bangalore, 18 January 2005	Wider implications of physical principles
	Visveswaraiah Industrial and Technological Museum, Bangalore, 28 February 2005	Albert Einstein
Rangwala S A	Photonics: Processes, Materials and Devices, Centre for Advanced Technology, Indore, 2 November 2004	Linear and non-linear behaviour in cold molecule traps (*Invited*)

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Rangwala S A (*contd.*)	World Year of Physics Celebration: S.N. Bose National Centre for Basic Sciences, Kolkata, 1 January 2005	Bose-Einstein condensation: The modern avatar (*Invited*)
	National Laser Symposium: Atom Laser School, Bhabha Atomic Research Centre, Mumbai, 9 January 2005	Coherence and atom optics of Bose condensates (*Invited*)
Reji Philip	National Workshop on Recent Trends in Optoelectronics and Optical Communication, University of Kerala, Trivandrum, 26-28 May 2004	Nonlinear optics of nanoclusters
	Faculty Development Programme Workshops (Series 23), Siddaganga Institute of Technology, Tumkur, 24 August 2004	Nanotechnology and applications
	UGC Refresher Course for College Lecturers, Dept. of Chemistry, Cochin Univ. of Science & Technology, Cochin 27 October 2004	Ultrafast lasers: Applications in nonlinear optics
	Photonics-2004: Seventh International Conf. on Opto-Electronics, Fibre Optics and Photonics, Cochin 9-11 December 2004	Observation of a fifth order optical nonlinearity in 29 kDa Au@alkane-thiol clusters
	National Seminar on Gravity and Light, Dept. of Physics, Cochin Univ. of Science & Technology, Cochin 14-15 January 2005	One hundred years of light
	UGC Academic Staff College, University of Kerala, Trivandrum 14-15 February 2005	1. History of light 2. Ultrafast laser spectroscopy

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Reji Philip (*contd.*)	Conference on Renewable Energy Sources, Sacred Heart College, Cochin 16 February 2005	Renewable energy and other modern trends in physics
	Annual Photonics Workshop, School of Photonics, Cochin Univ. Science & Technology, Cochin, 27-28 February 2005	Metal "Molecules": The limits of nano-particle synthesis
	Centre for Materials in Electronics Technology(C-MET), Trichur, 1 March 2005	Nonlinear optics of metal nanoclusters
Ruckmongathan T N	Photonics-2004: Seventh International Conference on Opto-Electroncis, Fibre Optics & Photonics, Cochin, 9-11 December 2004	1. Gray shades in LCDs using amplitude modulation 2. Liquid crystal display for an automobile dashboard
Sadashiva B K	The National College, Bangalore, 7 July 2004	The fascinating science of the delicate phase of matter (*Invited*)
	Conference on Disorder, Complexity and Biology, Banaras Hindu University, Varanasi, 12-15 July 2004	Molecular design of achiral bent-core mesogens with electro-optical switching properties. (*Invited*)
	Indo-US Materials Research Workshop on Collaborations and Networking, National Chemical Laboratory, Pune, 19-21 December 2004	Banana-shaped mesogens derived from 1,3-dihydroxy benzene and 2-7-dihydroxy naphthalene (*Invited*)
	The M.S. University of Baroda Vadodara, 27 January 2005	*Prof. J.S. Dave Memorial Lecture*: Banana-shaped mesogens: A new sub-field of liquid crystals (*Award lecture*)

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Sajal Kumar Ghosh	Disorder, Complexity and Biology, Banaras Hindu University, Varanasi, 12-15 July 2004	Phase behaviour of a mixed surfactant system
Sanat Karmakar	International School on Soft & Biological Matter, Institute for Advanced Studies in Basic Science, Zanjan, Iran, 5-25 June 2004	
	International Conference on Statistical Physics of Complex Fluids, Institute for Advanced Studies in Basic Science, Zanjan, Iran, 27 June – 1 July 2004	Phase behaviour of dipalmitoyl phosphatidyl-choline (DPPC)-cholesterol membranes
Sandeep Kumar	International Liquid Crystal Conference, Slovenia, 4-9 July 2004	Discotic-decorated gold nanoparticles
	Conference on Disorder, Complexity and Biology, Banaras Hindu University, Varanasi, 12-15 July 2004	Inclusion of gold nano-particles in the supra-molecular order of discotic liquid crystals. (*Invited*)
	National Physical Laboratory, New Delhi, 8 October 2004	Materials of OLEDs
	Conference on Chemistry, Biology Interface: Synergistic New Frontiers, Dr. B. R. Ambedkar Center for Biomedical Research, Delhi, 21-26 November 2004	Self-organization of disk-like molecules
Sarabagopalan G	VII Users Scientist Workshop, National MST Radar Facility, Tirupati 5-7 July 2004	

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Shiv K. Sethi	Coorg Meeting on Cosmology, Coorg, February 2004	Effect of reionization on CMBR anisotropies
Shukre C S	COSPAR Colloquium on Spectra and Timing of Compact X-ray Binaries, Tata Institute of Fundamental Research, Mumbai, 18 January 2005	Emission altitudes in radio pulsars with triple profiles *(Invited)*
Sridhar S	Institute for Advanced Study, Princeton, USA, 1 February - April 2005	Progress in MHD turbulence in the solar wind and galactic centre
Suchand Sandeep C S	Photonics-2004: Seventh International Conf. on Opto-Electronics, Fibre Optics and Photonics, Cochin, 9-11 December 2004	Picosecond Z-scan investigations of optical nonlinearity in CdS nanostructure films
	Sree Sathya Sai Institute for Higher Learning, Puttaparthi, 17-18 March 2005	
	Indian Institute of Technology Chennai, 12-15 April 2005	
Sumati Surya	Perimeter Institute, Waterloo, Canada, 1-31 July 2004	Local homogeneity from sums over topology
	University of Alberta, Edmonton, Canada, 1-16 August 2004	Local homogeneity from sums over topology
	Imperial College, London, UK, 4-11 December 2004	Topology in quantum gravity
	Workshop on Causal Sets, Dublin, UK, 10-16 December 2004	Observables in extended percolation models of causet cosmology *(Invited)*

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Supurna Sinha	STATPHYS-2004 (Inter-National Conference), 4-9 July 2004	Writhe distribution of long tense molecules
	Harish-Chandra Research Institute, Allahabad, 11 March 2005	Phase transitions in small systems
Suresh K A	School of Physical Sciences, Jawaharlal Nehru University, New Delhi, 31 March – 4 April 2004	Two-dimensional phases of mesogenic and biological molecules at interfaces
	Department of Physics, Kent State University, Kent, USA, 9 June – 13 November 2004	Molecular assembly of cholesterol and cholesteryl esters at interfaces
	Liquid Crystal Institute, Kent State University, Kent, USA, 13 October 2004	Langmuir and Langmuir-Blodgett films of mesogenic molecules
	Argonne National Laboratory, Chicago, USA, 14-22 June 2004	
Sutirtha Roy Chowdhury	SERC School on Theoretical High Energy Physics (Pre-School), Institute of Mathe-matical Sciences, Chennai, October 2004	
	SERC School on Theoretical High Energy Physics (Main) Indian Institute of Technology, Kanpur, December 2004	
	Harish-Chandra Research Institute, July 2004 and April 2005.	

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Suparna Roychowdhury	Department of Physics, Jadavpur University, 10-17 October 2004	Active galaxies and gas in galaxy clusters
	Twenty third Meeting of the Astronomical Society of India, Nainital, 21-24 February 2005	Active galaxies and "entropy floor" in galaxy clusters *(Invited)*
Udaya Shankar N	RAFCAP (Radio Astronomy Frequency Committee in the Asia-Pacific Region) Meet, National Space Agency, Kuala Lumpur, Malaysia, 19-20 May 2004	Radio astronomy in India
	VII User Scientists Workshop, National MST Radar Facility, Tirupati, 5-7 July 2004	Beam forming in radio astronomy *(Invited)*
	Aryabhatta Research Institute, of Observational Sciences, Nainital, 30 August 2004	1 Basic principles of synthesis imaging 2 Imaging with Mauritius Radio Telescope
	R.L. Science Institute, Belgaum, 21 September 2004	Seeing the Universe with radio eyes
	K.L.E. College of Engineering, 21 September 2004	Engineering challenges in radio astronomy
	Refresher Course, Kuvempu University, Shimoga, 18-19 November 2004	Fundamental physical constants and end-states of stars *(4 lectures)*
	Bangalore University, Bangalore, 30 November - 1 December 2004	Fundamental physical constants and end-states of stars *(3 lectures)*

Name	*Conferences attended / Institutions visited*	*Title of paper / talk*
Udaya Shankar N (*contd.*)	Indo-French Technical Association, Bangalore Chapter, 9 January 2005	Seeing the invisible Universe
	Twenty Third ASI Meeting, Aryabhatta Research Institute, of Observational Sciences, Nainital, 21-24 February 2005	1 Prototype of a 12m preloaded parabolic dish 2 Design of a control system for the RRI 12m radio Telescope 3 Modal analysis and surface metrology of the RRI 12m preloaded parabolic dish.
	National Science Day Program, Indian Institute of Science, Bangalore, 28 February 2005	Seeing the invisible Universe

Annexure III

COLLOQUIA

Name	Title	Date
Ofer Biham Racah Institute of Physics The Hebrew University Jerusalem	Reaction and diffusion on astrophysically relevant surfaces	6.4.2004
M. P. Das The Australian National University, Canberra Australia	How relevant is Occam's razor in the realm of mesoscopic electron transport	15.4.2004
Tarun Deep Saini Institute of Astronomy Cambridge, U.K.	Bayesian statistics and the dark energy problem	16.4.2004
Moumita Das Indian Institute of Science Bangalore	Soft sliding bilayers: Collective stochastic resonance and shear-induced melting	20.4.2004
Badri Krishnan Albert Einstein Institut Postdam, Germany	Searching for gravitational waves from pulsars using the Hough transform	21.4.2004
Dibyendu Nandi Montana State University USA	Detection of a Taylor-like Plasma Relaxation process in the Sun	23.4.2004
Narayanan Menon University of Massachusetts Amherst, USA	Forced crumpling of thin sheets	28.4.2004
Alok Sharan Pennsylvania State University USA	Probing ferroelectricity in $BiMnO_3$ thin films using optical second harmonic generation	28.4.2004
Satyan Bhongale Joint Institute for Laboratory Astrophysics, Boulder, USA	Fractional quantum Hall regime in dilute Bose gases	30.4.2004

Name	Title	Date
A.R. Prasanna Physical Research Laboratory Ahmedabad	Electromagnetism and gravity; could they have been coupled nonminimally?	10.5.2004
Swami Manohar PicoPeta Simputers Pvt. Ltd. Bangalore	Making of the Amida Simputer	11.5.2004
T.P. Singh Tata Institute of Fundamental Research, Mumbai	Quantum mechanics without spacetime	14.5.2004
	Quantum gravitational collapse	17.5.2004
Reuben Rabi Massachusetts Institute of Technology Cambridge, USA	Systems problems and biology	20.5.2004
Sushan Konar Indian Institute of Technology, Kharagpur	Magnetic fields of pulsars — Neutron star and strange star perspectives	21.5.2004
P.P. Rajeev Tata Institute of Fundamental Research Mumbai	"NANO" structures, "KILO" electron volts and "MEGA" gauss pulses	26.5.2004
David Rideout Hamilton College New York, USA	Causal sets: A review and some recent developments	31.5.2004
V.P.N. Nompoori Cochin University of Science & Technology Cochin, India	Dynamics of the human brain as inferred from Time Series Analysis of EEG patterns	10.6.2004
Pawan Kumar University of Texas Austin, USA	Recent developments in our understanding of gamma-ray bursts	23.6.2004
Y.C. Minh Korea Astronomy Observatory, S. Korea	Chemical properties of molecular cloud in our galactic center	24.6.2004

Name	Title	Date
Paul J. Witta Georgia State University Atlanta, USA	Combined radio and optical properties of extragalactic radio sources	25.6.2004
D. Narayana Rao National MST Radar Facility, Gadanki	An overview of National MST Radar Facility (NMRF)	1.7.2004
Indranil Chattopadhyay Centre for Plasma Astro Physics, K.U. Leuven Belgium	Radiatively driven jets from TCAF accretion disc	5.7.2004
Robin Stinchcombe Oxford University UK	Non-equilibrium collective behaviour	6.7.2004
Jayaram N. Chengalur National Centre for Radio Astrophysics, Pune	Observing organic molecules with a meterwave telescope	9.7.2004
V P N Nampoori Cochin University of Science and Technology, Cochin	Dynamics of the human brain as inferred from time series analysis of EEG patterns	10.7.2004
Yashwant Gupta National Centre for Radio Astrophysics Pune	The GMRT finds its first pulsar	15.7.2004
Shrinivas Kulkarni California Institute of Technology, USA	The central engines of gamma-ray bursts, x-ray flashes and supernovae	15.7.2004
Nirvikar Prasad Tata Institute of Fundamental Research, Mumbai	Strange stars with a density-dependent bag parameter	16.7.2004
David Lacoste ESPCI, Paris, France	Dynamics of active membranes with internal noise	16.7.2004
Manojendu Choudhury Tata Institute of Fundamental Research, Mumbai	Accretion-ejection mechanism in galactic micro-quasars	21.7.2004

Name	Title	Date
B.S. Sathyaprakash Cardiff University U K	1 Quest for gravitational waves 2 Testing non-linear gravity with gravitational wave observations	29.7.2004 4.8.2004
Jayant Murthy Indian Inst. of Astrophysics Bangalore	Observations of the diffuse UV radiation field – Past, present, and future	30.7.2004
Aditi Sen University of Hannover Germany	Locally accessible information: How much can the parties gain by cooperating?	3.8.2004
Rajaram Nityananda National Centre for Radio Astrophysics, Pune	From Leningrad to Levy: A short tale of long tails	4.8.2004
B.S. Sathyaprakash Cardiff University U K	Testing non-linear gravity with gravitational wave observations.	4.8.2004
Ujjwal Sen University of Hannover Hannover, Germany	Non-ergodicity of entanglement and its complementary behaviour to magnetization in infinite spin chain	5.8.2004
V. Girish ISAC, IISc JAP Program Bangalore	Search for northern hemisphere roAp stars	6.8.2004
Abhik Basu Max-Planck-Institute für Physik, Dresden, Germany	New Universality classes in *MHD* and other driven diffusive systems	6.8.2004
Arundati Dasgupta University of New Brunswick Canada	Entropy of a black hole apparent horizon	9.8.2004
Soumitra Sengupta Indian Association for Cultivation of Science Kolkata	Cosmological signals of string theory in a braneworld scenario	12.8.2004

Name	Title	Date
Deepak Raghavan Georgia State University Atlanta, Canada	Two Suns in the Sky: Many extrasolar planets orbiting stars in multiple systems	13.8.2004
Anand Kumar Centre for Mathematical Modelling & Computer Simulation, Bangalore	Isotropic numerical schemes	18.8.2004
Nick Seymour IAP, France	The nature of the faint submJy radio population	18.8.2004
G. Rajalakshmi Indian Institute of Astrophysics Bangalore	Experimental study of Casimir forces	19.8.2004
A.R.P. Rau Louisiana State University Baton Rouge, USA	A technique for solving master equations for dissipation and decoherence	19.8.2004
Sarmistha Banik Saha Institute of Nuclear Physics, Kolkata	Phase transitions in the dense interiors of of compact stars	31.8.2004
M. Gourie-Devi Institute of Human Behaviour and Allied Sciences New Delhi	Neurology of ageing	9.9.2004
Biswajit Paul Tata Institute of Fundamental Research, Mumbai	Timing X-ray pulsars	17.9.2004
Annapurni Subramanian Indian Institute of Astrophysics Bangalore	The bar(s) of the large magellanic cloud	24.9.2004
Apoorva Patel Indian Institute of Science Bangalore	A wave implementation of the optimal database search algorithm	22.9.2004
Hasi Ray Indian Institute of Technology Roorkee	Positronium and scattering	27.9.2004

Name	Title	Date
Vasant Natarajan Indian Institute of Science Bangalore	Frequency measurements of D lines and fine-structure interval in Cs	28.9.2004
Anita Richards Jodrell Bank University of Manchester U K	Next generation radio interferometers and data access	5.10.2004
Jonathan McDowell Harvard-Smithsonian Centre for Astrophysics U S A	Dawn of the space age	6.10.2004
Abhijit Saha NOAO, Tucson U S A	Type Ia supernova as standard candles: Calibration of their luminosities and the value of the Hubble constant.	8.10.2004
Anirban Roy Inst. of Mathematical Sciences, Chennai	Locally accessible information and distillable entanglement	8.10.2004
Arundati Dasgupta University of New Brunswick Canada	Entropy of a black hole	8.10.2004
Nandor Eber Research Institute for Solid State Physics and Optics Budapest, Hungary	Electroconvection in homeotropic nematic liquid crystals	10.11.2004
Maxim Tomilin S I Vavilov State Optical Institute, St. Petersburg Russia	LC Vision application to detecting malignant tumours and influenza viruses	17.11.2004
Tamio Endo Mie University Tsu, Japan	Reentrant phase and vortex dynamics under crossing field in Bi2212 crystal	22.11.2004
Yuri Shtanov Bogoliubov Institute for Theoretical Physics Kiev, Ukraine	Brane worlds	2.12.2004

Name	Title	Date
Sai Venkatesh Pingali University of Illinois Chicago, USA	Molecular ordering and phase transitions of mixed surfactant systems at the oil/water interface	8.12.2004
Abhay Ashtekar Pennsylvania State University U S A	Quantum geometry and the big-bang	16.12.2004
Pijush Bhattacharjee Indian Institute of Astrophysics, Bangalore	Matter-antimatter asymmetry, neutrino mass, and cosmic strings	17.12.2004
Pamidipati Gayatri Hela National Tsing Hua University Taiwan	BTP as a fluorescent blue emitter: Nano-aggregation boosts organic LED efficiency	29.12.2004
Kavita Jain University of Koeln Germany	Adaptive evolution *via* punctuated dynamics	5.1.2005
P. Nandakumar University of Stuttgart Germany	Coherent Raman scattering: Applications in femto-chemistry and biology	6.1.2005
Per Lyngs Hansen University of Southern Denmark, Denmark	Symmetry at the breakpoint: Oysters and spontaneous vesicles	7.1.2005
Martin Kilbinger Universitaet Bonn Germany	Cosmological parameters from combined second and third order statistics of cosmic shear	11.1.2005
Rupal Mittal Max-Planck-Institut fuer Radioastronomie, Germany	A VLBI study of the gravitational lens JVAS B0218 + 357	11.1.2005
Chinmay Das University of Leeds UK	Computational linear rheology of branched polymers	12.1.2005
Claude Nicollier CB/NASA Johnson Space Center, USA	Science and adventure in space	20.1.205

Name	Title	Date
Ajith Parameswaran Albert-Einstein-Institut Hannover, Germany	A new class of post-Newtonian approximants to the dynamics of inspiralling compact binaries: Test mass in the Schwarzschild spacetime	19.1.2005
Manoj Gopalakrishnan Max-Planck Institute for the Physics of Complex Systems, Germany	Kinetics of ligant (re)binding and the effects of receptor organization	25.1.2005
Sudip Bhattacharyya University of Maryland U S A	Surface atomic spectral lines from weakly magnetized rotating neutron stars	25.1.2005
L. Sriramkumar Harish-Chandra Research Institute, Allahabad	Does the primordial spectrum probe Planck scale physics?	25.1.2005
Tomoso Belloni INAF – Brera Astronomical Observatory, Merate, Italy	Black-hole transients: from QPOs to relativistic jets	28.1.2005
Banibrata Mukhopadhyay Harvard-Smithsonian Center for Astrophysics, USA	Hydrodynamic induced turbulence in accretion disks: Study of energy growth	31.1.2005
Miller Goss National Radio Astronomy Observatory, USA	1 VLBA observations of OH (1720 MHz) in supernova remnants	1.2.2005
	2 Ten years of very long baseline array science - The universe observed at milli-arcsec Resolutions	3.2.2005
Josef Gruska Masaryk University Brno, Czech Republic	Challenges of complexity theory	24.2.2005
Gin Jose Indian Inst. of Technology Guwahati	Planar integrated active waveguide devices on glass for optical communication	25.2.2005
S. Mohanty Physical Research Laboratory Ahmedabad	Low CMB quadropole from thermal fermions in inflation	10.3.2005

Name	Title	Date
Marsha Weaver University of Canberra Australia	The mass of a region of space	14.3.2005
Ranjeev Misra Inter-University Centre for Astronomy & Astrophysics Pune	The non-linear temporal behavior of the black hole system GRS 1915+105	28.3.2005
Biswajit Paul Tata Institute of Fundamental Research Mumbai	Polarimetry in X-ray astronomy: Techniques and science prospects	31.3.2005

Annexure IV

JOURNAL CLUB

Discussed by	Paper discussed	Date
Hema Ramachandran	Probable observation of a supersolid helium phase E. Kim and M.H.W. Chan *Nature*, **427**, 225 (2004)	1.4.2004
Anish Roshi	The inconstant constant? R. Srianand *et al.* to appear in *Phys. Rev. Lett.*, (astro-ph/0402177)	1.4.2004
S. Sridhar	Wave damping by magnetohydrodynamic turbulence and its effect on cosmic-ray propagation in the interstellar medium Alison J. Farmer and Peter Goldreich *Astrophys. J.*, **604**, 671 (2004)	22.4.2004
S. Jeyakumar	Light from the dark ages? R. Pello *et al.*, A and A, **416**, L35 (2004)	22.4.2004
Sumati Surya	The quantum interest conjecture L.H. Ford and Thomas A. Roman *Phys. Rev. D*, **60**, 104018 (1999)	29.4.2004
Ashok Vudayagiri	Exploding Bose-Einstein Condensates: Supernovae in a bottle? Elizabeth A. Donley *et al.* *Nature*, **412**, 295 (2001)	29.4.2004
K S Dwarakanath	Compact sources as the origin of the soft Gamma-ray emission of the milky way F. Lebrun *et al.* *Nature*, **428**, 293 (2004)	13.5.2004
T. Roopa	Force-clamp spectroscopy monitors the folding trajectory of a single protein J.M. Fernandez and H. Li *Science*, **303**, 1674 (2004).	13.5.2004
D. Vijayaraghavan	Carbon nanotubes as nanoscale mass conveyors B.C. Regan *et al.* *Nature*, **428**, 924 (2004)	27.5.2004

Discussed by	Paper discussed	Date
Arun Roy	Geometrically mediated breakup of drops in microfluidic devices D.R. Link *et al.* *Phys. Rev. Lett.*, **92**, 054503 (2004)	27.5.2004
Reji Philip	A quantum Carnot engine: Revisiting the second law of thermodynamics Scully *et al.* *Science*, **299**, 862 (2003).	10.6.2004
Dipanjan Bhattacharya	Mechanically driven ATP synthesis by F_1-ATPASE H. Itoh *et al.* *Nature*, **427**, 6973 (2004)	24.6.2004
Sandeep Kumar	Direct spinning of carbon nanotube fibers from chemical vapor deposition synthesis Ya-Li Li *et al.* *Science*, **304**, 276 (2004).	24.6.2004
Ganesh V	Fluctuations and bistabilities on catalyst nanoparticles V. Johanek *et al.* *Science*, **304**, 1639 (2004)	8.7.2004
Ruckmongathan T N	Electric Flex Yoseph Bar-Cohen *IEEE Spectrum*, 19 (2004)	8.7.2004
Govind M	Integration of photosynthetic protein molecular complexes in solid-state electronic devices Rupa Das *et al.* *Nanoletters*, **4**, 1081 (2004)	22.7.2004
Rajesh G	Radial and transverse velocities of nearby galaxies P J E Peebles *et al.* *Astrophysical Journal*, **554**, 104 (2001).	22.7.2004
Divya Sharma	Focusing of sound in a 3D phononic crystal Suxia Yang *et al.* *Phys. Rev. Lett.*, **93**, 024301 (2004)	5.8.2004

Discussed by	Paper discussed	Date
Sudipto Muhuri	Spontaneous sharp bending of double-stranded DNA Timothy E. Cloutier and Jonathan Widom *Molecular Cell*, **14**, 355 (2004)	5.8.2004
Iyer B R	Model-dependence of Shapiro time delay and the 'speed of gravity/speed of light' controversy S. Carlip *Classical & Quantum Gravity*, **21**, 3803 (2004)	2.9.2004
Pandey V N	Observation of optical forerunners in water Seung-Ho Choi and Ulf Österberg *Phys. Rev. Lett.* **92**, 193903 (2004).	2.9.2004
Manjula Devi V	New look for molecular photodiodes S. Yasutomi *et al.* *Science*, **304**, 1944 (2004)	16.9.2004
Udaya Shankar N	Probing the cosmological variation of the fine-structure constant Chandan H *et al.* *Astronomy and Astrophysics*, **417**, 853 (2004)	16.9.2004
Lakshminarayanan V	Powering fuel cells with CO *via* aqueous polyoxometalates and gold catalysts Won Bae Kim *et al.* *Science*, **305**, 1280 (2004)	30.9.2004
Suparna Roychowdhury	Flux and energy modulation of the redshifted iron emission in NGC3516: Implication for the black hole mass K. Iwasawa *et al.* *Accepted for publn. in MNRAS* (astro-ph/0409293)	30.9.2004
Anija M	Detachment fronts and the onset of dynamic friction S.M. Rubinstein *et al.* *Nature*, **430**, 1005 (2004)	14.10.2004
Umadevi S	A molecular elevator Jovica D. Badjic *et al.* *Science*, **303**, 1845 (2004)	14.10.2004

Discussed by	Paper discussed	Date
Amit K. Agarwal	Colour of shock waves in photonics crystals Evan J. Reed *et al.* *Phys. Rev. Lett.*, **90**, 203904 (2003)	28.10.2004
Karthikeyan B	Highly fluorescent, water-soluble, size-tunable gold quantum dots Jie Zheng *et al.* *Phys. Rev. Lett.*, **93**, 077402 (2004)	28.10.2004
Dipanjan Bhattacharya	Simultaneous atomic force microscope and fluorescence measurements of protein unfolding using a calibrated evanescent wave Atom Sarkar *et al.* *PNAS*, **12882**, 101 (2004)	25.11.2004
Rohini M. Godbole Indian Institute of Science, Bangalore	Nobel Prize for Minus Sign	13.1.2005
Hema Ramachandran	(A) Instant neural control of a movement signal M.D. Serruya *et al.* *Nature*, **416**, 141 (2002)	27.1.2005
	(B) A brain-computer interface using EcoG signals in humans E.C. Leuthardt *et al.* *Neural Engineering*, **1**, 63 (2004)	
Kumar N	Euler's disk and its finite-time singularity H.K. Moffatt *Nature*, **404**, 833 (2000)	27.1.2005
Dipankar Bhattacharya	A confirmation of the general relativistic prediction of the lense-thirring effect I. Ciufolini and E.C. Pavlis *Nature*, **431**, 958 (2004)	10.2.2004
Brindaban Kundu	Elastic torque and the levitation of metal wires by a nematic liquid crystal C.Lapointe *et al.* *Science*, **303**, 652 (2004)	3.3.2005

Discussed by	Paper discussed	Date
Andal Narayanan	Observation of the vacuum rabi spectrum for one trapped atom. A. Boca *et al.* *Phys. Rev. Lett.*, **93**, 233603 (2004)	3.3.2005
Abhishek Dhar	Self-running droplet: Emergence of regular Motion from nonequilibrium noise Yutaka Sumino *et al.* *Phys. Rev. Lett.*, **94**, 068301 (2005)	17.3.2005
Ramesh B	Single spin detection by magnetic resonance force microscopy D. Rugar *et al.* *Nature*, **430**, 329 (2004)	17.3.2005
Sadiq Rangwala	Electrostatic trapping of ammonia molecules H.L. Bethlem *et al.* *Nature*, **406**, 491 (2000)	24.3.2005
Resmi L	A giant flare in the gamma ray sky: A neutron star quake? Palmer *et al.* *Nature*, submitted astro-ph/0503030 (2005)	24.3.2005

ABBREVIATIONS

ARIES	Aryabhatta Research Institute of Observational Sciences, Nainital, India
ASTROSAT	ISRO's Astronomical Satellite
ATNF	Australia Telescope National Facility, Australia
BC	Bent-Core
BEC	
BITS	Birla Institute of Technology, Goa
CA	Cholesteric Acid
CGHS	Callan-Giddings-Harvey-Strominger (Model)
CP	Completely positive
CsPFO	Cesium Per Fluoro Octanoate
CV	Cyclic Voltammetry
CZT	Cadmium Zinc telluride
DHPC	Di Hexanoyl Phosphatidyl Choline
DMPC	Di Myristoyl Phosphatidyl Choline
DMPG	Di Myristoyl Phosphatidyl Glycerol
DPPC	Di Palmitoyl Phosphatidyl Choline
EIS	Electrochemical Impedance Spectroscopy
EIT	Electromagnetically-Induced Transparency
FCPM	Fluorescence Confocal Polarizing Microscopy
GHz	Giga Hertz
GMRT	Giant Meterwave Radio Telescope
GUV	Giant Unilamellar Vesicles
HI	Neutral Atomic Hydrogen
HII	Ionized Hydrogen
IAP	Institut d'Astrophysique de Paris

IHES	Institut des Hautes Etudes Scientifiques
INSAT	Indian National Satellite
IRA	Institute of Radio Astronomy, Ukraine
ISRO	Indian Space Research Organisation, Bangalore, India
JILA	Joint Institute for Laboratory Astrophysics, Colorado, USA.
JIVE	Joint Institute for VLBI in Europe
LIGO	Laser-Interferometric Gravitational Wave Observtory
LQG	Loop Quantum Gravity
MHz	Mega Hertz
MOT	Magento-Optic Trap
MRT	Mauritius Radio Telescope
NCRA	National Centre for Radio Astrophysics, Pune, India
NEGF	non-equilibrium Green function formalism
NLO	Non Linear Optical
NMRF	National MST Radar Facility
NPL	National Physical Laboratory, New Delhi, India
NRAO	National Radio Astronomical Observatory, USA
OH	Hydroxyl Radical
PDRs	Photodissociation regions
PM	Polarizing Microscopy
RAC	Radio Astronomy Centre, Ooty, India
RRL	Radio Recombination Lines
SEM	Scanning Electron Microscopy
SNR	Supernovae Remnants
SSM	Scanning Sky Monitor
STM	Scanning Tunneling Microscopy
TIFR	Tata Institute of Fundamental Research, Mumbai, India

UCHII	Ultra Compact HII
ULV	Uni Lamellar Vesicles
UOM	University of Mauritius, Mauritius
VLBA	Very Large Baseline Array, USA
VLBI	Very Long Baseline Interferometry
UMIST	University of Manchester Institute of Science and Technology, Manchester, UK
VSAT	Very Small Aperture Telescope
WLC	Worm Like Child
XRD	X-Ray Diffraction
(NEGF)	Non-Equilibrium Green Function Formalism
PN	Post-Newtonian
WLC	Worm Like Chain