RAMAN RESEARCH INSTITUTE

C. V. Raman Avenue, Sadashivanagar

Bangalore 560080, India

Annual Report

2005 - 2006

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PREAMBLE

The Annual report of the Raman Research Institute for the year 2005-2006 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 2005 to 31 March 2006. Four students received Ph.D. degrees and five have submitted their theses during the year. The report 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 2005, as was done in previous years. The two other major events that were organized at the Institute were: (1) A Three-Day Seminar on 'Recent Trends in Liquid Crystal Research' held during 14-16 November 2005 under the India-UK Exchange programme; this event was jointly supported by the Department of Science and Technology, New Delhi and The Royal Society, London. (2) A Workshop for Young Scientists on Laser Physics & Quantum Optics was held during 4-8 January 2006. This Workshop was held under the auspices of the Indo-French Centre for Promotion of Advanced Research, New Delhi.

The lists of Colloquia given at the Institute, the Journal-Club discussions held at the Institute and the visitors to the Institute display the remarkable breadth of research at the Institute and the extent of interactions and 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 endeavours.

Bangalore — RAVI SUBRAHMANYAN

18 September 2006 — Director

RAMAN RESEARCH INSTITUTE

Bangalore

Annual Report 2005 - 2006

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, Astronomy & Astrophysics, Light & Matter Physics, Soft Condensed Matter and Theoretical Physics. The Liquid Crystals research has expanded and diversified and is today the Soft Condensed Matter research theme that includes inter-disciplinary soft-condensed matter and biological physics (studies on membranes and single-DNA segments), which has a significant overlap and interaction with the Theoretical Physics activity. In addition, Laboratories in the theme of Light and Matter Physics are making experimental studies in the emerging fields of laser cooling and trapping of atoms and molecules, imaging through turbid media, and ultra-fast atomic processes using femtosecond (10^{-15} s) laser pulses.

1. Astronomy & Astrophysics and related signal processing, imaging, and instrumentation development

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 diverse objects in the Universe emit 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. 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 are building state-of-the-art digital receivers that enhance its capabilities with a view to continuing to use it for specific research programmes. The Radio Astronomy Lab of the Institute has in the past 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. Today, members of the Institute are in the initial stages of developing further upgrades to the GMRT: towards equipping the telescope with very low frequency receivers and feed arrays. Another project that was executed previously 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 also set-up a millimetre wave telescope of diameter 10.4 metres on campus and is currently equipping it for 40-50 GHz surveys of star-forming regions. Currently 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. Other activities include the development and construction of an interferometer array for satellite astrometry and a demonstration of capability to estimate differential Doppler motions of satellites with extreme precision. 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 requires 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.

2. Light and Matter Physics

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---for example, novel methods for determining the temperature of ultra-cold atom clouds---have 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 LAMP 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 LAMP group is on the road to pursuing experimental research into selected problems related to ultra-cold molecules; for this, experimental capability is currently under development.

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: during the year, this research included semiconductor oxide films and ferrofluids. Creation of infrastructure for ultrafast laser plasma experiments in vacuum, for studies of the interaction of intense laser pulses with liquid droplets and solid targets, is in progress.

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. Soft Condensed Matter

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 synthesizing new liquid crystalline materials.

Work on algorithms in liquid crystal displays has yielded new image-coding algorithms and demonstrated the use of wavelets in display addressing. Current research in the group includes synthesis of numerous liquid crystalline compounds and studies of their phases and transition behaviours. The research includes elucidating the relationship between molecular structure, relative ordering and orientation, and the phase behaviour. Studies include surfactant systems and polymer physics, and complexes and membrane molecules of biological significance.

4. 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 the formalisms associated with transport properties, conduction, and equilibration.

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. During the year, research has included examining signal detection with future space based gravity-wave detectors.

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 information loss problem in black holes. An example of the value of an interdisciplinary environment at the Institute has been the work proposing experiments with fluid membranes as a probe of the physics that underlies the cosmological constant, which is potentially the dark energy component of the Universe.

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. Interest centres on vesicle formation and transport. There is also related experimental activity both on campus and in the neighbouring NCBS.

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

ASTRONOMY AND ASTROPHYSICS

AREAS OF RESEARCH

Cosmology and Structure Formation
Extragalactic Astronomy
Neutron Stars and Pulsars
The Galaxy and the Interstellar Medium
Surveys
Topological Phase
Signal processing and Imaging,
Instrumentation for Astronomy

COSMOLOGY AND STRUCTURE FORMATION

Effect of primordial magnetic fields on reionization of the Universe. The effect of primordial magnetic fields on the reionization of the universe was probed. It was shown that the redshift of the epoch of reionization derived from WMAP data could be as low as 10 if the contribution of magnetic fields is taken into account, instead of the much higher values reported in the literature. [S. K. Sethi, Rajesh Gopal]

Light Cone Anisotropy. The effect of light cone anisotropy on the correlation function of neutral hydrogen brightness temperature at the epoch of reionization was studied. It was found that the anisotropy owing to this effect could be up to 20%. [S. K. Sethi + Zoltan Haiman (Columbia University, USA)]

Growth of supermassive black holes. A model has been developed of accretion onto the central black hole in a galaxy, where feedback from the black hole regulates the accretion flow. This model can explain the observed relation between black hole mass and bulge velocity dispersion in galaxies, without invoking any large scale wind outflow from the bulge, and predicts that this relation should be independent of redshift. [B. Nath + M. C. Begelman. (University of Colorado, Boulder, USA)]

Abundance anomaly of early stars. Certain puzzling abundance patterns in very metal poor stars in the Milky Way were explained by selective transport under radiation pressure of dust grains, created in the first generation stars, to the shells of supernova remnants which are thought to be the sites of later generations of stars. [B. Nath, + A. Venkatesan & J. M. Shull (University of Colorado, Boulder, USA)]

EXTRAGALACTIC ASTRONOMY

Starburst galaxy NGC 253. The highest resolution (about 2 arc second or better)

molecular line image ever has been obtained of the starburst galaxy NGC 253 in the 5 → 4 rotational transition of cyanoacetylene (HC_3N), using the recently installed Q-band receivers on the Very Large Array (VLA) radio telescope in the USA. [B. Ramesh + R. Niruj Mohan (Leiden University, The Netherlands)]

Molecular gas in Low Surface Brightness Galaxies. Molecular gas has been detected in the disks and nuclei of two Low Surface Brightness galaxies UGC 6614 and F568-6, using the BIMA interferometer (USA) and IRAM telescope (Spain). [M. Das + K. O'Neil (National Radio Astronomy Observatory, USA), S. Vogel & S. McGaugh (University of Maryland, USA)]

Gravitationally lensed quasar 2016+112. Global Very Large Baseline Interferometry observations of the gravitationally lensed quasar 2016+112 have been obtained at frequencies 8.4 GHz and 15 GHz. The initial analysis points to the existence of substructure in the mass distribution acting as the gravitational lens. [S. Nair + A. More, R. W. Porcas (Max Planck Institute of Radio Astronomy, Bonn), M. A. Garrett (Joint Institute for VLBI in Europe, Dwingeloo, The Netherlands)]

Active Nucleus in a Low Surface Brightness Galaxy. Observations with the Giant Metrewave Radio Telescope (GMRT) have revealed, for the first time, a radio lobe structure associated with a Low Surface Brightness galaxy. The galaxy is 1300+0144 and the observations were conducted at 1400, 610 and 325 MHz continuum bands. A spectral index of -0.7 between these bands has been derived. [M. Das + N. Kantharia (National Centre for Radio Astrophysics, Pune), S. McGaugh (University of Maryland, USA)]

Optical spectroscopy of 1300+0144 has been performed with the Himalayan Chandra Telescope. The data confirms the presence of an active nucleus in this Low Surface Brightness galaxy. [M. Das + T. P. Prabhu (Indian Institute of Astrophysics, Bangalore)]

Lopsidedness in galaxies of the Eridanus Group. The radial dependence of lopsidedness in the neutral hydrogen distribution in galaxies belonging to the Eridanus group has been derived using Fourier transforms of surface density maps. The lopsidedness in the inner regions of these galaxies is found to be almost twice that in field galaxies. The dependence of lopsidedness on galaxy type is found to be opposite to that for field galaxies. These indicate a different origin for lopsidedness of galaxies in groups compared to the field galaxies. [K. S. Dwarakanath + R. Angiras (Mahatma Gandhi University, Kottayam), C. J. Jog (Indian Institute of Science, Bangalore), A. Omar (Aryabhatta Research Institute for Observational Sciences, Nainital)]

Gas loss from galaxies in groups. A comparative study of neutral hydrogen content of individual galaxies in loose groups with and without diffuse X-ray emission from their intergalactic medium (IGM) has indicated that galaxies in X-ray bright groups have lost

more gas than those in non-X-ray groups. Mechanisms by which the hot IGM can aid the removal of gas were explored. [C. Sengupta, B. Ramesh]

Search for past nuclear activity in galaxies in groups. A sample of four X-ray underluminous groups of galaxies were imaged using the GMRT at 235 and 610 MHz, in order to look for relics of past activity of Active Galactic Nuclei (AGN) in them. No diffuse radio emission was found, implying that AGN activity has been far below that needed to cause the observed reduction of X-ray luminosity in these groups. [K. S. Dwarakanath, B. Nath]

Compton scattering from cluster gas heated by nuclear activity in central galaxy. A detailed calculation of the physical state of the diffuse hot gas pervading galaxy clusters, taking into account heating from a central active galaxy, thermal conduction, convection and radiative cooling, has shown that the anisotropy of the Cosmic Microwave Background Radiation, resulting from Compton scattering in this hot gas, is expected to be much less than previously thought. [S. Roychowdhury, B. Nath + M. Ruszowski & M. C. Begelman (University of Colorado, Boulder, USA)]

Signature of primordial cosmic rays. The excess lithium found in metal poor halo stars in the Milky Way was explained in terms of interaction with a cosmological population of cosmic rays. It was shown that heating by such a population of cosmic rays could explain the excess entropy observed in the diffuse gas in groups of galaxies. The energy required can be provided by cosmic rays from supernovae and radio galaxies. [B. Nath + P. Madau (University of California, Santa Cruz, USA), J. Silk (University of Oxford, UK)]

Gamma Ray Bursts. Multiwavelength monitoring of Gamma Ray Burst (GRB) afterglows continues. During this year seven afterglows were optically detected and in ten cases optical upper limits were obtained. Radio upper limits using the Giant Metrewave Radio Telescope (GMRT) located near Pune were obtained for five afterglows. Radio monitoring of the afterglow of the bright GRB 030329 was extended beyond three years using the GMRT. Theoretical modelling of several observed afterglows have been carried out and the energy released in these explosions has been estimated. [D. Bhattacharya, L. Resmi, A. Kamble, +Indian GRB collaboration with members from Aryabhatta Research Institute of Observational Sciences (Naini Tal), National Centre for Radio Astrophysics (Pune) and Indian Institute of Astrophysics (Bangalore)]

NEUTRON STARS AND PULSARS

ALFA pulsar survey. A Survey of pulsars with the Arecibo L-band Feed Array (a 7-beam receiver on the 1000-ft diameter Arecibo radio telescope at Puerto Rico) has been undertaken; precursor observations have already resulted in several new detections,

including a young, highly relativistic binary pulsar [A. A. Deshpande + PALFA consortium]

X-ray nebulae around Crab and Vela Pulsars. It has been shown that the variability and asymmetries in features, including jets, in the X-ray nebulae around Crab and Vela pulsars observed by the Chandra Observatory may be signatures of free precession of the central compact object. [A. A. Deshpande, V. Radhakrishnan]

Pulsar VLBI. Extensive Very Long Baseline Interferometry observations on separate selected sets of pulsars were conducted in order to (i) obtain pulsar distance measurements, (ii) detect signatures of Levy flight in statistics of interstellar scattering, (iii) explore correspondence between scattering disks and features in dynamic spectra of pulse intensity. [A. A. Deshpande + R. Ramachandran (University of California, Berkeley), C. Gwinn (University of California, Santa Barbara), T. Ghosh (Arecibo Observatory), S. Boldyrev (University of Wisconsin), D. Stinebring (Oberlin College, Ohio), M. Walker (Australia Telescope National Facility)]

Magnetars. A scenario for the evolution of neutron stars with highly magnetized quark cores has been worked out. The surface magnetic field of such a neutron star will show a secular rise till it attains a magnetar strength, about 10^{15} Gauss. In this picture, Anomalous X-ray Pulsars will be younger objects than Soft Gamma Repeaters, contrary to usual belief. [D. Bhattacharya + V. Soni (National Physical Laboratory, New Delhi)]

THE GALAXY AND THE INTERSTELLAR MEDIUM

Neutral Hydrogen Clouds in the Galactic Halo. Observations with the GMRT were made in order to study the 21-cm absorption line arising in neutral hydrogen (HI) clouds selected from a newly discovered galactic halo population. One of them has been clearly detected, with the observations implying a spin temperature of 240 Kelvin in the cloud. Further analysis is in progress. [K. S. Dwarakanath, G. Srinivasan + Y. Pidopryhora & J. Lockman (National Radio Astronomy Observatory, USA)]

Carbon Recombination Lines from Ultracompact ionized hydrogen regions. Carbon 91a recombination line emission at the radio frequency of 8.6 GHz has been detected using the Very Large Array (USA) towards four ultra-compact ionized hydrogen (HII) regions in the W49 North massive star forming region. These are indicative of photo-dissociation regions residing in the dense interface zone surrounding these HII regions. Upper limits on density of hydrogen molecules in these regions were derived, based on the carbon line observations, in a couple of these cases. [D. Anish Roshi, K. R. Anantharamaiah + C. G. De Pree (Agnes Scott College, USA), W. M. Goss (National Radio Astronomy Observatory, USA)]

Magnetic field estimates from recombination line widths. It was suggested that the non-thermal widths of carbon recombination lines observed towards molecular clouds arise due to Alfvén waves in these regions. Multifrequency observations of carbon recombination lines may thus be a potential tool for the determination of magnetic field strength in star forming regions. [D. Anish Roshi]

Extreme Scattering Events. It has been proposed that the observed Extreme Scattering Events arise as a combined manifestation of random fluctuations on a whole range of hierarchical scales in the distribution of ionized matter rather than in discrete concentrations. [A. A. Deshpande, V. Radhakrishnan]

A new model has been suggested for extreme diffractive scattering of radio waves inferred in lines of sight close to the centre of our galaxy. This model is based on folded magnetic field structures that have been reported in the numerical simulations of small scale dynamos. Nearly isothermal density variations across thin current sheets suffice to account for the scattering. [S. Sridhar + P. Goldreich (Institute of Advanced Study, Princeton, USA)]

Structures in the Interstellar Medium. Simulations of supernovae-driven interstellar medium have reproduced well the observed statistical features of neutral and ionized components. It has been shown that apparent non-Kolmogorov spectral characteristics observed in column densities may not be in conflict with a Kolmogorov velocity distribution of underlying turbulence. [A. A. Deshpande + J. Hodge (University of California, Davis)]

MHD turbulence. A phenomenological model of imbalanced MHD turbulence in an incompressible magnetofluid has been developed, in the limit where cascades of waves travelling in opposite directions along the mean magnetic field are strong. The results are particularly relevant for turbulence in the solar wind, and can provide insight into the origin of the turbulence. [S. Sridhar + Y. Lithwick (Canadian Institute of Theoretical Astrophysics), P. Goldreich (Institute of Advanced Study, Princeton)]

Hydroxyl Masers. Intrinsic short term variability in W3(OH) Hydroxyl Masers on time scales of 15-20 minutes or slower was detected using observations from the Very Long Baseline Array (USA). This implies a longitudinal spatial dimension of 2-3 Astronomical Units for the Maser sources, similar to their transverse dimensions. [A. A. Deshpande + R. Ramachandran (University of California, Berkeley), W. M. Goss (National Radio Astronomy Observatory, USA)]

SURVEYS

Mauritius Sky Survey. Wide field images covering ~1.25 steradian of the sky have been obtained from the Southern Sky Survey at 151.5 MHz carried out with the Mauritius Radio

Telescope. A source catalogue of ~2800 radio sources have been prepared and comparative studies including cross identification with the Molonglo Reference Catalogue at 408 MHz and Culgoora catalogue at 160 MHz have been completed. [N. Udaya Shankar, V. N. Pandey]

Arecibo Methanol Maser Survey. An ongoing, sensitive blind survey for 6.7 GHz methanol masers using the Arecibo telescope has resulted in 29 new detections so far within an area of 7.7 square degree. The distribution of masers in the galaxy, their counterparts at other wavelengths and statistics of line widths are being studied. [A. A. Deshpande + P. D. Pandian (Cornell University), P. F. Goldsmith (Cornell University/Jet Propulsion Laboratory)]

Arecibo Continuum Polarization Survey. As a precursor to the planned all Arecibo sky continuum polarization survey, a test region was observed in the meridian-nodding mode and mapped in full polarization successfully using the basket weaving technique. Suitable data taking and calibration techniques, along with relevant software for first-level reduction and mapping were developed. More detailed data analysis is in progress. [A. A. Deshpande + GALFACT sub-consortium]

Counterparts of HESS sources. Four of the new gamma sources discovered in the survey of the inner galaxy with the High Energy Stereoscopic System (Namibia) were observed at radio wavelengths with the GMRT. Good images of radio counterparts were obtained for two of these sources, at three frequencies, 240, 610 and 1420 MHz. The other two sources showed no radio counterpart. [N. Udaya Shankar + J. Osborne (University of Durham, UK), Mamta Pandey (National Centre for Radio Astrophysics, Pune)]

TOPOLOGICAL PHASE

Combined retarders. It was found that a retarder realised as a product of a general linear retarder and a linear half-wave retarder is always a half-wave one, if the principal axes of the two retarders make a 45 deg angle. The eigenstate of the assembly can be chosen to have any location on the Poincaré sphere by a simple adjustment of the retardation of the general linear retarder and the overall orientation of the pair. [R. Bhandari]

Freely precessing top. The condition for a freely precessing symmetric top to completely reproduce its orientation in space after every precession period was derived using the geometric phase. [R. Bhandari]

SIGNAL PROCESSING AND IMAGING, INSTRUMENTATION FOR ASTRONOMY

12m Preloaded Parabolic Dish. Construction of a 12m radio telescope operating in the frequency range 0.5 to 8 GHz based on a novel design was a major activity of the Radio Astronomy Laboratory in the 10th plan period. This is now in its final stage of completion. The fabrication of the dish and its assembly at the Gauribidanur field station has been completed. A Parallax method of measuring the surface accuracy of dishes using a theodolite has been developed and successfully employed for measuring the surface accuracy of the 12m dish. The illumination weighted surface rms error is about 3.3 mm. With this error, the maximum frequency of operation will be restricted to ~6 GHz. An alt-azimuth mount for the dish has been designed and fabricated to withstand wind speeds up to 150 km / hr. The mount along with other sub-structures is being installed in the Gauribidanur field station.

L band and the 4 – 8 GHz front-ends for the 12m dish have been characterized and system integration on-site is under progress. A wideband spectrometer based on a 2-bit 3-level correlator for processing a bandwidth of 320 MHz with a spectral resolution of 40 KHz has been integrated with other subsystems. The control system for the 12m preloaded parabolic dish consists of two redundant paths, one based on LINUX PC and the other on a programmable multi axis controller (PMAC). The integration of these two redundant paths is being carried out on-site.
(N. Udaya Shankar, C.M. Ateequlla, Durai Chelvan, B.S. Girish, A. Krishnan, Manohar Modgekar, A. Raghunathan, P.V. Rishin, S. Krishna Murthy, K.B. Raghavendra Rao, K.S. Srivani)

Satellite Astrometry. The installation and commissioning of the 4-antenna network within the GMRT campus for satellite interferometry has been completed. It consists of four 4.5 m antennas spread over 15 km; the signals received from the satellite by these antennas are directly transmitted to the central station using dark fibres in GMRT. The central receiver system includes a coherent two-stage downconversion to an intermediate frequency nominally centred at 70 MHz, and providing simultaneously for two subbands for 4 antennas. These signals are directly digitised using high speed analog-to-digital converters. The entire system was validated by recording the digitised data using high speed data acquisition cards in two separate PCs and bringing several terabytes of data to Bangalore for realising an offline correlator by software. The trials were done on INSAT 3A (7.5 cm wavelength) and Asiastar (20.2 cm wavelength) and the results were encouraging. An accuracy of a fraction a millimetre per second has been achieved for estimating differential Doppler motions of the satellite within a fraction of a second. [C. R. Subrahmanya, Peeyush Prasad, R. Somashekar]

Number Theoretic Transforms (NTT): Fast convolution and DFT provide solutions frequently to problems in signal processing. In practice these operations are most often

implemented using FFT. However, NTTs in some instances outperform FFT based systems. The essential advantage is that NTTs are based on modulo arithmetic which can be implemented in any desired bit width and is generally free from quantization noise due to rounding / truncation operations. In the first phase, we have implemented a simple convolver using NTT on FPGAs. We would now like to investigate the possibility of using NTT in implementing spectrometers for radio astronomy applications. (N. Udaya Shankar, B.S. Girish, Anjali Menon, K.S. Srivani)

10.4 m radio telescope. The advent of millimeter wave cryo-coolable low noise cryogenic amplifiers have opened the possibility of equipping the 10.4 m telescope with a world class broad-band receiver. This combined with our locational advantage (of being able to see much of the southern sky) will allow us to use the 10.4 m telescope to do competitive astronomy: e.g. to survey the inner galaxy for 43 GHz SiO masers and other high-density tracers. Therefore, we acquired two Q-band (40-50 GHz) cryo-coolable low noise amplifiers from the National Radio Astronomy Observatory, USA. The old cryo-cooler required for amplifiers was rejuvenated, and the process of building a Q-band front-end around it started. The mechanical motion of the 10.4 m telescope has also been made smooth by replacing several mechanical components. The process of mapping the surface of the primary to 100-micron accuracy to evaluate if the dish needs to be corrected to support efficient Q-band observations has been initiated. (B. Ramesh, P.G. Ananthasubramanian, M.R. Gopalakrishna)

Inter-institutional collaboration. From the beginning, RRI has been taking initiatives to provide value additions to international facilities and participating in national and international collaboration for instrumentation and signal processing related research in radio astronomy. As an example - A FPGA-based digital back-end for the Ooty radio telescope is being developed in the Radio Astronomy Laboratory (RAL). This can be reconfigured to provide all facilities offered by the existing systems as well as to provide increased sensitivity to new observing programmes. The subsystems required for this has already been developed and tested and are due for installation by the end of this year. As a part of this, a high-speed data acquisition system which can also carry out real-time signal processing providing sustained data transfer rates around 25 MHz has been developed and tested. (T. Prabu, C.R. Subrahmanya)

A collaboration with the Indian Institute of Science (I.I.Sc.) has been initiated for the development of a cooled receiver using the expertise of I.I.Sc. in the area of cryogenics. The phase one of this project has been completed. We have successfully adapted a lightweight and dynamically balanced commercially available sterling twin piston cryo-cooler for cooling a low noise HEMT amplifier for L band. In the second phase it is proposed to develop a pulse tube cooler. The unique feature of this is the absence of the cold moving parts, which considerably reduces the cooler generated noise and vibration. It is planned to use the linear motor compressor of the sterling cryo cooler for this

development. (A. Raghuanthan, N. Udaya Shankar, RRI; S. Kasthurirengan, N.B. Anand, N.S. Dinesh, I.I.Sc.)

Radio Frequency Interference mitigation. A comprehensive approach for mitigation of Radio Frequency Interference (RFI) has been developed that recognizes the time, frequency and polarization structure inherent in the interfering signal, and is shown to perform very effectively in post-detection excision of RFI. As a case study, this technique has been applied to the removal of interference caused by Iridium satellites. [A. A. Deshpande + B. M. Lewis (National Astronomy and Ionosphere Center, USA)]

Digital filters. A Finite Impulse Response filter bank has been designed with the aim to use it for multiple recombination line observations with the Ooty Radio Telescope. These filters will select 1 MHz band centred near the recombination line frequencies, from the time series generated by sampling the input signal at twice the full bandwidth (15 MHz). [K. Jeeva Priya, D. Anish Roshi, T. Prabu]

Coded mask imaging. Development of Coded Mask imaging techniques for ASTROSAT has continued. The coded mask for the Cadmium Zinc Telluride Imager has been redesigned, following changes in the mechanical design of the camera. For the Scanning Sky Monitor (SSM), a maximum likelihood method for source location and flux estimation has been developed and the effect of energy dependent interaction depth in proportional counters on its imaging property has been estimated. Software for ground calibration of an SSM camera using radioactive sources has been developed. [D. Bhattacharya, B. T. Ravishankar, Sushila Mishra, M. V. Amaresh Kumar + G. Arun (Tata Institute of Fundamental Research, Mumbai)]

New Initiatives

New activities have been initiated towards the end of the 10th plan, which would help the Institute formulate its activities for the 11th plan period.

1. **Development of X-ray polarimeters for astronomical studies:** Activity has been initiated towards building a Thompson scattering based X-ray polarimeter instrument using lithium/beryllium as scattering element and proportional counters as X-ray detectors. In future, development of photoelectron track imaging polarimeter will be taken up.

2. **Development of a focal plane array for GMRT:** This project envisages development of feed array systems to be installed on GMRT for general utility, useful for both continuum and spectral line observations with dual polarization capabilities.

3. **50 MHz system for GMRT:** It is proposed to design and develop a 50 MHz system

for GMRT to carry out a low frequency survey of the sky visible to GMRT with arc minute resolution and unprecedented surface brightness sensitivity.
[N. Udaya Shankar, K. S. Dwarakanath, S. Amiri]

4. **Collaboration with MWA**: The Mileura Wide field Array (MWA) is a joint project led by the Massachusetts Institute of Technology (MIT) with several other partner institutions in US and Australia. The goal of the MWA project is to develop powerful new capabilities for radio astronomy in the frequency range 80 - 300 MHz optimized for extremely wide fields of view and unprecedented sensitivity for a variety of survey applications. The astronomical topics of interest to RRI, which will be covered by this project, are radio transients, polarized emission from the galaxy, Faraday tomography, pulsar studies and radio recombination lines.

LIGHT & MATTER PHYSICS

AREAS OF RESEARCH

Bose Einstein Condensation, Laser Cooling & Trapping of Atoms
Ultracold Molecules
Light Scattering
Quantum Optics
Ultrafast & Nonlinear Optics

BEC, LASER COOLING AND TRAPPING OF ATOMS

We had built an upper-lower MOT (magneto-optic trap) arrangement with differential pumping to facilitate a large number BEC. Atoms were collected in the upper MOT and were pushed using a near resonant laser beam to the lower MOT. It was not manageable to collect enough number in the lower MOT. A second generation vacuum set up is being prepared to rectify this [Hema Ramachandran, N. Andal].

In the laser cooling and trapping laboratory, temperature of the MOT was determined by Time Of Flight (TOF) technique. The temperature was about 30 micro kelvin. In order to investigate quantum optical induced transparency phenomenon in the cold cloud, we improved the vacuum of our existing MOT set up. The published results of room temperature atoms can now be compared with ultra-cold atomic samples [Hema Ramachandran, N. Andal].

ULTRACOLD MOLECULES

This is a new experimental activity, the principal theme of which is the study of classical and quantum interactions in ultra-cold dilute gases of atoms and molecules. This activity thus expands on the existing and very fertile area of cold dilute atomic gases and aims to extend experimental studies of such systems. The basic long term directions are (a) the study of many body physics of constituents with anisotropic two body interactions (b) cold and ultra-cold bond formation, dissociation and ultra-cold quantum chemistry (c) quantum statistics of molecules. The approach here is to forge a bond between laser cooled (like or unlike) alkali atoms. A bond between unlike atoms results in an electric dipole moment and therefore an-isotopic interactions. The alkali atoms we shall work with are Rubidium, Potassium and Caesium. The experiment is under construction at present. [A. Sharma, K. Ravi and S. A. Rangwala]

The construction of the ultra-cold molecules experiment requires a great deal of instrumentation. The instrumentation that is ongoing at the moment can be sub-classified

into (a) Optical instrumentation: Fabrication of lasers and laser diagnostic devices, (b) Electrical and electronic instrumentation: The electrical driving devices for the optical and electrical circuits that are required for the experiment, (c) Control system development: Electronic master control that steers the experiment in real time, (d) Experimental interface and analysis platform: The user interface of (c) above as well as an integrated analysis platform, (e) Vacuum system development: design and development of a unique vacuum system and a test system which is nearing installation [K. Ravi, A. Sharma, S. A. Rangwala + A. Vijayakumar, Vipash Jayaswal (Manipal Institute of Technology), P. M. Harsha & P. T. Bushra (Mahatma Gandhi University), G. Hoover].

A compact partially ferromagnetic electromagnet to produce an Ioffe-Pritchard trap for neutral atoms has been developed. The structure permits strong magnetic confinement with low power consumption. It also allows for easy compensation of remnant fields and very high stability, along with cost-effective realization and compactness. This trap is characterized and the trapping and cooling of ^{87}Rb atoms to quantum degeneracy is demonstrated with it. Pure Bose-Einstein condensates containing 10^6 atoms are routinely realized on a half-minute cycle. In addition, the stability of the magnetic trap by producing atom lasers is tested. [S. A. Rangwala + M. Fauquembergue, J-F. Riou, W. Guerin, F. Moron, A. Villing, Y. Le Coq, P. Bouyer, A. Aspect (l'Institut d'Optique, France) and M. Lécrivain (SATIE, France)]

The trapping of dipolar molecules with kinetic temperatures of the order of 300mK was convincingly demonstrated. This is a new step in the effort to get to cold dilute interacting gases of electric dipolar molecules. The results also lay to rest the popular opinion that filtering translationally cold molecules from a dilute gas leads to a significant depletion of the lowest velocity molecules. [S. A. Rangwala + T. Rieger, T. Junglen, P. W. H. Pinkse, and G. Rempe (Max-Planck-Institut für Quantenoptik, Germany)]

LIGHT SCATTERING

Experiments on dye scatterer RAM (Random Amplifying Medium) to investigate the statistics of its emission intensity fluctuations over random realizations were conducted. These experiments were complemented by Monte-Carlo simulations of the random path of a photon diffusing in a multiply scattering RAM [Hema Ramachandran, N. Kumar, Divya Sharma].

QUANTUM OPTICS/MECHANICS, QUANTUM INFORMATION, FOUNDATIONS OF QUANTUM MECHANICS

Bosonic stimulation provides a natural realization of the Polya walk problem. This can be experimentally realized using photons in a two-mode laser cavity of very high quality

factor. [R.Srikanth, N.Kumar].

A Combinatoric approach to characterize entanglement as a partial ordering of entanglement configurations (EC) under transformations restricted to local operations and classical communication (LOCC) was studied. Each EC is represented by maximal entanglement shared along connected, spanning trees or hypertrees. In a recent addition to the work, the partial ordering is described as a non-distributive, uncomplemented lattice. Further, entanglement configurations from spanning trees to general graphs was extended. The classical communication cost for going from higher to lower entangled trees that are comparable under LOCC was studied. Future work to generalize these results in a number of directions have been identified. [R.Srikanth, S. P. Pal, Somesh Kumar and Sudhir K. Singh].

Studies on how pre-sharing classical information between legitimate parties can improve efficiency and rate of quantum key distribution is in progress. [R.Srikanth, Hema Ramachandran, Ashok Vudayagiri].

As an approach to resolve the quantum measurement problem, a model was proposed in which the Hilbert space is assumed to be discrete. The entanglement engendered during measurement between the measured system, the measuring apparatus and the decohering environment is quantified using a recently proposed entanglement measure. It is proposed that the so-called wavefunction collapse occurs at the point where, for a given degree of discreteness of Hilbert space, a highly entangled state becomes unresolvable. It is shown that cycles of Schrödinger evolution and such collapses are sufficient to reproduce macroscopic classical behaviour. [R.Srikanth].

The idea that the macroscopic world is classical is used to argue that the universe is both computable and tractable, in the computation theoretic sense. [R.Srikanth].

Using Dopplergram data from the Solar and Heliospheric Observatory (SoHO), the structure of Solar supergranular cells was studied. It was found that the fractal dimension of supergranulation is in agreement with a model of turbulent convection of the Solar atmosphere. [R.Srikanth, Jagdev Singh, Vinod Krishnan, Phaniveni Udayashankar].

ULTRAFAST AND NONLINEAR OPTICS

The nonlinear optical transmission in ferrofluids, semiconducting oxide films, and metal nanoparticles were investigated. It was demonstrated for the first time that ferrofluids

are potential candidates for optical limiting, since they show substantial stability with prolonged laser irradiation [M.R.Anantharaman (CUSAT, Cochin), Suchand Sandeep, Reji Philip]. From measurements, oxide films and metal nanoparticles are found to be potential candidates for photonic device fabrication [V.Kumar (CMET-Trichur), T.Pradeep (IIT-M), B.Karthikeyan]. Such nanocomposite polymer films were synthesized using *in-situ* chemical methods [B.Karthikeyan]. Laser induced clustering in gold nanoparticles was studied in detail, using a pulsed Nd:YAG laser [T.Pradeep (IIT-M), Suchand Sandeep, Reji Philip]. Nonlinear absorption in neutral density filters was also investigated. [P.R. Arunkumar (project student), M. Anija].

Stimulated Raman Scattering studies in polymer samples were carried out, and the Degenerate Four wave mixing (DFWM) experiment was set up and a few initial measurements were taken [Ceegan Alex Francis (project student), B. Karthikeyan]. The nonlinear optical behaviour of laser dyes in a sol-gel matrix also was investigated. [Arthur Varghese, Revathy (project students)].

Laser-induced plasma emission from planar microjets (250 micron thickness) of water and ethanol were recorded at atmospheric pressure in the visible region, and the results analysed [M. Anija]. The infrastructure for ultrafast laser plasma experiments in vacuum is completed. The working of the pumps and vacuum chamber are found to be satisfactory, and preliminary experiments have started [M. Anija, Suchand Sandeep, Reji Philip].

SOFT CONDENSED MATTER

AREAS OF RESEARCH

Liquid Crystals
Synthesis
Structure and phase behaviour
Displays
Surfactant Systems
Polymer Physics
Surface Science
Biological Physics

LIQUID CRYSTALS

SYNTHESIS

Liquid crystalline properties of unsymmetrical bent-core compounds containing chiral moieties: These compounds have been synthesized and are found to exhibit a direct transition from chiral calamitic phases to a polar banana phase with a two-dimensional lattice. Possible explanations for this unusual phase sequence and the structural models of these phases have been proposed based on x-ray diffraction and electric field experiments. [R.Amarnatha Reddy and B.K. Sadashiva + U. Baumeister, Martin-Luther University, Halle, Germany]

Ferroelectric and antiferroelectric switching behaviour in new unsymmetrical bent-core compounds derived from 3-hydroxybenzoic acid: These compounds have yielded interesting mesophases, such as a columnar phase with an oblique lattice. This is the first report of such a phase occurring between a rectangular columnar phase and a smectic phase with ferroelectric/antiferroelectric properties. [H.N. Shreenivasa Murthy and B.K. Sadashiva]

New symmetrical five-ring bent-core mesogens: Three new homologous series of symmetrical five-ring compounds have been synthesized and their mesomorphic properties studied. The laterally unsubstituted parent compounds exhibit a metastable polar antiferroelectric smectic *C* phase. The other two series of compounds containing a strongly polar cyano or nitro group at the angular position of the central phenyl unit show the classical B_7 phase. [S. Umadevi and B.K. Sadashiva]

Influence of a substituent on the central phenyl unit on the mesomorphic properties of five-ring bent-core compounds: The introduction of a bulky substituent, such as a methoxy group, at this position was found to result in a polar antiferroelectric smectic *C* phase in most of the compounds. In addition, replacement of the terminal *n*-alkoxy chains

by *n*-alkyl carboxylate groups induces a calamitic mesophase. [S. Umadevi, S. Radhika, and B.K. Sadashiva]

Bistable linear electro-optic switching in the B_7 phase of novel bent-core molecules: Three novel symmetrical bent-core compounds containing terminal *n*-alkyl carboxylate groups were investigated which exhibit a transition between B_7 and B_2 mesophases. The B_7 phase was found to show bistable linear electro-optic switching behaviour without any observable polarization peak. Two theoretical models were analysed and it was found that a local triclinic symmetry may be responsible for the unusual switching behaviour. [S. Umadevi and B.K. Sadashiva + A. Jakli, Kent State University, USA]

Mesogenic dimers of bent-core molecules with flexible spacers: These dimers have been synthesized and were characterized using x-ray and electro-optic studies. They are found to exhibit a ferroelectric columnar mesophase with an oblique lattice. The parity of the alkylene spacer is found to have no effect on the phase behaviour. [S. Umadevi, H.N. Shreenivasa Murthy, B.K. Sadashiva, and V.A. Raghunathan]

Synthesis of ionic discotic liquid crystals: A number of novel pyridinium salts tethered with hexaalkoxytriphenylene molecules were synthesized and their mesomorphic properties were studied. These salts with bromine counterions were found to be mesomorphic over a wide temperature range. [Sandeep Kumar and Santanu Kumar Pal]

Synthesis of terminally thiol-functionalized alkoxycyanobiphenyls: These novel compounds were synthesized and their mesomorphic behaviour was investigated. [Sandeep Kumar and Santanu Kumar Pal]

Microwave-assisted synthesis of liquid crystalline materials: An efficient, simple, economical and environment-friendly microwave-assisted "green chemistry" approach to the synthesis of liquid crystalline materials has been developed. This procedure is found to result in high yields of all the compounds with enhanced purity compared to conventional methods. [Sandeep Kumar]

STRUCTURE AND PHASE BEHAVIOUR

Studies on mixtures of rod-like and bent-core molecules: These mixtures have been shown to exhibit very interesting phase behaviour, with the occurrence of a biaxial smectic A phase in certain composition range. In this phase the long axis of the bent-core molecules lie in the smectic planes of the rod-like molecules. In the higher temperature uniaxial smectic A phase the relative orientations of the two types of molecules can change with temperature. An experiment has been set up to explore this possibility. [R. Pratibha, Brindavan Kundu, and N.V. Madhusudana]

Kinetics of smectic-isotropic phase separation in a binary mixture: The formation of spherical and cylindrical droplets during the smectic-isotropic phase separation of a mixture of dodecyloxybenzoic acid and octadecyl alcohol was studied using optical microscopy. Some of the spherical droplets are found to rotate, whereas others are stationary. The droplet size and the rate of rotation were monitored as a function of time. Theoretical analysis of the problem is being carried out to understand the experimental observations. [Anita Semwal and N.V. Madhusudana]

Phase behaviour of discotic hexa-*n*-alkoxyanthraquinones under pressure: These materials were synthesized and their phase behaviour under pressure was investigated. [Sandeep Kumar + Yoji Maeda and H. Yokoyama, Nanotechnology Research Institute, Tsukuba, Japan]

Landau theory of phase transitions in compounds with bent-core molecules: In many homologous series of bent-core molecules the phase sequence B_6 - B_1 - B_2 is observed as the chain length is increased. A phenomenological theory of phase transitions in these materials has been developed, which shows that frustration in molecular packing can account for the observed phase behaviour. [Arun Roy and N.V. Madhusudana]

Structures of ferroelectric and antiferroelectric liquid crystals in the surface stabilized geometry: Many compounds consisting of chiral rod-like molecules exhibit ferroelectric and antiferroelectric phases. In very thin cells these compounds usually form chevron structures in the ferroelectric phase. A bilayer model has been developed to describe the equilibrium structures of these compounds in the surface stabilized geometry. [Arun Roy]

DISPLAYS

Wavelets for displaying gray shades in LCDs: A line-by-line addressing technique based on wavelets for displaying gray shades in liquid crystal displays has been developed. A prototype consisting of a display, driver boards, and controller has been fabricated. [T.N. Ruckmongathan and A.R. Shashidhara + V. Arun and Babu Hemanth Kumar, M.S. Ramaiah Institute of Technology, Bangalore]

Development of a new image-coding algorithm: A new algorithm for coding images that exploits the correlation in the samples of neighbouring pixels has been developed. A reasonable compression ratio while ensuring good image quality has been achieved by using a non-linear quantizer. [T.N. Ruckmongathan + C. Aruna, Pondicherry Engineering College, Pondicherry]

SURFACTANT SYSTEMS

Mesh phases of surfactant-water systems: Mesh-like aggregates are known to occur in some surfactant systems, at compositions in between those corresponding to the hexagonal and lamellar phases. Thermodynamic phases of a mixed surfactant system formed by such aggregates have been studied in detail. These studies have led to some understanding of the conditions under which this unconventional micellar morphology occurs. [Sajal Ghosh, Rema Krishnaswamy and V.A. Raghunathan + Ajay Sood, Indian Institute of Science, Bangalore]

Influence of a strongly bound counterion on the phase behaviour of a charged surfactant: Some charged surfactants exhibit the coexistence of two lamellar phases over a wide range of water content. The influence of strongly bound counterions on the phase behaviour of one such system has been studied in detail. The phase behaviour is found to be sensitive to even very small amounts of these ions, with the formation of a cubic phase at higher ion concentrations. [Sajal Kumar Ghosh and V.A. Raghunathan]

Magnetic susceptibility of a lyotropic nematic liquid crystal: The magnetic susceptibility of a lyotropic nematic has been measured as a function of temperature. It is found to depend on the size and shape of the micellar aggregates; there is also some evidence for the presence of water molecules bound to the micelles. [D. Vijayaraghavan, K.A. Suresh, and Sandeep Kumar]

POLYMER PHYSICS

Formation of tent-like structures in solution-grown polymer crystals: A theory for the spontaneous formation of tent-like structures in polyethylene crystals is being developed. It is based on the connection between geometry and topology of membranes with tangent-plane order. [A. Jayakumar and Yashodhan Hatwalne]

SURFACE SCIENCE

Stability of Langmuir-Blodget films of octadecanethiol: The stability of monolayers of octadecanethiol molecules at the air-water interface was studied using surface manometry and optical microscopy techniques. These monolayers were then transferred on to hydrophobically treated silicon substrates to form Langmuir-Blodget films, which were studied by atomic force microscopy (AFM). The effect of divalent cadmium ions in the subphase on these monolayers was also studied. AFM images show dendrite-like structures in the films, which correspond to a layer of octadecanethiol-cadmium chloride complex. [Raj Kumar Gupta and K.A. Suresh + Rui Guo and Satyendra Kumar, Kent State University, USA]

Phase behaviour of mixed monolayers: The phase behaviour of mixed monolayers of

mesogenic molecules diheptylazoxybenzene and octylcyanobiphenyl at the air-water interface was studied using Brewster angle and atomic force microscopy. These monolayers are found to be stable and a new phase is found to be induced in the mixed system that is absent in either of the pure monolayers. A structural model for the induced phase has been proposed. [P. Vishwanath, Alpana Nayak, and K.A. Suresh]

Preparation of self-assembled monolayers (SAMs) on gold surfaces: SAMs of decanethiol and hexadecanethiol were prepared on gold surfaces using a lyotropic liquid crystalline phase as the adsorbing medium, and were characterized using electrochemical techniques. These SAMs are found to be highly compact and to have better blocking ability towards redox probes than conventional SAMs prepared from organic solvents, such as ethanol. Similar results were obtained for SAMs of alkoxycyanobiphenyl molecules functionalized with thiol moiety having different alkyl chain lengths. [V. Ganesh, V. Lakshminarayanan, and Sandeep Kumar]

Dispersion of gold nanoparticles in a lyotropic liquid crystalline medium: Stable dispersions of gold nanoparticles in a lyotropic liquid crystalline medium have been prepared. The stability of these dispersions has been probed using x-ray, optical microscopy and surface plasmon studies. [P. Suresh Kumar, V. Lakshminarayanan, and Sandeep Kumar]

Development of a scanning tunneling spectroscopy technique: The necessary instrumentation has been developed and incorporated into the existing scanning tunneling microscopy set-up. The new facility allows the study of current-voltage characteristics of quantum dots and single molecular species. [V. Lakshminarayanan and M. Jayadeviah]

Aggregation behaviour of a C60 based dyad in binary solvent mixtures: The aggregates were studied using dynamic light scattering. The dyads were found to form aggregates beyond a critical value of the dielectric constant of the solvent, and the aggregate size was found to increase with increasing dyad concentration. In some solvent mixtures the aggregates were non-spherical in shape. [Amit Kumar Agarwal, K.A. Suresh + S.S. Gayatri and A. Patnaik, Indian Institute of Technology, Chennai].

Effect of a magnetic field on electron transfer kinetics: The influence of a magnetic field (3 Tesla) on an inner electron transfer system and on an outer electron transfer system was probed using electrochemical studies. The field is found to facilitate the charge transfer in the latter case, whereas it inhibits the transfer in the former system. [D. Vijayaraghavan, S. Mohanapriya, and V. Lakshminarayanan]

BIOLOGICAL PHYSICS

Influence of sterols on artificial membranes: Sterols such as cholesterol are important

constituents of cell membranes and are known to play a key role in many cellular processes. Although there have been many studies on the influence of cholesterol on artificial membranes the influence of other sterols has not been well documented. Preliminary results indicate that even small changes in the sterol structure can have very significant influence on membrane properties. [Bibhu Ranjan Sarangi, V.A. Raghunathan]

Structure of DNA-surfactant complexes: DNA forms complexes with cationic surfactants due to the release of counterions. The influence of a strongly bound counterion on the structure of these complexes was studied. Interestingly, they are found to have different structures depending on the concentration of the surfactant in the aqueous solution. Such a concentration dependence has not been seen in earlier experiments. [Sajal Ghosh, Rema Krishnaswamy and V.A. Raghunathan + Ajay Sood, Indian Institute of Science, Bangalore]

THEORETICAL PHYSICS

AREAS OF RESEARCH

Condensed Matter & Statistical Physics
Gravitation
Physics in Biology

CONDENSED MATTER AND STATISTICAL PHYSICS

Transport in mesoscopic systems: Recently it has been shown (A. Dhar, D. Sen, B. S. Shastry) that the quantum Langevin equation approach can be used to give a simpler and physically more intuitive derivation of the nonequilibrium Green's function formalism, which currently is one the most widely used approaches for understanding transport in mesoscopic systems. This formalism has been used to derive transport properties of wires in the presence of inelastic scatterers. Exact expressions for electrical and thermal conductivity and thermoelectric coefficients have been obtained. It is shown explicitly that for wires of length much smaller than the coherence length, dissipation is at the contacts while for long wires Joule heat loss takes place uniformly in the bulk of the wire. [Dibyendu Roy and Abhishek Dhar]

Heat transport and local equilibration in one dimensions. Extensive numerical simulations have been performed to determine the exponent for the system size dependence of the heat current in a one-dimensional system of interacting particles. This settles a controversy between two different theoretical predictions for the exponent. It is also shown that nonlinearity is not enough to ensure local thermal equilibration. [Abhishek Dhar, Trieu Mai and Onuttom Narayan (University of California, Santa Cruz)]

Classical limit of master equation of quantum harmonic oscillator coupled to a heat bath. It has been shown that correlated and uncorrelated initial conditions are described by different classical Langevin equations. These lead to different Fokker-Planck equations, which correspond to the correct classical limits of the quantum-mechanical equations for the Wigner function. This resolves an earlier confusion regarding the classical limit and shows the importance of initial conditions in the modelling of physical phenomena. [Subhashish Banerjee and Abhishek Dhar]

Models of classical heat pumps. A number of simple microscopic models of heat pumps have been studied. Unlike macroscopic heat engines, in this case fluctuations are important and the main object of the study has been to understand this quantitatively. It is shown by a careful analysis that some of the models that have been proposed earlier in the literature do not actually function as pumps. [Rahul Marathe and Abhishek Dhar]

Equilibration problem for the generalized Langevin equation. The problem of equilibration of a particle moving in a potential well and attached to a heat bath is studied. The heat bath is modelled through the generalized Langevin equation. For a harmonic potential well, the necessary conditions for equilibration are determined. It is shown that adding nonlinearity can lead to loss of equilibration. This surprising finding is related to the formation of nonlinear localized modes. [Abhishek Dhar and Kshitij Wagh]

GRAVITATION

Testing post-Newtonian theory with gravitational wave observations. The Laser Interferometric Space Antenna (LISA) will observe supermassive black hole binary mergers with amplitude signal-to-noise ratio of several thousands. The extent to which such observations afford high-precision tests of Einstein's gravity is investigated. It is shown that LISA provides a unique opportunity to probe the non-linear structure of post-Newtonian theory both in the context of General Relativity and its alternatives. [K.G. Arun, Bala R. Iyer, Moh'd S.S. Qusailah and B.S. Sathyaprakash (Cardiff University, U.K.)].

Tail effects in the 3PN gravitational wave energy flux of inspiralling compact binaries. The far-zone flux of energy contains hereditary contributions that depend on the entire past history of the source. Using the Multipolar post-Minkowskian wave generation formalism, a semi-analytical method is proposed and implemented to compute these contributions from the inspiral phase of a binary system of compact objects moving in quasi-elliptical orbits up to 3PN order. The method explicitly uses the 1PN quasi-Keplerian representation of elliptical orbits and crucially exploits the implicit double periodicity of the motion to average the fluxes over the binary's orbit up to 3PN order. [K.G. Arun, Bala R. Iyer, Moh'd S.S. Qusailah and L. Blanchet (IAP, France)].

Inspiralling compact binaries in quasi-elliptical orbits - the 3PN energy flux. The instantaneous contributions to the 3PN gravitational wave luminosity from the inspiral phase of a binary system of compact objects moving in an elliptical orbit is computed using the Multipolar post-Minkowskian wave generation formalism. The new inputs for this calculation include the mass octupole and current quadrupole at 2PN for general orbits and the 3PN accurate mass quadrupole. Supplementing this by the important hereditary contributions arising from tails, tails-of-tails and tails squared terms the complete energy flux is obtained. The energy flux is a crucial input for the construction of ready-to-use templates for binaries moving in quasi-elliptic orbits, a possible source for LISA. [K.G. Arun, Bala R. Iyer, Moh'd S.S. Qusailah and L. Blanchet (IAP, France)].

Surface Tension and the Cosmological Constant. An analogy has been noted between the cosmological constant of the Universe and the surface tension of membranes. It has been pointed out that fluid membranes provide some insight into the cosmological constant problem. An outstanding problem in modern cosmology is the problem of the cosmological

constant: (a) why is the cosmological constant so nearly zero?, (b) why is it not it exactly zero? Sorkin proposes that (b) can be understood as a fluctuation originating in quantum gravity. This idea of Sorkin is realized in an analogous soft matter context. It is shown that the vanishing surface tension of fluid membranes has some insights to offer about part (a) and also suggests a mechanism for solving part b) in the context of Sorkin's approach to quantum gravity. This work leads to the possibility of probing quantum gravity effects in analogue experiments. [J. Samuel and Supurna Sinha].

Ricci Flows and the Positive Mass Theorem. A connection between the Ricci Flow and the Positive Mass theorem in General Relativity has been pointed out. This is an effort to use the Ricci Flow to better understand physical quantities like energy and entropy in GR. The initial data for Einstein equations is studied and a flow on the space of initial data using the Ricci Flow is defined. This results in a new approach to proving the positive mass theorem and on approaching the Penrose inequalities. In the time symmetric case, the problem is purely one of Riemannian geometry and this special case is addressed. [Javed Ahmad, Sutirtha Roy Chowdhury and J. Samuel].

Recovering Continuum Topology From Causal Sets. The goal of this project was to understand how continuum information about geometry and topology can be encoded in the discrete structure represented by a causal set. Using preliminary numerical results, a set of analytical arguments to demonstrate this was first constructed. Subsequently, these arguments were strengthened into rigorous mathematical proofs. They demonstrate that despite being ``sparse'' compared to the continuum, causal sets do encode continuum topology relevant at scales larger than the discreteness scale. [S. Surya, Seth Major (Hamilton College, NY, USA) and David Rideout (Imperial College, UK)].

Reduced Models of Causal Set Quantum Gravity. The aim of this project was to quantise special restricted classes of causal sets, as a preliminary to full quantization. This process can be viewed as an analog of the so-called symmetry reduced models of other approaches. However, because the discrete-continuum correspondence for causets is non-trivial, the exercise of restricting to physically meaningful classes is not straightforward and has been a stumbling block to progress in causal set theory. Progress has been made in identifying a subclass, which corresponds to 2-dimensional gravity. This can be viewed as a first stepping stone to a full quantization of the model. [S. Surya and Joe Henson (University of Utrecht, Netherlands)].

Functional evolution of quantum cylindrical waves. It has been shown that the functional Schrödinger picture does not exist as a quantum description of cylindrically symmetric gravitational fields. From formal arguments, if a Dirac quantization exists then its most straightforward implementation leads to the functional Schrödinger picture based quantum theory. Hence, it has also been shown that the most straightforward Dirac quantization of this cylindrical wave system does not exist. This has obvious implications

for a similar treatment of the quantum dynamics of general (i.e., not cylindrically symmetric) gravitational fields. [Demian Cho and Madhavan Varadarajan].

Quantum resolution of the black hole information loss problem in 1+1 black holes. The Hawking Information Loss Puzzle was analyzed in the context of a non-perturbative quantization of a toy model of black holes in 2 spacetime dimensions. The puzzle was resolved within a unitary quantum framework and it was shown that the resolution came about because of the existence of a quantum extension of spacetime beyond the classical singularity. Though the broad features of the resolution have been worked out, a detailed picture of the black hole evaporation through Hawking radiation is not yet available and constitutes a project for the future. This work is an invaluable source of intuition for the realistic case of black holes in 4 spacetime dimensions as it is the only case known in which a complete non-perturbative study of the quantum dynamics of black holes is possible. [Madhavan Varadarajan and Abhay Ashtekar (Penn State, USA)].

Dirac Quantization of Parametrized Field Theory. Parametrized Field Theory is a description of free field theory on a flat spacetime in a generally covariant disguise. In this work, despite well accepted heuristic arguments to the contrary, a Dirac quantization of Parametrized Field Theory in any spacetime dimension was constructed which was equivalent to the standard Fock representation of free field theory. This work crucially used Loop Quantum Gravity techniques and thus serves as an important test for the Loop Quantum Gravity approach. [Madhavan Varadarajan]

PHYSICS IN BIOLOGY

Transition rate model for vesicle transport. The transition rate model for vesicle transport on a single microtubule in the dilute limit has been studied. Transport by different kinds of motors have been considered. Some of the predictions can be tested in in-vitro controlled cell experiments. [Sudipto Muhuri and Madan Rao]

Three-species model for vesicle transport. A driven one-dimensional model for vesicle transport which also includes excluded volume effects and boundary effects is studied. In the parameter regime of fast interconversion between different species a mean field phase diagram is obtained. Results of Monte-Carlo simulations are found to be in good agreement with the mean field results. [Sudipto Muhuri, Abhishek Dhar and Madan Rao]

COMPUTERS

As part of a major upgrade of computational facilities, a 8 node, 32 CPU high performance compute cluster was procured and deployment of the same was taken up.

Components for a switched Gigabit LAN, as a replacement for the aging ATM network, was procured to provide faster access between computer systems and services. Installation of the key components were carried out and a complete switch over is expected to be made shortly.

To accommodate increasing load and provide quicker access to and from the campus to the World Wide Web, it was decided to upgrade the link from 512 Kbps to 2 Mbps. Due process for identifying a suitable service provider was initiated.

A decision to participate in the National Grid Computing initiative 'Garuda' was made and an MOU was arrived at.

Hardware upgrades and suitable steps to safeguard against data loss were implemented. Software upgrades where required to all key systems and services was carried out to improve functionality and security. Routine maintenance of computer systems and networking for overall improvement in the computational facilities were undertaken.

LIBRARY

The library continued to provide information services to the staff/faculty/students and others. Close liaison with FORSA Group and Bangalore Special Libraries is continued for resource sharing, information exchange and provided access to wide range of information resources both in print and electronic forms.

LIBRARY RESOURCES DEVELOPMENT

➢ Books	Scientific	:	229
	Technical	:	121
	Reference	:	65
	Gratis	:	46
	E-books	:	5
	Hindi	:	35
➢ Bound volumes of Journals		:	1705
➢ Scientific/technical journals subscribed		:	151
➢ Print and online journals		:	64
➢ Online through consortia		:	19
➢ IoP Non-Cancellation Option		:	19
➢ Online only		:	10
➢ General Periodicals - English		:	12
	Hindi	:	5
	Kannada (Gratis)	:	1
➢ News papers	English	:	6
	Kannada	:	1

The collection at the end of the reporting period is: books - 23880; bound volumes of journals - 34640 and total library collection is: 58,520.

Databases

- Physical Review Online Archive (Prola): 1893 -2002;
- The Liquid Crystal Database Ver.4.6
- ACS Archive with back files accessible up to 2000;
- Scientific American Online Archive with back files from 1993 to current issue;
- Lecture Notes in Physics with back files accessible from 1999+.

Strengthening Library Facilities

- Procured two PCs;
- Installed Library Security System of DIALOC Ellipse 2020 Rev.2.00;
- Digital Photocopier, Model Toshiba Studio 230 with the provision of security access code for general use;
- Expanded Compact Storage Racks in the basement floor.

Consortia Activities

Under FORSA Consortium activities, we have renewed /subscribed the following journals from different publishers:

- Springer Physics/Astronomy Journals Consortium
  Participants: ARIES, IIA, PRL, RRI and SNBNCBS;
- Nature Online
  Participants: ARIES, IIA, IUCAA, JNCASR, PRL, RRI, SNBNCBS and TIFR;
- Scientific American Online Archive
  Participants: IIA, IUCAA, JNCASR, NCBS, NCRA, PRL, and RRI;
- Under Open Consortium: Lecture Notes in Physics;
- Under INDEST Consortium, subscribed: IEEE/IEE Electronic Library Online (IEL Online): IEEE Xplore. Access is provided from back files: 1988 + to current issues of all journals, conference proceedings, etc.

Digital Library Initiatives

The Raman Research Institute Digital Repository (DR) (URL: http://dspace.rri.res.in) has been set up to collect, preserve and disseminate in digital format the research out put of RRI Community and thus support the Open Access Movement in scholarly publishing. An open source software DSpace developed by MIT and Hewlett Packard (Version 1.3. 2 on Linux) is being used. The content of the Digital Repository is:

- Preprints/reprints;
- Published papers in journals/conference proceedings (subject to copyright clearance);
- Annual Reports of RRI;
- Newspaper clippings of Raman Archives.

It is also planned to add RRI Ph.D. theses, Raman Archival materials and create Photo Gallery in due course. As of now, more than one thousand documents in the DR have been added.

Digitization of scientific slides/video cassettes/audio cassettes was initiated and list of the same is available at our home page.

Library Visitors/ Trainees

- Scientists from DST visited the library on 8.6.2005. They were taken around the library and a presentation was made on the library activities. They had interaction with the library staff;
- Ten M.L.I.Sc. Students and two faculty members of the Kakatiya University, Warangal, A.P. visited the library on 14.3.2006. They were taken around the library and explained library activities;

Four M.L.I.Sc. Students from Bangalore University visited the library from 6 -18 March 2006 and imparted intensive training as part of their Master's programme.

OTHER ACTIVITIES

Ph.D.

Awarded

R. Amaranatha Reddy	Synthesis and characterization of mesophases formed by compounds composed of banana-shaped molecules
Rekhesh Mohan	Kinematics of diffuse interstellar clouds in the galaxy
Uday Kumar Khan	Some investigations of laser cooled atoms
Suparna Roychowdhury	Energy deposition into the intergalactic medium

Submitted

Sanat Karmakar	Structure and phase behavior of lipid-cholesterol Membranes
Raj Kumar Gupta	Studies on Langmuir monolayers and Langmuir-Blodgett films of mesogenic and organometallic Molecules
Ganesh V.	Electrochemical studies and molecular self-assembly on surfaces in surfactant based systems
Navinder Singh	Electronic relaxation and diffusion in dynamically disordered lattices and nanoparticles: decoherence and dissipation
Rajesh Gopal	Primordial magnetic fields and large-scale structure formation in the Universe

Gandhi Memorial Lecture

The Gandhi Memorial Lecture for 2005, entitled "*Our experiments with Truth - The Right to Know, the Right to Live*", was delivered by Mrs. Aruna Roy of the Mazdoor Kisan Sanghatan, Devdungri, Rajasthan, on 02 October 2005.

India-UK Seminar Series

A Three-Day Seminar on '*Recent Trends in Liquid Crystal Research*' was organized during 14-16 November 2005 at the Raman Research Institute, under the India-UK Exchange programme. The event was jointly supported by the Department of Science and Technology, New Delhi and The Royal Society, London.

There were five speakers from the UK and seven speakers from India. In addition, a Poster Session was organized in which active researchers working on Liquid Crystals from across the country were invited to present their work; about twenty posters were presented. In all about eighty researchers participated in this very successful meeting where many students could interact freely with the experts in the field.

Workshop for Young Scientists

A Workshop for Young Scientists on Laser Physics and Quantum Optics was held from 4-8 January 2006 under the auspices of the Indo-French Centre for the Promotion of Advanced Research, New Delhi.

This workshop was different from most workshops conducted earlier, as it was solely for young scientists, below the age of 35, who have just begun their career as scientist. The aims were to:

- provide opportunities for young scientists of both countries to meet and exchange information
- favour development of scientific cooperation between French and Indian laboratories
- increase information about possibilities of postdoctoral positions
- give a good scientific background to the young audience through tutorial lectures

The following areas were covered in the discussions:

- Ultrafast processes, non-linear optics, technology and applications of femtosecond lasers
- Cold atoms and molecules, metrology, atomic clocks, atomic interferometry
- Quantum optics, quantum cryptography, noise reduction
- Photonics, optical fibres, optical communication

The scientific activities, spread over 4 days, had lectures by one or two senior speakers in the field, followed by half-an-hour presentations by the young scientists, on their recent work. The proceedings were interactive and lively.

Based on the unanimously positive feedback from the participants, it has been decided to hold such meetings every other year, alternating between India and France.

Hindi Cell

A section dedicated to Hindi literature has been functioning in the Library; a number of books and journals have been acquired during this year.

A study programme has been initiated through the Hindi Language Cell at the Institute. Classes were conducted, and a batch of 8 employees appeared for the examinations held in May 2006.

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 well as those submitted and in press, is given at Annexure I (Pages 49-63).

Summer Programme

This year, 10 students drawn from different parts of the country, representing universities, IITs and colleges were selected for the Summer Programme of the Institute. Of the 10 students, 6 were enrolled through the Indian Academy of Sciences and 4 through direct contact with the Institute. These students were at different levels in their educational background: M.Sc. - 6, B.Tech. - 3 and B.Sc. - 1.

The summer students worked with the respective supervisors / faculty members of the Institute for periods ranging from 6 to 8 weeks.

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, Pages 64-70).

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, Pages 71-75).

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 is a regular annual feature at the Institute that serves as a forum for the staff and students to present their research work. The meeting for this year was held during the period April 07-08 & 12, 2005.

Half-a-day sessions of the meeting on April 07 and 12 were Special Sessions on the *Centennial Anniversary of Einstein's Miraculous Year - The World Year of Physics 2005.* These Special Sessions consisted of a total of six presentations by the faculty members.

The other sessions of the meeting comprised of 40 presentations by the faculty and students, each followed by lively discussions with critical comments and suggestions relevant to the reported research work.

There were also 26 Poster presentations.

The abstracts of the presentations have been compiled and made available for referencing both in the Library and 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 (Pages 41-48).

General

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

PLAN (Recurring & Non-Recurring)	:	Rs.2,000.00 lakhs
NON-PLAN (Recurring)	:	Rs. 240.00 lakhs
Total	:	Rs.2,240.00 lakhs

COUNCIL

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 382 428*
Prof. N. Kumar *(up to 31.7.2005)* ***Prof. Ravi Subrahmanyan*** *(from 1.8.2005)*	*Director, Raman Research Institute* *Bangalore 560 080*
Prof. G. Mehta *(up to 31.12.2005)*	*Director, Indian Institute of Science* *Bangalore 560 012*
Prof. A.K. Sood *(from 1.1.2006)*	*Department of Physics, Indian Institute of Science* *Indian Institute of Science, Bangalore 560012*
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

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 (*up to 31.7.2005*) ***Prof. Ravi Subrahmanyan*** *(from 1.8.2005)*	*Director, Raman Research Institute* *Bangalore 560 080*
Prof. V. Radhakrishnan	*Member-Secretary* *Raman Research Institute Trust* *Bangalore 560 080*

STAFF

N. KUMAR
Director *(up to 31.7.2005)*
Homi Bhabha Distinguished Professor (from 1.8.2005)

RAVI SUBRAHMANYAN
Director *(from 1.8.2005)*

V. RADHAKRISHNAN
Distinguished Professor Emeritus

N.V. Madhusudana, *Dean of Research*

THEORETICAL PHYSICS

Research
Abhishek Dhar *(Coordinator)*
B.R. Iyer
Joseph Samuel
Madan Rao
Madhavan Varadarajan
G.S. Ranganath
Sumati Surya

Research Associate
Supurna Sinha

Post-Doctoral Fellows
Demian Cho
Subhashish Banerjee (from 12.9.2005)
Abhishek Chaudhury (from 17.3.2006)

Secretary
G. Manjunatha

Research Students
Abhijit Ghosh
K.G. Arun
Javed Ahmad *(up to 11.11.2005)*
G. Kripa
Mohd. Arif Kamal
Mohd. S.S. Qusailah
Rahul Marathe
Siddhartha Sinha *(JAP)*[*]
Sudipto Muhuri
Suthirtha Roy Chowdhury

Technical Assistants
V.S. Gayathri
Ramya Gamini
P. Sowmya

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[*] *Joint Astronomy Programme*

LIGHT AND MATTER PHYSICS

Research

Hema Ramachandran *(Coordinator)*
N. Andal
A.A. Deshpande
Reji Philip
Sadiqali Rangwala
C. S. Shukre

Post-Doctoral Fellows

Ashok Vudayagiri *(up to 30.9.2005)*
B. Kartikeyan
R. Srikanth

Technical Assistant

M.S. Meena

Research Students

M. Anija
Archana Sharma
Arijit Sharma *(from 15.7.2005)*
Divya Sharma
Nandan Satapathy *(from 15.7.2005)*
Navinder Singh
K. Ravi *(from 15.7.2005)*
Suchand Sandeep

Visiting Professor

R. Srinivasan

SOFT CONDENSED MATTER

Research

B.K. Sadashiva *(Coordinator)*
Arun Roy
V. Lakshminarayanan
N.V. Madhusudana
R. Pratibha
V.A. Raghunathan
G.S. Ranganath
Ranjini Bandyopadhyay *(from 2.4.2005)*
T.N. Ruckmongathan
Sandeep Kumar
K.A. Suresh
Yashodhan Hatwalne

Scientific/Technical

A. Dhason
Mohammed Ishaq

Research Students

Alpana Nayak
Amit Kumar Agarwal
Antara Pal
Bharat Kumar
Biburanjan Sarangi
Brindaban Kundu
Dibyendu Roy
Dipanjan Bhattacharya
V. Ganesh *(up to 15.2.2006)*
M. Govind
Harikrishna Bisoyi
A. Jayakumar *(from 18.7.2005)*
V. Manjuladevi *(up to 26.5.2005)*
S. Mohanapriya *(up to 19.8.2005)*
D.H. Nagaraju *(from 19.8.2005)*
A.V. Radhakrishnan

SOFT CONDENSED MATTER (Contd.)

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

Visiting Scientist
G. V. Shivashankar

Post-Doctoral Fellows
Anita Semwal
Ashish Kumar Prajapati *(from 24.11.2005)*

Research Students
Raj Kumar Gupta *(up to 31.10.2005)*
Rakesh Kumar Pandey *(from 16.8.2005)*
T. Roopa
Sajal Kumar Ghosh
Sanat Karmakar *(up to 31.10.2005)*
Santanu Kumar Pal
Satyam Kumar Gupta *(from 14.7.2005)*
P. Suresh Kumar
Tripta Bhatia
S. Umadevi

Secretary
K. Radhakrishna

ASTRONOMY & ASTROPHYSICS

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

Research Associates
Sunita Nair
Mousumi Das *(from 15.9.2005)*

Post-Doctoral Fellows
Christian Zier
Nirvikar Prasad

Research Students
Atish Kamble
Chandrayee Sengupta
V.N. Pandey
Peeyush Prasad *(from 1.8.2005)*
Rajesh Gopal
Raju Ramakrishna Baddi
L. Resmi *(JAP)*[*]
Ruta Kale *(from 18.7.2005)*
Shahram Amiri
Supurna Roychowdhury *(up to 10.1.2006)*
Wasim Raja *(from 15.7.2005)*

Technical
B.T. Ravishankar

Honorary Visiting Professor
P. Sreekumar

Secretary
V. Vidyamani

---

[*] *Joint Astronomy Programme*

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
B.T. Ravishankar
P.V. Rishin
P. Sandhya
G. Sarabagopalan
P.S. Sasi Kumar
R. Somashekar
S. Sujatha
C. Vinutha

Visiting Scientist

A. Krishnan

Secretary

R. Mamatha Bai

GAURIBIDANUR TELESCOPE

Technical

H.S. Aswathappa

Support Staff

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

LIBRARY

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

Support Staff

K. Chowdasetty
C. Elumalai

COMPUTERS

C.R. Subrahmanya (*In-Charge*)
Jacob Rajan
R. Nanda Kumar
B.T. Ravishankar
B. Sridhar

GRAPHIC ARTS

Raju Verghese

MECHANICAL ENGINEERING SERVICES

C.M. Ateequlla, *In-Charge*
S. Abdul Rahim
M. Achankunju
I. Charles Paul
V. Dhamodaran
R. Duraichelvan
R. Elumalai
K.O. Francis
V. Gokula Chandran
N. Gopal
G. Gopi
I. Henry
M. Mani
K.M. Mohandas
V.K. Muthu
V. Nagarajan
N. Narayanaswamy
T. Puttaswamy
P. Srinivasa
D. Sunand
S Sunderaj
M. Suresh Kumar
V. Venu

CARPENTRY

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

ADMINISTRATION

K. Krishnama Raju, *Admin. Officer*
K. Raghunatha, *Dy. Admn. Officer*
S. Raghavachar, *Asst. Admn. Officer (up to 28.2.2006)*
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 (up to 28.2.2006)*
Sowjanya Kumar *(up to 31.1.2006)*
Sujatha Anil Kumar *(up to 30.9.2005)*
B. Srinivasa Murthy

STORES

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

TRANSPORT

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

MEDICAL

Consultant Paediatrician

Dr. M.R. Baliga

Technician

R. Shanthamma

Consultant Physicians

Dr. A.R. Pai
Dr. B.V Sanjay Rao

ESTATES & 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

V. Raghunath (Secretarial)

AMENITIES (Guest Houses & Hostels)

C.V. Bhargavan
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

UPKEEP

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

HORTICULTURE

V. Krishnappa, *Consultant*
Bylappa
Lakshmamma
Lingegowda
D. Mahalinga
Maiga (up to 28.2.2006)
Mailarappa
Marappa
D. Muniraja
S. Muniraju
Rahamathulla Khan
Rangalakshmi
Varalakshmi

SECURITY

V. Jayaraman, *In-Charge*
B.M. Basavarajaiah
U.A. Erappa
H. Gangaiah
Govind K. Kundagol
K. Govindappa
Joseph Kunjachan
Keshavamurthy
Balaji (*Consultant*)
K. Krishnappa
Munihobalaiah
K. Pushparaj
O.M. Ramachandra
G. Ramakrishna
M. Sannaiah
Suresha
H. Vaderappa

VISITORS

Dr. S.M. Iftiquar Phlam University of Science & Technology	31 March - 02 April 2005
Dr. Jagdish K. Vij Trinity College University of Dublin Ireland	01 - 02 April 2005
Dr. Indranil Mitra Kolkata	01 - 7 April 2005
Dr. Sushil Majumdar University of Alberta Canada	12 April - 14 April 2005
Dr. Joe Henson University of California San Diego, USA	7 May - 6 July 2005
Dr. Sheelan Sengupta University of Kalyani Kalyani, West Bengal	13 May 2005
Prof. J. Maharana Institute of Physics Bhubaneshwar	31 May - 3 June 2005
Dr. Sujit Sarkar Tata Institute of Fundamental Research Mumbai	1 June 2005
Mr. Aayan Mukhopadhyay Harish-Chandra Research Institute Allahabad	6 June - 6 July 2005

Prof. V.P.N. Nampori International School of Photonics Cochin University of Science & Technology Cochin	16 June - 17 June 2005
Dr. Indranil Mitra Kolkata	1 - 7 July 2005
Mr. Kshitij Wagh Indian Institute of Technology-Bombay Mumbai	4 - 15 July 2005
Dr. Subhashish Banerjee Technische Universitat Kaiserslautern Germany	5 July 2005
Prof. Sumathi Rao Harish-Chandra Research Institute Allahabad	6 July 2005
Dr. Apratim Chatterjee Johannes-Gutenberg-Universitat Mainz Germany	12 July 2005
Prof. A.R.P. Rau Louisiana State University Baton Rouge, USA	31 July - 8 August 2005
Girija Subramaniam Penn State University USA	01 August - 31 December 2005
Prof. Onnotum Narayan University of California Santa Cruz, USA	8 August 2005
Dr. Vikram Soni National Physical Laboratory New Delhi	15 - 23 August 2005

Prof. John Osborne University of Durham Durham, UK	16 - 19 August 2005
Dr. Jagdish K. Vij Trinity College University of Dublin Ireland	21 - 22 August 2005
Dr. Aparna Venkatesan University of Colorado Boulder, USA	28 August - 2 September 2005
Prof. B.S. Sathyaprakash Cardiff University UK	17 - 26 August 2005
Dr. Arti Dua Max-Planck-Institut for Polymer Research Mainz, Germany	19 August 2005
Dr. M.J. Joseph Cochin University	13 - 18 September 205
Ms. Ummal Momeen Indian Institute of Technology-Madras Chennai	19 - 25 September 2005
Prof. G. Swarup National Centre for Radio Astrophysics Pune	3 - 4 October 2005
Prof. Deepak Mathur Tata Institute of Fundamental Research Mumbai	05 October 2005
Dr. Stephen O'Brien Tyndall National Institute University College Lee Maltings Cork, Ireland	08 - 15 November 2005

Prof. A. Russell Taylor University of Calgary Alberta, Canada	6 - 13 November 2005
Prof. R. D. Ekers Australia Telescope National Facility CSIRO, Australia	6 - 10 November 2005
Dr. Ralph Spencer Jodrell Bank Observatory University of Manchester Manchester, UK	6 - 7 November 2005
Dr. Justin Jonas Hartebeesthoek Radio Astronomy Observatory South Africa	6 - 7 November 2005
Dr. Andrew Faulkner Jodrell Bank Observatory University of Manchester Manchester, UK	6 - 7 November 2005
Dr. Jacques Lepine Universidade de Sao Paulo Sao Paulo, Brazil	6 - 10 November 2006
Ms Swapna S. Nair Cochin University of Science & Technology Cochin	14 - 16 November 2005
Dr. Chandrashekar Madaiah University of Oxford Oxford, UK	15 November 2005
Dr. S. Sivaramakrishnan Sri Satya Sai Institute of Higher Learning Prasanthi Nilayam	18 - 20 November 2005

Dr. Arnab K. Ray Harish-Chandra Research Institute Allahabad	21 - 28 November 2005
Prof. Dmitry Budker University of Berkeley California, USA	21 November 2005
Ms. Monika Presidency College Kolkata	23 - 27 November 2005
Dr. Rajesh Narayanan Forshungszentrum Karlsruhe GmBH Institute for Nanotechnology Karlsruhe, Germany	23 - 27 November 2005
Dr. K. Rema Laboratoire de Physique des Solides Universite Paris-Sud Orsay, France	25 November 2005
Mr. R. Krishnan / Mr. Deepak Khurana Indian Institute of Technology Kharagpur	27 November - 31 December 2005
Dr. Ketalin Fodor-Csorba Research Institute for Solid State Physics Hungarian Academy of Sciences Budapest, Hungary	02 - 13 December 2005
Mr. Debasish Chowdhury S N Bose National Centre for Basic Science Kolkata	13 December 2005 - 31 January 2006
Dr. Shrirang S. Deshingkar Harish-Chandra Research Institute Allahabad	26 December 2005 - 4 January 2006

Mr. Ajith Parameswaram Max-Planck-Institut fur Gravitationsphysik Albert-Einstein- Institut Callinstrasse, Hannover, Germany	2 - 4 January 2006
Dr. Archana Pai Max-Planck-Institut fur Gravitationsphysik Albert-Einstein-Institut Muhlenberg, Potsdam, Germany	5 - 6 January 2006
Dr. K. Subramanian Inter-University Centre for Astronomy and Astrophysics, Pune	10 January 2006
Dr. Emmanuelle Rollinde Institute of Astrophysics Paris, France	18 - 24 January 2006
Dr. Ronojoy Adhikari SUPA, School of Physics University of Edinburgh, UK	22 - 31 January 2006
Dr. G.K. Padmashree Tata Institute of Fundamental Research Mumbai	25 - 27 January 2006
Dr. D.J. Pisano Naval Research Laboratory Washington DC, USA	28 January - 2 February 2006
Prof. Jim Pringle Institute of Astronomy University of Cambridge Cambridge, UK	14 - 21 February 2006
Dr. N. Tamaoki Institute of Materials Chemical Process National Institute of Advanced Fundamental Science and Technology, Tsukuba, Japan	31 January 2006

Dr. Biswajit Paul Tata Institute of Fundamental Research Mumbai	3 - 7 February 2006
Dr. Sushmita R. Franklin GE India Technology Center Pvt. Ltd. Bangalore	04 February 2006
Dr. Sandeep Krishna Niels Bohr Institute University of Copenhagen Denmark	14 February 2006
Dr. Tracey Clarke / Dr. Aaron Cohen Naval Research Laboratory Washington DC, USA	15 - 18 February 2006
Prof. Luc Blanchet Institut d'Astrophysique de Paris Paris, France	16 February - 2 March 2006
Dr. Jayanti Prasad Harish-Chandra Research Institute Allahabad	18 - 21 February 2006
Dr. Sanjib Sabhapandit Laboratoire de Physique Theoretique et Models Statistiques Universite de Paris-Sud Orsay Cedex, France	18 - 25 February 2006
Prof. Janos Mink Institute of Structural Chemistry Chemical Research Centre Hungarian Academy of Sciences Hungary	19 - 24 February 2005
Dr. Tamas Koranyi Institute of Structural Chemistry Chemical Research Centre Hungarian Academy of Sciences Hungary	19 - 24 February 2005

Dr. Kapil Krishan University of California Irvine, U S A	24 February 2006
Dr. Golam Mortuza Hossain The Institute of Mathematical Sciences Chennai	19 - 21 March 2006
Dr. Suryadeep Ray Inter-University Centre for Astronomy and Astrophysics Pune	24 March - 4 April 2006

Annexure I

PAPERS PUBLISHED

April 2005 - March 2006

In Journals

1. Probing messenger RNA conformational heterogeneity using single-molecule fluorescence anisotropy
   Sinha, Deepak*; Sastry, Srikanth*; Shivashankar G V
   Applied Physics Letters **88**, 103901, 2006

2. Gravitational recoil of inspiraling black hole binaries to second post-Newtonian order
   Blanchet, Luc*; Qusailah, Moh'd S S; Will, Clifford M*
   Astrophysical Journal **635**, 508, 2005

3. Use of Forster's resonance energy transfer microscopy to study lipid rafts
   Rao, Madan; Mayor, Satyajit*
   Biochimica et Biophysica Acta: Molecular Cell Research **1746**, 221, 2005

4. Complete adiabatic waveform templates for a test mass in the Schwarzschild spacetime: VIRGO and advanced LIGO studies
   Ajith P; Iyer B R; Robinson C A K*; Sathyaprakash B S*
   Classical and Quantum Gravity **22**, S1179, 2005

5. Phasing of gravitational waves from inspiralling eccentric binaries
   Damour, Thibault*; Gopakumar, A*; Iyer B R
   Classical and Quantum Gravity **22**, S381, 2005

6. Observables in extended percolation models of causal set cosmology
   Dowker, Fay*; Surya, Sumati
   Classical and Quantum Gravity **23**, 1381, 2006

7. Testing post-Newtonian theory with gravitational wave observations
   Arun K G; Iyer B R; Qusailah, Moh'd S S; Sathyaprakash B S*
   Classical and Quantum Gravity **23**, L37, 2006

8. Bose-Einstein condensation: Where many become one and so there is plenty of room at the bottom
Kumar N
Current Science **89**, 2093, 2005

9. Flow driven electronic transport in carbon nanotubes
Sood A K*; Ghosh, Shankar*; Kumar N
International Journal of Nanoscience **4**, 839, 2005

10. Equipartition of current in parallel conductors on cooling through the superconducting transition
Sarangi S*; Chockalingam S P*; Mavinkurve R G*; Bhat S V*; Kumar N
Journal of Physics: Condensed Matter **18**, L143, 2006

11. DNA elasticity: Topology of self-avoidance
Samuel, Joseph; Sinha, Supurna; Ghosh, Abhijit
Journal of Physics: Condensed Matter **18**, S253, 2006

12. Euler buckling-induced folding and rotation of red blood cells in an optical trap
Ghosh, Abhijit; Sinha, Supurna; Dharmadhikari J A*; Roy S*; Dharmadhikari A K*; Samuel, Joseph; Sharma S*; Mathur D*
Physical Biology **3**, 67, 2006

13. Nonequilibrium Green's function formalism and the problem of bound states
Dhar, Abhishek; Sen, Diptiman*
Physical Review B **73**, 085119, 2006

14. Parameter estimation of inspiralling compact binaries using 3.5 post-Newtonian gravitational wave phasing: The nonspinning case
Arun K G; Iyer B R; Sathyaprakash B S*; Sundarajan P A*
Physical Review D **71**, 084008, 2005

15. Dimensional regularization of the third post-Newtonian gravitational wave generation from two point masses
Blanchet, Luc*; Damour, Thibault*; Esposito-Farese, G*; Iyer B R
Physical Review D **71**, 124004, 2005

16. Work distribution functions for hysteresis loops in a single-spin system
Marathe, Rahul; Dhar, Abhishek
Physical Review E **72**, 066112, 2005

17. Heat conduction in a two-dimensional harmonic crystal with disorder
Lee, Lik Wee*; Dhar, Abhishek
Physical Review Letters **95**, 094302, 2005

18. Stress relaxation in a perfect nanocrystal by coherent ejection of lattice layers
Chaudhuri, Abhishek*; Sengupta, Surajit*; Rao, Madan
Physical Review Letters **95**, 266103, 2005

19. *In situ* synthesis and nonlinear optical properties of Au:Ag nanocomposite polymer films
Karthikeyan B; Anija M; Philip, Reji
Applied Physics Letters **88**, 053104, 2006

20. Optical nonlinearity in glass-embedded silver nanoclusters under ultrafast laser excitation
Karthikeyan B; Thomas, Jinto; Philip, Reji
Chemical Physics Letters **414**, 346, 2005

21. Lévy statistical fluctuations from a random amplifying medium
Sharma, Divya; Ramachandran, Hema; Kumar N
Fluctuation and Noise Letters **6**, L95, 2006

22. A combinatorial approach for studying local operations and classical communication transformations of multipartite states
Singh, Sudhir Kumar*; Pal, Sudebkumar Prasant*; Kumar S*; Srikanth R
Journal of Mathematical Physics **46**, 122105, 2005

23. Dissipative electron-phonon system photo-excited far from equilibrium
Navinder Singh; Kumar N
Journal of Statistical Mechanics: Theory and Experiment , L06001, 2005

24. Quantum diffusion on a dynamically disordered and harmonically driven lattice with static bias: Decoherence
Navinder Singh; Kumar N
Modern Physics Letters B **19**, 379, 2005

25. Spectroscopic studies on Ag-polyvinyl alcohol nanocomposite films
Karthikeyan B
Physica B **364**, 328, 2005

26. Continuous loading of an electrostatic trap for polar molecules
Rieger T*; Junglen T*; Rangwala Sadiq A; Pinkse P W H*; Rempe G*
Physical Review Letters **95**, 173002, 2005

27. Vortices in Bose-Einstein condensates: A review of the experimental results
Srinivasan R+
Pramana **66**, 3, 2006

28. Partially ferromagnetic electromagnet for trapping and cooling neutral atoms to quantum degeneracy
Fauquembergue M*; Riou J F*; Guerin W*; Rangwala S; Moron F*; Villing A*; Le Coq Y*; Lecrivain M*
Review of Scientific Instruments **76**, 103104, 2005

29. On the fractal structure of solar supergranulation
Paniveni U*; Krishan V*; Singh, J*; Srikanth R
Solar Physics **231**, 1, 2005

30. Electrochemical oxidation of L-dopa at a carbon paste electrode
Mascarenhas R J*; Reddy K V*; Kumaraswamy B E*; Sherigara B S*; Lakshminarayan V
Bulletin of Electrochemistry **21**, 341, 2005

31. Self-organization of disc-like molecules: Chemical aspects
Kumar, Sandeep
Chemical Society Reviews **35**, 83, 2006

32. Assessment of liquid crystal template deposited porous nickel as a supercapacitor electrode material
Ganesh V; Lakshminarayanan V; Pitchumani S*
Electrochemical and Solid-state Letters **8**, A308, 2005

33. A frustrated packing model for the B_6-B_1-$SmAP_A$ sequence of phases in banana shaped molecules
Roy, Arun; Madhusudana N V
European Physical Journal E **18**, 253, 2005

34. Self-assembled monolayers (SAMs) of alkoxycyanobiphenyl thiols on gold: A study of electron transfer reaction using cyclic voltammetry and electrochemical impedance spectroscopy
Ganesh V; Pal, Santanu Kumar; Kumar, Sandeep; Lakshminarayanan V
Journal of Colloid and Interface Science **296**, 195, 2006

35. Sparse orthogonal matrices for scanning liquid crystal displays
Ruckmongathan T N; Shashidhara A R
Journal of Display Technology **1**, 240, 2005

36. A controller for liquid crystal displays in logic analyzers and oscilloscopes
Panikumar K G; Ruckmongathan T N
Journal of Display Technology **1**, 82, 2005

37. Ferroelectric and antiferroelectric switching behaviour in new unsymmetrical bent-core compounds derived from 3-hydroxybenzoic acid
Shreenivasa Murthy H N; Sadashiva B K
Journal of Materials Chemistry **15**, 2056, 2005

38. Liquid crystalline properties of unsymmetrical bent-core compounds containing chiral moieties
Reddy, R Amaranatha; Sadashiva B K; Baumeister U*
Journal of Materials Chemistry **15**, 3303, 2005

39. Scanning tunneling microscopy, Fourier transform infrared spectroscopy, and electrochemical characterization of 2-Naphthalenethiol self-assembled monolayers on the Au surface: A study of bridge-mediated electron transfer in $Ru(NH_3)_6^{2+}|Ru(NH_3)_6^{3+}$ redox reactions
Ganesh V; Lakshminarayanan V
Journal of Physical Chemistry B **109**, 16372, 2005

40. Thermotropic uniaxial and biaxial nematic and smectic phases in bent-core mesogens
Prasad, Veena*; Kang, Shin-Woong*; Suresh K A; Joshi, Leela*; Wang, Qingbing*; Kumar, Satyendra*
Journal of the American Chemical Society **127**, 17224, 2005

41. Comprehensive examination of mesophases formed by DMPC and DHPC mixtures
Harroun, Thad A*; Koslowsky, Martin*; Nieh, Mu-Ping*; De Lannoy C F*; Raghunathan V A; Katsaras, John*
Langmuir **21**, 5356, 2005

42. Spontaneously formed unilamellar vesicles with path-dependent size distribution
Nieh, Mu-Ping*; Raghunathan V A; Kline, Steve R*; Harroun, Thad A*; Huang, Chien-Yueh*; Pencer, Jeremy*; Katsaras, John*
Langmuir **21**, 6656, 2005

43. Phase behavior of concentrated aqueous solutions of cetyltrimethylammonium bromide (CTAB) and sodium hydroxy naphthoate (SHN)
Krishnaswamy, Rema; Ghosh S K; Lakshmanan S; Raghunathan V A; Sood A K*
Langmuir **21**, 10439, 2005

44. Frequency-dependent shape changes of colloidal clusters under transverse electric field
Negi, Ajay Singh*; Sengupta, Kheya; Sood A K*
Langmuir **21**, 11623, 2005

45. Structure and dynamics in solvent-polarity-induced aggregates from a C_{60} fullerene-based dyad
Gayathri S S*; Agarwal, Amit K; Suresh K A; Patnaik, Archita*
Langmuir **21**, 12139, 2005

46. Self-assembled monolayers of alkanethiols on gold prepared in a hexagonal lyotropic liquid crystalline phase of Triton X-100/water system
Ganesh V; Lakshminarayanan V
Langmuir **22**, 1561, 2006

47. The first examples of terminally thiol-functionalized alkoxycyanobiphenyls
Kumar, Sandeep; Pal, Santanu Kumar
Liquid Crystals **32**, 659, 2005

48. Phase behaviour of three homologues of the discotic hexa-n-alkoxyanthraquinones under pressure
Maeda, Yoji*; Yokoyama, Hiroshi*; Kumar, Sandeep
Liquid Crystals **32**, 833, 2005

49. High pressure studies on a binary mixture exhibiting two TGB phases
Manjuladevi V; Madhusudana N V
Liquid Crystals **32**, 1071, 2005

50. Triphenylene-based discotic liquid crystal dimers, oligomers and polymers
Kumar, Sandeep
Liquid Crystals **32**, 1089, 2005

51. New five-ring symmetrical bent-core mesogens exhibiting the fascinating B_7 phase
Umadevi S; Sadashiva B K
Liquid Crystals **32**, 1233, 2005

52. The $SmCP_A$ phase in five-ring bent-core compounds derived from 5-methoxyisophthalic acid
Umadevi S; Radhika S; Sadashiva B K
Liquid Crystals **33**, 139, 2006

53. Investigations on the influence of process parameters on the structural evolution of ion beam sputter deposited chromium thin films
Balu R*; Raju A R*; Lakshminarayanan V; Mohan S*
Materials Science and Engineering B **123**, 7, 2005

54. Discotic-decorated gold nanoparticles
Kumar, Sandeep; Pal, Santanu Kumar; Lakshminarayanan V
Molecular Crystals and Liquid Crystals **434**, 251, 2005

55. Magnetic susceptibility studies on a lyotropic nematic system
Vijayaraghavan D; Suresh K A
Molecular Crystals and Liquid Crystals **434**, 281, 2005

56. Thermal indexing in cholesteric liquid crystals
Agarwal, Amit K; Ranganath G S
Molecular Crystals and Liquid Crystals **437**, 279, 2005

57. Structure of phospholipid-cholesterol membranes: An x-ray diffraction study
Karmakar, Sanat; Raghunathan V A
Physical Review E **71**, 061924, 2005

58. Structure of DNA-CTAB-hexanol complexes
Krishnaswamy, Rema; Pabst, Georg*; Rappolt, Michael*; Raghunathan V A; Sood A K*
Physical Review E **73**, 031904, 2006

59. Giant-block twist grain boundary smectic phases
Fernsler J*; Hough L*; Shao R F*; Maclennan J E*; Navailles L*; Brunet M*; Madhusudana N V and 6 co-authors.
Proceedings of the National Academy of Sciences, USA **102**, 14191, 2005

60. Speckle-visibility spectroscopy: A tool to study time-varying dynamics
Bandyopadhyay, R; Gittings A S*; Suh S S*; Dixon P K*; Durian D J*
Review of Scientific Instruments **76**, 093110, 2005

61. Mesogenic dimers composed of bent-core molecules with flexible alkylene spacer
Umadevi S; Sadashiva B K; Shreenivasa Murthy H N; Raghunathan V A
Soft Matter **2**, 210, 2006

62. Bistable linear electro-optical switching in the B_7' phase of novel bent-core molecules
Umadevi S; Jakli A*; Sadashiva B K
Soft Matter **2**, 215, 2006

63. Ionic discotic liquid crystals: synthesis and characterization of pyridinium bromides containing a triphenylene core
Kumar, Sandeep; Pal, Santanu Kumar
Tetrahedron Letters **46**, 4127, 2005

64. Radio recombination lines from the starburst galaxy NGC 3256
Roy A L*; Goss W M*; Mohan, Niruj R*; Anantharamaiah K R
Astronomy and Astrophysics **435**, 831, 2005

65. Radio, millimeter and optical monitoring of GRB 030329 afterglow: constraining the double jet model
Resmi L; Ishwara-Chandra C H*; Castro-Tirado A J*; Bhattacharya D; and 14 co-authors
Astronomy and Astrophysics **440**, 477, 2005

66. An 8.5 GHz Arecibo survey of carbon recombination lines toward ultracompact H II regions: physical properties of dense molecular material
Roshi, D Anish; Balser, Dana S*; Bania T M*; Goss W M*; De Pree C G*
Astrophysical Journal **625**, 181, 2005

67. Multiwavelength carbon recombination line observations with the Very Large Array toward an ultracompact H II region in W48: Physical properties and kinematics of neutral material
Roshi, D Anish; Goss W M*; Anantharamaiah K R; Jeyakumar S*
Astrophysical Journal **626**, 253, 2005

68. VLA H53a radio recombination line observations of the ultraluminous infrared galaxy ARP 220
Rodriguez-Rico C A*; Goss W M*; Viallefond F*; Zhao J -H*; Gomez Y*; Anantharamaiah K R
Astrophysical Journal **633**, 198, 2005

69. AGN heating, thermal conduction, and the Sunyaev-Zel'dovich effect in galaxy groups and clusters
Roychowdhury, Supurna; Ruszkowski M*; Nath, Biman B
Astrophysical Journal **634**, 90, 2005

70. Arecibo pulsar survey using ALFA. I. Survey strategy and first discoveries
Cordes J M*; Freire P C C*; Lorimer D R*; Camilo F*; Deshpande A A; and 19 co-authors
Astrophysical Journal **637**, 446, 2006

71. The radiative transport of dust in primordial galaxies and second-generation star formation
Venkatesan, Aparna*; Nath, Biman B; Shull J M*
Astrophysical Journal **640**, 31, 2006

72. Arecibo pulsar survey using ALFA. II. The young, highly relativistic binary pulsar J1906+0746
Lorimer D R*; Stairs I H*; Freire P C*; Cordes J M*; Camilo F*; Deshpande A A; and 30 co-authors.
Astrophysical Journal **640**, 428, 2006

73. A molecular line survey of W3(OH) and W3 IRS 5 from 84.7 to 115.6 GHz: Observational data and analyses
Kim, Sang-Joon*; Kim, Hun-Dae*; Lee, Youngung*; Minh, Young Chol*; Balasubramanyam, R; Burton, Michael G*; Millar, Tom J*; Lee, Dong-Wook*
Astrophysical Journal Supplement Series **162**, 161, 2006

74. Optical observations and multiband modelling of the afterglow of GRB 041006: Evidence of a hard electron energy spectrum
Misra, Kuntal*; Resmi L; Pandey S B*; Bhattacharya D; Sagar R*
Bulletin of the Astronomical Society of India **33**, 487, 2005

75. Effects of the magnetic flux and of the electron momentum on the transmission amplitude in the Aharonov-Bohm interferometer
Amaresh Kumar M V; Sahoo, Debendranath*
International Journal of Modern Physics B **19**, 3483, 2005

76. The Tully-Fisher relations of the Eridanus group of galaxies
Omar A*; Dwarakanath K S
Journal of Astrophysics and Astronomy **27**, 7, 2006

77. Multiband optical photometry and bolometric light curve of the Type Ia supernova SN 2004S
Misra, Kuntal*; Kamble, Atish P; Bhattacharya D; Sagar R*
Monthly Notices of the Royal Astronomical Society **360**, 662, 2005

78. Self-regulated black hole accretion, the M-σ relation and the growth of bulges in galaxies
Begelman, M C*; Nath, Biman B
Monthly Notices of the Royal Astronomical Society **361**, 1387, 2005

79. Helical jet in the gravitationally lensed blazar PKS1830-211
Nair, Sunita; Jin C*; Garrett M A*
Monthly Notices of the Royal Astronomical Society **362**, 1157, 2005

80. Generation of magnetic field in the pre-recombination era
Gopal, Rajesh; Sethi S K
Monthly Notices of the Royal Astronomical Society **363**, 521, 2005

81. H I signal from re-ionization epoch
Sethi S K
Monthly Notices of the Royal Astronomical Society **363**, 818, 2005

82. Orientation and size of the `Z' in X-shaped radio galaxies
Zier C
Monthly Notices of the Royal Astronomical Society **364**, 583, 2005

83. Cosmic rays, lithium abundance and excess entropy in galaxy clusters
Nath, Biman B; Madau, Piero*; Silk, Joseph*
Monthly Notices of the Royal Astronomical Society **366**, L35, 2006

84. A CH_3CN and HCO+ survey towards southern methanol masers associated with star formation
Purcell C R*; Balasubramanyam R; Burton M G*; Walsh A J*; Minier V* and 30 co-authors.
Monthly Notices of the Royal Astronomical Society **367**, 553, 2006

85. Tangled magnetic fields and CMBR signal from reionization epoch
Gopal, Rajesh; Sethi S K
Physical Review D **72**, 103003, 2005

86. Water-vapor maser survey for active galactic nuclei: A megamaser in NGC 6926
Sato, Naoko*; Yamauchi, Aya*; Ishihara, Yuko*; Sorai, Kazuo*; Kuno, Nario*; Nakai, Naomasa*; Balasubramanyam R; Hall, Peter*
Publications of the Astronomical Society of Japan **57**, 587, 2005

87. Correlations of spectral intensity fluctuations: Applications to radio frequency interference mitigation
Deshpande A A
Radio Science **40**, 1, 2005

88. Sivaramakrishna Chandrasekhar (1930-2004)
Madhusudana N V
Biographical Memoirs of Fellows of the Indian National Science Academy **28**, 133, 2005

89. Of connections and fields - I. Chern's mathematical ideas in physics
Samuel J
Resonance **10**, 10, April, 2005

90. Of connections and fields - II. Chern's mathematical ideas in physics
Samuel J
Resonance **10**, 54, May, 2005

91. Roentgen and his rays
Lakshminarayanan V
Resonance **10**, 2, June, 2005

92. Small angle X-ray scattering: going beyond the Bragg peaks
Raghunathan V A
Resonance **10**, 24, June, 2005

93. Spintronics
Srinivasan R+
Resonance **10**, 53, Sept., 2005

94. Spintronics 2: Devices and materials
Srinivasan R+
Resonance **10**, 8, Nov., 2005

95. Dark matter 2: Dark matter in the universe
Phookun, Bikram*; Nath, Biman B
Resonance **10**, 76, Dec, 2005
Originally published in Resonance Vol.4, No.10, p40, 1999

96. Einstein and the special theory of relativity
Sinha, Supurna
Resonance **10**, 96, Dec, 2005
Originally published in Resonance Vol.5, No.3, p6, 2000

97. The scientific outlook
Raman C V
Resonance **10**, 242, Dec, 2005
Originally published in The New Physics - Talks on Aspects of Science by C V Raman, Philosophical Library, New York p135, 1951. Reprinted in Resonance Vol.2, No.11, p107, 1997

98. Scientometric portrait of Prof. Peter John Wyllie
Sangam S L*; Savanur K P; Manjunath M; Vasudevan R*
Scientometrics **66**, 43, 2006

99. A telescope made with cylinders constructing a 3 m sub-millimeterwave prototype
Balasubramanyam R; Gurumoorthy B*; Menon, S Raghu*; Ramakrishna Reddy N*; Ananthasubramanian P G; Ghosal A*; Ateequlla C M; Dhamodaran V
International conference on submillimeterwave science and technology, October 2004, Ahmedabad. Eds. H Dave et al. p156, Allied,, 2006

In Conference Proceedings/Books

1. Analytic approximation and perturbation methods
Iyer B R
Proceedings of the 17th international conference on general relativity, Dublin. Eds. P. Florides, B. Nolan and A. Ottewill, World Scientific, Singapore, 2005

2. Fractal structure of solar supergranulation
Paniveni U*; Krishan V*; Singh J*; Srikanth R
Proceedings of the 11th European solar physics meeting "The Dynamic Sun: challenges for theory and observations" (ESA SP-600). Ed. by D. Danesy et al. Published in CD-ROM, p66.1 Belgium, 2005

3. Supramolecular assemblies of disk-shaped molecules
Kumar, Sandeep
Proceedings of the international conference on electronic and photonic materials, devices and system, EPMDS - 2006, F1-3, 2006

4. Dynamic light scattering studies on a lyotropic discotic nematic liquid crystal
Agarwal, Amit K; Suresh K A
Proceedings of SPIE **5947**, 59470A-1, 2005

5. Wavelets for displaying gray shades in LCDs
Ruckmongathan T N; Rao, Nanditha P; Prasad, Ankita
SID Symposium Digest of Technical Papers **36**, 168, 2005

6. Radio recombination lines from starbursts: NGC 4945 and the circinus galaxy
Roy A L*; Goss W M*; Mohan, Niruj R; Oosterloo, T*; Anantharamaiah K R
The evolution of starbursts: The 331st Wilhelm and Else Heraeus Seminar, AIP Conference Proceedings Vol.783, p303,, 2005

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* denotes co-authors who do not belong to RRI
+ denotes co-authors who are Visiting Professors

IN PRESS

In Journals

1. New symmetric and asymmetric supercapacitors based on high surface area porous nickel and activated carbon
   V. Ganesh; S. Pitchumani*; V. Lakshminarayanan
   Journal of Power Sciences

2. Langmuir-Blodgett films of octadecanethiol - properties and potential applications
   Raj Kumar Gupta; K.A. Suresh; Rui Guo*; Satyendra Kumar*
   Analytica Chimica Acta

3. Reducing power consumption in liquid crystal displays
   T.N. Ruckmongathan; M. Govind; G. Deepak*
   IEEE Transactions on Electron Devices

4. Integer wavelets for displaying gray shades in RMS responding displays
   T.N. Ruckmongathan; U. Manasa*; R. Nethravathi*; A.R. Shashidhara
   IEEE/OSA Journal of Display Technology

5. Slow dynamics, aging and glassy rheology in soft and living matter
   Ranjini Bandyopadhyay
   Solid State Communications

6. Microscopic dynamics of recovery in sheared depletion gels
   B. Chung*; S. Ramakrishnan*; Ranjini Bandyopadhyay; D. Liang*; C.F. Zukoski*; J.L. Harden*; R.L. Leheny*
   Phys. Rev. Lett.

7. Microwave-assisted facile synthesis of liquid crystalline alkoxycyanobiphenyls
   Sandeep Kumar; Hari Krishna Bisoyi
   Phase Transitions

8. Effect of slow cooling on a discotic nematic liquid crystal: Evidences for nematic-nematic transitions
   D. Vijayaraghavan; Sandeep Kumar
   Mol. Cryst. Liq. Cryst.

9. The effect of laser field on the phase transitions in liquid crystals
   Amit K. Agarwal; G.S. Ranganath
   Phase Transitions

10. Lévy statistical fluctuations from a random amplifying medium
Divya Sharma; Hema Ramachandran; N. Kumar
Optics Letters

11. Polarization-rich continuous wave direct imaging: Modeling and visualization
R.S. Umesh*; A.G. Ramakrishnan*; R. Srikanth; Hema Ramachandran; Divya Sharma
Applied Optics

12. Water vapour at a translational temperature of one Kelvin
T. Rieger*; T. Junglen*; S.A. Rangwala; G. Rempe*; P.W.H. Pinkse*; J. Bulthuis*
Phys. Rev. A. (Rapid Communications)

In Conference Proceedings

1. Imaging with the ASTROSAT Scanning Sky Monitor
D. Bhattacharya
Advances in Space Research

2. Quantum computation
R. Srikanth
Two-Day State Level Seminar of the Frontiers of Physic, St. Philomena's College, Mysore

3. Lévy statistical fluctuations from a random amplifying medium
Divya Sharma; Hema Ramachandran; N. Kumar
National Laser Symposium, Vellore Institute of Technology, Chennai

4. Tunable Lévy exponent of emission statistics of a fiber-random amplifying medium
Divya Sharma; Hema Ramachandran; N Kumar
International Conference on Optics and Optoelectronics, Instruments Research and Development Establishment, Uttaranchal

5. Lévy statistics in optics: Violation of the central limit theorem
Divya Sharma; Hema Ramachandran; N. Kumar
International Conference on Current Developments in Atomic, Molecular and Optical Physics with Applications, University of Delhi, New Delhi

6. Quantum computation using coherent population trop (CPT) states
Ashok Vudayagiri
Proceedings of Current Developments in Atomic, Molecular and Optical Physics, University of Delhi, New Delhi

Annexure – III

COLLOQUIA

Name		Title	Date
Jagdish K. Vij University of Dublin Ireland	1.	Two kinds of smectic C*a phases in antiferroelectric liquid crystals	1.4.2005
	2.	Biaxial nematics	2.4.2005
	3.	Problems of current interest in antiferroelectric liquid crystals	22.8.2005
L. Resmi Raman Research Institute Bangalore		CRB030329: Double jet or re-energized jet?	29.4.2005
Sushil Majumdar University of Alberta Canada		Random lasing in disordered media: Anderson localization or lucky photons?	12.4.2005
N.D. Hari Dass The Institute of Mathematical Sciences Chennai		KABRU – The Linux supercomputer for lattice gauge theory	21.4.2005
Sheelan Sengupta University of Kalyani Kalyani		Effect of positional correlations on the spectral properties of certain low dimensional quasi-periodic model systems	13.5.2005
Stefan Guenster Laser Zentrum, Hannover & Manfred Hettwer Metrolux, Hannover, Germany		On spectrophotometers, laser beam profilers, cameras and attenuators	26.5.2005
Sujit Sarkar Tata Institute of Fundamental Research Mumbai		Fractionally quantized magnetization plateaus of low dimensional spin systems	1.6.2005
J. Maharana Institute of Physics Bhubaneshwar	1.	Perspectives in string theory	2.6.2005
	2.	Axion-Dilaton quantum cosmology	3.6.2005

Name	Title	Date
D.J. Saikia National Centre for Radio Astrophysics, Pune	Outflows in nearby galaxies	17.6.2005
Hans Vangheluwe McGill University Montreal, Canada	Computer automated multi-paradigm modeling	1.7.2005
Arif Babul University of Victoria Canada	M31 Giant Southern Stream: The quest for the source	4.7.2005
Subhashish Banerjee Technische Universitat Kaiserlautem Germany	1. Canonical transformations 2. Open quantum systems (2 *lectures*)	5.7.2005 22&29.10.2005
Sumathi Rao Harish-Chandra Research Institute Allahabad	Correlation effects on transport through junctions of quantum wires	6.7.2005
Aparatim Chatterjee Johannes-Gutenberg-Universitat Mainz, Germany	Transport phenomena in (charged) colloids: A hybrid MD-LB method with hydrodynamic interactions	12.7.2005
Onuttom Narayan University of California Santa Cruz USA	Energy transport in one dimension	8.8.2005
J.L. Osborne University of Durham UK	The latest results from the H.E.S.S. VHE gamma-ray telescopes	17.8.2005
S. Rakshit Centre for Artificial Intelligence and Robotics	Human vision to computer vision	18.8.2005
Arti Dua Max-Planck Institute for Polymer Research Mainz, Germany	Dynamics of area preserving polymer rings	19.8.2005

Name	Title	Date
Shashi Bhushan Pandey Aryabhata Research Institute of Observational Sciences (ARIES) Naini Tal	Optical observations of GRB afterglows	19.8.2005
G.K. Padmashree University of Mysore & Inter-University Accererator Centre, New Delhi	Ion collisions with liquid microdroplets	22.8.2005
Girija Subramaniyam Penn State University USA	Materials for photonic applications	22.9.2005
J.J. Isaac National Aerospace Laboratory Bangalore	Power generation from solar energy: The Pondicherry Solar Pond Power Plant	22.9.2005
Aruna Roy Mazdoor Kisan Sanghatan Dendungri Rajasthan	Gandhi Memorial Lecture for 2005 Our experiments with Truth - The Right to Know, the Right to Live	2.10.2005
Deepak Mathur Tata Institute of Fundamental Research Mumbai	Light-induced stress on molecules and living cells	5.10.2005
Prafulla K. Panda University of Santa Catarina Brazil	Relativistic equation of state for neutron star	7.10.2005
M.V. Ramana Centre for Interdisciplinary Studies in Environment and Development, Bangalore	Promises and failures: The story of atomic energy in India	6.10.2005
P. Gopakumar Mahatma Gandhi University Kottayam	Inflation on branes and alternate cosmologies	25.10.2005

Name	Title	Date
Rajesh Narayanan Institute for Nanotechnology Karlsruhe Germany	1. Griffiths phase in unconventional quantum Hall effect 2. Quantum critical behavior in itinerant magnets	3.11.2005 5.11.2005
Ron Ekers Australia Telescope National Facility, CSIRO Australia	Paths to discovery	8.11.2005
Russ Tayor The University of Calgary Canada	Polarization observations of the galaxy	11.11.2005
Stephen O'Brien University College Cork Ireland	Spectral manipulation in Fabry-Pèrot lasers: Inverse scattering approach	14.11.2005
Chandrashekar Madaiah University of Oxford UK	Creation of dynamic optical potential for ultra-cold atoms using a Spatial Light Modulator	15.11.2005
Arnab K. Ray Harish-Chandra Research Institute Allahabad	A time-dependent perturbative study of the shallow water hydraulic jump	22.11.2005
Monika Sinha Presidency College Kolkata	Strange quark matter and astrophysical observations	25.11.2005
Abhishek Dhar Raman Research Institute Bangalore	Surprises in the theory of heat conduction	1.12.2005
K. Rema Universite Paris-Sud Orsay, France	One-step synthesis of Pt and Au nanoparticles using lamellar phases	25.11.2005
Katalin Fodor-Csorba Research Institute for Solid State Physics, Budapest, Hungary	New monomeric and polymeric ester type banana-shaped liquid crystals	13.12.2005

Name	Title	Date
Zoltan Haiman Columbia University USA	Probing the end of the cosmic dark age	13.12.2005
Anil Seth University of Washington USA	Resolving extended stellar components in nearby galaxies	14.12.2005
M.F. Saldanha Former Judge Karnataka High Court Bangalore	Has the professional failed in public life	15.12.2005
Ajith Parameswaran Max-Planck-Institut fur Gravitationsphysik Hannover Germany	Null-stream veto for the network analysis of gravitational-wave bursts	2.1.2006
Archana Pai Max-Planck-Institut fur Gravitationsphysik Potsdam Germany	Bet chirplet-chain: Detecting "unmodelled" gravitational wave chirps	5.1.2006
Antoine Browaeys Institut d'Optique Orsay France	Single-photon source from a single trapped atom	13.1.2006
N. Kumar Raman Research Institute Bangalore	Supersolid: Square root of a quantum solid?	19.1.2006
R. Nityananda National Centre for Radio Astrophysics Pune	The graver side of light	20.1.2006

Name		Title	Date
Emmanuel Rollinde University of Pierre and Marie Curie & Institut D'Astrophysique de Paris France		Lithium between Big-Bang nucleosynthesis PopIII and VMPHS	23.1.2006
Ronojoy Adhikari University of Edinburgh UK	1. 2.	Arrested coarsening in binary fluid mixtures: A route to bicontinuous gels Non-equilibrium steady states in sheared binary fluids	30.1.2006 31.1.2006
D. Pisano Naval Research Laboratory Washington USA		What do loose groups tell us about galaxy formation?	31.1.2006
N. Tamaoki National Institute of Advanced Industrial Science and Technology Tsukuba Japan		Photochemical control and reversible fixing of iridescent colors of cholesteric liquid crystals	31.1.2006
Ajay K. Sood Indian Institute of Science Bangalore		Order and chaos in soft condensed matter	2.2.2006
Sushmita R. Franklin GE India Technology Center Pvt. Ltd. Bangalore		Laser ablation and cluster formation	4.2.2006
Sandeep Krishna University of Copenhagen Denmark		Modelling oscillations in genetic circuits	14.2.2006
Jim Pringle Institute of Astronomy Cambridge UK	1. 2.	Spinning black holes: Which way do they point Star formation and molecular clouds in spiral galaxies	16.2.2006 17.2.2006
Jayanti Prasad Harish-Chandra Research Institute Allahabad		Gravitational collapse in an expanding background and the role of substructure	20.2.2006

Name	Title	Date
Luc Blanchet Institute d'Astrophysique de Paris France	Gravitational waves from black holes binary systems	20.2.2006
Sanjib Sabhapandit Universite de Paris-Sud Orsay Cedex France	Functionals of the paths of a particle diffusing in a one-dimensional random potential	21.2.2006
N. Kumar Raman Research Institute Bangalore	Current division in parallel: A surprise	22.2.2006
Janos Mink Chemical Research Centre Hungarian Academy of Science Hungary	Application of FTIR and Raman spectroscopy in medical diagnostics	23.2.2006
Jagadheep D. Pandian Cornell University USA	The Arecibo methanol maser galactic plane survey	24.2.2006
Uma P. Vijh Space Telescope Science Institute Baltimore USA	Photoluminescence by interstellar dust and a look at the dust characteristics in the LMC using the Spitzer Space Telescope	24.2.2006
Kapil Krishnan University o California USA	Topological constraints in dynamical systems	24.2.2006
K.S. Valdiya Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore	Detachment of the North Himalayan tethyan sedimentary cover from its foundation: The implications	2.3.2006
Golam Mortuza Hossain The Institute of Mathematical Sciences Chennai	Effective description of loop quantum cosmology	20.3.2006

Annexure - IV

JOURNAL CLUB

Discussed by	Paper discussed	Date
Navinder Singh	Simulating quantum Brownian motion with single trapped ions S. Maniscalo *et al.* *Phys. Rev. A.*, **69**, 052101 (2004)	28.4.2005
V. Ganesh	Single walled carbon nanotube -A chemi capacitor and near-infrared optical sensor E.S. Snow *et al.*, *Science*, **307**, 1942 (2005) Paul W. Browne *et al.* *Nature Materials*, **4**, 86 (2005)	
D. Anish Roshi	Measurement of gravitational spin-orbit coupling in a binary pulsar system I.H. Stairs (UBC), S.E. Thorsett (UCSC), Z. Arzoumanian (NASA-GSFC) *et al.* *Phys. Rev. Lett.*, **93**, 141101 (2004)	5.5.2005
Sajal Kumar Ghosh	Origin of the short-range, strong repulsive force between ionic surfactant layers Jordi Faraudo and Fernando Bresme *Phys. Rev. Lett.*, **94**, 077802 (2005)	
Rajesh Gopal	Detection of the Baryon acoustic peak in the large-scale correlation function of SDSS luminous red galaxies Eisenstein *et al.* *Astrophysical Journal* (submitted, 0501171)	12.5.2005
Nirvikar Prasad	Nuclear powered millisecond pulsars and the maximum spin frequency of neutron stars D. Chakrabarty *et al.* *Nature*, **42-44**, 424 (2003)	26.5.2005
S. Umadevi	Homeotropic alignment on surface-initiated liquid crystalline polymer brushes Paul J. Hamelinck and Wilhelm T.S. Huck *J. Mater. Chem.*, **15**, 381 (2005)	16.6.2005

K.G. Arun	Intermediate mass black holes in accreting binaries: Formation, evolution and observational appearance Simon Portegies Zwart (UvA), Jasinta Dewi (Oxford), Tom Maccarone (UvA) *et al.* *Mon. Not. R. Astron. Soc.*, **413**, 355 (2004)	16.6.2005
Suchand Sandeep	Observation of nuclear fusion driven by a pyroelectric crystal B. Naranjo, J.K. Gimzewski and S.Putterman *Nature*, **434**, 1115-1117 (2005)	23.6.2005
Archana Sharma	Real-time quantum feedback control of atomic spin-squeezing J.M.Geremia, John K. Stockton, Hideo Mabuchi *Science*, **304**, 270 (2004)	7.7.2005
R. Srikanth	Is quantum mechanics an island in theory-space? S. Aaronson *Proc. Foundations of Probability & Physics 3*, Växjö, Sweden (2004); eprint quant-ph / 0401062	
D. Amudha Kumari	Photon recoil momentum in dispersive media Gretchen K. Campbell *et al.* *Phy. Rev. Lett.*, **94**, 170403 (2005)	11.8.2005
N. Udaya Shankar	Detection and imaging of atmospheric radio flashes from cosmic ray air showers H. Flake *et al.* *Nature*, **435**, 313-316 (2005)	
D. Vijayaraghavan	Is the lotus leaf superhydrophobic? Yang-Tse Cheng *et al.* *Appl. Phy. Lett.*, **86**, 144101 (2005)	18.8.2005
Biman Nath	Regulating the growth of black holes in galaxies Tiziana Di Matteo, Volker Springel and Lars Hernquist *Nature*, **433**, 604 (2005)	
T.N. Ruckmongathan	Strong, transparent, multifunctional, carbon nanotube sheets Mei Zhang *et al.* *Science*, **309**, 1215-1219 (2005)	1.9.2005

Divya Sharma	Weak localizations and time reversal of ultrasound in a rotational flow Julien de Rosny *et al.* *Phy. Rev. Lett.*, **45**, 074301 (2005)	
Supurna Sinha	Solvenoids and plectonemes in stretched and twisted elastomeric filaments A. Ghatak and L. Mahadevan *Phy. Rev. Lett.*, **95**, 057801 (2005)	15.9.2005
Sandeep Kumar	Photovoltaic cells using composite nanoclusters of porphyrins and fullerenes with gold nanoparticles Taku Hasobe *et al.* *J. Am. Chem. Soc.*, **127**(4), 1216-1228 (2005)	
M. Govind	Low-cost and nanoscale non-volatile memory concept for future silicon chips Martijn H.R. Lankhorst *et al.* *Nature Materials*, **4**, 347-352 (2005)	29.9.2005
V.A. Raghunathan	Observation of a hexatic columnar liquid crystal of polydisperse colloidal disks A.V. Petukhov *et al.* *Phys. Rev. Lett.*, **95**, 077801 (2005)	
	Open-ended and Interactive Discussion Session **Marginal Questions**	10.11.2005
M. Anija	Probing hot and dense laser-induced plasmas with ultrafast SUV pulses S. Dobosz *et al.* *Phys. Rev. Lett.*, **95**, 025001 (2005)	20.10.2005
Rahul Marathe	Microscopic analysis of a thermal Brownian motor C.Van den Broeck *et al.* *Phys. Rev. Lett.*, **93**, 090601 (2004)	
Demian Cho	In an expanding universe, what does not expand? Richard H. Price *Gr-qc/*, 0508052	27.10.2005
Joseph Samuel	Corrections and counting statistics of an atom laser Anton Ott *et al.* *Phys. Rev. Lett.*, **95**, 090404 (2005)	

Dmitry Budker University of California, Berkeley, USA	**Special Journal Club Session: Nobel Prize in Physics, 2005**	21.11.2005
Ranjini Bandyopadhyay	Liquefaction of quicksand under stress A. Khaldoun, E.Eiser, G.H. Wegdam and D. Bonn *Nature*, **437**, 635 (2005)	12.1.2006
Abhishek Dhar	Signature of effective mass in crackling noise a symmetry Stegano Zapperi, Claudio Castellano, Francesca Colaiori and Gianfranco Durin *Nature* **1**, 46 (2005)	
Abhijit Ghosh	Geometry of Calugareanu's theorem Dennis M.R. and Hannay J.H. *Proc. R Soc Lond A*, **461**, 3245-54 (2005)	9.2.2006
Sadiqali Rangwala	Functional group dependent site specific fragmentation of molecules by low energy electrons Vaibhav S. Prabhudesai, Aditya H. Kelkar, Dhananjay Nandi E. Krishnakumar *Phys. Rev. Lett.*, **95**, 143202 (2005)	
Suthirtha Roy Chowdhury	Hawking radiation in an electromagnetic waveguide? Ralf Schutzhold and William G. Unruh *Phys. Rev. Lett.* **95**, 031301 (2005)	23.2.2006
Tripta Bhatia	Allosteric control through mechanical tension Brian Choi, G. Zocchi, Yim Wu, S. Chan, L.J. Perry *Phys. Rev. Lett.* **95**, 078102 (2005)	
Subhashish Banerjee	Geometric nature of the environment-induced Berry phase and geometric dephasing R.S. Whitney, Y. Makhlin, A. Shnirman and Y. Gefen *Phys. Rev. Lett.*, **94**, 070407 (2005)	9.3.2006
Dipankar Bhattacharya	Ultraluminous X-ray source in M82 P. Kaaret, M.G. Simet and C.C. Lang *Science*, **311**, 491 (2006)	

P. Suresh Kumar	Directional control in thermally driven single-molecule nanocars Yasuhiro shirai, Andrew J. Osgood, Yamino Zhao, Kevin F. Kelly and James M. Tour *Nanoletters*, **5(11)**, 2330 (2005)	23.3.2006

List of Abbreviations

AGN	Active Galactic Nuclei
ALFA	Arecibo L-Band Feed Array
ASTROSAT	ISRO's Astronomical Satellite
BIMA	Berkeley Illinois Maryland Association
GALFACTS	Galactic ALFA Continuum Transit Survey
GHz	Giga Hertz
GMRT	Giant Meterwave Radio Telescope
GRB	Gamma Ray Burst
HESS	High Energy Stereoscopic System
HI	Neutral Atomic Hydrogen
HII	Ionized Hydrogen
IGM	Inter Galactic Medium
INSAT	Indian National Satellite
IRAM	Institut de Radioastronomie Millimetrique
JIVE	Joint Institute for VLBI in Europe
MHD	Magneto Hydro Dynamics
MHz	Mega Hertz
NGC	New General Catalogue
OH	Hydroxyl Radical
PALFA	Pulsar ALFA
RFI	Radio Frequency Interference
r.m.s.	root mean square
SSM	Scanning Sky Monitor
UGC	Uppsala General Catalogue
VLA	Very Large Array
VLBI	Very Long Baseline Interferometry
VSAT	Very Small Aperture Telescope
WMAP	Wilkinson Microwave Anisotropy Probe (Satellite Mission)