RAMAN RESEARCH INSTITUTE

C.V.Raman Avenue, Sadashivanagar
Bangalore 560 080, India

Annual Report

2007 – 2008

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For further information, please write to:

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

Phone : +91 (80) 2361 0122 – 2361 0129
Fax : +91 (80) 2361 0492
Telegram : RAMANINST, BANGALORE
e-mail : root@rri.res.in
library@rri.res.in
URL : http://www.rri.res.in

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C O N T E N T S

P R E A M B L E

The Annual report of the Raman Research Institute for the year 2007-2008 is a summary of the research and academic activities of the Institute during the year. The Annual Report presents synopses of the ongoing knowledge creation activities in the different research groups, many of which have outcomes in the form of publications in refereed scientific journals. Included are lists of research publications, PhD degrees awarded during the period 01 April 2007 to 31 March 2008, as well as seminars and review meetings focused on current research, which were held at the Institute. The report also lists the scientists who have visited the Institute from within India and from overseas during the period.

One student received the PhD degree and another five have submitted their PhD theses during the year. It is heartening that the Visiting Students Programme, which was started in the 2006-07 period, to provide opportunities for students at the undergraduate and post-graduate levels to participate in ongoing research activities of the Institute – and hopefully be motivated to pursue a research career – has seen significant growth: as many as 65 students visited the Institute during 2006-07 under this programme.

Bangalore
September 6, 2008

Ravi Subrahmanyan
Director

RAMAN RESEARCH INSTITUTE

Bangalore

Annual Report 2007 - 2008

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, 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 built a Decametre wave Radio Telescope at Gauribidanur − about 80 km from Bangalore − jointly with the Indian Institute of Astrophysics. Members of the Institute use the Ooty Radio Telescope (ORT), which is operated by the Tata Institute of Fundamental Research (TIFR), Mumbai, and have also contributed by modernising its capabilities with state-of-the-art reconfigurable digital receivers that enhance its capabilities and versatility with a view to continuing to use it for new 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), operated by TIFR, and also built specialized pulsar receivers for GMRT. Today, members of the Institute are giving new capabilities to the GMRT: equipping the telescope with very low frequency receivers in the 30-90 MHz band. 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; outcomes of this research in the form of images of large regions of the southern sky at 150 MHz are being placed on the world-wide-web as a resource for the astronomy community. The Raman Institute has also built a millimetre wave telescope of diameter 10.4 metres on campus and is currently engaged in refurbishing and modernising the telescope and installing receivers in the 40-50 GHz band for a dedicated spectral-line survey of star-forming regions.

The Raman Research Institute is now a full partner in an international collaboration – the Muchison Wide-field Array – to build a large low radio frequency telescope array in a remote Western Australian radio-quiet location, which is a pathfinder to the International Square Kilometer Array project. The participation includes contributing to engineering in the form of digital systems and software – which challenge and stretch our in-house capabilities in appropriate directions – and involvement in specific science goals by sharing in the development of innovative observing techniques, analysis methods, detection algorithms and parameter extraction tools. Developments during 2007-2008 include design, fabrication and testing of digital receivers and data processing electronics, which form part of the telescope. RRI members worked as part of international teams in campaign mode installing, testing and commissioning telescope systems at the remote site in Western Australia.

The year saw the initiation of a novel project developing a wide-band antenna and a multi-band receiver that will enable simultaneous observations of celestial phenomena over a range of radio wavelengths when mounted at the focus of a large dish antenna. The project is being specifically designed to be mounted at the focus of the US Green Bank telescope, which is the largest steerable dish antenna in the world. RRI members, including our PhD students, have been granted competitive telescope time to use the instrumentation for specific investigations before it would be made available to the international community as a new facility.

The developmental effort towards realizing an X-ray polarimeter has taken off: the X-ray astronomy laboratory that was setup in 2006-2007 is now actively building and testing critical components and evaluating novel design configurations for the polarimeter, and designing and testing electronics and logic circuits that are essential for the detectors.

The Institute continued its development of low-cost 12-15 metre class parabolic dish antennas, based on the pre-formed parabolic dish concept, as a strategic initiative. Noteworthy developmental effort during the year was the application of photogrammetry for antenna metrology, to provide a feedback to structural analysis.

Members of the Astronomy & Astrophysics group are currently engaged in research into the understanding of events in the evolving universe and a variety of phenomena associated with cosmic bodies: structure formation in the early universe, epoch of reionization, clusters of galaxies, active galaxies, barred spiral and low-surface-brightness galaxies, X-ray binaries, pulsars and star forming regions. This report includes synopses of research on, for example, problems of relevance to cosmology like the influence of primordial magnetic fields on the formation of the first collapsed objects in the early universe, the effect of supernovae explosions on circumstellar dust grains, and 21-cm emission from the epoch of reionization. Extragalactic astronomy research themes include the formation of diffuse synchrotron plasma and radio galaxies within clusters of galaxies, outflows from active galactic nuclei and the interaction of jets with the ambient medium, the AGN activity, molecular gas abundance and diffuse X-ray gas associated with low-surface brightness galaxies. The X-ray flux variations in a number of Galactic X-ray binaries have been used to expand our knowledge of these enigmatic astrophysical objects, just as details of the temporal and frequency dependance of the radio emission from pulsars have been used to refine our models of their emission mechanism.

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 LAMP group has adopted a basic science research approach, as opposed to a competitive technology development approach, in keeping with the overall philosophy of the Institute.

Members of the LAMP group, as in previous years, continued to do extensive In-house developmental activities. A very stable External Cavity Diode Laser (ECDL) system has been developed using the expertise available in our precision workshop. Additionally, an ion trap that could work in conjunction with a Magneto Optical Trap (MOT) was successfully designed, simulated and built. The BEC team has built a new MOT with the MOT coils inside the chamber, which allows for lower operational currents. In the Laser Cooling Lab, a new grating mount for the ECDL system was designed, and it is currently under fabrication at the Central Manufacturing Technology Institute, Bangalore.

The last several years of committed effort has brought the experimental capability to the stage where confidence has been established in the setting up of laser systems, vacuum chambers, and laser cooling and trapping of atoms in magneto-optic traps, and efforts are on to produce ultra-cold atom clouds in configurations appropriate for addressing interesting questions in quantum physics.

The Non-Linear Optics Group and its collaborators within and outside India have continued their research work mainly based on non-linear optical properties of nano rods, nanocomposite films, nano-clusters, optical diodes and quantum dots. In addition, slow light experiments in Bacteriorhodopsin were carried out giving rise to new ways of thinking about this effect. In the Light Scattering lab, a novel ferro-fluid material is being investigated for its

photonic bandgap (PBG) properties. The forward transmission of light vanishes in these materials leading to a robust room temperature and reversible PBG systems. In addition, a Hadamard walk protocol is being investigated for implementation in cold atoms. Squeezing under three-photon resonance was theoretically investigated. The Quantum Interactions group carried out experiments in room temperature paraffin coated vapour cells containing alkali atoms under high electric fields. Ultra-narrow absorption lines of a few hundred KHz width (of transitions with a natural linewidth of a few MHz) was seen in Rubidium Vapour cells at room temperature under Electro-Magnetically Induced Transparency (EIT) conditions. Their efficiency in transfer of classical and quantum correlations are being investigated.

3. Soft Condensed Matter

The Raman Research Institute has made outstanding contributions to the development of the field of liquid crystals for over three and a half 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 members 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. Novel mesogens with bent-core molecules continue to be synthesised in the liquid crystal laboratory, and uncommon and sometimes completely new phase transitions have been observed. Synthesis of discotic liquid crystalline trimers and pentamers and experimental studies of their mesophase behavior represent further examples of current research.

The physics of liquid crystalline matter, for example, in the interaction between liquid crystal droplets and polarized light, and in the variation of flexoelectric coefficients and elastic constants on varing the relative concentrations of bent-core and rod-like molecules in binary mixtures, has continued to be an area of research. Laboratory experiments on pattern formation corresponding to topological defects that arise as a result of electroconvection may point to lines of investigation concerning defect models of structure formation in cosmology. Research of the soft condensed matter group, which was earlier focussed on liquid crystals, has now expanded into examining physical effects, including electical conductivity, arising from the dispersion of nanoparticles and enzymes into the bulk of liquid crystalline phases, and properties of films and monolayers formed by mesogens and complexes containing mesogens.

Of intersest to members of the group are the phase behavior of ionic surfactants, specifically those with strongly bound counterions and complexes consisting of such surfactants and DNA. Related are experimental studies of instabilities in lipid bilayers. Studies of aging clay suspensions – of the stress relaxation behavior and of the microviscosity using a falling ball viscometer – are examples of research on colloids.

We are witness to a proliferation of liquid crystal display devices at home and beyond and industrial research has invested enormous resources into research in this field. Nevertheless, a niche area of research at the Raman Institute, which is a significant contribution to this highly competitive field, is in the development of techniques for driving the matrix displays: using sophisticated signal processing algorithms and methods to reduce power consumption in the display drivers. International patents have been filed to protect intellectual property rights, in this area.

Soft matter research has in some cases used specialized investigative techniques, for example, oscillatory rheology studies and magnetic susceptibility studies, for appropriate problems. All of the investigations into the fascinating behaviours, quantitative measurements of the properties and the response to various control parameters, and the experimental elucidation of the molecular ordering in different circumstances, require sophisticated and modern equipment. The group has, in its laboratories, instruments like an atomic force microscope, scanning tunnelling microscope, polarization and confocal microscopes, and apparatus for X-ray diffraction. Upgrades to existing equipment and measuring devices, as well as the acquisition of new facilities that open new windows to the studies, are an ongoing activity so as to maintain the relevance and to enable new dimensions and directions in the research.

4. Theoretical Physics

Theoretical physics research in the Institute is in the areas of condensed matter physics, statistical physics and gravitation, which includes classical and quantum gravity and gravitational radiation. Nevertheless, as might be expected in a small institute where interactions within a research community with diverse pursuits and experimental activity triggers lateral thinking, the research outcomes include analyses of fundamental questions in quantum mechanics and general physics. Some years ago, the activity in the theoretical physics group diversified into physics in biology, in an active effort to research in inter-disciplinary areas and to build bridges with the National Centre for Biological Sciences (NCBS) at Bangalore.

Recent theoretical work considered a variety of issues, including questions related to quantum resistance, wave-particle duality, geometric phase in neutrino propagation, habitability of Europa via tests on bio-indicator signals, and on the classical anomaly that a recursive network composed essentially of reactive elements may be dissipative! A theoretical study examined the prospect of a laboratory detection of the gravitational deflection of light, when propagating ultra slowly in a highly dispersive medium. Synopses presented herein include work related to quantum information and quantum computation, and open quantum systems. In non-equilibrium statistical mechanics, research continues in the formalisms associated with transport properties, conduction and equilibration, and jamming dynamics.

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 coming on-line of gravitational wave detectors, which need an accurate 'template' with which the data may be cross correlated in order to detect cosmic signals. During the year, research has moved into examining signal detection with future space based gravity-wave detectors, pointing out that LISA observation of SMBH coalescence events could potentially constrain the dark energy equation of state.

Geometry has often given deep insights and elegant formulations of concepts in theoretical physics. Geometrical formulations also enable connections to be visualized between seemingly different branches of physics. Primers in theoretical physics begin with analogies between translation and rotational invariance in space and time with conservation laws of energy and momentum. Einstein's formulation of the theory of gravity – General Relativity – via the metric defining the

geometric of space time had an elegance that led to its acceptance as opposed to alternatives. Recent work at RRI has explored the Ricci tensor description of the curvature in a metric and derived a flow equation that may be parameterized by a geometric equivalent of 'entropy' pointing a way towards the possible application of thermodynamic ideas to gravitation.

A long standing issue in physics is the proposition presented by General Relativity that anything, including information, is destroyed by black-hole singularities, which appears in contradiction with the insistence by Quantum Mechanics that all information contained in quantum states must be preserved. Progress towards resolution of this paradox has been made at RRI in the form of work using quantum gravity formulations to examine the space-time geometry of a black-hole – though with reduced dimensionality – and the eventual emergence of the information owing to Hawking radiation.

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. Recent work includes a satistical mechanical study of stiff polymers motivated by buckling phenomena in cellular cytoskeletons. 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 Research Institute are given in the pages that follow.

ASTRONOMY AND ASTROPHYSICS (A&A)

Areas of research:
- Cosmology and Structure Formation
- Extragalactic Astronomy
- Neutron Stars and Pulsars
- The Galaxy and the Interstellar Medium
- Surveys
- Topological Phase
- Instrumentation and signal processing

COSMOLOGY AND STRUCTURE FORMATION

Primordial magnetic fields and H_2 formation: The implication of primordial magnetic fields for the formation of molecular hydrogen in the IGM and collapsing halo was studied. It was shown that, for magnetic field strengths in the range of 0.2 to 1 nano-Gauss, the molecular hydrogen fraction in IGM and collapsing halo can increase by a factor 5 to 1000 above the case with no magnetic fields. Also discussed were the implications of the increased molecular hydrogen fraction on the radiative transfer of ultra violet photons and the formation of first structures in the universe. [Shiv Sethi, Biman Nath + K. Subramanian (IUCAA, Pune)].

Epoch of reionization and light-cone effect: The effect of light cone anisotropy on the correlation function of neutral hydrogen brightness temperature during the epoch of reionization was studied. The results suggest that this effect could lead to a detectable level of anisotropy for many models of interest. The expected level of anisotropy is likely to swamp the better understood anisotropy from the redshift space distortion. The detection of this anisotropy can be useful in determining the nature of ionizing sources [Shiv Sethi + Z. Haiman (U. Columbia, USA)].

EXTRAGALACTIC ASTRONOMY

Diffuse radio emission in galaxy clusters: Diffuse radio emission was detected in Galaxy Clusters at 150 MHz from the observations carried out using the Giant Meterwave Radio Telescope. Multi-frequency data sets were created using the current and archival data from GMRT and the Very Large Array. These data were interpreted in the light of the adiabatic compression model for radio emission from halos and relics. [Ruta Kale & K S Dwarakanath].

Nature of steep spectrum sources in the VLA 74 MHz survey: A select number of ultra steep-spectrum sources (α>1.8, where $S \propto \upsilon^{-\alpha}$) were imaged in the radio continuum at 328 MHz using the VLA and at 1300 MHz using the GMRT. Most of these sources are extended (30″- 3′) and display rather unusual morphologies. Three of the nine sources observed appear to be in Galaxy Clusters. Identification of the rest of the sources is unclear. [K S Dwarakanath & Ruta Kale].

Outflows from active galaxies: Neutral and ionized gas outflows within an active galaxy, the radio-loud Seyfert galaxy IC5063, were studied via new ATCA 17- and 24-GHz radio images and ESO-NTT optical spectra. The radio and optical data show that the neutral gas outflow is off-nuclear and driven by the interaction between the radio jet and the ISM and that photoionization from the AGN rather than shocks is the likely dominant ionization mechanism for the ionized gas outflow. The outflow velocities, mass outflow rates and kinetic power indicate that the outflows may have a significant impact on the ISM in the galaxy. [L. Saripalli + Morganti & Oosterloo (NFRA, The Netherlands), Holt & Tadhunter (U. Sheffield, UK)]

Re-started jet activity: The radio galaxy PKS B1545−321, well known for its re-started nuclear activity, was studied in detail using sensitive and high-resolution radio images based on which a new scenario is proposed for the interaction of the new jet with the surrounding synchrotron plasma. The data allow a detailed study of the dynamics of the restarted jets and time-scales of activity. [L. Saripalli, R. Subrahmanyan + V. Safouris (ANU & CSIRO-ATNF, Australia), G. V. Bicknell (ANU, Australia)].

Giant radio galaxies and the large scale structure: A radio-optical study of the giant radio galaxy, MSH 05-22 has been used to relate the radio structure with the large-scale galaxy distribution. The clear correspondence is used to examine and quantify the influence of the environment on the radio galaxy with implications for the evolution of the radio galaxy as well as on the state of the IGM. [L. Saripalli, R. Subrahmanyan + V. Safouris (ANU & CSIRO-ATNF, Australia), R. W. Hunstead (Univ. Sydney, Australia)].

New class of X-shaped radio galaxies: Radio observations of the radio galaxy, J2018−556 were used to highlight the presence of a new class of X-shaped radio galaxies and to present clear evidence in support of 'wings' forming as a result of a redirection of backflows by asymmetric gas distribution associated with the host galaxy rather than merger of a binary black hole pair. [L. Saripalli, R. Subrahmanyan + T Laskar (St. Stephen's College, Delhi), A. Koekemoer (STScI, USA)].

Radio Continuum Observations of AGN in Low Surface Brightness Galaxies: GMRT radio data of several Low Surface Brightness (LSB) galaxies was analyzed. Preliminary analysis reveals that radio cores and jets are present in these galaxies even though they are very poor in star formation. [(Mousumi Das + Kantharia N. G. (NCRA, Pune), Vogel & McGaugh (U. Maryland, USA)]

Molecular Gas in Low Surface Brightness Galaxies: The CO(2-1) emission from molecular hydrogen gas in 3 giant LSB galaxies was observed using the HERA instrument on the IRAM telescope (France). The main goal was to see if the molecular gas distribution was extended in these galaxies. In one galaxy it appears extended (Malin 2) whereas in another (UGC1922) it is concentrated in the galaxy center. For the third galaxy the data was not good enough to make conclusions. [(Mousumi Das + F.Boone & F. Viallefond (IAP, France), K. O'Neil (NRAO, USA)] .

Chandra Observations of AGN in Low Surface Brightness Galaxies: The Chandra X-ray telescope data (Cycle 8; Das 2007) of 8 LSB target galaxies was analyzed. Two galaxies were found to be bright at X-ray wavelengths and the emission is from the AGN; for the remaining galaxies upper limits to the expected X-ray luminosities were established. Also, diffuse X-ray emission was detected from the centers of 3 target galaxies. The paper is in preparation and will be submitted shortly. [(Mousumi Das + Reynolds, Vogel & McGaugh (U. Maryland, USA), Kantharia N. G. (NCRA, Pune)].

Barred Galaxies - Variation of Nuclear Velocity Dispersion and Bar Strength in Spiral Galaxies: The bar strength has been found to have a significant correlation with the nuclear stellar velocity dispersion in barred galaxies. This indicates that galaxies with weaker bars have centers that are dynamically hotter and hence have a larger central mass concentration. Central mass concentrations in bars may eventually cause bar dissolution and so this result is an important step in understanding the secular evolution of barred galaxies. [(Mousumi Das + E. Laurikainen & H. Salo (U. Oulu, Finland), R. Buta (U. Alabama, USA)] .

Dust particles in supernovae remnants: A project was carried out to determine the degree of destruction of dust particles that are produced in core-collapse supernovae, as the stellar ejecta goes through the reverse shock. Since dust particles are crucial as cooling agents for the generation of stars after the very first generation stars collapse, it is important to determine the fraction of dust grains that actually survive. The detailed analytical calculations show that reverse shock does not in general destroy a substantial fraction of dust grain, except in some

special cases. [Biman Nath + T. Laskar (St. Stephen's College, Delhi), J. M. Shull (U. Colorado)]

Distribution of radio galaxies in galaxy clusters: Recent observations have shown that radio galaxies in galaxy clusters are concentrated in the central region. It has been suggested that the effect of dynamical friction of massive galaxies embedded in galaxy clusters can explain these observations, since hosts of radio galaxies are found to be massive elliptical galaxies. The calculations show that it is possible to explain the observations given a time scale of a few billion years, less than the age of galaxy clusters. [Biman Nath]

NEUTRON STARS AND PULSARS

Super-orbital flux variation of Cen X-3: The long-term flux variations in the accretion powered binary X-ray pulsar Cen X-3 was investigated using orbital modulation, pulsed fraction, and quasi-periodic oscillations in different flux states. Based on these studies it was concluded that the long term aperiodic intensity variations of Cen X-3 are mainly due to obscuration by aperiodically processing warps in the accretion disk and not due to changes in the mass accretion rate. [H. Raichur & B. Paul]

QPOs and a possible supernova fall back accretion disk in 4U 1626-67: Two separate timing studies were carried out on an enigmatic accretion powered X-ray pulsar 4U 1626−67. A gradual decrease in the frequency of the quasi-periodic oscillations (QPOs) during the last 13 years was discovered along with a gradual decrease in the X-ray luminosity. This is the only X-ray pulsar to show persistent QPOs and is also the first accreting X-ray pulsar in which the QPO history is reported for a long timescale relating to it with the long-term evolution of the accretion disk. In a different study, using a long observation of 4U 1626−67 with the RXTE-PCA, a 3 sigma upper limit of the projected semi major axis of the neutron star binary orbit was determined to be 13 light-ms over a wide range of its possible orbital period. This puts very stringent upper limits for the mass of the companion object except for the unlikely case of a complete face-on orientation of the binary system with respect to our line of sight. The possibility of this system being a neutron star with a supernovae fall-back accretion disk was pointed out. [B. Paul + R. Kaur (ARIES, Nainital), C. Jain & A. Dutta (U. Delhi), R. Sagar (ARIES, Nainital) and B. Kumar (ARIES, Nainital)]

Orbital evolution of the millisecond X-ray pulsar SAX J1808.4–3658: Using a pulse timing analysis developed at RRI, an evolution of the binary period of the

accretion powered millisecond X-ray pulsar SAX J1808.4−3658 was detected. Using 27 measurements of orbital ephemerids during the four outbursts spread over more than 7 years and more than 31,000 binary orbits, an accurate orbital period derivative was measured. It was pointed out that the measured rate of orbital period evolution is considerably faster than the most commonly discussed mechanisms of orbital period evolution like mass transfer, mass loss from the companion star and gravitational wave radiation. [B. Paul + C. Jain & A. Dutta (U. Delhi)]

Pulse phase dependence of the magnetar X-ray bursts: A unique study of the pulse phase dependence of X-ray bursts was carried out in three of the magnetar candidates SGR 1806−20, SGR 1900+14 and AXP 1E 2259+586. A very significant burst rate for all pulse phases and some pulse phase dependence of the bursts in SGR 1900+14 was discovered. [B. Paul + C. Jain & A. Dutta (U. Delhi)]

Multi wavelength studies of the transient X-ray binary IGR J01583+6713: X-ray and optical photometric variability and stability of the H_{∇} line profile of a new transient X-ray binary IGR J01583+6713 was investigated using observations made with the RXTE, Swift, HCT and Nainital Observatory. [B. Paul + R. Kaur, R. Sagar, B. Kumar (ARIES, Nainital)]

Sub-pulse fluctuation studies of Pulsar B1237+25: Recent studies of the drifting-subpulse phenomenon in radio pulsars suggest that the emission region may be organized as a system of emission columns seeded by a rotating spark pattern in the acceleration zone, as in the model by Ruderman & Sutherland (1975). Sub-pulse fluctuation properties of one of the bright pulsars B1237+25 (multi-component profile) was studied, to establish its sub-beam circulation period and to look for any correlation between its various conal emission rings using existing observational data (courtesy Joanna Rankin, Uni. of Vermont). Preliminary results indicate that conal emission at different radii may have significant correlation, implying a common underlying pattern may be responsible for emission associated with different conal rings. [Yogesh Maan, Avinash Deshpande]

Multi-frequency observations of bright pulsars to probe in polar emission region: The emission patterns in the Polar Regions have been *mapped* at mostly a single frequency at a time, and for only a few pulsars. To probe the configuration of emission columns, suggested by available observations, simultaneous mapping of the emission pattern at several heights from the star surface can be used to obtain a tomographic view of the polar emission cone. With this aim, multi-frequency observations were conducted on a few bright pulsars using the GMRT (at two

frequencies), along with the telescopes at Gauribidanur, Ooty, and the MST radar facility simultaneously. The data are being analysed. Such observations suffer from various constraints and difficulties (viz. calibration and sensitivity issues, polarization issues, scheduling constraints due to transit telescopes etc.). To overcome these short-comings, a solution in the form of a multi-band receiver to be used at the focus of a large aperture telescope, is considered. [Yogesh Maan, Avinash Deshpande, T. Prabu, Wasim Raja, H. A. Aswathappa + Venkatesh (RAC, Ooty), Rajendra Prasad (MST, Tirupathi)]

THE GALAXY AND THE INTERSTELLAR MEDIUM

Work on waves in accretion discs and astrophysical shear flows is in progress. [S. Sridhar, Mamta Gulati, Nishant Singh + Tarun Saini (IISc. Bangalore)].

Hot molecular cores: The formation of massive stars is preceded by a great build-up in density and succeeded by a release of large amounts of mechanical energy, heat and ionizing radiation to the surrounding dense core. Methanol masers are found to get excited over a brief period in the early stages as the dust mantles in the accretion disk slowly get evaporated and the adsorbed complex molecules get released into gas phase before their eventual destruction. In order to understand the physical and chemical conditions existing in this `hot-core' phase, a molecular line survey with the Mopra telescope was conducted of 83 cores in the mm-wave transitions of $N_2H+$, HNC, HCN and $CH_3OH$ (thermal). It is shown that the combination of methanol and other emission measured with a single dish can be used as a crude `chronometer' for events in the early stages of massive star formation. The derived luminosity-gas mass relation is found to be rather shallow with a spectral index of 0.68 compared to the 3 for stars. [B. Ramesh + C. R. Purcell, S. N. Longmore, M. G. Burton, A. J. Walsh, V. Minier, M. R. Cunningham (U New South Wales, Australia)].

SURVEYS

Images of a steradian of the southern sky at 151.5 MHz using the Mauritius Radio Telescope (MRT) were produced. 2-D homography, a technique ubiquitous in the computer vision and graphics community, was applied to correct the errors in the image domain. Homography estimates a transformation matrix (includes rotation, translation) that accounts for positional errors in the linearly gridded 2-D images, and this technique was applied comparing positions of sources common to MRT and the Molonglo Reference Catalog. Positions of 50 common sources, above 10-σ

(at MRT), were used in a 15° × 15° image patch to set up an over-determined system and solving for the correction matrix. From the analysis it was inferred that systematics are due to errors in the estimates of antenna positions which are of the order of 1 mm per metre; and for a 1 km North-South arm, errors reach half a wavelength. Corrected MRT images are being made available in FITS format at http://www.rri.res.in/surveys. MRT data is currently being processed to obtain images of the remaining 3.5 steradians of the MRT survey. [N. Udaya Shankar & Arvind Nayak].

TOPOLOGICAL PHASE

Polarization optics and topological phases: A convenient formulation of the reciprocity theorem in polarization optics and a simple method for handling double passage problems in polarization optics were proposed. Using this method, (1) an experimental method for separately determining isotropic and topological phase shifts in an arbitrary reciprocal optical medium and (2) A simple method for cancellation, by reflection and double passage, of simple kinds of optical anisotropy in a medium, without the use of a Faraday mirror, were proposed. The second result led to a liquid crystal device which behaves, in reflection, as a phase modulator for light in any polarization state. [R. Bhandari]

INSTRUMENTATION AND SIGNAL PROCESSING

Holography of the 10.4 m telescope: The 10.4 m telescope on campus is being rejuvenated to undertake mm-wave astronomy. The telescope control system was migrated from an old DOS based PC to a new, linux-based machine. The radio holography of the 10.4 m telescope to measure the goodness of the surface was then undertaken using a dual channel receiver system that had been built earlier using commercial LNBCs. The surface measurement accuracy is about 50 microns and overall rms deviation is about 350 microns. While this is good enough to support Q-band observations, it is observed that there are only a few panels that are deviant by large amounts and hence, if they are set properly, the rms deviations can possibly be brought below 200 microns thereby supporting W-band observations. [(B. Ramesh + V. Suresh & B. Sharath Raju (VSP)].

Developing an economical PWM drive: A prototype PWM drive system based on IGBTs and a single-board computer was built and tested as an upgrade of the existing drive system on the 10.4 m telescope. The tests on the azimuth axis show that the prototype can be expanded into a full-fledged, stand-alone, canonical, compact, network-ready and efficient antenna motion control unit. Positioning, tracking and slewing tests have been performed in single motor drive

configuration. Interestingly, the results show that the azimuth time-constant is about 3 seconds as measured from step responses and that, at normal elevations, the back-torque configuration is not necessary in azimuth. A single motor drive performs as well as the existing drive while tracking a source. The prototype is clearly much more compact and power-efficient. [(B. Ramesh + S. Sudarshan (VSP)].

12m Preloaded Parabolic Dish: After the first-light observations using both L-band and C-band receiver systems, fine tuning of mechanical control and receiver systems including synchronization and incorporation of several observing modes was successfully completed. Measurements and characterization of the dish surface and possible deviations under gravity and wind loads were undertaken. Phase coherent holographic measurements using C-band INSAT-3A VSAT signal and a 3.2-m antenna with a C-band feed as a reference element, were conducted. Extensive measurements using photogrammetry technique were made with the help of ISRO scientists. The analysis of the data from these investigations revealed need for increasing rigidity of the backup structure. Simulations were performed to compare the expectation of surface deviations with those observed and the correspondence is encouraging. Based on this experience a 15-m antenna design study has been taken up. [N. Udaya Shankar, P. V. Rishin, Durai Chelvan, C.M. Ateequlla, B.S. Girish, S. Krishna Murthy, H. A. Aswathappa, A. Krishnan, T. S. Mamatha, G. Rajgopala, K. B. Raghavendra Rao, A. Raghunathan, R. Somashekar, + ISRO scientists]

A new Digital backend for the Ooty Radio Telescope (ORT): The FPGA-based digital backend for the ORT has been commissioned at Ooty. This instrument digitizes signals from each of the 22 modules of ORT at IF stage and the raw signal voltages can be either recorded directly or can be used to form beams in desired directions. The software development for analyzing array calibration data and for phasing the array is complete. The several operating modes of this instrument, in both narrow-band and broad-band modes for acquisition and correlation have been verified to work satisfactorily through extensive test observations at the site. Using this system spectral line and single pulse observations have been and are being carried out. [T. Prabu, C. R. Subrahmanya, P. A. Kamini, D. Anish Roshi, A.A. Deshpande, Raju R. Buddy, + Venkatesh (of RAC, Ooty)].

50 MHz system for GMRT: With the view to 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, 4 antennas of GMRT are now equipped with low-frequency feeds and front-end receivers.

Elaborate system tests and concept proving in terms of imaging at low frequencies using GMRT were undertaken. Initial tests using the existing signal and correlation pipelines at GMRT showed satisfactory performance of the low frequency system. In order to enhance the dynamic range and the overall data quality, interferometer observations were conducted by direct digitization of the signals at respective antenna bases. For this purpose suitable signal processing units and data acquisition systems, (ensuring synchronization between the systems at different locations), were developed. [N. Udaya Shankar, K.S. Dwarakanath, Shahram Amiri, R. Somashekar, B. S. Girish, Wences Laus]

An all-sky EOR telescope: Design of an all-sky EOR telescope was continued. Software simulations of the characteristics of a mesh screen (innovative use as a beam splitter) together with antennas are being conducted to study characteristics of such a system. [A. Raghunathan, Ravi Subrahmanyan]

A lightweight cryo-cooler for prime focus operation: After successful tests of a cryo-cooler system on 6.4m telescope where noise temperature of the LNA was reduced to 10K, the second phase of development was undertaken. As a part of this second phase, a pulse-cooled cryo-cooler is being developed in collaboration with the Centre for Cryogenic Technology, IISc. [A. Raghuanthan, + N.B. Anand, N.S. Dinesh, & S. Kasthurirengan (I.I.Sc.)]

A Q-band receiver for the 10.4m radio telescope: Q-band receiver development for the 10.4-m radio telescope, to enable studies of SiO Masers, was completed. With the cryogenically cooled Low Noise Amplifier (LNA) the design goal for noise temperature of about 45 K was achieved. Design of a lens coupling the beam to the receiver horn was completed and its fabrication is nearly over. The 10.4-m telescope's overall system characterization and optimization are in progress. [P. G. Ananthasubramanian, B. Ramesh, K. Chandrashekhara, M. S. Ezhilarasi, T. S. Mamatha]

RRI-GBT Multi-Band Receiver: To enable observations of pulsars simultaneously at several frequency bands to tomographically probe the emission cone, an elegant possibility is proposed. This consists of a self-contained receiver system, with a dual-polarization feed with wide-span spectral response and appropriate electronics for simultaneous sampling of a number of frequency bands, and using it at the focus of a large aperture in general, and at the prime focus of the Green Bank Telescope (GBT) in USA, in particular. To avoid the RFI-prone bands a multi-band response, a modified version of a Kildal feed, as well some other designs of dual polarization feeds were studied and proto-types were tested. The adopted design has shown promising responses in about 8 of the desired frequency bands

and further tests (pattern measurement etc) are in progress. The electronics system will cater to simultaneous sampling of 10 bands tunable in pre-selected (relatively) RFI-free windows. Each of these 10 pipelines will contain RF/IF sections with appropriate filters and an option of recording directly the raw voltage time-sequence in the two polarization channels with either 8-bit or 4-bit digitization. The RF front-end and one of the ten pipelines have been developed and successfully tested in the lab. [Yogesh Maan, C. Vinutha, Avinash Deshpande, Jayanth Chennamagalam, Shahram Amiri, Nikhil Mehta, M. S. Ezhilarsi, S. Sujatha, S. Kasturi, P. Sandhya, K. B. Raghavendra Rao, K. S. Srivani, H. N. Nagaraja, G. Sarabagopalan, Salna Viswanathan, Deepa Dhamnekar, RRI Computer and MES groups, and GBT/NRAO colleagues]

X-ray laboratory: An X-ray laboratory has been built for astronomical instrumentation. Fabrication of a Thomson scattering X-ray polarimeter has been completed and assembly and testing of the same is in progress. A collimator with a flat top response has been designed and tested for the polarimeter experiment. Anti-coincidence logic circuit, HV controller/filter circuits and counters have been designed and tested for the Thomson X-ray polarimeter. A new kind of X-ray detector for photo-electron X-ray polarimeter was also fabricated. Co-incidence logic circuit and HV filter/distribution circuits have been designed, fabricated, and tested for this detector. After some preliminary tests, design modifications have been carried out. For a double crystal X-ray monochromator and polariser, single and double crystal reflections have been tested. A timing calibration system for the LAXPC detectors of ASTROSAT has been developed. Some software development work for the data reduction pipeline and simulation of the energy response of the ASTROSAT-LAXPC has been carried out. [B. Paul, P. V. Rishin, Jincy Devasia (VSP), Marykutty James (VSP), Chetana Jain (Delhi University), G. Rajagopala, H.N. Nagaraja, P. Sandhya, S. Sujatha and support from Durai Chelvan R, C.M. Ateequla and the entire MES on detector design and fabrication].

SATNAV Project: Prototype receivers and signal processing systems have been realized with the help of indigenous industry. Software/firmware development is in progress. [C. R. Subrahmanya]

Low Frequency Radio Survey with the GMRT: As part of a programme to conduct a low frequency radio survey with the GMRT assisted by using the L-band navigation signals for phase calibration, test observations were conducted by modifying real time software at the GMRT observatory to accommodate the transit observations and enhance data acquisition capability to manage large volumes of data (about 50 GBytes/hour) to be recorded during observations. Software tools

have been developed for data quality analyzer and editing/displaying high volume GMRT visibilities. [C. R. Subrahmanya, Peeyush Prasad]

Murchison Wide-field Array (MWA): A conceptual design of the digital receiver system for the Murchison Wide-field Array (MWA) was worked out in collaboration with the Australian National University (ANU), Canberra, Australia. The hardware components of the digital receiver consist of two Analog-to-digital converter (ADFB) boards, a data aggregation and formatting (AgFo) board and a back-plane. The AgFo board and the back-plane are fully designed and constructed by RAL. The ADFB board is based on a design provided by the CSIRO-ICT center, Sydney, and the hardware was duplicated by RAL. The firmware components for the digital receiver needed for the MWA observations are developed at RRI.

The basic function of the digital receiver is to digitize the 16 analog signals from 8 tiles. The signals are sampled at 660 MHz using an 8-bit ADC. A PFB breaks up the 330 MHz band into 256 channels of 1.28 MHz bandwidth. For observations, 25 spectral channels, which amounts to about 32 MHz, from each of the 8 tiles will be selected and send to AgFo board through the backplane. The selected channel data from all the 8 tiles are packetized and transmitted through 3 fibers at about 2.5 Gbps rate to the central processing station. The central processing station of the MWA is located about 3 km away from the location of the tiles.

At RRI, the design, fabrication and testing of the AgFo and ADFB board have been completed. Considerable progress has been made on the firmware development.

RRI team also actively participated in the MWA-expeditions at the telescope site with other collaborators for conducting various system commissioning and validation tests. [Anish Roshi, K. S. Srivani, M. R. Gopal Krishna, T. Prabu, P. A. Kamini, S. Madhavi, Deepak Kumar, R. Somashekar]

LIGHT AND MATTER PHYSICS

Areas of research:

Bose-Einstein condensation
Light Scattering
Laser Cooling and Trapping of Atoms
Ultra-fast Processes, Non-linear Optics
Quantum Interactions
Quantum Optics

BOSE-EINSTEIN CONDENSATION

Work on Bose-Einstein Condensation setup (which had been dismantled, shifted and reassembled last year) has continued. Stable upper MOT operation has been achieved. The parameters for the optimization of the cloud have been determined and the pushing of atoms to the lower MOT taken up. Unfortunately a Vacuum leak developed reducing the cloud lifetime below that suited for transfer to the lower MOT. This is currently being rectified. (Nandan S, Dhana D, Hema R, for sometime Amudha D and Srihari)

In addition, a Hadamard walk protocol is being investigated for implementation in cold atoms (Hema R and Nandan S). A double optical lattice seems an ideal setup where despite poor spatial resolution of detectors a quantum walk may be detected and the displacement measured by examining the population in the two hyperfine ground states of the atom.

Squeezing under three-photon resonance was theoretically investigated by casting the four level N system as a pseudo spin 5/2 system. (Hema R, Archana Sharma, S. Banerjee and R. Srikanth).

LIGHT SCATTERING

In the Light Scattering lab, a novel ferro-fluid material is being investigated for its photonic bandgap (PBG) properties under the influence of external magnetic fields. Experiments initially carried out at the Bhavnagar university Gujarat (by R.V. Mehta, R.J. Patel and B. Chudasuma) were repeated with similar results (Hema R and Shalini V). The forward transmission of light vanishes in these materials leading to robust room temperature light storage systems. The light was found to be retrieved upon removal of the magnetic field. The physical process responsible for this novel behavior is being experimentally and theoretically investigated. (Hema R, Kumar N and Shalini M)

LASER COOLING AND TRAPPING OF ATOMS

A stable MOT at a few micro-Kelvin temperatures is being built for quantum optics experiments. The idea is to trap the very cold atoms in a dipole trap with a far detuned laser or an evanescent field of a fiber and look at fundamental quantum interactions of atoms with light like the induced transparency effect. (Andal N, Project student: Remya M)

ULTRA-FAST PROCESSES AND NON-LINEAR OPTICS

Optical nonlinearity in a variety of nanosystems including Bismuth nanorod suspensions, Platinum-polyvinyl alcohol films, and ion-beam synthesized Ag nanoclusters, CdS quantum dots, copper nano-composite glasses and ferrofluids were investigated. All these materials exhibited nonlinear optical transmission to various degrees so that they have the potential for device applications. A significant outcome was the report of efficient optical limiting in ferrofluids (Reji Philip, Suchand Sandeep C.S., and external collaborators).

A novel optical diode was developed experimentally (Reji Philip, M. Anija, and collaborators from UMass); additionally, subluminal and superluminal light propagation studies also were conducted in Bacteriorhodopsin (Reji Philip, collaborators from UMass).

QUANTUM INTERACTIONS

Two vacuum systems and several laser systems have been set up to pursue the simultaneous cooling and trapping of Rubidium (Rb) and Potassium atoms. In both the vacuum systems a Magneto-Optic Trap (MOT) has been realized with Rb. The Rb MOT numbers realized are as follows: number of atoms = 10 million, MOT lifetime is 12 s. The MOT temperature is less than 100 micro-kelvin. Work on the potassium MOT is in progress [A. Sharma, K. Ravi and S. A. Rangwala]

The possibility of integrating an Ion Trap with a MOT was investigated. Numerical simulations of the ion trap were successful and led to a concrete design for the practical realization of the Ion Trap. This design is now implemented on the experiment and the Rb MOT has been created in this system. Preliminary measurements show that the action of ion-trapping fields leaves the MOT unaffected. Further experiments are required to confirm these results and electronic circuits for this purpose are under production. [K. Ravi, A. Sharma and S. A. Rangwala]

In Ultra-cold Molecule Physics, molecule detection remains a very challenging problem. We have devised a solution for this using a Fabry-Perot cavity in vacuum. Unfortunately the appropriate cavity design that is compatible with ultra

high vacuum required for these experiments and the relatively large finesse requirement proved to be a technological challenge. During the year there has been success with these cavities outside vacuum with a design that can go into vacuum, which is now being implemented. [A. Sharma, K. Ravi and S. A. Rangwala]

The molecular spectroscopy of the Rb-Rb dimer was studied in spectroscopy cells with the idea of using spectroscopy and light collection techniques to make an accurate determination of the monomer to dimer concentrations. [A. Sharma, K. Ravi and S.A. Rangwala + V. Acosta, D. Budker (U.C. Berkeley, USA) + D.F. Jackson-Kimball (C.S.U. Eastbay, USA)]

Large changes were observed in atomic absorption of resonant light on the application of strong electric fields across paraffin coated alkali vapor cells. Several peculiar aspects emerged during this study. Complementary studies have been executed at CSU Eastbay and RRI to investigate these observations. A probable mechanism has been proposed for consistent interpretation of the data. [K. Ravi, A. Sharma, S. A. Rangwala + V. Prabhudesai (TIFR, Mumbai), + K. Nguyen, D.F. Jackson-Kimball (C.S.U. Eastbay, USA) + D. Budker (U.C. Berkeley, USA)]

Neutral ground-state rubidium atoms were confined in a macroscopic trap based on purely electric fields. For this, three electrostatic field configurations are alternated in a periodic manner. The rubidium is pre-cooled in a magneto-optical trap, transferred into a magnetic trap, and then translated into the electric trap. The electric trap consists of six rod-shaped electrodes in a cubic arrangement, giving ample optical access. Up to 10^5 atoms have been trapped with an initial temperature of around 20 micro-Kelvin in the three-phase electric trap. The observations are in good agreement with detailed numerical simulations. [S. A. Rangwala + T. Rieger, P. Windpassinger, G. Rempe, P. W. H. Pinkse (Max Planck Institute for Quantum Optics, Germany)]

QUANTUM OPTICS

The simultaneous absence of linear absorption through Electro-magnetically Induced Transparency (EIT) effect and the presence of higher order non-linearities in an atomic system irradiated by multiple fields is not well understood. The higher order non-linear interactions in these systems are not of a perturbative nature since the leading linear term is identically zero. The particular phenomenon of Kerr non-linearity in gaseous Rubidium samples at room temperature has been investigated experimentally and theoreically. Threshold behavior was found for this non-linearity in the frequency domain. It is believed

that it is the first such effect seen in these systems. The results are currently being investigated [Andal N, Abheera Hazra (VSP) and Sandhya S. N (IIT Kanpur)]

IN-HOUSE DEVELOPMENTAL WORK

The LAMP group, as in previous years, continues to do extensive In-house developmental activities. A very stable External Cavity Diode Laser (ECDL) system has been developed [S. Rangwala and his PhD students: Ravi K. and Arijit S.], using the expertise available in our precision workshop. In the BEC group, new MOT with the MOT coils inside the chamber has been built [Hema R., Deepak P. & Smitha J.]. This allows for lower operational currents. In the Laser Cooling Lab a new grating mount for their ECDL system was designed and it has been given to CMTI, Bangalore [Andal N. & Remya M]. Extensive electronics and instrumentation development were carried out to facilitate the activities in BEC and Quantum Interactions Labs respectively [Meena M. S. & Sujatha S.]

SOFT CONDENSED MATTER

Areas of research: Liquid Crystals
- Synthesis
- Structure, Phase Behaviour and Physical Properties
- Displays

Colloids
Amphiphilic Systems
Surface Science and Nanocomposites

LIQUID CRYSTALS

Synthesis

Novel mesogens with bent-core molecules: A new series of seven-ring achiral bent-core compounds derived from 5-methoxyisophthalic acid was synthesized and the liquid crystalline properties exhibited by it was investigated. Four different types of mesophases were observed in these compounds. A very uncommon transition between a ferroelectric polar columnar phase and an antiferroelectric racemic smectic phase was also observed. [S. Radhika and B.K. Sadashiva]

Three new homologous series of compounds derived from methyl 3,5-dihydroxybenzoate were synthesized. In one of these compounds a transition from an antiferroelectric columnar phase to an antiferroelectric smectic C phase was observed for the first time. [S. Umadevi, S. Radhika and B.K. Sadashiva]

Novel triphenylene-anthraquinone-based liquid crystalline trimers: Two series of novel triphenylene-anthraquinone based symmetric discotic liquid crystalline trimers with varying side chain length have been synthesized. Their mesophase behaviour was studied using polarizing optical microscopy and differential scanning calorimetry. [Satyam Kumar Gupta and Sandeep Kumar]

Mesomorphism of discotic liquid crystalline pentamers: Discotic pentamers of triphenylene and anthraquinone were synthesized. Their mesophase behaviour was characterized by polarizing optical microscopy, differential scanning calorimetry and X-ray diffraction techniques. [Hari Krishna Bisoyi and Sandeep Kumar]

Structure, phase behaviour and physical properties

Binary mixtures of bent-core and rod-like molecules: Flexoelectric polarization can be induced in a liquid crystalline medium by splay and bend distortions of the director field. The molecular shape and electric quadrupole moments can influence the flexoelectric coefficients. In order to investigate these effects the flexoelectric coefficients and elastic constants of liquid crystalline materials made up of rod-like molecules and their mixtures with bent-core molecules have been measured. [B. Kundu, R. Pratibha and N.V. Madhusudana]

Ion distribution between two charged plates confining a smectic liquid crystal: A model based on Poisson-Boltzmann theory has been developed by including a one dimensional periodic potential due to the smectic layering. In a closed system the ion distribution in the smectic phase is found to follow closely that in the nematic phase, except for the oscillations arising from the periodic smectic potential. However, in samples in contact with an external reservoir there is an influx of ions due to the minimum in the periodic potential, effectively reducing the screening length compared to that in the nematic phase. [Arun Roy and N.V. Madhusudana]

Pattern formation and domain coarsening in electroconvection of liquid crystals: Certain liquid crystals exhibit electroconvection when subjected to an external electric field, leading to different types of patterns. Formation of topological defects in these systems is currently an important topic in condensed matter physics, promising to shed some light on the early stages of evolution of the universe. Experiments on such pattern formation and their dynamical evolution under rapid changes of an external control parameter are currently underway. [Meenal Gupta and Arun Roy]

Experimental studies of transient fluctuation theorems using liquid crystals: Recently a fundamental theorem known as the Transient Fluctuation Theorem has been proposed which generalizes the second law of thermodynamics for small systems. An experimental test of this theorem has been set up using a spatially extended liquid crystalline system. [Soma Datta and Arun Roy]

Lehman rotation of chiral nematic droplets: Detailed quantitative measurements have been made on the Lehman rotation of optically trapped chiral nematic liquid crystal droplets, subjected to plane-polarized light. These droplets are mini-motors which rotate because of the temperature gradient across the droplet caused by illumination on one side of the droplet. [Marjan Mosallaeipour, Yashodhan Hatwalne + Sharath Ananthamurthy (Bangalore University)]

Displays

Development of new addressing techniques for driving matrix displays: A gray scale technique that requires less number of time intervals and voltages as compared to the successive approximation technique was developed and applications for Indian and US patents have been filed. The technique has been demonstrated by displaying 64 gray shades in a 32x32 matrix display. [A.R. Shashidhara, T.N. Ruckmongathan and R.N. Roopesh (visiting student)]

Nearly uniform gray shade to gray shade response times with a small deviation of about 5% from the average has been obtained in a display addressed with discrete cosine transform. Encouraged by this, the possibility of obtaining uniform response times is being explored by revisiting the wavelet based addressing techniques and modifying the waveforms to obtain uniform switching. [A.R. Shashidhara and T.N. Ruckmongathan]

COLLOIDS

Effects of deformation on the relaxation time spectra of aging clay suspensions: The stress relaxation behavior on application of step strains to aging suspensions of the synthetic clay laponite was investigated. The slow relaxation mode is found to be unaffected as the step strain is increased by up to 300%. For higher strains the relaxation time of this mode increases with strain, which can be interpreted as overaging. [Ranjini Bandyopadhyay + Y. M. Joshi (IIT Kanpur)]

Falling ball viscometer experiments to calculate the microviscosity of aging clay suspensions: A falling ball viscometer was set up to estimate the microviscosity of aging laponite suspensions. The microviscosity values obtained from these experiments for suspensions aged less than four hours were found to be much lower than the bulk viscosity estimates, implying that the ball rejuvenates the boundary layer surrounding it as it falls through the suspension. For suspensions that were aged longer, the microviscosity values were higher than the bulk viscosity values. [Ranjini Bandyopadhyay + Rema Govindarajan (JNCASR, Bangalore)]

AMPHIPHILIC SYSTEMS

Instabilities of a swelling lipid bilayer stack: The complex process of preparation of giant unilamellar lipid vesicles using the electroformation method is not understood. To understand the mechanisms involved, simpler experiments without an electric field have been performed. Novel instabilities of the lipid bilayer stack have been observed and mechanisms responsible for them have been proposed. [Tripta Bhatia, Yashodhan Hatwalne and Madan Rao]

Influence of strongly bound counterions on the phase behaviour of ionic surfactants: Strongly bound counterions are known to significantly influence the phase behaviour of ionic surfactants. A novel isotropic phase has been observed in some of these systems, which is structurally different from isotropic sponge phases seen in other systems. X-ray scattering experiments are underway to determine the structure of this phase. [Sajal Ghosh, Antara Pal, V. A. Raghunathan + A. K. Sood (IISc, Bangalore)]

Counterion induced structures of DNA-surfactant complexes: The salt-induced melting of these complexes has been studied using microscopy and X-ray diffraction techniques. Certain salts are found to lead to novel structures of these complexes, which have been determined from the diffraction data. [Sajal Ghosh, A. V. Radhakrishnan, V. A. Raghunathan, + A. K. Sood (IISc, Bangalore), G. Pabst (Austrian Academy of Sciences, Graz, Austria)]

SURFACE SCIENCE AND NANOCOMPOSITES

Dispersions of ferroelectric nanoparticles in liquid crystalline media: These dispersions have been made in nematic and smectic A liquid crystalline phases. At low concentrations of the particles the Freederickz transition threshold and the dielectric constants are found to be influenced by the addition of small amounts of these particles. At higher particle concentrations arrays of droplets are found embedded in the medium. This concentration regime, which has not been previously studied, is being investigated in detail. [Ispita Satpathy, Meenal Gupta and R. Pratibha]

Discotic mesogen-DNA complex at the air-water interface: These complexes were prepared by adding a small amount of DNA in the subphase. The collapse pressure of these films is found to increase by 25% and their limiting area to

decrease by 22% compared to films of the pure disotic mesogen. It has been possible to form films of varying thickness, from a single layer to 20 layers thick. The electrical conductivities of these films were studied using current-sensing atomic force microscopy. A possible mechanism for electron transport in such films has been proposed. [Alpana Nayak and K. A. Suresh]

Monolayers of an amphiphilic dimer: Films of an amphiphilic dimer of disc-shaped molecules was formed at the air-water and solid-air interfaces. Studies using surface manometry and Brewster angle microscopy showed the coexistence of solid and gas phases at large area per molecule (> 200 A^2), and a single solid phase at lower area per molecule. The monolayer collapsed at 165 A^2 with a collapse pressure of 12 mN/m. The collapse of the monolayer was studied as a visco-elastic relaxation of the monolayer. It is found that the constitutive equations developed earlier for plastic flow in monolayer collapse can be applied to the present case. [Bharat Kumar and K. A. Suresh]

Discotic columnar liquid crystals – Ferrocene conducting nanocomposites: The dispersion of electron-deficient ferrocenium ions was studied in the electron rich medium of two different triphenylene based columnar hexagonal liquid crystalline phases. They were found to form donor-acceptor systems thereby enhancing the quasi-one-dimensional conductivity of the liquid crystalline medium, without altering the structure of the hexagonal columnar phase. [P. S. Suresh Kumar, Sandeep Kumar and V. Lakshminarayanan]

Electron transfer studies of proteins immobilized on self-assembled monolayers: The direct electron transfer and electrocatalysis of enzymes such as myoglobin, glucose oxidase and horse radish peroxidase dispersed in self-assembled monolayers were studied. The electrochemically immobilized enzyme electrodes were found to provide excellent electrochemical response that can be attributed to the formation of very dense enzyme clusters on the electrode surface. [D. H. Nagaraju and V. Lakshminarayanan]

Formation of self-assembled monolayers composed of guest-host inclusion complexes of cyclodexrins: Self-assembled monolayers of guest-host inclusion complexes of cyclodextrins and thiocholesterol, as well as of naphthalenethiol and cyclodexrin were prepared. They were characterized using electrochemical methods as well as scanning tunneling microscopy and atomic force microscopy. [Rakesh Pandey and V. Lakshminarayanan]

Layer-by-layer assembly of polyelectrolytes under potential control: Layer-by-layer assembly of polyelectrolytes have been formed on gold substrates under the

application of an electrochemical potential. Atomic force microscopy studies show that the application of the potential during deposition produces a smoother film. [Rakesh Pandey and V. Lakshminarayanan]

Magnetic properties of carbon nanotube-nematic liquid crystal composites: These composites are found to have a negative diamagnetic anisotropy and their susceptibility shows a marked increase near room temperature, indicating a large enhancement in the nematic order parameter due presumably to the polar ordering of the nematic liquid crystal. [D. Vijayaraghavan and Sandeep Kumar]

THEORETICAL PHYSICS

Areas of Research: Condensed Matter and Statistical Physics
Physics in Biology
Gravitation
Optics, Quantum Mechanics & General Physics

Condensed Matter and Statistical Physics

Microscopic model of a particle pump: In an earlier study, a particle ratchet model was introduced, where a system of diffusing hard-core particles was subjected to a AC driving field. It was shown that DC currents could be generated in these systems. These results have recently been extended and generalized in various directions and the analytic treatment considerably simplified. [Abhishek Dhar, Rahul Marathe + Kavita Jain (JNCASR, Bangalore)].

Transport in mesoscopic systems: The problem of transmission of electrons between two non-interacting leads, through a region where they interact (quantum dot), has been addressed. In a particular model of spinless electrons, using the Lippmann-Schwinger scattering theory, the two-particle problem was solved exactly. For the N-particle case, the scattering state was obtained within a 2-particle scattering approximation and the change in the Landauer current resulting from the interactions on the dot is computed. [Abhishek Dhar, Dibyendu Roy + Diptiman Sen (IISc., Bangalore)].

Effect of interactions on Anderson localization: In the presence of disorder in non-interacting systems, it is known that either some or all Eigen states of the system become spatially localized. This causes the system to behave as an insulator. The presence of interactions among the modes can cause delocalization and may lead to an insulator-to-conductor transition. This transition has been studied extensively in the electronic case where the question as to whether this transition takes place at a finite value of the interaction strength is still not settled. This question was addressed, in the phonon context where it was found that a very small amount of interaction causes a transition to the conducting phase. [Abhishek Dhar + Joel Lebowitz (Rutgers University, USA)].

Equilibration in classical harmonic networks: The problem of current magnification and general problem of equilibration in classical harmonic networks has been studied. The current magnification phenomena is well studied in

Quantum mesoscopic systems (for electrons) and even experimentally realized. It is believed that this is a purely quantum phenomena. This phenomenon occurs for a system composed of a loop with asymmetric arm lengths connected to two leads. It has been shown that there is a possibility of such a phenomenon for a single sound frequency as well as in the presence of heat bath (band of frequencies) with a pinning potential. Thus it is not a quantum phenomenon but a wave phenomenon. The problem of equilibration in such networks has been studied and it was shown that a system with asymmetric arm lengths and bond or mass disorder always equilibrates but the symmetric one does not. [Rahul Marathe, Abhishek Chaudhuri + A.M. Jayannavar (IOP, Bhubaneshwar), Kavita Jain (JNCASR, Bangalore)]

Heat current: Heat conduction across an ordered oscillator chain with harmonic inter-particle interactions and also onsite harmonic potentials has been considered. The onsite spring constant is the same for all sites excepting the boundary sites. The chain is connected to Ohmic heat reservoirs at different temperatures. An exact formula for the heat current in the limit of system size N to infinity has been obtained. Results for the quantum mechanical case have also been obtained where the temperature dependence of the heat current was studied. The crossover from ballistic to diffusive thermal transport has been demonstrated using the quantum Langevin dynamics methods. [Dibyendu Roy, Abhishek Dhar].

An exact Green-Kubo like relation has been obtained for the linear response heat current in an open system. Unlike the usual Green -Kubo formula, the derivation here is rigorous, and the result of much more general validity. [Anupam Kundu, Abhishek Dhar + Onuttom Narayan (University of California, Santa Cruz, USA)].

Jamming Dynamics in Grain Mixtures: Jamming in granular mixtures has been studied from the novel point of view of extended hydrodynamics. Using a hard sphere binary mixture model it has been predicted that a few large grains are expected to get caged more effectively in a matrix of small grains compared to a few small grains in a matrix of larger ones. A similar effect has been experimentally seen in the context of colloidal mixtures. [Supurna Sinha].

Physics in Biology

Elasticity of Stiff Biopolymers: A statistical mechanical study of stiff polymers is presented, motivated by experiments on actin filaments and the considerable current interest in polymer networks. Simple, approximate analytical forms for the force-extension relations are obtained and compared with numerical treatments. The important role of boundary conditions in determining force-extension relations

is noted. The theoretical predictions presented may be tested against single molecule experiments on neuron-filaments and cytoskeletal filaments like actin and microtubules. This work is motivated by the buckling of the cytoskeleton of a cell under compression, a phenomenon of interest to biology. [Joseph Samuel, Abhijit Ghosh and Supurna Sinha].

Free Energy of Twisted Semiflexible Polymers: The role of fluctuations in single molecule measurements of torque-link ($t - lk$) curves is investigated. For semiflexible polymers of finite persistence length (i.e. polymers with contour length L comparable to the persistence length LP), the torque versus link curve in the constant torque (isotorque) ensemble is distinct from the one in the constant link (isolink) ensemble. Thus, the conceptually interesting issue of a "free energy of transition" in switching ensembles while making torque-link measurements is encountered. The dependence on the semiflexibility parameter L/LP of this extra contribution to the free energy which shows up as an area in the torque-link plane is predicted. This can be tested against future torque-link experiments with single biopolymers. The inequivalence of torque-link curves for a stiff polymer is studied and explicit analytical expressions are presented for the *distinct* torquelink relations in the two ensembles and the free energy difference in switching ensembles in this context. The predictions of the work can be tested against single molecule experiments on torsionally constrained biopolymers. [Supurna Sinha].

Gravitation

Causal Order and Topology: A rigourous correlation between continuum homology and a locally finite covering was found. New results on the connection between poset topology and spacetime topology were found. [Sumati Surya].

The Relationship between Way-below and the Chronological order in Strongly Causal Spacetimes: Martin and Panangaden showed that a globally hyperbolic spacetime is a bicontinuous poset. A possible generalisation to spacetimes that are merely strongly causal has been investigated. [Sumati Surya + Prakash Panangaden (McGill University, London)].

Numerics on Causal Set Homology: The spatial homology of causal sets that are manifoldlike has been computed numerically for a large class and the numerics systematically analysed. Earlier theoretical results required the assumption of large sprinkling density, but the numerics seems to suggest that there is a strong correlation between causal set topology and continuum topology even at relatively

weak sprinkling densities. [Sumati Surya + Seth Major (Hamilton College, USA) and David Rideout (Perimeter Institute, Canada)].

Decoherent histories approach to Time: The Problem of Time in Quantum Gravity using an alternative formulation to Quantum Theory called ”Decoherent Histories” has been examined. Class operators that respect the Hamiltonian constraint have been obtained, and their decoherence properties were examined in order to assign probabilities. The second topic was the recovery of continuum geometry from a fundamentally discrete underlying spacetime (aka causal set). A new proposal of spacelike distance (for causal sets that correspond to Minkowski) that did not suffer from previous problems is proffered. Closest neighbors and lengths of curves were deduced, even in the case where spacetime was curved. [Petros Wallden + David Rideout (Perimeter Institute, Canada)].

Information is not lost in the evaporation of 2D black holes : This work was a continuation of a long terms research project still in progress. In previous work, 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 and the proposed resolution of the puzzle was within a unitary quantum framework. A crucial ingredient was the anticipated existence of a quantum extension of spacetime beyond the classical singularity. Crucial issues, regarding a proof of the extension from robust semiclassical considerations and its connection with the vanishing of energy flux as well the distinction between *information* and *energy*, were elucidated. Further, standard objections in the literature to a unitary picture of evaporation were analysed in the context of the work and subtle loopholes in these standard arguments were shown to exist and it was shown that these arguments did not apply to the work. [Madhavan Varadarajan + Abhay Ashtekar and Victor Taveras (Penn State, USA)].

Polymer Parametrised Field Theory : A Dirac quantization of Parametrise Field Theory on the cylinder was constructed using a representation and techniques similar to those used in Loop Quantum Gravity (LQG). Several fine points regarding the non- trivial spatial topology were resolved and robust results regarding semiclassical states were derived. The work provides a ‘perfect toy model’ for LQG issues. The relation of this quantization to the standard Fock quantization constitutes work in progress. [Madhavan Varadarajan + Alok Laddha (IMSc., Chennai)].

Higher signal harmonics, LISA’s angular resolution and dark energy: The angular resolution of the Laser Interferometer Space Antenna (LISA) for binary

supermassive black holes (SMBH) based on using only the dominant harmonic of the binary SMBH signal in the templates is generally believed to be not good enough to identify the host galaxy or galaxy cluster. However, when higher signal harmonics are included in assessing the parameter estimation problem, the angular resolution increases by more than a factor of 10 thereby making it possible for ISA to identify the host galaxy/galaxy cluster. Thus, LISA's observation of certain binary SMBH coalescence events could constrain the dark energy equation of state to within a few percent, comparable to the level expected from other dark energy missions. [Bala R. Iyer, S. Sinha + K.G. Arun (LAL, Orsay), B. S. Sathyaprakash (Cardiff University) and C. van den Broeck (Cardiff University)].

Radiation reaction in the 2.5PN waveform from inspiralling binaries in circular orbits: The contributions of the radiation reaction force in the 2.5 post-Newtonian (PN) gravitational wave polarizations for compact binaries in circular orbits are recomputed and it is shown that all contributions from radiation reaction in the 2.5PN waveform are negligible (5PN modification of the orbital phase). [Bala R. Iyer + L. Kidder (Cornell, USA) and L. Blanchet (IAP, Paris)].

Third post-Newtonian gravitational wave polarisations and associated spherical harmonic modes for inspiralling compact binaries in quasi-circular orbits: The gravitational waveform generated by inspiralling compact binaries moving in quasi-circular orbits is computed at the third post-Newtonian (3PN) approximation employing an algorithm of the multipolar post-Minkowskian formalism to compute relations between the radiative, canonical and source multipole moments at 3PN order. This not only provides accurate templates for the data analysis of gravitational wave inspiral signals in laser interferometric detectors but also the associated spin-weighted spherical harmonic decomposition to facilitate comparison and match of the high post-Newtonian prediction for the inspiral waveform to the numerically-generated waveforms for the merger and ringdown. [Bala R. Iyer, S. Sinha + L. Blanchet (IAP, Paris) and G. Faye (IAP, Paris)].

The Ricci Flow in General Relativity: Research is being carried out into physical applications of the Ricci flow in general relativity. The Ricci flow is a heat equation for metrics, which tends to smooth out geometries and wipe out memory of the initial conditions. The analogy between the Ricci flow and the approach of a physical system to thermal equilibrium is being studied as a method of understanding black hole entropy. [Joseph Samuel and Sutirtha Roy Chowdhury].

Geometric Flows and Black Hole Entropy: Perelman has given a gradient formulation for the Ricci flow, introducing an entropy function which increases monotonically along the flow. A thermodynamic analogy is pursued and Ricci flow ideas are applied to general relativity. Is Perelman's entropy related to (Bekenstein Hawking) geometric entropy as familiar from black hole thermodynamics? From a study of the fixed points of the flow, it is concluded that Perelman entropy is not connected to geometric entropy. However, it is noted that there is a very similar flow which does appear to be connected to geometric entropy. The new flow may find applications in black hole physics suggesting, for instance, new approaches to the Penrose inequality. [Joseph Samuel and Sutirtha Roy Chowdhury].

Energy, Entropy and the Ricci Flow: Ricci flow techniques are applied to general relativity. Three-dimensional asymptotically flat Riemannian metric is viewed as a time symmetric initial data set for Einstein's equations. The evolution of the area A and Hawking mass MH of a two-dimensional closed surface under the Ricci flow is studied. The physical relevance of this study derives from the fact that in general relativity the area of apparent horizons is related to black hole entropy and the Hawking mass of an asymptotic round 2-sphere is the ADM energy. It is suggested that there may be a maximum principle which governs the long-term existence of the asymptotically flat Ricci flow. [Joseph Samuel and Sutirtha Roy Chowdhury].

Surface Tension and the cosmological constant: The analogy noticed earlier between the surface tension of membranes and the cosmological constant in general relativity is being pursued. This analogy leads to the conclusion that Sorkin's proposal regarding the cosmological constant is far more general than the context in which it was proposed. Work is in progress to exploit these directions. [Joseph Samuel and Supurna Sinha].

Deflection of ultra slow light by Earth's gravity on laboratory length scale: The high speed of light in vacuo together with the weakness of Earth's gravity rules out any experimental detection of gravitational deflection of light on the laboratory length scale. Recent advances in coherent nonlinear optics that produce ultra slow light in highly dispersive media with group velocities down to _ 102 ms−1, or even less, however, open up this possibility. The work presents a theoretical study for a possible laboratory observation of the deflection of such an ultra slow light in the highly dispersive medium under Earth's gravity. The general relativistic calculation is based on the Gordon optical metric modified so as to include dispersion. The calculated linear vertical deflection turns out to be _ 0.1

mm for a horizontal traversal of 0.5 m and a group speed vg _ 102 ms−1. [N. Kumar].

Optics, Quantum Mechanics & General Physics

Decohering d-dimensional quantum resistance: The Landauer scattering approach to 4-probe resistance is revisited for the case of a d-dimensional disordered resistor in the presence of decoherence. The treatment is based on an invariant imbedding equation for the evolution of the coherent reflection amplitude coefficient in the length of a 1-dimensional disordered conductor, where decoherence is introduced through an outcoupling, or stochastic absorption of the wave amplitude into the side (transverse) channels, and its subsequent incoherent re-injection into the conductor, which is essentially in the spirit of B¨uttiker's reservoir-induced decoherence. [Dibyendu Roy and N. Kumar]

Random phase reservoir and quantum resistor - the Lloyd model: Phase disorder is introduced in a 1D quantum resistor through the formal device of 'fake channels' distributed uniformly over its length such that the out-coupled wave amplitude is re-injected back into the system, but with a phase which is random. The associated scattering problem is treated via invariant imbedding in the continuum limit, and the resulting transport equation is found to correspond exactly to the Lloyd model. The latter has been a subject of much interest in recent years. This conversion of the random phase into the random Cauchy potential is a notable feature of our work. It is further argued that the phase-randomizing reservoir, as distinct from the well known phase-breaking reservoirs, induces no decoherence, but essentially destroys all interference effects other than the coherent back scattering. [Dibyendu Roy and N. Kumar]

Resistance without Resistance – an anomaly: The elementary 2-terminal network consisting of a resistively (R-) shunted inductance (L) in series with a capacitatively (C−) shunted resistance (R) with R = qL/C, is known for its nondispersive dissipative response, *i.e.*, with the input impedance Z0(!) = R, independent of the frequency (!). The properties of a novel equivalent network derived iteratively from this 2-terminal network by replacing everywhere the elemental resistive part R with the whole 2-terminal network has been examined. This replacement suggests a recursion Zn+1(!) = f(Zn(!)), with the recursive function f(z) = (i!Lz/i!L + Z) + (z/1 + i!Cz). This recursive map has two fixed points - an unstable fixed point Z_u = 0, and a stable fixed point Z_u = R. Thus, resistances at the boundary terminating the infinitely iterated network can now be made arbitrarily small without changing the input impedance Z1(= R). This,

therefore, leads to realizing in the limit n ! 1 an effectively dissipative network comprising essentially the non-dissipative reactive elements (L and C) only. Hence the oxymoron - resistance without resistance! This is best viewed as a classical anomaly akin to the one encountered in turbulence. Possible application as a formal decoherence device - the *fake channel* - is briefly discussed for its quantum analogue. [N. Kumar]

Characterization of radiation as an electromagnetic wave or a particle - a criterion: The wave-particle duality of radiation from a source in the electromagnetic spectrum is well known. A criterion is proposed to determine when the radiation will predominantly exhibit the properties of a particle and when will it behave as a wave. An experiment is suggested to validate the criterion. [N. Kumar and G.S. Sanyal].

Quantum Covers in Quantum Measure Theory. The existence of strong constraints on the sets of zero quantum measure in the histories space of a quantum theory was demonstrated for a strongly positive decoherence functional. It suggests that the notion of a classical covering of a measure space be replaced by a quantum cover which forms an antichain in the powerset lattice. [Sumati Surya, Petros Wallden].

Returning to Europa: Can traces of surficial life be detected? : There is at present a possibility for returning to Europa with LAPLACE (Blanc *et al.*, 2008), a mission to Europa and the Jupiter System for ESA's Cosmic Vision Programme. The question of habitability by the identification of reliable bioindicators is a major priority. Arguments have been presented in favor of data analysis that addresses fluctuations of the data retrieved, rather than its mean. For this purpose the significance of deviations of Sulphur abundances relative to normal (meteoritic) values is reconsidered. The fluctuation test proposed in the context of future missions to Europa may well be appropriate to a laboratory experiment with Sulphur-reducing bacteria with the corresponding isotopic fractionation. [J. Chela-Flores and N. Kumar]

Open quantum systems: The reduced dynamics of a multi-qubit system, interacting with a bath of harmonic oscillators, is considered. The system-bath interactions are taken to be both of QND as well as of dissipative type. The multi-qubit system dynamics results in a number of interesting collective behavioral patterns, both coherent as well as incoherent. This is specialized to the case of two qubits where use is made of the dynamics to calculate the qubit entanglement in a number of different scenarios. [S. Banerjee, R. Srikanth + V. Ravishankar (IIT, Kanpur)].

Open quantum systems in quantum computation and quantum information:
The work done on the reduced dynamics of the multi-qubit system is used to compute the geometric phase of a two-qubit system interacting with its bath via both QND as well as dissipative interactions. [S. Banerjee and R. Srikanth].

Augmenting the unitary transformation which generates a quantum walk by a generalized phase gate G is a symmetry for both noisy and noiseless quantum walk on a line, in the sense that it leaves the position probability distribution invariant. However, this symmetry breaks down in the case of a quantum walk on an n-cycle, and hence can be regarded as a probe of the walk topology. Noise, modeled here as phase flip and generalized amplitude damping channels, tends to restore the symmetry because it classicalizes the walk. However, symmetry restoration happens even in the regime where the walker is not entirely classical, because noise also has the effect of desensitizing the operation G to the walk topology. This provides a nontrivial instance of the interplay between geometry and noise in a quantum information processing system. Discussed are methods for physical implementation and the wider implications to condensed matter systems. [S.Banerjee, R. Srikanth, C.M. Chandrasekar and P. Rungta].

Open quantum systems and foundations of quantum mechanics: An information theoretic interpretation of the number-phase complementarity in atomic systems has been developed, where phase is treated as a continuous positive operator valued measure (POVM). The relevant uncertainty principle is obtained numerically in terms of a weighted knowledge sum involving these variables. It is pointed out that complementarity in these systems departs from mutual unbiasedness in two significant ways: first, the maximum knowledge of a POVM variable is less than log (dimension) bits; second, surprisingly, for higher dimensional systems, the unbiasedness may not be mutual but unidirectional in that phase remains unbiased with respect to number states, but not vice versa. Finally, the effect of non-dissipative and dissipative noise on these complementary variables for a single-qubit system has been studied. [S. Banerjee and R. Srikanth].

Nonadiabatic corrections to neutrino propagation in matter: The work involves corrections beyond the standard adiabatic approximation in a general situation in neutrino physics. Solving the full neutrino evolution equation in matter exactly is analytically very difficult because the of the fact that density in general is not constant but varies in
space (or in time). Aspects related to the appearance of a geometric phase term in case of neutrinos are being studied. Additionally, astrophysical configurations in which such a geometric phase may be realized are being examined. [Poonam Mehta, Joseph Samuel and Supurna Sinha]

COMPUTERS

Key servers were upgraded to accommodate increased workloads. New servers were added to run compute intensive applications like 'Matlab' and 'Mathematica'.

First phase replacement of CRT monitors with energy efficient TFT monitors was undertaken.

Wireless network deployment was undertaken to cover more areas on campus.

Upgrades and suitable steps to safeguard against data loss were implemented. Software upgrades where required to all key systems and services were 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 RRI Library, which is endowed with rich collections of both print and electronics versions of books and journals, provides need based information services to its users. To share resources, a close liaison is maintained with many related institutes in the country and formed consortia through FORSA. Brief activities of the library are highlighted as follows:

Library Resources Development

- Books: Scientific and technical : 401; Gratis:44
  Hindi : 14
- Bound volumes of journals : 1093
- Scientific and Technical Journals subscribed : 177

  Print + Online : 77
  Online : 64
  Consortia subscriptions : 24
  IOC No cancellation Option : 19
  Online Archives : 5
- General Periodicals - English : 14
  Hindi : 5
  Kannada – gratis : 1
- News Papers -English : 6
  Hindi : 3
  Kannada : 1

The total collection at the end of the reporting period is: Books – 24876; Bound volumes of journals: 36563 and the total library collection is: 61,439.

Strengthening Library Facilities: The Library was strengthened with the following materials during the period:

- For security reasons, 8 channels DVR and 8 CCTV cameras were fitted around the library building;
- The Map Room has been renovated for creating Digital Library;
- One Library Counter got fabricated and installed at the entrance of the library.

Library Hardware/software updates

- Libsys updates was received and installed with enhanced features – ver.4, Rel.5.7.1
- Added 8 PCs for use in the Digital Library and for use by the library staff;
- Deployed two PCs for OPAC access by users;
- One Wireless Access Point has been added in the main reading area of the library for use by walk-in users of laptops;
- Four laptops and one Digital Camera were added in the library for library users

Consortia activities

Under FORSA activities, the following consortia subscriptions were renewed for the year 2008:

- FORSA Consortium for Nature Publishing consisting: Nature, Nature Physics, Nature Materials, Nature Photonics (all online) with 3 – 8 participants;
- Indian Astrophysics Consortium for Springer Physics and Astronomy Journals Print + online – five participants;
- University of Chicago Press and FORSA Consortium for Astrophysical Journal and Suppl. Series, Online – two participants and Print + Online – six participants;
- Institute of Physics Publishing and FORSA Consortium for Astronomy Journal – Online – two participants and Print + Online – six participants;
- FORSA Consortium for Scientific American Archive Online;
- FORSA Open Consortium for Lecture Notes in Physics; and
- IEEE/IEE Electronic Library though INDEST Consortium (IEL Online).

Digital Library activities

- New additions are continuously made to the RRI Digital Repository including research papers and other miscellaneous publications. Action has been initiated for digitization of papers published between 1948 and 1971 with authors other than C.V.Raman and is being posted in the IR;

- Digitization of Ph.D. theses has been completed. Consent from all authors/guides is being attempted to post all the theses in the IR.

- In order to make wider accessibility of RRI Digital Repository, a brief note was prepared and sent to the Chief Editor, Journal of the Raman Spectroscopy and it will be covered in the April 2008 issue.

- Details of postings done in the Repository:

- Astronomy and Astrophysics	-	699
- Light and Matter Physics	-	110
- Soft Condensed matter	-	870
- Theoretical Physics	-	366
- C.V.Raman's collected works	-	502
- News Papers Clippings	-	752
- Miscellaneous publications	-	135

OTHER ACTIVITIES

Ph. D.

Awarded

Atish P. Kamble	An investigation of Gamma Ray Burst Collimation *Jawaharlal Nehru University, New Delhi*

Submitted

Santanu Kumar Pal	Synthesis characterization and self-assembly of functionalized soft nanomaterials *Jawaharlal Nehru University, New Delhi*
Sajal Kumar Ghosh	Influence of strongly bound counterions on the phase behaviour of ionic amphiphiles *Jawaharlal Nehru University, New Delhi*
Sutirtha Roy Chowdhury	Geometric flows and black hole entropy *Jawaharlal Nehru University, New Delhi*
Anija M.	Investigation of nonlinear effects induced in condensed matter by intense laser fields *Jawaharlal Nehru University, New Delhi*
Abhijit Ghosh	Semiflexible polymer elasticity *Jawaharlal Nehru University, New Delhi*

Gandhi Memorial Lecture

The Gandhi Memorial Lecture for 2007, entitled "Demystifying professionalism: the Gandhian approach", was delivered by Mr. S. Bunker Roy, Founder & Director, Barefoot College, Tilonia, Rajasthan on 30 January 2008.

Hindi Cell

As a part of the implementation of official language at the Institute, a study programme initiated earlier was continued. Many employees are currently enrolled for this programme. Official language workshops were also conducted to enhance the usage skills of Hindi. Many other requirements for usage of official languages in administration are being implemented. This process is being accelerated to attain the goals set.

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 63-82).

Visiting Student Programme (VSP)

Visiting Student Programme introduced in the year 2007 is aimed at offering research experience to highly motivated students who are pursuing their undergraduate or master's studies. Students seeking such opportunities mainly during their summer vacations are continued to be supported under this programme.

During the period of the visit, these students work closely with at least one staff member of the Institute on a suitable project, or on a part of a project, as appropriate. The students' work and the interaction with the staff and the graduate students at the Institute are expected to provide them a flavour of the research pursuits at the Institute, in general, and a first-hand experience in research, in particular.

During the year, 65 students from different parts of the country attended the programme. The average duration was around 3-4 months.

Conferences/Seminars and Meetings

The staff of the Institute visited various institutions in India and abroad and attended conferences and presented papers. In addition, lectures were given by them at other places. Details are available at Annexure II (pages 83-104).

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 105-114).

Journal Club Meetings

Forty meetings were held during the year. Preprints as well as recently published papers dealing with topics of current interest were reviewed in the meetings (Annexure IV, Pages 115-118).

And, as in the past, several informal Group meetings in Theoretical Physics, Light & Matter Physics, Soft Condensed Matter and Astronomy & Astrophysics were held on a regular basis throughout the year.

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 54-62).

In-House Meeting

An In-House Meeting, which is an annual feature at the Institute, was held on 10, 11 and 12 May, 2007 where the staff and students presented their research work. The presentations were followed by lively scientific discussions with critical comments and suggestions relevant to the reported research from the members.

General

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

PLAN (Recurring & Non-Recurring)	Rs.2,300.00 lakhs
NON-PLAN (Recurring)	Rs. 223.00 lakhs
Total :	Rs. 2,523.00 lakhs

COUNCIL

Dr. K. Kasturirangan Chairman	Member of Parliament, Rajya Sabha, & Director, National Institute of Advanced Studies, Bangalore
Prof. P. K. Kaw	Director, Institute of Plasma Research Gandhinagar 382 428
Mr. K.P. Pandian	Joint Secretary & Financial Adviser Ministry of Science & Technology Government of India, New Delhi 110 016
Prof. V. Radhakrishnan	Member-Secretary Raman Research Institute Trust Bangalore 560 080
Dr.T.Ramsami	Department of Science & Technology Ministry of Science & Technology New Delhi 110 016
Prof. Ravi Subrahmanyan	Director, Raman Research Institute Bangalore 560 080
Prof. O. Siddiqi	TIFR; National Centre for Biological Sciences GKVK Campus, Bangalore 560 065
Prof. A.K. Sood	Department of Physics Indian Institute of Science Bangalore 560012

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. Ravi Subrahmanyan	Director, Raman Research Institute Bangalore 560 080
Prof. V. Radhakrishnan	Member-Secretary Raman Research Institute Trust Bangalore 560 080

STAFF

RAVI SUBRAHMANYAN
Director

N. KUMAR
Homi Bhabha Distinguished Professor

V. RADHAKRISHNAN
Distinguished Professor Emeritus

N.V. Madhusudana
INSA Scientist

THEORETICAL PHYSICS

Research

Sumati Surya (Coordinator)
B.R. Iyer
Joseph Samuel
Madan Rao
Madhavan Varadarajan
Abhishek Dhar
N. Kumar

Research Associate

Supurna Sinha

Post-Doctoral Fellows

Subhashish Banerjee
Abhishek Chaudhuri (up to 31.10.2007)
Petros Wallden
Poonam Mehta (from 15.2.2008)

Secretary

G. Manjunatha

Research Students

Abhijit Ghosh
K.G. Arun (up to 25.1.2007)
G. Kripa
Mohd. Arif Kamal
Mohd. S.S. Qusailah (up to 30.5.2007)
Rahul Marathe
Siddhartha Sinha *(JAP)*[*]
Anupam Kundu
Chaitra Hegde
P.R. Venkatramanan
Sutirtha Roy Chowdhury
Suva Roy (from 16.7.2007)
Pragya Srivastava (from 16.7.2007)
Anirban Polley (from 17.7.2007)
Anagha Datar (from 16.7.2007)
Chandrakant Mishra *(JAP)*[*] (from 17.8.2007)

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[*] *Joint Astronomy Programme*

LIGHT AND MATTER PHYSICS

Research
N. Andal (Coordinator)
Sadiqali Rangwala
Hema Ramachandran
Reji Philip

Technical Assistant
M.S. Meena

Research Students
M. Anija (up to 19.12.2007)
Archana Sharma
Arijit Sharma
Nandan Satapathy
K. Ravi
Suchand Sandeep
Deepak Pandey
Seunghyun Lee (from 16.7.2007)
Tridib Ray (from 24.7.2007)

SOFT CONDENSED MATTER

Research
V.A. Raghunathan (Coordinator)
B.K.Sadashiva
Arun Roy
V. Lakshminarayanan
R. Pratibha
Ranjini Bandyopadhyay
T.N. Ruckmongathan
Sandeep Kumar
K.A. Suresh
Yashodhan Hatwalne
Pramod Pullarkat (from 14.11.2007)

Scientific/Technical
A. Dhason
Mohammed Ishaq

Research Students
Alpana Nayak
Antara Pal
Bharat Kumar
Biburanjan Sarangi
Brindaban Kundu
Dibyendu Roy
Dipanjan Bhattacharya (up to 31.12.2007)
Harikrishna Bisoyi
A. Jayakumar
D.H. Nagaraju
A.V. Radhakrishnan
S. Radhika
S. Madhukar (from 16.7.2007)

SOFT CONDENSED MATTER
(Contd.)

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

Visiting Scientist
G. V. Shivashankar

Post-Doctoral Fellows
Soma Datta (from 1.6.2007)
Meenal Gupta (from 2.1.2008)

Research Students
Rakesh Kumar Pandey
Sajal Kumar Ghosh
Santanu Kumar Pal (up to 14.1.2008)
Satyam Kumar Gupta
P. Suresh Kumar
Tripta Bhatia

Secretary
K. Radhakrishna

ASTRONOMY & ASTROPHYSICS

Research
Shiv Kumar Sethi (Coordinator)
Anish Roshi
R. Bhandari
Biman B. Nath
A.A.Deshpande
Dipankar Bhattacharya
B. Ramesh
C.S.Shukre (up to 30.6.2007)
S. Sridhar
C.R.Subrahmanya
N. Udaya Shankar
Biswajit Paul

Research Associates
Sunita Nair (up to 25.5.2007)
Mousumi Das

Post-Doctoral Fellows
Nirvikar Prasad (up to 31.3.2008)

Research Students
Atish Kamble (up to 31.7.2007)
Peeyush Prasad
Raju Ramakrishna Baddi
Ruta Kale
Shahram Amiri
Wasim Raja
Harsha Raichur (*JAP*)
Yogesh Maan (*JAP*)
Mamta Gulati (*JAP-17.8.2007*)
Nishant Kumar Singh (*JAP-17.8.2007*)
Kanhaiya Lal Pandey (*from 10.7.2007*)
Seshagiri Rao R.V. (*from 9.7.2007)*

Honorary Visiting Professor
P. Sreekumar

Secretary
V. Vidyamani

RADIO ASTRONOMY LAB

Scientific/Technical

A.A. Deshpande *(In-Charge)*
N. Udaya Shankar
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 (up to 14.8.2006)
P.V. Rishin
P. Sandhya
G. Sarabagopalan
P.S. Sasi Kumar
R. Somashekar
S. Sujatha
C. Vinutha
Deepak Kumar (from 3.10.2007)
K.S.Srivani (from 1.6.2007)

Visiting Scientist

A. Krishnan

Secretary

R. Mamatha Bai

GAURIBIDANUR TELESCOPE

Technical

H.A. Aswathappa

Support Staff

Bheema Naik
Gangaram
M. Muniyappa
Papanna
N. Raja Rao
R.P. Ramji Naik
Ranoji Rao
Shivarudraradhya
Thippanna
Venkataswamy
N.R.Srinath (from 1.4.2007)

LIBRARY

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

GRAPHIC ARTS

Raju Varghese

Support Staff

K. Chowdasetty
C. Elumalai

MECHANICAL ENGINEERING SERVICES

C.M. Ateequlla, *In-Charge*
M. Achankunju
L. Charles Paul
V. Dhamodharan
R. Durai Chelvan
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
D. Sunand
S. Sunderaj
M. Suresh Kumar
V. Venu

TRANSPORT

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

COMPUTERS

R. Nanda Kumar (In-charge)
Jacob Rajan
B. Sridhar

ADMINISTRATION

K. Krishnama Raju, *Admin. Officer*
K. Raghunatha, *Dy. Admin. Officer*
L.P. Kumar
Marisa D'Silva
K. Radha
S.R. Ramasubramaniyan
V. Raveendran
R. Ganesh
V.S.Shailaja
G.V. Indira

ACCOUNTS

K.R.Shankar (up to 31.5.2007)
P.V.Subramanya (*Accounts Officer*)
V. Raghunath

INTERNAL AUDIT

R. Ramesh

PURCHASE

S. Srinivasa Murthy, *Purchase Officer* (*from 31.5.2007*)
B. Srinivasa Murthy
M. Prema

STORES

S. Rajashekaran Nair (*up to 31.5.2007*)
C.N.Ramamurthy, *In-Charge* (*from 1.6.2007*)
M.V.Subramanyam

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
K.N. Srinivas
K.G.Narasimhalu
T. Subramaniyam Naidu
M. Ramesh
N. Narayanappa (*In-charge*)
D.B. Padmavathy
P.C. Prabhakar
N. Puttaswamy

AMENITIES (Guest Houses & Hostels)

C.V.Bhargavan
Mangala Singh
Muniratna
T.Naganna
N.Narayanappa (*In-charge*)
D.B.Padmavathy
P.C.Prabhakar
N. Puttaswamy

MEDICAL

Consultant Paediatrician

Dr.M.R. Baliga

Consultant Physicians

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

Technician

R.Shanthamma

UPKEEP

Hanumantha
Jayamma
K.N. Kawalappa
D. Krishna
C. Lakshamma
T. Mahadeva
T. Murali
Narayana
A. Ramanna
Ranjithamma
A. Sarojamma
Sidde Gowda
V. Venkatesh
M. Venkateshappa *from 1.4.2007*)

HORTICULTURE

V. Krishnappa, *Consultant (up to 30.9.2007)*
Bylappa
Govind K. Kundagol
Lingegowda
D. Mahalinga
Mailarappa
Marappa
D. Muniraja
S. Muniraju
Rahamathulla Khan
Rangalakshmi
Varalakshmi

SECURITY

V. Jayaraman, *In-Charge*
B.M. Basavarajaiah
U.A. Earappa
H. Gangaiah
K. Govindappa (retd. 31.5.2006)
Joseph Kunjachan
Keshavamurthy
Balaji (*Consultant*)
S.Nagaraja (*Consultant)*
K. Krishnappa
Munihobalaiah
K. Pushparaj
O.M. Ramachandra
G. Ramakrishna
M. Sannaiah
Suresha
H. Vaderappa

V I S I T O R S

V.V.Sreedhar Indian Institute of Technology Kanpur	8 January–7 June 2007
Subharti Ray Inter University Centre for Astronomy & Astrophysics, Pune	6-11 April 2007
Daniel R. Stinebring Oberlin College, Oberlin	6-15 April 2007
Tirthabir Biswas Penn State University USA	13 April 2007
David P Rideout Imperial College, London, United Kingdom	1-18 May 2007
Jayaram N. Chengalur National Centre for Radio Astronomy Pune	16-17 May 2007
Alok Laddha Institute of Mathematical Sciences, Chennai	17-28 May 2007
Susmita Chakravorty Inter-University Centre for Astronomy & Astrophysics, Pune	20-25 May 2007
Sanjoy Roychowdhury Physical Research Laboratory Ahmedabad – 380 009	24-25 May 2007
Shrirang S. Deshingkar Harish-Chandra Research Institute Allahabad	7-15 June 2007

Ken Baldwin Research Institute in Physical Sciences Australian National University	13-17 June 2007
Lisa George University of Queensland Brisbane, 4072, Queensland Australia	12-14 June 2007
Shyamal Biswas Indian Institute for Cultivation of Science Jadavpur, Kolkata	22 June 2007
Manjari Bagchi Tata Institute of Fundamental Research Mumbai	10-20 June 2007
Kanan Kumar Datta Indian Institute of Technology Kharagpur	23 June-1 July 2007
Ramanath Cowsik Washington University USA	29 June-14 July 2007
Dana S. Balser National Radio Astronomy Observatory USA	9-14 July 2007
Aaron Chippendale Australia Telescope National Facility Australia	11-29 July 2008
Luc Blanchet Institut d'Astrophysique de Paris France	30 June-5 July 2007

Chandra S. Yelleswarapu University of Massachusetts Boston, USA	4-5 August 2007
R. J. Patel Bhavnagar University Gujarath	6-9 August 2007
V. Ravishankar Indian Institute of Technology, Kanpur	13 August 2007 – 17 July 2008
Boby Joseph Institute of Physics Bhubaneswar	16-18 August 2007
Vincent Rodgers University of Iowa, Iowa USA	21 August 2007
A.R.P.Rau Lousiana State University Baton Rouge, USA	21-24 August 2007
Vijay Kumar Indian Institute of Science Bangalore	28 August 2007
Shyamal Biswas Indian Institute for Cultivation of Science Jadavpur, Kolkata	31 August - 1 October 2007
Colin Benjamin Centre de Physique Théorique CNRS, France	3-4 September 2007
Govind S. Krishnaswami Spinoza Institute & Institute for Theoretical Physics, Utrecht University The Netherlands	6 September 2007

Tamoghna Das SN Bose National Center for Basic Sciences, Kolkata	10-30 September 2007
Anders Kastberg Umea University, Department of Physics Umea, Sweden	20 September – 15 October 2007 & 9-19 January 2008
Himanshu Kumar Poswal & Shanavas K. V. Bhabha Atomic Research Centre Mumbai	8-13 September 2007
Prateek Sharma University of California Berkeley, USA	2-4 October 2007
Colin Lonsdale Massachussets Institute of Technology USA	4-7 October 2007
U. Desai Goddard Space Flight Centre USA	10-12 October 2007
B. Karthikeyan National Institute of Technology Trichy	7-14 October 2007
Subrata Chattopadhyay Centre for Development of Advanced Computing Bangalore	10 October 2007
Patel Chudasama Bhavnagar University Bhavnagar 364 002	15-20 October 2007

Kumar S Gupta Saha Institute of Nuclear Physics Kolkata	15-21 October 2007
Ashish Asgekar Birla Institute of Technological Sciences Goa	17-21 October 2007
Soobash Daiboo Mauritius Radio Telescope University of Mauritius Mauritius	25 October – 30 November 2008
Narayanan T. Cochin University of Science & Technology Cochin 682 022	6-8 November 2007
Abhishek Khunte Pune University, Pune	25-27 November 2007
Subroto Mukerjee University of California, Berkeley	4-6 December 2007
Natan Andrei Rutgers University, USA	4-7 December 2007
Tamas Borzsonyi Központi Fizikai Kutató Intézet Budapest, Hungary	8-13 December 2007
Raj Gandhi Harish-Chandra Research Institute Allahabad	11-14 December 2007
Carsten Tschierske Martin-Luther University Halle, Germany	11-15 December 2007

Emily Freeland University of Wisconsin-Madison USA	16-19 December 2007
Andrzej A. Zdziarski N. Copernicus Astronomical Center, Poland	20-22 December 2007
Tanmoy Laskar Cambridge University United Kingdom	16-21 December 2007
Shamik Gupta Tata Institute of Fundamental Research Mumbai	17-23 December 2007
Onuttam Narayan University of California Santa Cruz, USA	20-24 December 2007
Anupam Madhukar University of Southern California USA	23-24 December 2007
Keiichi Kaneto Kyushu Institute of Technology Kitakyushu, Japan	25-27 December 2007
Heath Jones Anglo-Australian Observatory Australia	28 December 2007-13 January 2008
Vicky Safouris Australian National University Australia	28 December 2007-13 January 2008
P.Viswanath Laboratoire Interdisciplinaire sur 1'Organisation Saclay, France	2-4 January 2008

V. N. Pandey, Netherlands Institute for Radio Astronomy Netherlands	2-6 January 2008
Manjari Baghchi Tata Institute of Fundamental Research Mumbai	6-19 January 2008
Sandeep Krishna Center for Models of Life, Niels Bohr Institute University of Copenhagen	8 January 2008
K.G.Arun Laboratoire de I' Acceleratuer Lineaire Universite Paris Sud, Paris	11-17 January 2008
Mark Tuominen University of Massachusetts Boston, USA	17-18 January 2008
DVGLN Rao University of Massachusetts Boston, USA	18-23 January 2008
Debasish Chaudhuri Max-Planck-Institute for the Physics of Complex Systems, Nothnitzer Strasse, Dresden, Germany	20-25 January 2008
Goutam Tripathi Institute of Physics Bhubaneshwar	21-22 January 2008
D. Narasimha Tata Institute of Fundamental Research Mumbai	21 January-4 February 2008
Chinmay Das Department of Physics and Astronomy University of Leeds, UK	22 January 2008

P. Ajith Max-Planck-Institute for Gravitational Physics (AEI) Hannover, Germany	23-24 January 2008
A. Gopakumar Theoretisch-Physikalisches Institut Friedrich-Schiller-Universitat, Jena, Germany	24-25 January 2008
Alok Laddha Institute of Mathematical Sciences Chennai	29 January-15 February 2008
Leonid Levitov Massachusetts Institute of Technology Cambridge, USA	3-5 February 2008
Ajay Patwardhan Bombay University Mumbai	17-18 February 2008
C. Sengupta National Centre for Radio Astronomy, Pune	19 February - 6 March, 2008
Harvinder Kaur Jassal Harish-Chandra-Research Institute Allahabad	27 February - 10 March 2008
J.S. Bagla Hyderabad Research Institute Allahabad	27 February - 10 March 2008
Siddharth Malu Inter University Centre for Astronomy & Astrophysics Pune	1-7 March 2008

G. Swarup National Centre for Radio Astronomy Pune	2-6 March 2008
Mr. Girish Kulkarni Harishchandra Research Institute Allahabad	3-7 March 2008
Raja Paul University of California USA	4 March 2008
John Osborne University of Durham, Durham United Kingdom	4-31 March, 2008
Navinder Singh Institute of Physics Bhubaneshwar	9-22 March 2008
Irina Pushkina Spinoza Institute Utrech University, The Netherlands	10-13 March 2008
Jozef Gruska Masaryk University Czech Republic	12-17 March 2008
Erika Andersson Heriot-Watt University Edinburgh, UK	17 March 2008
Dipak Munshi Institute of Astronomy Cambridge	20-26 March 2008
Shri Kulkarni Caltech, USA	25 March 2008

ANNEXURE I

PUBLICATIONS

Papers in Journals

1. A search for H I 21 cm absorption toward the highest redshift (z~5.2) radio-loud objects
   Carilli CL*; Wang, Ran*; van Hoven MB*; Dwarakanath KS; Chengalur JN*, Wyithe, Stuart*
   Astronomical Journal **133**, 2841, 2007

2. Variable x-ray absorption toward the gravitationally-lensed blazar PKS 1830-211
   Dai, Xinyu*; Mathur, Smita*; Chartas, George*; Nair, Sunita; Garmire, Gordon P*
   Astronomical Journal **135**, 333, 2008

3. The dark nature of GRB 051022 and its host galaxy
   Castro-Tirado AJ*; Bremer M*; Kamble Atish P; Bhattacharya D; and 18 co-authors
   Astronomy and Astrophysics **475**, 101, 2007

4. Magnetic field near the central region of the galaxy: rotation measure of extragalactic sources
   Roy S*; Pramesh Rao A*; Subrahmanyan Ravi
   Astronomy and Astrophysics **478**, 435, 2008

5. Detailed study of the GRB 030329 radio afterglow deep into the non-relativistic phase
   van der Horst A J*; Kamble, Atish P; Resmi L; Wijers RAMJ*; Bhattacharya D; Scheers B*; and 5 co-authors
   Astronomy and Astrophysics **480**, 35, 2008

6. GRB 030329: 3 years of radio afterglow monitoring
   van der Horst AJ*; Kamble, Atish; Wijers RAMJ; Resmi L; Bhattacharya D; Rol E*; Strom R*; Kouveliotou C*; Oosterloo T*; Ishwara-Chandra CH*
   Philosophical Transactions of The Royal Society A **365,** 1241, 2007

7. Quasi-periodic oscillations in XTE J0111.2-7317: Highest frequency among the HMXB pulsars
   Kaur, Ramanpreet*; Paul, Biswajit; Raichur, Harsha; Sagar, Ram*
   Astrophysical Journal **660**, 1409, 2007

8. Can we detect anisotropic shape of quasar H II regions during reionization through the small-scale redshifted 21 cm power spectrum?
   Sethi SK; Haiman, Zoltan*
   The Astrophysical Journal **673**, 1, 2008

9. Hydrogen $2p - 2s$ transition: signals from the epochs of recombination and reionization
   Sethi SK; Subrahmanyan Ravi; Roshi, Anish D
   Astrophysical Journal **664**, 1, 2007

10. WSRT ultradeep neutral hydrogen imaging of galaxy clusters at $z \approx 0.2$: A pilot survey of Abell 963 and Abell 2192
    Verheijen, Marc*; Van Gorkom JH*; Szomoru A*; Dwarakanath KS; Poggianti BM*; Schiminovich D*
    Astrophysical Journal **668**, L9, 2007

11. Errors in near-field radioholography
    Morris D
    IET Microwaves, Antennas and Propagation **1**, 586, 2007

12. Search for orbital motion of the pulsar 4U 1626-67: Candidate for a neutron star with a supernova fall-back accretion disk
    Jain, Chetana*; Paul, Biswajit; Joshi, Kaustubh*; Dutta, Anjan*; Raichur, Harsha
    Journal of Astrophysics and Astronomy **28**, 175, 2007

13. Pulse phase dependence of the magnetar bursts
    Jain, Chetana*; Dutta, Anjan*; Paul, Biswajit
    Journal of Astrophysics and Astronomy **28**, 185, 2007

14. Orbital evolution measurement of the accreting millisecond X-ray pulsar SAX J1808.4-3658
    Jain, Chetana*; Dutta, Anjan*; Paul, Biswajit*
    Journal of Astrophysics and Astronomy **28**, 197, 2007

15. Cylindrical Hall-MHD waves: A nonlinear solution
    Krishan V+; Varghese BA*
    Solar Physics **247,** 343, 2008

16. Light propagation through a coiled optical fiber and Pancharatnam phase
    Bhandari, Rajendra
    Journal of the Optical Society of American B **24**, 2343, 2007

17. Merging of a massive binary due to ejection of bound stars - II
Zier C
Monthly Notices of the Royal Astronomical Society **378**, 1309, 2007

18. H I imaging of galaxies in X-ray bright groups
Sengupta, Chandreyee; Ramesh B; Dwarakanath KS
Monthly Notices of the Royal Astronomical Society **378**, 137, 2007

19. Spatial and kinematical lopsidedness of atomic hydrogen in the Ursa Major group of galaxies
Angiras RA*; Jog CJ*; Dwarakanath KS; Verheijen MAW*
Monthly Notices of the Royal Astronomical Society **378**, 276, 2007

20. Type IIP supernova SN 2004et: a multiwavelength study in X-ray, optical and radio
Misra, Kuntal*; Pooley, Dave*; Chandra, Poonam*; Bhattacharya D; Ray, Alak K*; Sagar R*; Lewin, Walter HG*
Monthly Notices of the Royal Astronomical Society **381**, 280, 2007

21. Observations of the optical afterglow of GRB 050319: The wind-to-ism transition in view
Kamble, Atish; Resmi L; Misra, Kuntal*
Astrophysical Journal **664**, L5, 2007

22. The Australia telescope 20 GHz (AT20G) survey: the bright source sample
Massardi, Marcella*; Ekers RD*; Murphy, Tara*; Subrahmanyan, Ravi; and 13 co-authors
Monthly Notices of the Royal Astronomical Society **384**, 775, 2008

23. PKS B1545-321: bow shocks of a relativistic jet?
Safouris V*; Subrahmanyan, Ravi; Bicknell GV*; Saripalli, Lakshmi
Monthly Notices of the Royal Astronomical Society **385**, 2117, 2008

24. IC 5063: AGN driven outflow of warm and cold gas
Morganti R*; Holt J*; Saripalli, Lakshmi; Osterloo TA*; Tadhunter CN*
Astronomy & Astrophysics **476,** 735, 2007

25. The AGN and gas disc in the low surface brightness galaxy PGC045080
Das, M; Kantharia N*; Ramya S*; Prabhu TP*; McGaugh, SS* and Vogel SN *
Monthly Notices of the Royal Astronomical Society, **379**, 11, 2007

26. A versatile multi-functional glass adapter for use in chemistry laboratories
Dhason A; Ajayakumar S*
Journal **45**, 65, 2007

27. A bilayer model for the chevron structures in surface-stabilised antiferroelectric liquid crystals
Europhysics Letters **80**, 16004, 2007

28. Stripes in biaxial smectic-A liquid crystals arising from spontaneous surface charge modulation
Pratibha R; Madhusudana NV; Sadashiva BK
Europhysics Letters **80**, 46001, 2007

29. Gray shades in RMS responding displays with wavelets based on the slant transform
Ruckmongathan TN; Nadig, Deepa S*; Ranjitha PR*
IEEE Transactions on Electron Devices **54**, 663, 2007

30. Twist viscoelastic coefficient of novel thiol terminated alkoxy-cyanobiphenyl nematic liquid crystals
Agarwal, Amit K; Suresh KA; Pal, Santanu K; Kumar, Sandeep
Journal of Chemical Physics **126**, 164901, 2007

31. Electron transfer studies on cholesterol LB films assembled on thiophenol and 2-naphthalenethiol self-assembled monolayers
Pandey, Rakesh K; Suresh KA; Lakshminarayanan V
Journal of Colloid and Interface Science **315**, 528, 2007

32. Orthogonal matrices for multi-line addressing
Ruckmongathan TN
Journal of Display Technology **4**, 6, 2008

33. Line-by-line addressing of RMS responding matrix displays with wavelets
Ruckmongathan TN; Arun V; Kumar, Babu Hemanth
Journal of Display technology **3**, 413, 2007

34. On the application of a modified self-organizing neural network to estimate stereo disparity
Venkatesh YV*; Raja SK*; Kumar A Jaya
IEEE Transactions On Image Processing **16**, 2822, 2007

35. Films of novel mesogenic molecules at air-water and air-solid interfaces
Nayak, Alpana; Suresh KA; Pal, Santanu Kumar; Kumar, Sandeep
Journal of Physical Chemistry B **111**, 11157, 2007

36. Discogen - DNA complex films at air-water and air-solid interfaces
Nayak, Alpana; Suresh KA
Journal of Physical Chemistry B **112**, 2930, 2008

37. Techniques with low hardware complexity of the driver electronics
Ruckmongathan TN
Journal of the SID **15**, 1121, 2007

38. Liquid crystalline properties and dependence of transition temperature on the length of the flexible alkylene spacer of symmetric dimers composed of bent-core units
Umadevi S; Sadashiva BK
Liquid Crystals **34**, 673, 2007

39. Magnetic susceptibility studies on a lyotropic liquid crystal system- the role of bound water
Vijayaraghavan D; Suresh KA
Molecular Crystals and Liquid Crystals **478**, 15, 2007

40. Gold-nanoparticle-assisted laser perturbation of chromatin assembly reveals unusual aspects of nuclear architecture within living cells
Mazumder A*, Shivashankar GV+
Biophysical Journal **93,** 2209, 2007

41. Distinct levels in the nanoscale organization of DNA-histone complex revealed by its mechanical unfolding
Soni GV*; Brar L*; Hameed FM*; Raychaudhuri A K*; Shivashankar GV+
Applied Physics Letters **90** 163904, 2007

42. A reply to comments on“ Direct measurement of the oscillation frequency in an optical-tweezers trap by parametric excitation" Physical Review Letters, 1995, Vol.95, p193902
Natarajan V*; Kumar N
Physical Review Letters **98**, 189803, 2007

43. Anomalous temperature dependence of elastic constants in the nematic phase of binary mixtures made of rodlike and bent-core molecules
Kundu, Brindaban; Pratibha R; Madhusudana NV
Physical Review Letters **99**, 247802, 2007

44. Novel conducting nanocomposites: synthesis of triphenylene-covered gold nanoparticles and their insertion into a columnar matrix
Kumar, Sandeep; Pal, Santanu Kumar; Suresh Kumar P; Lakshminarayanan V
Soft Matter **3**, 896, 2007

45. Synthesis of monohydroxy-functionalized triphenylene discotics: Green chemistry approach
Pal, Santanu Kumar; Bisoyi, Hari Krishna; Kumar, Sandeep
Tetrahedron **63**, 6874, 2007

46. Microwave-assisted synthesis of rufigallol and its novel room-temperature liquid crystalline derivatives
Bisoyi, Hari Krishna; Kumar, Sandeep
Tetrahedron Letters **48**, 4399, 2007

47. On the propensity of phosphotidylglycerols to form interdigitated phases
Pabst G; Danner S; Karmakar S; Deutsch G. and Raghunathan VA
Biophysical Journal, **93**, 513, 2007

48. Discotic-functionalized Nanomaterials
Kumar Sandeep
Synthesis and Reactivity in Inorganic, Metal-organic and Nano-Metal Chemistry, **37**, 327, 2007

49. Films of novel mesogenic molecules at air-water and air-solid interfaces
Nayak A, Suresh KA, Pal SK, Kumar S
Journal of Physical Chemistry B, **111**, 11157-61 (2007)

50. Synthesis and mesomorphic properties of banana-shaped monomers containing 2,7-naphthalene as central core
Md. Lutfor Rahman, Asik J, Kumar S, Tschierske C
Electronic Liquid Crystal Communications, **1**, 23 October 2007

51. Green chemistry approach to the synthesis of liquid crystalline materials
Kumar Sandeep, Bisoyi Hari Krishna and Pal Santanu Kumar
Molecular Crystals and Liquid Crystals, **480**, 287, 2008

52. Rufigallol-based self-assembled supramolecular architectures
Kumar Sandeep
Phase Transitions, **81**, 113, 2008

53. Microwave-assisted facile synthesis of liquid crystalline nonsymmetrical hexaalkoxytriphenylenes containing a branched chain and their characterization
Bisoyi Hari Krishna and Kumar Sandeep
Journal of Physical Organic Chemistry, **21**, 47, 2008

54. Nonlinear optical scattering and absorption in bismuth nanorod suspensions
Sivaramakrishnan S*; Muthukumar VS*; Sivasankara Sai S*; Venkataramaniah K*; Reppert, Jason*; Rao, Apparao M*; Anija M; Philip Reji; Kuthirummal N*
Applied Physics Letters **91**, 093104, 2007

55. Passive all-optical diode using asymmetric nonlinear absorption
Philip, Reji; Anija M; Yelleswarapu, Chandra S.; Rao DVGLN
Applied Physics Letters **91**, 141118, 2007

56. Nonlinear optical properties of *p*-(*N*,*N*-dimethylamino)dibenzylideneacetone doped polymer
Kiran A J*; Nooji S R*; Udayakumar D*; Chandrasekharan K*; Kalluraya B*; Philip, Reji; Shashikala H D*; Adhikari A V*
Materials Research Bulletin **43,** 707, 2008

57. General circuits for indirecting and distributing measurement in quantum computation
Gupta M*; Pathak A*; Srikanth R; Panigrahi PK*
International Journal of Quantum Information **5**, 627, 2007

58. Observation of three-photon absorption and saturation of two-photon absorption in amorphous nanolayered Se/As_2S_3 thin film structures
Adarsh KV*; Sangunni KS*; Sandeep, CS Suchand; Philip, Reji
Journal of Applied Physics **102**, 026102, 2007

59. Excitonic transitions and off-resonant optical limiting in CdS quantum dots stabilized in a synthetic glue matrix
Kurian, Pushpa Ann*; Vijayan C*; Sathiyamoorthy K*; Sandeep, CS Suchand; Philip, Reji
Nanoscale Research Letters **2**, 561, 2007

60. Nonlinear optical properties of MeV and keV ion beam synthesized Ag nanoclusters
Joseph B*; Sandeep, CS Suchand; Sekhar BR*; Mahapatra DP*; Philip Reji
Nuclear Instruments and Methods in Physics Research B **265**, 631, 2007

61. Ultrafast optical power limiting in free-standing Pt-polyvinl alcohol nanocomposite films synthesized *in situ*
Karthikeyan B*; Anija M; Venkatesan P*; Sandeep, CS Suchand; Philip, Reji
Optics Communications **280**, 482, 2007

62. Optical and nonlinear optical properties of copper nanocomposite glasses annealed near the glass softening temperature
Karthikeyan B; Anija M; Sandeep, CS Suchand; Nadeer, TM Muhammad*; Philip, Reji
Optics Communications **281**, 2933, 2008

63. Slow light in bacteriorhodopsin solution using coherent population oscillations
Yelleswarapu C S*; Philip, Reji; Arando, Francisco J*; Kimball, Brian R*; Rao DVGLN*
Optics Letters **32**, 1788, 2007

64. Coherent population oscillations and superluminal light in a protein complex
Yelleswarapu CS; Laoui Samir; Philip Reji; Rao DVGLN
Optics Express **16,** 3844, 2008

65. Gaussian-to-Levy statistical crossover in a random amplifying medium: Monte Carlo simulation
Sharma, Divya; Ramachandran, Hema; Kumar N
Optics communications **273**, 1, 2007

66. Characteristics and benchmarks of entanglement of mixed states: The two-qubit case
Bhardwaj, Shanthanu*; Ravishankar V
Physical Review A **77**, 022322, 2008

67. Optimizing the discrete time quantum walk using a SU(2) coin
Chandrasekhar C M*; Srikant R; Laflamme, Raymond*
Physical Review A **77**, 032326, 2008

68. Hot QCD equations of state and relativistic heavy ion collisions
Chandra, Vinod*; Kumar, Ravindra*; Ravishankar V
Physical Review C **76**, 054909, 2007

69. Trapping of neutral rubidium with a macroscopic three-phase electric trap
Rieger T*; Windpassinger P*; Rangwala, Sadiq A; Rempe G*; Pinkse PWH*
Physical Review Letters **99**, 063001, 2007

70. Chirality-induced budding: A raft-mediated mechanism for endocytosis and morphology of Caveolae?
Sarasij R C; Mayor, Satyajit*; Rao, Madan
Biophysical Journal **92**, 3140, 2007

71. A note on the radiation reaction in the 2.5PN waveform from inspiralling binaries in quasi-circular orbits
Kidder, Lawrence E*; Blanchet, Luc*; Iyer BR
Classical and Quantum Gravity **24**, 5307, 2007

72. Geometric flows and black hole entropy
Samuel J; Roy Chowdhury, Sutirtha
Classical and Quantum Gravity **24**, F47, 2007

73. Energy, entropy and the Ricci flow
Samuel, Joseph; Roy Chowdhury, Sutirtha
Classical and Quantum Gravity **25**, 035012, 2008

74. Resistance without resistance: An anomaly
Kumar N
Current Science **93**, 357, 2007

75. Geometric phase of a qubit interacting with a squeezed-thermal bath
Banerjee, Subhashish; Srikanth R
European Physical Journal D **46**, 335, 2008

76. Crossover from normal (N) Ohmic subdivision to superconducting (S) equipartition of current in parallel conductors at the N-S transition: Theory
Kumar N
Europhysics Letters **78**, 37001, 2007

77. Shear-flow-induced isotropic-to-nematic transition in a suspension of active filaments
Muhuri S; Rao, Madan; Ramaswamy S*
Europhysics Letters **78**, 48002, 2007

78. Fluctuation-induced chiral symmetry breaking in autocatalytic reaction-diffusion systems
Gayathri VS; Rao, Madan
Europhysics Letters **80**, 28001, 2007

79. Jamming dynamics in grain mixtures: an extended hydrodynamic approach
Sinha, Supurna
Fluctuation and Noise Letters **7**, L163, 2007

80. Dynamics of decoherence without dissipation in a squeezed thermal bath
Banerjee, Subhashish; Ghosh R*
Journal of Physics A **40**, 13735, 2007

81. Electron transport in an open mesoscopic metallic ring
Roy, Dibyendu
Journal of Physics: Condensed Matter **20**, 025206, 2008

82. Heat transport in ordered harmonic lattices
Roy, Dibyendu; Dhar, Abhishek
Journal of Statistical Physics **131**, 535, 2008

83. Active-filament hydrodynamics: instabilities, boundary conditions and rheology
Ramaswamy, Sriram*; Rao, Madan
New Journal of Physics **9**, 423, 2007

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+ denotes Visiting Professors of RRI

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2. Primordial magnetic fields and early structure formation
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3. Can we detect the anisotropic shapes of cosmic HII regions during reionization through the small-scale redshifted 21cm power spectrum
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4. Primordial magnetic fields and formation of molecular hydrogen
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17. Synthesis and characterization of novel rod-disc oligomers
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Liquid Crystals

18. Carbon nanotubes in monomeric and polymeric discotic liquid crystals
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Annexure - III

COLLOQUIA

Name	Title	Date
Subharthi Ray Inter University Centre for Astronomy & Astrophyics Pune	Strange quark stars: From theory to their current standings	9.4.2007
V.V.Sreedhar Chennai Mathematical Institute, Chennai	Quantum information theory `	10.4.2007
Daniel R. Stinebring Oberlin College, Oberlin, USA	Pulsar Scintillation: Probing AU-size structure in the ISM	10.4.2007
Tirthabir Biswas Penn State University, USA	Nonperturbative and nonsingular (?) gravity	13.4.2007
Sudeshna Sinha Institute of Mathematical Sciences, Chennai	Spatiotemporal consequences of random coupling	18.4.2007
Sudeshna Sinha Institute of Mathematical Sciences, Chennai	Exploiting chaos for computation	19.4.2007
Suren Erkman University of Lausanne, Switzerland	The emerging field of industrial ecology: perspectives for research and action	2.5.2007
G.V.Shivashankar National Centre for Biological Sciences, TIFR, Bangalore	Spatial Genomics: How does DNA maximally compact & still do its job?	3.5.2007
David Rideout Imperial College, London, UK	Entropy bound from discrete quantum gravity	7.5.2007

Name	Title	Date
Susmita Chakravorty Inter University Centre for Astronomy & Astrophysics Pune	Warm absorbers in AGN	25.5.2007
Sanjoy Roychowdhury Physics Research Laboratory Ahmedabad	Interferometric analysis of properties including distribution functions of phase singular beams	25.5.2007
Arindam Ghosh Indian Institute of Science, Bangalore	Designing magnetism with electricity in small systems	31.5.2007
Sreeja Sreedharan (VSP seminar)	Dynamic light scattering in liquid crystals	5.6.2007
Shrirang S. Deshingkar Harish-Chandra Research Institute, Allahabad	Can we see naked singularity?	11.6.2007
Ken Baldwin The Australian National University, Canberra	A tale of two heliums: triplet and singlet states for atop optics and precision measurement	14.6.2007
N. Kumar Raman Research Institute	Resistance without resistors: an anomaly	20.6.2007
Keiji Saito University of Tokyo	Landau-Zener transition: How important and how nontrivial	21.6.2007
Shyamal Biswas Indian Institute for Cultivation of Science Kolkata	Temperature dependence of critical number of particles for attracting atomic bose gas	22.6.2007
G.S. Agarwal Oklahama State University Stillwater, OK	Quantum coherence, interferences and entanglement in radiating systems	27.6.2007

Name	Title	Date
Kanan K Datta Indian Institute of Technology, Kharagpur	21 cm signal from the reionization era and its detection	29.6.2007
Luc Blanchet Institut d' Astrophysique de Paris, France	Gravitational polarization and the phenomenology of MOND	2.7.2007
Sujit Sarkar Poornaprajna Institute Bangalore	Quantum phase diagram of super-conducting quantum dots array	3.7.2007
Debasis Sengupta Indian Institute of Science, Bangalore	Rivers, rain, storms and the warm bay of Bengal	5.7.2007
Amitabha Chattopadhyay Centre for Cellular and Molecular Biology Hyderabad	Monitoring organization and dynamics of membranes and proteins using the wavelength-selective fluorescence approach	11.7.2007
Dana S Balser National Radio Astronomy Observatory, USA	Stalking the cosmic 3He abundance	11.7.2007
C.S.Unnikrishnan Tata Institute of Funda- mental Research, Mumbai	Bose-Einstein condensation in an optical dipole trap	19.7.2007
Ramanath Cowsik Washington University St. Louis	Understanding the radiant sun – a quintessential example of the scientific method	23.7.2007
Narendar Pani National Institute of Advanced Studies Bangalore	Gandhi after Ideology	2.8.2007
Varun Raghunathan University of California Los Angeles	Stipulated Raman scattering in silicon: with applications in chip-scale amplifiers, lasers and wavelength converters	7.8.2007

Name	Title	Date
Sriram Ramaswamy Indian Institute of Science, Bangalore	Self-driven systems dead or alive	16.8.2007
T.N. Rengarajan Tata Institute of Fundamental Research, Mumbai	Radio-far infrared correlation in ultra luminous IR galaxies and the role of secondary cosmic ray electrons	17.8.2007
Vincent Rodgers University of Iowa Iowa, USA	Diffeomorphism invariance and dark energy	21.8.2007
A.R.P. Rau Department of Physics & Astronomy, Louisiana State University, USA	Issues of quantum entanglement	22.8.2007
K. Vijay Kumar Department of Physics Indian Institute of Science, Bangalore	Active elastic dimers: self-propulsion and current reversal on a featureless track	28.8.2007
Colin Benjamin Centre de Physique Théorique, CNRS France	Positive Hanbury-Brown and Twiss correlations in superconducting hybrids: Role of interfaces	4.9.2007
Sadiq Rangwala Raman Research Institute	A filtered tale of cold dipolar molecules	6.9.2007
Govind S Krishnaswami Spinoza Institute and Institute for Theoretical Physics, Utrecht University The Netherlands	Scale invariance and naturalness in a 4d O(N) scalar field model	6.9.2007
Shri Kulkarni Caltech, California, USA	Palomar transient factory	11.9.2007
Debashish Chowdhury Indian Institute of Technology, Kanpur	Members of kinesin superfamily: lame, limping biped and regulator	19.9.2007

Name	Title	Date
Debashish Chowdhury Indian Institute of Technology, Kanpur	Molecular machines: packers and movers assemblers and shredders	20.9.2007
Sushanta Dattagupta Indian Institute of Science Education and Research Kolkata	Quantum mechanics of rapidly and periodically driven systems	21.9.2007
R. Nityananda National Centre for Radio Astrophysics, Pune	PCA, SVD, CMB and RFI	24.9.2007
Meenal Gupta Mody Institute of Tech-nology & Science, Rajasthan	Dielectric spectroscopy of a binary mixture showing wide temperature range twisted grain boundary phase with re-entrant cholesteric phase	1.10.2007
Anders Kastberg University of Umea, Sweden	A 3D Brownian Motor – rectification of noise in optical lattices	3.10.2007
Prateek Sharma University of California Berkeley, USA	Transport and heating in low luminosity accretion flows	3.10.2007
Mohan Tambe Innomedia Technologies Private Ltd., Bangalore	Netway: A next generation video internet network for India	4.10.2007
Colin Lonsdale MIT Haystack Observatory USA	Science with the Murchison Widefield Array	5.10.2007
Subrata Chattopadhyay Centre for Development of Advanced Computing Bangalore	The Garuda grid	10.10.2007

Name	Title	Date
M.R.N. Murthy Molecular Biophysics Unit Indian Institute of Science Bangalore	Structure and assembly of viruses	18.10.2007
Kumar S Gupta Institute of Nuclear Physics, Kolkata	Noncommutative gravity and black holes	16.10.2007 Saha
K.N.Shivananda Bangalore University Bangalore	Reactivity study of bisphenol A-based epoxy resins with different curing agents and accelerators	22.10.2007
Kheya Sengupta Centre de Recherche en Matière Condensée et Nanosciences, CNRS, Marseille, France	Unspecific interactions in cell adhesion	31.10.2007
Christopher Reynolds University of Maryland College Park, USA	Constraining black hole spin with X-ray spectroscopy	7.11.2007
Subroto Mukerjee University of California Berkeley, USA	Spinor condensates: Phase transitions, vortex lattices and dynamics	5.12.2007
Abhishek Khunte JRF, Pune University Pune	Microstrip resonator oscillator (Radio Astronomy Meeting)	26.11.2007
Natan Andrei Rutgers University, USA	Quantum impurities out of equilibrium: Currents and entropy productions	6.12.2007
Tamas Borzsonyi Research Institute for Solid State Physics and Optics Hungarian Academy of Sciences, Budapest, Hungary	Interfacial instabilities during solidification: experimental studies and numerical simulations	13.12.2007

Name	Title	Date
Carsten Tschierske Martin-Luther University Halle, Germany	Complex liquid crystalline superstructures by selforganization of polyphilic molecules	14.12.2007
Emily Freeland University of Wisconsin Madison, USA	Bent-double radio sources as probes of the intragroup medium	17.12.2007
Shamik Gupta Dept. of Theoretical Physics Tata Institute of Fundamental Research, Mumbai	Dynamics of driven diffusive systems: finite-size effects	18.12.2007
Andrzej A Zdziarski N.Copernicus Astronomical Center, Poland	The ultracompact binary 4U 1820-30	20.12.2007
Anupam Madhukar University of Southern California, USA	The ubiquitous dipole: a new paradigm for solar energy conversion	24.12.2007
Keiichi Kaneto LSSE, Kyushu Institute of Technology, Kitakyushu Japan	Field effect transistors and the light effects based on composite films of conducting polymers and fullerene derivatives	26.12.2007
Gautam I Menon The Institute of Mathematical Sciences, Chennai	Universality class of the reversible-irreversible transition in sheared suspensions	3.1.2008
P. Viswanath Laboratoire Interdisciplinaire sur l'Organisation Nanomatrique et Supramolaculaire, Saclay, France	Specific ion adsorption and solvent features at the air-electrolyte interface	4.1.2008
Heath Jones Anglo-Australian Observatory, Epping NSW Australia	The 6dF galaxy survey: initial results on large-scale structure and galaxy evolution	4.1.2008

Name	Title	Date
Sandeep Krishna Center for Models of Life, Niels Bohr Institute University of Copenhagen	Oscillation patterns in negative feedback loops	8.1.2008
Mamoru Doi Institute of Astronomy University of Tokyo, Japan	Supernova observations for dark energy	10.1.2008
Debashish Chaudhuri Max Planck Institute for the Physics of Complex Systems, Nőthnitzer Strasse, Dresden Germany	Fasciculation dynamics of sensory neurons	22.1.2008
Chinmay Das Department of Physics and Astronomy, University of Leeds, UK	Nano-scale mechanical probing of supported lipid bilayer with atomic force microscopy	22.1.2008
P. Ajith Max Planck Institute for Gravitational Physics (Albert Einstein Institute) Hannover, Germany	A template bank for gravitational waveforms from coalescing black holes	23.1.2008
A. Gopakumar Theoretisch-Physikalisches Institut Friedrich-Schiller-Universitat, Jena, Germany	TaylorET GW templates and the SAPE	25.1.2008
S. Bunker Roy Barefoot College, Tilonia Rajasthan	Demystifying professionalism: the Gandhian approach – Gandhi Memorial Lecture	30.1.2008
Leonid Levitov Massachusetts Institute of Technology, Cambridge, USA	Dirac fermions and atomic collapse in grapheme	4.2.2008

Name	Title	Date
Crew of Aldebaran	Sailing around the world: every child's Dream – Special Lecture	6.2.2008
Ajay Patwardhan University of Mumbai, Mumbai	Some alternatives in cosmological models	18.2.2008
Govind Swarup National Centre for Radio Astronomy, Tata Institute of Fundamental Research, Pune	On the detection of the lunar Cerenkov emission by the UHE cosmic rays and neutrinos using the GMRT and the ORT	4.3.2008
Raja Paul Dept. of Neurobiology, Physiology and Behavior University of California, USA	Mechanical regulation of cell contractility and spontaneous cell patterning	4.3.2008
Harvinder Kaur Jassal Harish Chandra Research Institute, Allahabad	Dark energy: observational and theoretical aspect	3.3.2008
D. Balasubramanian Hyderabad Eye Research Foundation, L.V.Prasad Institute, Hyderabad	Diamond Jubilee Colloquium**:** Helping them see: application of biology and sociology	7.3.2008
Irana Pushkina Spinoza Institute Utrech University The Netherlands	Quantum systems of gravity and matter from casual dynamical triangulations	10.3.2008
Jozef Gruska Masaryk University Czech Republic	Quantum complexity theory and implications for (quantum) physics	14.3.2008
Navinder Singh Institute of Physics Bhubaneswar	Onsager-machlup theory and work fluctuation theorem for a harmonically driven Brownanian particle	14.3.2008

Name	Title	Date
Dipak Munshi Institute of Astronomy Cambridge, UK	Probing the dark side of the universe: cosmology with weak lensing surveys	24.3.2008
Shri Kulkarni California Institute of Technology, Pasadena USA	The space interferometer mission planetquest	25.3.2008

Annexure IV

JOURNAL CLUB

Discussed by	Paper discussed	Date
Raghunathan A.	Focusing beyond the diffraction limit Geoffroy Lerosey *et al.*, *Science*, **315**, 1120 (23 February 2007)	12.4.2007
Ravi Subrahmanyan	The WSRT Virgo filament survey A. Popping and R. Braun *astro-ph*/0703670	12.4.2007
C.R.Subrahmanya	Time and frequency distribution using satellites J. Levine *Rep. Prog. Phys.*, **65**, (2002)	26.4.2007
Tarun Deep Saini	Pros and cons of Bayesian model selection Eric V. Linder and Ramon Miquel, astro-ph/0702542 Andrew R. Liddle *et al.*, astro-ph/0703285	26.4.2007
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List of Abbreviations:

AGN – Active Galactic Nucleus
ANU – Australian National University
ARIES – Aryabhatta Research Institute of Observational Sciences
ASTROSAT - ISRO's Astronomical Satellite
AXP – Anomalous X-ray Pulsar
ATCA – Australia Telescope Compact Array
ESO-NTT- European Southern Observatory-New Technology Telescope
GMRT - Giant Meterwave Radio Telescope
HCT – Himalayan Chandra Telescope
HERA - HEterodyne Receiver Array
H_I - Atomic Hydrogen
H_{II} - Ionized Hydrogen
IAP - Institut d Astrophysique de Paris, France
IGBTs - Integrated-gate bipolar transistors
IGM – Inter Galactic Medium
ISM – Inter Stellar Medium
IRAM – Institut de Radioastronomie Millimetrique
ISRO – Indian Space Research Organisation
IUCAA – Inter University Centre for Astronomy & Astrophysics, Pune
LNA – Low Noise Amplifier
LNBCs - Low-noise block converters
MHD – Magneto Hydro Dynamics
MPIFR - Max Planck Institute for Radio Astronomy
MST – Mesosphere Stratosphere Troposphere Radar Facility, Tirupati
NGC – New General Catalogue
NCRA – National Centre for Radio Astrophysics
OH - Hydroxyl Radical
ORT – Ooty Radio Telescope
PKS - Parkes
PWM – PWM Pulse-width modulation drive
QPOs - Quasi-Periodic Oscillations (QPOs)
RAC – Radio Astronomy Centre, Ooty
r.m.s. – root mean square
RXTE-PCA – Rossi X-ray Timing Explorer-Proportional Counter Array
SGR – Sub-gamma ray repeater
STScI – Space Telescope Science Institute, USA
TIFR – Tata Institute of Fundamental Research, India
UGC - Uppsala General Catalogue
VSP – Visiting Students Programme
VLA – Very Large Array, USA
VLBI - Very Long Baseline Interferometry
W-Band - (80-115 GHz)